Code changes affecting Short-Circuit Current Ratings based on the 2017 NEC®
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The reader is expressly warned to consider and adopt all safety precautions that might be indicated by the activities described herein and to avoid all potential hazards. By following directions in this publication, the reader willingly assumes all risks in connection with such directions.

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Please refer to the NFPA 70 2017 NEC for complete information on the sections referenced in this publication.

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This publication conveys information related to each of the Code changes it contains as of August, 2016, but does not reflect any subsequent appeal or action taken by the NFPA Standards Council.

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**Overview**

**Scope**

The scope of this publication is limited to the most significant chapters, articles and parts of the 2017 NEC dealing with available short-circuit current and Short-Circuit Current Ratings (SCCRs).

**The introduction**

To provide the reader a frame of reference, the introduction is an in-depth review of this subject covering:

- Why SCCR is important.
- The hazards posed by insufficient SCCR.
- What a Short-Circuit Current Rating is.
- How to comply with NEC SCCR requirements.
- The Occupational Safety and Health Administration's standing on SCCR.
- How equipment SCCR markings are determined.
- Compliance with 110.10.
- The various articles with SCCR requirements relating to 110.10.
- Equipment types requiring SCCR markings, requirements for field marking or documentation of available short-circuit current and specific restrictions on installations.
- Practical considerations for SCCR compliance.

**Significant Code changes**

The NEC sections are identified at the top of each page specifying exactly where in the NEC they are to be found.

Next, this publication covers the significant sections of the 2017 NEC changes dealing with SCCR (revisions to existing sections or the addition of new sections).

They are presented in their order of appearance in the NEC.

Each code section is noted as being a “REVISION” or “NEW” followed by an explanation on its significance, related NEC sections, what to look for to determine if there is Code compliance, and, if appropriate, a more detailed explanation of agency standards or equipment markings that impact short-circuit current ratings.

**Annexes**

Following the Code changes are annexes containing associated information, resources and products available from Eaton’s Bussmann Division that help equipment designers, Authorities Having Jurisdiction (AHJs) and others involved in the specification, design, installation and approval of equipment subject to the 2017 NEC SCCR requirements covered in this handbook.

These resources are available online at no cost* and are provided to help advance electrical safety and Code compliance.

* Bussmann series OSCAR™ 2.1 Online Compliance Software is available as a 7-day free trial or a yearly subscription. See OSCAR 2.1 for details.

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**NFPA Codes and Standards**

Eaton’s Bussmann Division recommends referencing the 2017 NEC for complete and detailed code requirements.

All NFPA Codes and standards are available online in a read-only format (not available to print or search). To view the read-only version of the Codes and standards, perform the following:

- Go to www.nfpa.org.
- In the header, roll over “CODES & STANDARDS.”
- Click “List of NFPA codes and standards.”

- Scroll down and click on “NFPA 70.”

- Click on “Free access to the 2017 edition of NFPA 70.”
- To buy the 2017 NEC, click on the “BUY THIS EDITION” link.

- This will bring up a page where you may specify the desired formats and transact your purchase.

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What are the hazards of insufficient SCCR?

The hazards are external to the equipment enclosure since equipment SCCR testing and evaluation criteria for product standards is most often performed with the enclosure doors closed and latched, and the fault occurring external to the enclosure. Installing electrical equipment where its SCCR is less than the available short-circuit current creates serious safety hazards. These may include:

- **Shock:** The enclosure becomes energized from conductors pulling out of their terminations or device destruction occurring within the enclosure.
- **Fire:** The explosive power of the internal devices failing causes the closed and latched door to become ajar and spew flame and molten metal to the exterior. This is a fire hazard to both the facility and personnel.
- **Projectile (shrapnel):** The enclosure door may blow open or off with fire and failing device debris (shrapnel) shooting out. In laboratory tests, equipment SCCR failures have resulted in enclosure doors explosively blowing off and flying up to 100 feet away. Additionally, the shrapnel, from the rapid failure of internal devices, can be ejected at speeds up to 700 miles per hour.

Inadequate SCCR demonstration

![Before](image1.png) ![During](image2.png) ![After](image3.png)

Scan this QR code to see an actual equipment SCCR test and the consequences of having an equipment SCCR that is too low.

**Note:** Even if electrical equipment is installed with the proper SCCR, there may remain shock, arc flash, and arc blast hazards for workers performing work on energized equipment with the enclosure door open.

**What is Short-Circuit Current Rating?**

The NEC Article 100 defines SCCR as:

- **Short-Circuit Current Rating.** The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptable criteria.

SCCR may be an attribute of a single electrical device, such as a contactor, or of an electrical apparatus which has multiple devices in an enclosure, such as an industrial control panel. An OCPD that is specified to help an apparatus or device achieve an SCCR may either be integral to the apparatus, such as the main OCPD for an industrial control panel, or it may be on the lineside of the apparatus, physically separate, as in Figure 1B.

SCCR is very different from the interrupting rating of an overcurrent protective device (OCPD) which is defined by the NEC in Article 100 as:

- **Interrupting Rating.** The highest current at rated voltage that a device is identified to interrupt under standard test conditions.

The interrupting rating of a circuit breaker or fuse is an overcurrent protective device (OCPD) self-protection rating. This rating by itself does not ensure loadside electrical equipment will be provided with adequate short-circuit current protection.

The general NEC equipment short-circuit current protection requirement is in 110.10:

110.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics. The overcurrent protective devices, the total impedance, the equipment short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without extensive damage to the electrical equipment of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the equipment grounding conductor(s) permitted in 250.118. Listed equipment applied in accordance with their listing shall be considered to meet the requirements of this section.

110.10 is in Chapter 1 General, and it applies to all electrical installations unless supplemented or modified in Chapters 1 through 7 (see NEC 90.3). This fundamental NEC requirement exists to ensure electrical equipment is provided with protection under short-circuit current conditions.

Compliance with equipment short-circuit current protection (110.10) is an analysis much different than compliance with overcurrent protective device interrupting ratings (110.9). 110.10 requires all electrical equipment be provided with adequate short-circuit current protection.

The intent of 110.10 is that the equipment and OCPDs must be “selected and coordinated” so that under fault conditions up to the available short-circuit current value, the equipment will not sustain extensive damage. It is the ability of the equipment to withstand a certain magnitude of short-circuit current at a specific voltage in conjunction with an OCPD(s) without becoming a shock, fire, or projectile hazard external to its enclosure.
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Figure 1A. Main overcurrent protective device is a part of the equipment.

Figure 1B. Overcurrent protective device is not part of the equipment and located on the lineside.

Depending on the equipment type, there may be various means for determining whether equipment is provided adequate short-circuit protection in accordance with 110.10. These include:

- **Analysis methods.** There are analysis methods for some types of devices and apparatus. An example for industrial control panels is the analysis method in UL 508A Industrial Control Panel product standard, Supplement SB.

- **Short-circuit current testing in a high power laboratory.** Most products that are marked with an SCCR and are listed to a UL product standard utilize this method in conjunction with criteria to evaluate acceptable damage.

- **Device default short-circuit current ratings.** In some cases, for lower magnitude SCCRs, a product is assumed to have a default SCCR. For instance, UL 508A Industrial Control Panel product standard, Supplement SB, Table SB4.1 has default SCCR values for various devices.

NEC 110.10 does not require equipment to be marked with its SCCR. However, there are several NEC requirements for various equipment types that do require SCCR marking. These other NEC requirements complement the 110.10 requirement. Requiring equipment to be marked with its SCCR greatly simplifies the equipment short-circuit current protection compliance process. To comply, the equipment SCCR simply must be equal to or greater than the available short-circuit current.

In addition to the NEC, Underwriters Laboratories (UL®) product standards have safety evaluation criteria and SCCR marking requirements for much of the equipment used in low voltage electrical systems. The safety evaluation criteria concerns shock, fire, and projectile hazards external to the enclosure. The testing procedures typically require the enclosure doors to be closed and latched and they must remain closed and not become deformed, nor allow fire, molten melt, or projectiles to escape the enclosure during the test. Within the enclosure, some degree of damage to devices is normally permitted; devices may need to be repaired or replaced.

