Advanced Guide To
Understanding Assembly
Short-Circuit Current Rating

WITH ENGINEERING SOLUTIONS AND OVERCURRENT PROTECTION DEVICES TO ENHANCE SCCR
Assembly Short-Circuit Current Ratings

What Is A Short-Circuit Current Rating (SCCR)?
SCCRs on components and assemblies represent the maximum level of short-circuit current that the component or assembly can withstand and is used for determining compliance with NEC® 110.10. This rating can be marked on individual components or assemblies. Assembly ratings take into account all components contained within the equipment.

A common mistake is to assume that the interrupting rating of the overcurrent protective device protecting the circuit represents the SCCR for the entire circuit. Interrupting ratings, used for compliance with NEC® 110.9, apply solely to the overcurrent protective device. It is the characteristics of the overcurrent protective device (e.g. opening time, let-through energy) that need to be used in determining compliance with NEC® 110.10, not the interrupting rating.

Effective April, 2006, all equipment listed to UL508A will be required to be marked with an assembly SCCR. Inspectors and installers need this information in order to ensure compliance with NEC® 110.10. Equipment installed where fault current levels exceed their short-circuit current can be hazardous to persons and property. SCCR marked on components and assemblies make it easier to verify proper protection for components and assemblies for specific applications — whether it be the initial installation or relocation of equipment.

How Is SCCR Determined?
For meter disconnect switches and motor controllers, this withstand level or SCCR is often determined by product testing. For assemblies, the marking can be determined through product listing or by an approved method. With the release of the UL508A Industrial Control Panel standard, an industry approved method is now available. Any method used, whether UL508A or another approved method, should be based upon the weakest link approach. In other words, the assembly should be limited to installation where fault levels do not exceed the withstand rating of devices with the lowest SCCR. The marking determined should represent the limits of the assembly for a safe installation. Current-limiting overcurrent protective devices can be used in the feeder or branch circuits to increase the assembly SCCR where lower rated components are used.

CAUTION: Short-circuit current ratings (SCCRs) are different than interrupting ratings marked on overcurrent protective devices.

Who Is Affected By The SCCR Markings
The 2005 NEC® has requirements for anyone building equipment listed to the 2005 NEC® or to UL508A and requires the following to be marked with an SCCR:
- Industrial control panels [409.110]
- Industrial machinery electrical panels [670.3(A)]
- HVAC equipment [440.4(B)]
- Meter disconnect switches [230.82(3)]
- Motor controllers [430.8]

<table>
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<tr>
<th>Who Is Affected</th>
<th>How Are They Affected</th>
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<tr>
<td>Facility/Process Engineers/ Consulting Engineers</td>
<td>Need to specify end use equipment with ratings adequate for available short-circuit current.</td>
</tr>
<tr>
<td>Control Panel Builders/ Machine Builders/ HVAC Manufacturers</td>
<td>Need to determine and mark the assembly short-circuit current rating on the equipment being built. Need to market equipment with ratings at least as high as their competition.</td>
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<tr>
<td>Electrical Contractors</td>
<td>Need assurance that the equipment installed is adequate for the available short-circuit current at the point of installation, to avoid red tags and lost time and labor.</td>
</tr>
<tr>
<td>Electrical Inspectors</td>
<td>Need to assure that the available short-circuit current where equipment is being installed does not exceed the rating marked on the equipment.</td>
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Assembly Short-Circuit Current Ratings

Determining Assembly SCCR
In order to determine the short-circuit current rating for the entire assembly, every component and device used in the power circuits of the assembly needs to be assessed. The investigation is based upon two sweeps of review.

Sweep 1: The Component Protection Sweep
The first sweep is an investigation to determine the component with the lowest short-circuit current rating.

Sweep 2: The Interrupting Rating Sweep
The second sweep determines the device with the lowest interrupting rating.

The ratings determined from these two sweeps directly affect the overall assembly rating as the lowest value is represented in the new mandatory marking.

To determine the assembly rating for industrial control panels, HVAC equipment, and industrial machinery, there are three main areas of consideration:

1. The short-circuit current (withstand) rating of every device used in the power circuits needs to be determined. The device or component with the lowest short-circuit current rating would represent the assembly short-circuit current rating.

2. The interrupting rating of every overcurrent protective device in the assembly needs to be determined. The device or component with the lowest interrupting rating would be compared to the lowest rated component and the lower of the two ratings would represent the assembly short-circuit current rating.

3. The use of modern current-limiting fuses in the feeder circuits can increase the short-circuit current ratings of components and circuits with low short-circuit current (withstand) ratings.

The example beginning on page 8 highlights some weak links that could be encountered and the Cooper Bussmann fusible solutions to help...

Find It, Fix It and Forget It.

Sweep 1: Check for component with the lowest short-circuit current rating.
Sweep 2: Check for the lowest interrupting rating of any overcurrent protective device used in the panel.
### Find It, Fix It...Forget It

**Look For... The Weakest Link**

Many components used in industrial control panels, industrial machinery, and HVAC equipment may be the *weakest link* and therefore limit the assembly short-circuit current rating. These include, but are not limited to, motor controllers, definite purpose contactors, supplemental protectors, circuit breakers with low interrupting ratings, and power distribution blocks.

The short-circuit current rating marking for the assembly will be based upon the lowest short-circuit current or withstand rating of any component contained within the assembly, or the *weakest link* approach.

Low rated components can result in a low assembly short-circuit current rating and therefore limit the usage of the assembly.

Use this table to initiate the process of identifying the short-circuit current rating of your components.

<table>
<thead>
<tr>
<th>Branch Circuit Fuses</th>
<th>UL489 Circuit Breakers</th>
<th>UL98 Fusible Disconnect Switch</th>
<th>UL98 Non-Fusable Disconnect Switch</th>
<th>UL1429 Pullout</th>
<th>Molded Case Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>200kA*</td>
<td>5kA</td>
<td>200kA*</td>
<td>5kA****</td>
<td>10kA*</td>
<td>5kA*</td>
</tr>
</tbody>
</table>

* Class CC, J, L, R and T UL248 branch circuit type fuses.
** When used in conjunction with Class CC, J, L, R and T UL248 branch circuit type fuses.
*** 50Hp or less 480V
**** Default value increases to 10kA when protected by fuses