Marked SCCR

With listed equipment, compliance with 110.10 corresponds to the meaning of its last sentence “...Listed equipment applied in accordance with their listing shall be considered to meet the requirements of this section.” If the equipment is listed to a product standard that requires its SCCR to be marked, and if the installation complies with the equipment SCCR marking, then the installation complies with 110.10.

Additionally, 110.3(B) requires the equipment to be installed in accordance with instructions included in the listing or labeling.

This means, that for both 110.10 and 110.3(B), the marked equipment SCCR in amps must be equal to or greater than the available short-circuit current along with SCCR voltage equal to or greater than the nominal system voltage.

In addition, if the equipment SCCR is conditional on a specific OCPD amp rating or specific type OCPD, the proper overcurrent protective device must be used. It is common that some electrical equipment types may have multiple SCCRs that are conditional. The conditions are typically based on the OCPD(s) and magnitude of SCCR in amps. See Figure 2 which is a power distribution block label that shows several different conditional SCCRs.

![Figure 2. SCCR varies and depends upon the upstream overcurrent protective device type, amp rating and conductor size.](image)

In Figure 2, this PDB has a default SCCR of 10 kA per UL 508A SB4 Table SB4.1. However, it has also been combination tested and UL Listed with higher SCCRs when in combination with specific current-limiting fuse types and maximum amp ratings. For example, the label is marked with a 200 kA SCCR when protected by 400 A or less Class J fuses and the conductors on the lineside and loadside are in the range of 2 to 6 AWG.

When apparatus are SCCR marked, there are two types of markings:

1. The main OCPD is part of the equipment (see Figure 1A). In this case, the equipment manufacturer includes the OCPD in the equipment and the SCCR marking states the SCCR rms symmetrical amperage and voltage.

2. The equipment does not have a main OCPD and it relies on a field installed OCPD device on the lineside (see Figure 1B). In this case, the SCCR marking states the SCCR rms symmetrical amperage, voltage, and required OCPD type, and amp rating (often stated as a maximum). For example, the SCCR marking may state “100 kA rms symmetrical, 480 V, and maximum 400 A Class J fuse.” This requires 400 amp or less Class J fuses to be field installed on the equipment’s lineside in order to comply with the SCCR marking.

Note: When the NEC requires an SCCR marking and the equipment is not listed to a product standard, the manufacturer may be able to use an industry method to determine its SCCR. One way to establish the SCCR is to have the equipment tested in a laboratory. For industrial control panels, UL 508A Industrial Control Panel product standard in Supplemental SB Short-Circuit Current Ratings for Industrial Control Panels, is an industry analysis method.
Complying with 110.10 is relatively simple

1. **Determine the available short-circuit currents.**
   Take into account future electrical system changes or equipment moves that may result in higher available short-circuit currents. Moving equipment within a facility or to another facility may result in the inability to install the equipment because the SCCR is inadequate for the new location’s available short-circuit current.

2. **When specifying and ordering electrical equipment, communicate the required SCCR levels.**
   Equipment builders should require the purchaser to specify the minimum acceptable SCCR level for each piece of equipment. Those who specify or order equipment need to know the available short-circuit currents at the planned installation sites and must communicate to the equipment builders the required minimum SCCR for each piece of equipment. Equipment with SCCRs that exceed the available short-circuit current is recommended as a safety factor, while providing flexibility for system changes and equipment moves. However, equipment SCCR that is not at least equal to the available short-circuit current is a safety hazard and a Code and OSHA violation.

3. **Do not install equipment if its SCCR is not equal to or greater than the available short-circuit current.**
   The installer should not install equipment with an SCCR lower than the available short-circuit current. Free tools exist that make it easy to calculate available short-circuit currents when an available short-circuit current is not marked at the equipment’s location. This is similar to working with enclosures; an installer would not install a Type 1 enclosure outdoors where a Type 3R is required.

4. **Before energizing any equipment, the Authority Having Jurisdiction (AHJ) should verify the equipment SCCR is equal to or greater than the available short-circuit current.**
   The AHJ must ensure the equipment has an SCCR equal to or greater than the available short-circuit current. See the information note for the definition of Authority Having Jurisdiction in NEC Article 100.

The NEC emphasis on proper installation for equipment SCCR

There are several requirements within the NEC that complement the general 110.10 equipment short-circuit current protection requirement. Most of these complementary requirements pertain to specific types of apparatus that have multiple devices within an enclosure and simplify the compliance process.

Table 1 shows some of these requirements in three groupings.

From design to energizing, each industry discipline in the process has its own responsibility for ensuring compliance to equipment short-circuit current protection. Unfortunately, too often equipment is being ordered, installed, and energized with an inadequate SCCR. To help prevent this from occurring, the AHJs, who are responsible for verifying compliance to a safe installation, need tools and procedures to simplify enforcement of NEC SCCR requirements.

The NEC requirements in Tables 1 and 2 help simplify and improve the process for the AHJ. During the development of the 2017 NEC SCCR changes, the Public Inputs and Committee Statement substantiations mention that these requirements are intended to make it simpler and easier for the inspectors/AHJs to ensure compliance.

- **First Revision No. 3002** (what eventually became 409.22(B) in the Second Revision): “This change provides much needed information to aid the electrical inspector when enforcing 409.22. It will help the inspector ensure that the industrial control panel is installed within its short-circuit current rating.”
- **First Revision No. 3006** (440.10): “Inspectors are having an extremely difficult time enforcing proper short-circuit current ratings of HVACR equipment because there is typically no information on the job site as to the available fault current at the HVACR equipment.

If documentation of the available fault current were provided to the electrical inspector, it would be much easier for the inspector to assure that the equipment was being properly protected. This change provides that fault current information to the AHJ.”

- **First Revision No. 3016** (430.99): “If documentation of the available short-circuit current were provided to the electrical inspector, it would be much easier for the inspector to assure that the equipment was being properly protected.”

Table 1. NEC SCCR requirements that complement 110.101

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<td>Equipment transfer switches for emergency systems</td>
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</table>

1 This is a high level summary. Reference the 2017 NEC for complete requirements and exceptions.
2 440.4(B) revised to eliminate the SCCR marking exemption for 60 amp or less equipment.
3 Requires field marking SCCR on the transfer equipment’s enclosure exterior. See detailed discussion for each requirement in this publication.
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For expanded information and in-depth discussion on SCCR as well as resources and products that help achieve high equipment SCCRs, see the following annexes in the back of this publication.

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1. This is a high level summary. Reference the 2017 NEC for complete requirements and exceptions.
2. The 430.130(A)(4) requirement pertains to listed adjustable speed drives. UL 508C and UL 61800-5-1 require when high speed fuses or MCPs are used in lieu of branch circuit overcurrent protective devices, the adjustable speed drive must be marked with the specific fuse manufacturer and its high speed fuse model number or MCP manufacturer and its MCP model number. For more information on this requirement, see the in-depth discussion under 430.130(A) in this publication.
3. 440.4(B) has been revised to eliminate the SCCR marking exemption for 60 amp or less equipment.
4. These sections require field marking SCCR on the transfer equipment’s enclosure exterior. See detailed discussion for each requirement in this publication.

More information

Table 2. NEC requirements (2017 NEC change in red italic text)¹

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<th>Mark SCCR</th>
<th>Available short-circuit current variances</th>
<th>SCCR must be greater than available short-circuit current</th>
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<tr>
<td></td>
<td>- UL product standard SCCR marking required</td>
<td>- Field mark and/or document/date calculation of available short-circuit current</td>
<td>- Not permitted to install equipment if SCCR is less than the available short-circuit current</td>
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<td></td>
<td>- OEM responsibility unless noted as field marked</td>
<td>- Make available to inspector (AHJ)</td>
<td>- Essentially 110.10 and 110.3(B) requirement</td>
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<td>- 620.16(B)</td>
<td>- 620.16(B)</td>
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<td>- UL 508A</td>
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<td>- NFPA 79</td>
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<td>- 670.5(1)</td>
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<td>- UL 508A</td>
<td>- Document</td>
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<tr>
<td>Transfer equipment in emergency systems</td>
<td>- 700.5(E)</td>
<td>- 700.5(E)</td>
<td>- 110.10</td>
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<td></td>
<td>- Field mark²</td>
<td>- Field mark²</td>
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<td></td>
<td>- UL 1006</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Transfer equipment in legally required standby systems</td>
<td>- 701.5(D)</td>
<td>- 701.5(D)</td>
<td>- 110.10</td>
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<td></td>
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<td>- Field mark²</td>
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<td>- UL 1006</td>
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<td>-</td>
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<tr>
<td>Transfer equipment in optional standby systems</td>
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<td>- 702.5</td>
<td>- 110.10</td>
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<td>- UL 67</td>
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<td>- UL 98</td>
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<td>Transfer equipment in critical operations power systems</td>
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<tr>
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<td>- UL 1006</td>
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</tbody>
</table>

¹ This is a high level summary. Reference the 2017 NEC for complete requirements and exceptions.
² The 430.130(A)(4) requirement pertains to listed adjustable speed drives. UL 508C and UL 61800-5-1 require when high speed fuses or MCPs are used in lieu of branch circuit overcurrent protective devices, the adjustable speed drive must be marked with the specific fuse manufacturer and its high speed fuse model number or MCP manufacturer and its MCP model number. For more information on this requirement, see the in-depth discussion under 430.130(A) in this publication.
³ 440.4(B) has been revised to eliminate the SCCR marking exemption for 60 amp or less equipment.
⁴ These sections require field marking SCCR on the transfer equipment’s enclosure exterior. See detailed discussion for each requirement in this publication.
Significance of the change

This change requires documentation for the maximum available short-circuit current calculation be available to those authorized to design, install, inspect, maintain or operate the system.

Section 110.24(B) continues to require service equipment to be field marked with the available short-circuit current along with the date the calculation was performed. This does not apply to dwelling units and some industrial installations. 110.24(B) requires the marking to be updated whenever system modifications are made that result in changes to the available short-circuit current.

The intent of this marking is to:

1. Help ensure that the service equipment is purchased and installed with short-circuit current rating (SCCR) and overcurrent protective device (OCPD) interrupting ratings equal to or greater than the available short-circuit current.
2. This information simplifies the process for the AHJ to verify compliance with OCPD interrupting ratings (110.9) and electrical equipment SCCR (110.10).

Methods to simplify compliance

The available short-circuit current can be conservatively calculated using infinite available short-circuit current on the service transformer primary or omitting the service conductor impedance.

A common cause for an increase in available short-circuit current is the utility changing the service transformer. If the transformer has a larger kVA rating and/or lower percentage impedance, the available short-circuit current can significantly increase.

Typically, the service equipment SCCR is primarily dependent upon the overcurrent protective devices’ interrupting ratings.

Circuit breaker interrupting ratings vary, based upon the applied voltage, and range from 5 kA to 200 kA.

Current-limiting fuses commonly have interrupting ratings of 200 kA or 300 kA.

By using OCPDs with a high interrupting rating — whether fuses or circuit breakers — facility owners may not get surprised with a safety issue if the utility replaces the service transformer and the available short-circuit current substantially increases.

Related NEC sections

- 110.9
- 110.10
- 240.86

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.
Chapter 4 Equipment for General Use
Article 409 Industrial Control Panels
Part II. Installation
409.22 Short-Circuit Current Rating

Significance of the change
The 2014 NEC 409.22 text was moved to 409.22(A) Installation along with changing the term “available fault current” to “available short-circuit current.”

409.22(B) Documentation is entirely new. It stipulates any panel required to be marked with its SCCR in accordance with 409.110(4) must also have the available short-circuit current calculated and documented, along with the date it was calculated, and made available to those authorized to inspect the installation.

409.22 does not apply to industrial control panels that contain only control circuit components (not having power circuits) per 409.110(4).

These three requirements work together to make it easier for inspectors to ensure a safer installation:

- 409.110(4) did not change from the 2014 NEC. It still requires the panel builder to mark the equipment short-circuit current rating and it must be “plainly visible after installation.”
- If the industrial control panel is to be marked with its SCCR, then 409.22(B) now requires the available short-circuit current to be determined. This calculation and the date it was performed must be made available to the inspector or Authority Having Jurisdiction (AHJ).
- 409.22(A) makes it clear that an industrial control panel cannot be installed when its marked short-circuit current rating is less than the available short-circuit current.

In some cases, a designated government inspector may not be involved in an industrial control panel (ICP) installation, such as when an ICP is:

- Installed after the final building inspection.
- Moved within an existing facility or moved to another existing facility.
- An integral part of business process equipment that gets bought or moved after the final government inspection.

Regardless, someone, such as the property owner or his designated representative, is the AHJ with responsibility for verifying the electrical installation complies with the NEC (see NEC Article 100 definition for AHJ including the Informational Note). This includes ensuring an industrial control panel is only installed if its SCCR is equal to or greater than the available short-circuit current.

Related NEC sections
- 110.10
- 409.110(4)

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

What to look for:
- Available short-circuit current and documentation supporting the calculation being provided.
- Industrial control panel SCCR marked on equipment by manufacturer.
- SCCR equal to or greater than the available short-circuit current.

Manufacturer's nameplate with equipment SCCR marking appears on the enclosure’s interior.

Documentation for the available short-circuit current and the date it was performed is available to the inspector.
Significance of the addition

The new NEC section 430.99 requires:

- Calculating the available short-circuit current where a motor control center (MCC) is to be installed.
- The documentation of the available short-circuit current and the date it was calculated must be made available to the inspector or Authority Having Jurisdiction (AHJ).

This new section works in conjunction with the already existing 430.98 that requires an MCC to be marked with its short-circuit current rating. Now, with 430.98 and 430.99 in place, it will be relatively easy for the inspector to determine if an MCC installation is compliant by comparing the MCC SCCR to the available short-circuit current.

Related NEC sections

- 110.10
- 430.98

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

What to look for:

- Available short-circuit current and documentation supporting the calculation being provided to inspector.
- SCCR marked by motor control center manufacturer.
- SCCR equal to or greater than the available short-circuit current.
Significance of the change

This Code change is for listed adjustable speed drive short-circuit current ratings (SCCRs). The applicable UL product standards UL 508C Standard for Power Conversion Equipment and UL 61800-5-1 Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy already have this requirement. The Protecting power electronics devices requires extra consideration discussion on this page and Annex 3 provide greater insight into a significant transition occurring for adjustable speed drive SCCR protection.

• This Code change: Where the manufacturer’s instructions for their listed power electronic conversion equipment permits semiconductor fuses or instantaneous trip circuit breakers for use as the branch circuit short-circuit and ground fault protective device, they must be integrated in the same assembly.

• Semiconductor fuses are also commonly referred to as high speed fuses and instantaneous trip circuit breakers are commonly referred to as motor circuit protectors or MCPs.

• In addition, when semiconductor fuses or MCPs are used, UL 508C and UL 61800-5-1 require the drives to be marked with the specific fuse manufacturer and fuse model number or MCP manufacturer and MCP model number, plus the marking must state these protective devices must be integrated in the same assembly with the adjustable speed drive controller.

• These extra precautions are necessary since the MCPs and most semiconductor fuses are not branch circuit overcurrent protective devices as defined in Article 100. These application-limited devices are permitted in the NEC to be applied, with restrictions, for this application: see 430.52(C)(3), 430.52(C)(5), and 430.130(A)(4). They are recognized products which require the drive manufacturer to evaluate these specific devices for the specific application.

• Most adjustable speed drives are listed with specific OCPD types. For safety and compliance to 110.3(B), the adjustable speed drive manufacturer’s markings and instructions concerning the specific OCPD and corresponding SCCR must be followed.

Protecting power electronic conversion equipment requires extra considerations

The adjustable speed drive product standard is transitioning from UL 508C to UL 61800-5-1 and will result in more stringent short-circuit current testing for enhanced safety. The use of more current-limiting OCPDs and high speed fuses are expected to become more prevalent.

Adjustable speed drives present different short-circuit and ground fault protection challenges compared to the traditional electromechanical motor circuit devices. Typically, adjustable speed drives with Insulated Gate Bipolar Transistors (IGBTs) will shut down quickly for external faults on the adjustable speed drive output. However, drives listed to UL 508C may not have been evaluated for internal faults. The internal fault damage can be catastrophic and result in extensive damage to the drive and adjacent circuits and devices. In some cases, high speed fuses are the only type of OCPDs that provide the high degree of current-limitation necessary for drive internal fault protection. Superior current-limiting protection may minimize drive damage as well as collateral damage to adjacent circuits.

A specific adjustable speed drive model number may have multiple SCCR condition on the OCPD type and corresponding SCCR level achieved in the product standard testing evaluation, e.g., a drive may have two SCCR: 5 kA for an OCPD complying with 430.52, and 100 kA when protected by a manufacturer’s specific high speed fuse model number. In some cases, an adjustable speed drive may be listed with only one permissible specific OCPD and corresponding SCCR. This information will be marked on the drive and/or noted in the installation instructions.

UL 508C is being phased out as the industry transitions to the new UL 61800-5-1 standard. These product standards pertain to open or enclosed power electronic conversion equipment that supply power to control a motor, or motors, operating at a frequency or voltage different than that of the input supply. One of the benefits is a significant improvement for adjustable speed drive short-circuit current protection.

Continued on the next page.
Changing UL Standards

Effective February, 2016, any new adjustable speed drive design must be evaluated to UL 61800-5-1. Effective February, 2020, all adjustable speed drives are required to be evaluated to UL 61800-5-1 and UL 508C will be withdrawn. Table 4 details three important differences affecting adjustable speed drive overcurrent protection as a result of this change.

Table 4: Change in UL Standards

<table>
<thead>
<tr>
<th>Phasing out UL 508C</th>
<th>Effective February 2020 UL 61800-5-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor output of the drive short-circuit tested.</td>
<td>All drive outputs short-circuit tested.</td>
</tr>
<tr>
<td>No specific requirements for the short-circuit testing of adjustable speed drive internal components (breakdown of components testing).</td>
<td>Internal adjustable speed drive components must be tested for both standard and high fault currents based on manufacturer’s short-circuit current rating; unless analysis shows a different value is more severe.</td>
</tr>
<tr>
<td>Testing with cotton not required during short-circuit and breakdown of components testing with circuit breakers.</td>
<td>Cotton indicator is required for all short-circuit and breakdown of components tests when testing with circuit breakers.</td>
</tr>
</tbody>
</table>

Providing adjustable speed drives with adequate short-circuit protection can be a challenge. Adjustable speed drives listed to UL 61800-5-1 will include the additional (not required in 508C) short-circuit current testing and evaluation criteria for internal drive component failure (breakdown of components).

Without proper overcurrent protection, internal adjustable speed drive components, such as the power electronic devices and capacitors, can fail resulting in short-circuit current damage that may be catastrophic. Extensive damage could occur to the various drive elements and collateral damage could occur as well to adjacent devices and circuits.

UL 61800-5-1 requires testing to simulate internal drive component failures, therefore, the damage to other drive elements or collateral damage to other adjacent circuits will be greatly reduced or contained.

The drive manufacturers are transitioning to the new standard. To meet the requirements for short-circuit and breakdown of components testing, damage to internal drive components must be either contained (by physical means such as more rugged enclosure) or reduced through the use of current-limiting OCPDs. In many cases, traditional branch circuit breakers and some less current-limiting fuses may not be able to provide adequate protection. This may lead to the use of very current-limiting OCPDs with the semiconductor (high speed) fuses being the most current-limiting. The protection requirements can vary based on the horsepower range and typical adjustable speed drive designs in those ranges.

Significance of the change

This code change concerns multi-motor and combination-load hermetic refrigeration equipment rated 60 amps or less.

- Previous editions of the NEC exempted this equipment’s nameplate from being marked with their short-circuit current rating (SCCR). This exception has been removed.
- Now, this type of equipment must have its short-circuit current rating marked on its nameplate, the same as all other HVAC equipment in 440.4(B).

Marking the nameplate with the short-circuit current rating as required by 440.4(B) ties in with 440.10(A) and 440.10(B).

Significance of the addition

With a few exceptions, 440.4(B) already requires that air conditioning and refrigeration, multi-motor and combination-load equipment be marked with their SCCR.

If the equipment is required to be marked with an SCCR, now:

- New 440.10(B) — the available short-circuit current must be calculated, documented and made available to the inspector along with the date the calculation was made.
- New 440.10(A) — the equipment shall not be installed if its SCCR is not equal to or greater than the available short-circuit current (see Figure 3).

The specifications provided to the HVAC original equipment manufacturer need to include the minimum required SCCR.

If consulting engineers are involved, coordination between the electrical and mechanical engineering departments should be made so that the specified minimum acceptable equipment SCCR is greater than the available short-circuit current.

Summary of Short-Circuit Current Study for Ernest Operations, Inc.,
January, 23, 2017

By Fred Byrd

The calculations are on the pages following this summary table.

<table>
<thead>
<tr>
<th>Equipment Designation</th>
<th>Available Short-Circuit Current (amps rms sym.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Equipment</td>
<td>45,340</td>
</tr>
<tr>
<td>Motor Control Center 1</td>
<td>30,600</td>
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<tr>
<td>Motor Control Center 2</td>
<td>26,780</td>
</tr>
<tr>
<td>Distribution Panel - North</td>
<td>15,345</td>
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<tr>
<td>Distribution Panel - South</td>
<td>36,070</td>
</tr>
<tr>
<td>Industrial Control Panel 1</td>
<td>16,290</td>
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<tr>
<td>HVAC Rooftop — North</td>
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<tr>
<td>HVAC Rooftop — South</td>
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<td>Panelboard 1</td>
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<tr>
<td>Panelboard 3</td>
<td>15,050</td>
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<tr>
<td>Panelboard 4</td>
<td>36,745</td>
</tr>
</tbody>
</table>

Figure 3. This report documents the available short-circuit current for HVAC — North. The SCCR must be equal to or greater than the available short-circuit current.

What to look for:

- All hermetic refrigerant motor-compressors and equipment subject to 440.4(B) is manufacturer nameplate marked with their SCCR, including equipment rated less than 60 amps.
- Available short-circuit current and documentation is provided to inspector.
- Do not install nor approve equipment installation if the SCCR is less than the available short-circuit current.
Chapter 6 Special Equipment
Article 620 Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts

Part II. Conductors
620.16 Short-Circuit Current Rating

Part VI. Disconnecting Means and Control
620.51 Disconnecting Means
620.51(D)(2) Available Short-Circuit Current Field Marking

Significance of the additions
These new requirements make it easier for inspectors to verify elevator control panels have sufficient equipment SCCR for the available short-circuit current.

- 620.16(A) - manufacturers must mark their elevator control panels with an equipment short-circuit current rating (SCCR). The SCCR can be based on an assembly product standard listing and labeling, or an approved analysis method, such as UL 508A, Supplement SB.

- 620.51(D) - An elevator control panel must now be field marked with the maximum available short-circuit current along with the date the calculation was made.

- 620.16(B) - if the SCCR of an elevator control panel is not equal to or greater than the available short-circuit current, the elevator control panel must not be installed.

- With the marked SCCR and marked available short-circuit current on the elevator control panel, an inspector can easily check for compliance.

The person responsible for the specifications or for ordering the elevator controls needs to communicate the minimum elevator control panel SCCR level that is required for a specific installation to the equipment supplier. This requires knowing the available short-circuit current. Elevator control suppliers should require customers to provide the minimum SCCR level as necessary in their specification data.

If there is a change to the available short-circuit current, then 620.51(D)(2) requires revising the field marking. Then the equipment SCCR must be verified that it is not less than this revised available short-circuit current.

Changes to the electrical distribution system can increase the available short-circuit current when a larger kVA or lower percent impedance transformer is installed, or premise wiring changes occur.

Related NEC sections
- 110.10

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

Elevator control panel has a manufacturer’s nameplate SCCR of 10 kA and is field marked with available short-circuit current 9055 A.

Photo courtesy of MCE.

What to look for:
- The elevator control panel’s manufacturer nameplate is marked with its SCCR.
- The control panel is field marked with the available short-circuit current and documentation supporting the calculation is available.
- If the control panel’s SCCR is equal to or greater than the marked available short-circuit current.
Significance of the addition

This new requirement 670.5(2) is related to 670.3(A)(4) and 670.5(1).

- The existing 670.3(A)(4) requires the industrial machinery nameplate to be marked with the equipment short-circuit current rating (SCCR). This nameplate must be plainly visible on the control panel enclosure or machine.
- The new 670.5(2) requires field marking the available short-circuit current and the date the calculation was made. It is advisable to place this label adjacent to the manufacturer’s nameplate which has the equipment SCCR marking.
- If the equipment’s SCCR is less than the available short-circuit current, 670.5(1) makes it clear that the equipment should not be installed and the Authority Having Jurisdiction (AHJ) shall not approve the installation.

The requirement in 670.5(2) along with the already existing requirements of 670.3(A)(4) and 670.5(1) simplifies the enforcement process for the AHJ.

Some industrial machinery installations do not involve a designated government inspector. Regardless, someone, such as the property owner or a designated agent, assumes the inspection (AHJ) responsibility (see NEC Article 100 definition for AHJ including the Informational Note). The same applies if an industrial machine is moved within a facility or to a different facility and a government inspector is not involved. Enforcing these three requirements — 670.5(2), 670.3(A)(4), and 670.5(1) — are extremely important for preventing fire hazards as well for personnel safety in facilities and around the equipment.

Related NEC sections

- 110.10
- 670.3(A)(4)

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.
Significance of the addition

The short-circuit current rating (SCCR) for emergency system transfer equipment must be field marked on the equipment’s exterior. This addition makes it easier for inspectors to verify that the equipment SCCR is equal to or greater than the available short-circuit current and helps to verify compliance with NEC 110.10.

Background

An Automatic Transfer Switch (ATS) listed for emergency system use is a key component for switching between the normal and the alternate, emergency power source. ATSs listed to UL 1008 Transfer Switch Equipment are often marked inside the unit with many possible SCCR levels making it difficult for inspectors to decipher them, much less determine which SCCR level applies to a specific installation.

The ATS marked SCCR values can vary based on the voltage and overcurrent protective device (OCPD) type, amp rating, settings and characteristics. The OCPD providing the ATS’s SCCR level may be integral to the ATS, but often it’s installed on the lineside of the ATS equipment. For a specific installation, it may not be obvious which of many ATS SCCR levels is being utilized and expressed in terms of the SCCR in kA rms symmetrical for the specific installation. This field marking must be affixed to the transfer equipment exterior and will help the inspection process.

For compliance with NEC 110.10, the transfer equipment SCCR must be equal to or greater than the available short-circuit current. To improve the process further, the inspector could also require documentation for the available short-circuit current to be provided to verify compliance to NEC 110.3(B) and 110.10.

UL 1008 has unique SCCR nomenclature. The following information expands upon ATS SCCR equipment markings (also see label example on the next page).

UL 1008 SCCR nomenclature

The SCCR nomenclature used in UL 1008 for marking ATSs that are suitable for emergency systems make use of “short-circuit withstand and closing rating,” “short-time current rating,” or other similar derivatives. Often, “short-circuit withstand and closing rating” is shortened to “withstand and closing rating” with WCR as its acronym. The WCR is applicable when evaluating the ATS OCPD — either a circuit breaker with an instantaneous trip, even if it also has a short-time-delay, or current-limiting fuses.

The short-time current ratings are applicable when an ATS is being evaluated for protection by circuit breakers with a short-time delay (no instantaneous trip) and the interrupting time is intentionally delayed for a duration such as 0.1, 0.3, or 0.5 second. In some applications, circuit breakers with short-time delays are utilized to achieve selective coordination with downstream circuit breakers. However, when a circuit breaker with intentional short-time delay and no instantaneous trip is protecting an ATS, the ATS must withstand the fault current for the duration of the set time delay. Therefore, the ATS’s SCCR for “short-time current rating” is normally lower than the when an ATS is protected by a circuit breaker with instantaneous trip.

Related NEC sections

- 110.10
- 701.5(D)
- 702.5
- 708.24(E)]

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

What to look for:

- Emergency system transfer equipment is field marked on the enclosure exterior with the SCCR from the manufacturer’s equipment marking label that corresponds to the specific installation (voltage, OCPD type, amp rating, setting, etc.).
- If the equipment SCCR is equal to or greater than the available short-circuit current.
1. Specific manufacturer’s circuit breaker and type (with instantaneous trip):
The CB manufacturer and type permitted has to be explicitly stated on the SCCR marking.
Example: if an Eaton CHLD 600 A CB is used on a 480 V system, field mark the exterior with “Short-Circuit Current Rating 65 kA rms symmetrical at 480 V.”

2. Short-circuit current withstand and closing with a circuit breaker:
Requires a CB with an instantaneous trip having a maximum interrupting time (verified by the manufacturer’s time-current curve) that’s equal to or less than the value in the Time Duration column.
Example: if an Eaton CHLD 600 A CB is used on a 480 V system, field mark the exterior with “Short-Circuit Current Rating 65 kA rms symmetrical at 480 V.”

3. Short-time current ratings with a circuit breaker:
Any CB with a short-time delay can be used if the circuit breaker’s short-time delay setting is equal to or less than the marked Time Duration.
Example: if using a 600 A trip/800 A frame power CB with a short-time delay set at 0.5 second then field mark the exterior with “Short-Circuit Current Rating 20 kA rms symmetrical at 480 V.”

4. Short-circuit current withstand and closing with fuses:
Fuses of a specific class and not exceeding the maximum ampere rating shown can be used.
Example: if Bussmann series Class J LPJ-600SP fuses (600 A /600 V) are selected, the equipment exterior could be field marked with “Short-Circuit Current Rating 200 kA rms symmetrical at 480 V.”

Notes:
• Verify the circuit breakers have adequate interrupting rating or short-time withstand rating and voltage rating. Most current-limiting fuses have 200 kA or higher interrupting ratings.
• Selective coordination with loadside and lineside fuses is easy to achieve if all the fuses in the system are Bussmann series Low-Peak fuses and the amp ratio between each pairing of lineside to loadside fuses is 2.1 or greater.
Chapter 7 Special Conditions
Article 701 Legally Required Standby Systems
Part I. General
701.5 Transfer Equipment
701.5(D) Documentation

Significance of the addition
Legally required standby system transfer equipment must be field marked on the enclosure exterior with the SCCR for the specific installation. This change makes it easier for inspectors to verify the SCCR for legally required standby system transfer equipment is met. See 700.5(E) in this publication for more information.

Related NEC sections
110.10
700.5(E)
702.5
708.24(E)
See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

What to look for:
• Legally required standby system transfer equipment is field marked on the enclosure exterior with the SCCR from the manufacturer’s equipment marking label that corresponds to the specific installation (voltage, OCPD type, amp rating, setting, etc.).
• If the transfer equipment SCCR is equal to or greater than the available short-circuit current.

Chapter 7 Special Conditions
Article 702 Optional Standby Systems
Part I. General
702.5 Transfer Equipment

Significance of the change
The SCCR for optional standby system transfer equipment must be field marked on the enclosure’s exterior. This change makes it easier for inspectors to verify the SCCR for optional standby system transfer equipment complies with 110.10.

This changed requirement for optional standby systems is similar to the new requirement for emergency systems. See 700.5(E) in this publication.

In some cases, the transfer switch for an optional standby system is an ATS and may be listed for emergency systems. However, the transfer switches for optional standby systems are not required to be automatic and they are not required to be listed for emergency systems. For example, transfer equipment may use other transferring devices such as double throw switches and interlocking circuit breakers.

UL 98 Enclosed and Dead-Front Switches evaluates double throw switches and UL 67 Panelboards evaluates panelboards with interlocking circuit breakers. The SCCR for this equipment may be easier to determine compared to transfer equipment for emergency use.

Related NEC sections
110.10
701.5(D)
702.5
708.24(E)
See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

What to look for:
• Optional standby system transfer equipment is field marked on the enclosure exterior with the SCCR from the manufacturer’s equipment marking label that corresponds to the specific installation (voltage, OCPD type, amp rating, setting, etc.).
• If the equipment SCCR is equal to or greater than the available short-circuit current.
**Significance of the addition**

Critical Operation Power System (COPS) transfer equipment must be field marked on the enclosure exterior with the SCCR specific to the installation. This addition makes it easier for inspectors to verify the SCCR for critical operation power system transfer equipment. See 700.5(E) in this publication for more information.

**Related NEC sections**

110.10
700.5(E)
701.5(E)
702.5

See pages 4 to 7 for an in-depth SCCR discussion and pages 23 to 25 for resources and 26 to 27 for products.

**Product Solution for ATS protection**

The proper selection of overcurrent protective devices installed in the electrical distribution system that are intended to provide protection for ATSs is critical. For emergency systems, legally required standby systems, and critical operations power systems, these OCPDs must provide short-circuit protection for the ATSs, selectively coordinate with loadside and lineside fuses, and have an adequate interrupting rating.

This is an easy protection task when using Bussmann series Low-Peak™ fuses:

- Low-Peak fuses have 300 kA* interrupting ratings.
- ATSs usually are listed and labeled with a 200 kA SCCR (short-circuit withstand/closing rating) when protected by Low-Peak fuses.
- Low-Peak fuses have selectivity lineside to loadside amp rating ratio of only 2:1.

* LP-CC is rated 200 kA.

**What to look for:**

- Critical operation power system transfer equipment is field marked on the enclosure exterior with the SCCR from the manufacturer’s equipment marking label that corresponds to the specific installation (voltage, OCPD type, amp rating, setting, etc.).
- If the field marked transfer equipment SCCR is equal to or greater than the available short-circuit current.
Annex 1
Practical approaches to determining available short-circuit current

The available short-circuit current must be established before Code compliance can be achieved. Ideally, an available short-circuit current study has already been completed for a facility prior to, or at the time of, installing electrical distribution switchboards and panelboards, or as part of an arc flash study. If no study was performed, then the available short-circuit current must be determined from design information, or gathered at the installation site. This information may be challenging to obtain, depending on the equipment’s installation location and the arrangement of the electrical distribution system.

However, some practical approaches can be applied with information requirements ranging from minimal to very detailed. The Code requires that the equipment SCCR to be at least equal to, but not less than the available short-circuit current. Thus a quick and simple calculation that provides a conservative (on the high side) available short-circuit current value can be used. It may be more beneficial in some cases to use an approach that requires minimal information, while providing a more conservative value, than an approach that yields a value closer to actual conditions.

Any of the following approaches, from simple to complex, can be used to determine available short-circuit current.

Use data from an existing available short-circuit current study

- Ideally, a study has already been completed that details the facility locations where the equipment is to be installed. The study can be used as the source when the available short-circuit current is required to be documented. In cases where a marking is required, the study details can be used to create the required equipment labels. If an existing study is used, it’s important to verify that no system changes have been made that would alter the calculated available short-circuit current since the study was performed. It is also worth noting that often the available short-circuit current calculations are determined just down to the panelboard level, but not further downstream. In these situations, the panelboard’s calculated value may be used as a conservative value, as the actual available short-circuit current will be lower due to conductor impedance.
  - Benefit: No calculation required.
  - Resultant value: Nearest the actual value, or close to the actual value if the study did not evaluate points downstream of the panelboard.
  - Considerations: Verify no changes have been made since the study was performed.

Complete a simple calculation based solely on the nearest upstream transformer’s attributes

- The required information (size/kVA, secondary voltage, phase, percent impedance) can be obtained from the transformer’s nameplate. The benefit to this approach is a simplified calculation that assumes an infinite available short-circuit current on the transformer primary and ignores the affect of conductors on the secondary. When equipment can meet this SCCR requirement, it can be relocated to any point downstream of the transformer.
  - Benefit: Simple calculation using information that is readily accessible along with equipment relocation flexibility.
  - Resultant value: Most conservative, as it’s based on the available short-circuit current at the transformer’s secondary. The actual available short-circuit current is less than this value.

Complete a detailed calculation

- This approach requires the same information as the previous simple calculation approach, but also requires detail for each conductor between the transformer and the location where the equipment is to be installed. When the conductor is a wire, then the conductor size, length, material, quantity per phase, and conduit type are required. For busway type conductors, this detail includes the ampacity, material, length and type.
  - Benefit: Most accurate and provides the lowest available short-circuit current value of all approaches, and lowers that equipment SCCR needed.
  - Resultant value: Most accurate, as it’s closest to the actual available short-circuit current.

To further simplify calculation of available short-circuit current, Eaton provides a free tool called the Bussmann series FC2 Fault Current Calculator. See the resource section for more information.

The Eaton Bussmann Division’s Paul P. Gubany Center for High Power Technology is the electrical industry’s most comprehensive facility for testing and certifying device and equipment SCCRs. Capable of performing electrical tests up to 600 volt three-phase, 300,000 amps of short-circuit current for meeting ANCE, ANSI, CE, CSA, ETL, IEC and UL testing requirements.
Annex 2
Best practices for SCCR requirements during various project stages

This table contains “best practice” suggestions that apply whether a project is a new building, adding new equipment to an existing building or moving a piece of equipment within or between facilities.

### Best practice suggestions for SCCR requirements during various project stages

<table>
<thead>
<tr>
<th>Project stage</th>
<th>Best practices</th>
</tr>
</thead>
</table>
| **Design**    | - Electrical distribution system designer determines available short-circuit currents.  
- Electrical distribution system designer communicates available short-circuit currents to each entity responsible for specifying the various types of electrical equipment, such as:  
  - Switchgear, switchboard, power distribution panelboard, panelboards, MCCs, etc.  
  - HVAC equipment  
  - Industrial control panels  
  - Industrial machinery  
  - Elevator controller  
  - Automatic Transfer Switch equipment (ATSs)  
- Those responsible for various types of equipment specifications should specify the required SCCRs.  
- Specify a minimum equipment SCCR that will be adequate for anywhere in the facility. The level specified should be high enough to accommodate any equipment relocation inside the facility or improvements to the electrical system that would result in higher available short-circuit current.  
- Electrical distribution system designer submits plans with available short-circuit currents to AHJs.  
- Designer evaluates “value engineering” submittals to ensure equipment SCCRs will be adequate.  
- Before approving designs and drawings for industrial control panels, require the OEM to verify the SCCR using compliance software such as the Bussmann series OSCAR 2.1 and submit the documentation it provides. |
| **Procurement** | - OEMs make the available short-circuit current or SCCR a required part of the specification information the customer must submit.  
- OEMs who provide the same solution at varying SCCR ratings are easier to work with in regard to applying adequately rated equipment in the most cost effective manner.  
- For simplicity, and to gain a competitive advantage, OEMs should design their equipment with high SCCRs, such as at 65 kA or 100 kA. |
| **Installation** | - Before installing, verify the equipment SCCR is equal to or greater than the available short-circuit current. If the SCCR is less than the available short-circuit current, do not proceed, and notify those responsible that it’s inadequate and needs correcting before installation can be made. Once installed, it is much more difficult to correct an inadequate equipment SCCR.  
- Contractors for distribution systems and equipment verify SCCR is equal to or greater than the available short-circuit current.  
- If the installation for a circuit is substantially different from the design, contractors should verify that the equipment SCCR is still equal to or greater than the available short-circuit current.  
- If contractors recommend “value engineering” changes, be sure to verify equipment SCCRs remain adequate. |
| **Inspection — Authority Having Jurisdiction (AHJ)** | - AHJ requires plan submittals with available short-circuit currents so this information is available for installation inspections.  
- AHJ field verifies that equipment marked SCCRs are equal to or greater than the available short-circuit current.  
- AHJ reviews “value engineering” changes to ensure equipment SCCRs remain adequate. |

Design

- For all electrical equipment, determine the available short-circuit current.

Procurement

- Each party responsible for ordering electrical equipment communicates the required SCCR specification to equipment builders (original equipment manufacturers/OEMs).

Installation

- Do not install electrical equipment unless the SCCR is equal to or greater than the available short-circuit current.
- Field mark the available short-circuit current where required.
- Field mark the SCCR on the outside of transfer equipment.
Annex 3
Product solutions for adjustable speed drive short-circuit protection

Product solutions
The table below provides OCPDs that are likely to meet the enhanced safety requirements of UL 61800-5-1. Equipment manufacturers who integrate adjustable speed drives into their equipment should stay informed and incorporate the proper OCPD and SCCR data into their markings and instructions. For more in-depth information on adjustable speed drive overcurrent protection options please contact your Eaton Bussmann Division Field Application Engineer.

Adjustable speed drive short-circuit overcurrent protective device suggestions (600 V or less) for UL 61800-5-1*

<table>
<thead>
<tr>
<th>Adjustable speed drive capacity/type</th>
<th>Preferred [key reason]</th>
<th>Other types</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5 HP</td>
<td>LP-CC or KTK-R (Class CC) [small physical size]</td>
<td>TCF or FCF (Class CF), LPJ, JKS, or DFJ (Class J), JNJ/JJS (Class T) fuses or Type E self-protected starter**</td>
</tr>
<tr>
<td>≤ 50 HP</td>
<td>TCF (Class CF), LPJ_SP (Class J) [time-delay for bypass, finger safe disconnects and holders]</td>
<td>FCF (Class CF), JKS (Class J) or Type E self-protected starter**</td>
</tr>
<tr>
<td></td>
<td>JNJ/JJS (Class T) fuses: [small size]</td>
<td></td>
</tr>
<tr>
<td>≤ 200 HP</td>
<td>DFJ high speed fuse (Class J) [standard Class J holders and switches]</td>
<td>FW ferrule high speed fuses (UL Recognized)</td>
</tr>
<tr>
<td></td>
<td>CHSF compact high speed fuses (UL Recognized) [compact size ]</td>
<td></td>
</tr>
<tr>
<td>&gt; 200 HP</td>
<td>170M square body high speed fuses (UL Recognized) [many mounting configurations]</td>
<td>FW ferrule high speed fuses (UL Recognized)</td>
</tr>
<tr>
<td>Servo drive or drive DC output</td>
<td>North American cylindrical high speed fuses (UL Recognized):</td>
<td>IGBT high speed fuses (UL Recognized)</td>
</tr>
</tbody>
</table>

* The fuses in this table are current-limiting. However, there are different degrees of current-limitation which is a key consideration in adjustable speed drive protection.

** Type E self-protected starters are typically limited by a slash voltage rating, such as 480/277 V.

Note: Installers and users must default to the manufacturer’s instructions or markings. If the adjustable speed drive label or instructions require specific type/ampere fuse(s) or specific manufacturer’s fuse model number, then that OCPD must be used per NEC 110.3(B) and UL 508C or UL 61800-5-1.

Products
High speed fuses

- **CHSF**
  - 500 Vac/dc, 50 to 400 A, compact high speed fuses
  - Require up to 48% less space

- **DFJ**
  - 600 Vac, 1 to 600 A, Class J
  - Easily mounts in Class J holders, blocks and switches
  - * Class J branch circuit fuse.

- **FW**
  - Up to 1000 Vac, 1 to 100 A ferrule
  - Small size

- **North American**
  - Up to 1000 Vac, 1 to 4000 A cylindrical

- **170M**
  - Up to 2000 Vac, 10 to 7500 A, square body
  - Higher voltage and power
  - Compact size

- **IGBT**
  - Up to 1000 Vdc, 25 to 630 A

Branch circuit fuses

- **Time-delay LP-CC and fast-acting KTK-R**
  - 600 Vac, 1/4 to 30 A, Class CC
  - Small size, easily mounts in Class CC holders, blocks and switches

- **Time-delay and fast-acting CUBEFuse™**
  - 600 Vac, 1 to 100 A, Class CF
  - Compact, finger-safe design

- **Time-delay LPJ and fast-acting JKS**
  - 600 Vac, 1 to 600 A, Class J
  - Easily mounts in Class J holders, blocks and switches

- **JJN (300 Vac) and JJS (600 Vac)**
  - 1 to 1200 A (JJN) and 1 to 800 A (JJS), Class T
  - Compact size
Annex 4
Bussmann series resources to help achieve SCCR compliance

Bussmann series FC² Available Fault Current Calculator

Knowing the available short-circuit current is essential for Code compliance with SCCR requirements. This no-cost application is available online or as a free, mobile app download. FC² provides users:

- The option to use English, Spanish or French.
- Calculations for three-phase and single-phase systems.
- Documentation for the available short-circuit current at one or multiple points in an electrical system.
- An easy way to comply with field marking requirements by creating and emailing 110.24 labels, in jpeg or PDF formats.
- A system printout that documents the calculation along with the date it was performed.
- The option to generate labels and documentation in English, Spanish or French.

Visit Eaton.com/bussmannseries/FC2 or scan the QR code above for downloading an Apple® iPhone/iPad or Android™ mobile device compatible version.

Eaton.com/bussmannseries

Bussmann series FC² available fault current calculator produces label images of the available short-circuit current calculation for field marking equipment.

FC² provides a dated printout that documents the calculation and the system values used to determine the available short-circuit current.

Short-circuit current is calculated on the transformer secondary assuming infinite available short-circuit-current on the primary.

FC² is capable of using many circuit variables to calculate available short-circuit current, including motor contribution.
Annex 4
Bussmann series resources to help achieve SCCR compliance

Bussmann series OSCAR™ 2.1 SCCR Online Compliance Software

Bussmann series OSCAR™ 2.1 online compliance software greatly simplifies determining equipment SCCRs. This award-winning tool easily guides users through entering an electrical panel’s devices, calculates its equipment SCCR and provides documented results.

OSCAR 2.1:
• Lets users create a one-line diagram of a control panel’s circuit from a vast database of over 65,000 devices.
• Permits entering custom devices and their electrical values.
• Calculates the panel’s SCCR.
• Highlights the “weak links” that limit equipment SCCR.
• Allows for editing the one-line diagram with higher SCCR devices to achieve a higher equipment SCCR.
• Permits printing one-line diagrams.
• Provides a report of devices and their ratings to document compliance with UL 508A Supplement SB for equipment SCCR marking requirements covering Industrial Control Panels (409.110), Industrial Machinery Electrical Panels (670.3(A)) and HVAC Equipment (440.4(B)).

Available 24/7 — 365, OSCAR 2.1 creates a one-line diagram from specified devices and calculates the equipment SCCR. Red circles identify the “weak links” limiting the equipment SCCR.

Subscribers can create and save as many one-line diagrams as they want. To save time and effort with similar panel circuits, one-line diagrams can be copied and modified for easier calculations.

To subscribe or request a free 7-day trial, visit OSCAR.Eaton.com.

Eaton’s SCCR Protection Suite

This free, online resource is a comprehensive product portfolio of circuit protection and wiring distribution/termination and switching devices. It provides equipment designers with easy access to product information for meeting a broad range of SCCRs needs from 18 kA to 200 kA.

With SCCR Protection Suite, designers can:
• Select circuit attributes:
  • Desired panel SCCR
  • Circuit location (branch or feeder)
  • Circuit type (device combinations)
  • Circuit power and control voltage
  • Load type and amps (motor or non-motor)
• View options for:
  • Upstream current limitation
  • Component preferences (fuses/circuit breakers, disconnects, contactors/starters, drives, power and terminal blocks, etc.)

After a search is made, results include a detailed listing of the devices, their catalog numbers, ratings, SCCR and their UL references. This resource greatly helps designers eliminate “weak links” by easily and quickly searching for solutions that raise the component SCCR or limit the short-circuit current. Visit SCCR.Eaton.com.
Annex 4
Bussmann series resources to help achieve SCCR compliance

Application notes, literature and whitepapers

Both industrial equipment manufacturers and users need to know about SCCR, and the related Code and regulatory requirements. The following documents will help provide insight into this often misunderstood subject and how to effectively plan and implement an SCCR strategy.

• Application note No. 10367 — Developing an effective SCCR plan for facilities and purchasers of industrial equipment.
• Application note No. 10368 — Developing an equipment SCCR standard for manufacturers of industrial equipment.
• Brochure No. 10374 — Equipment SCCR made easy.
• Whitepaper No. WP083020EN — Applying current-limiting devices to raise SCCR.

Visit Eaton.com/SCCR.

Product catalogs

The following Bussmann series product catalogs and application guide are available for viewing and download at Eaton.com/bussmannseries.

• Full line product catalog No. 1007 — Over 560 pages of Bussmann series products, accessories and services.
• Rotary disconnect catalog No. 10076 — 48 pages on UL 98 fused and non-fused disconnects up to 1200 amps and UL 508 non-fused disconnects up to 80 amps.
• DIN-Rail terminal blocks catalog No. 3197 — 48 pages of DIN-Rail terminal blocks with SCCR up to 200 kA.
• High speed fuse catalog No. 10506 — 100 pages covering North American, square body, ferrule and BS88 high speed fuse offerings.
• High speed fuse application guide No. 10507 — 36 pages covering the considerations and factors affecting the selection and application of high speed fuses.

More resources

• Eaton’s Application Engineering team — available for no-cost SCCR analysis of equipment one-line diagrams and schematics. Email FuseTech@Eaton.com.
• Eaton Bussmann Division Field Application Engineers — contact your Bussmann series product sales representative for details.

Bussmann series Selecting Protective Devices (SPD) Handbook

With over 250 pages, this comprehensive circuit protection handbook has an entire section on 110.24, including methods for calculating point-to-point short-circuit current at multiple points in single-phase and three-phase systems. To download this valuable resource, visit www.cooperbussmann.com/SPD.

Eaton’s Bussmann Division Application Engineering team is available to perform a no-cost equipment SCCR analysis.
Table 3. Keys to achieving high panel SCCRs

<table>
<thead>
<tr>
<th>Location</th>
<th>Keys to achieving high control panel SCCRs *</th>
<th>Why they are key?</th>
<th>Bussmann series product advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch circuits</td>
<td>OCPDs with high interrupting ratings.</td>
<td>• Panel SCCR is limited to the lowest OCPD interrupting rating.</td>
<td>• Bussmann series fuses typically have 200 kA or greater interrupting ratings, and do not limit panel SCCR.</td>
</tr>
<tr>
<td></td>
<td>Tested and listed high SCCR devices.</td>
<td>• OCPD interrupting ratings cannot be raised by a feeder OCPD’s current-limiting as permitted for branch circuit SCCRs.</td>
<td>• Branch circuit devices are commonly available with tested and listed high SCCRs when protected by specified Bussmann series fuses, e.g., a motor starter has a 100 kA SCCR when protected by Bussmann series fuses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For panel SCCR analysis, each branch circuit SCCR is based upon the lowest device SCCR in the circuit.</td>
<td>• Protection of power conversion equipment may require Bussmann series high speed fuses per the manufacturing’s instructions.</td>
</tr>
<tr>
<td>Feeder circuits</td>
<td>OCPDs with high interrupting ratings.</td>
<td>• Panel SCCR is limited to the lowest OCPD interrupting rating.</td>
<td>• Bussmann series fuses typically have 200 kA or greater interrupting ratings, and do not limit panel SCCR.</td>
</tr>
<tr>
<td></td>
<td>Tested and listed high SCCR devices.</td>
<td>• A feeder circuit device’s SCCR cannot be increased by the feeder OCPD’s current-limiting capability (as described in ③ below).</td>
<td>• Bussmann series power distribution blocks are available with tested and listed high SCCRs when protected by specified Bussmann series fuses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• By analysis, feeder OCPD current-limiting let-through data can increase individual branch circuit SCCRs to even higher levels.</td>
<td>• Patented Bussmann series power distribution fuse blocks provide listed high SCCRs while reducing component count and space.</td>
</tr>
<tr>
<td></td>
<td>Listed current-limiting OCPDs.</td>
<td></td>
<td>• Bussmann series fuses, with a high degree of current-limitation, can be selected to increase the branch circuit SCCR to a much higher level, making it easier to achieve a high panel SCCR.</td>
</tr>
</tbody>
</table>

* See UL 508A, Supplement SB for details.
Annex 5
Bussmann series products to help achieve SCCR compliance

① Branch OCPDs with high interrupting ratings.

LPJ-.SP
600 V, 1 to 600 A
time-delay Class J
Easily mounts in Class J
holders, blocks and switches

CUBEFuse
600 V, 1 to 100 A
time-delay Class CF
Compact, finger-safe design
mounts in holders and
CCP-.CF switches

LP-CC
600 V, up to 30 A
time-delay Class CC
Small size, mounts in Class CC
holders, blocks and switches

Bussmann series branch circuit fuses offer high interrupting ratings up to 300 kA.

② Branch circuit devices with tested and listed high SCCR.

LP-CC
600 V, up to 30 A
time-delay Class CC
Small size, easily
mounts in Class CC
holders, blocks and switches

CUBEFuse
600 V, 1 to 100 A
time-delay Class CF
Compact, finger-safe design
mounts in holders or
CCP-.CF switches

JJN(300 V) and
JJS (600 V)
1 to 1200 A (JJN) and 1
to 800 A (JJS), Class T

Use branch circuit devices, such as contactors, motor controllers, solid state relays,
motor starters, soft starters, adjustable speed drives and terminal blocks, which
have high listed SCCRs when in combination with Bussmann series fuses.

③ Feeder circuit OCPDs with high interrupting ratings.

KRP-C.SP
600 V, 601 to 6000 A
time-delay Class L
Easily mounts in Class L
blocks and switches

LPJ-.SP
600 V, 1 to 600 A
time-delay Class J
Easily mounts in Class J
holders, blocks and switches

Bussmann series feeder circuit fuses offer high interrupting ratings up to 300 kA.

④ Feeder circuit devices with tested and listed high SCCR.

PDBFS_
200 kA SCCR finger-safe,
DIN-Rail mount 600 V modular power
distribution blocks up to 760 A

PDB__
200 kA SCCR panel mount 600 V
power distribution blocks up to 760 A

JM600_-_MW_
200 kA SCCR, 600 V Class J ferrule and
knifeblade modular power distribution
fuse blocks up to 400 A. Optional
covers provide IP20 protection.

⑤ Listed feeder current-limiting OCPDs.

KRP-C.SP
600 V, 601 to 6000 A
time-delay Class L

LPJ-.SP
600 V, 1 to 600 A
time-delay Class J

See UL 508A table SB4.2 for let-through values.

Eaton.com/bussmannseries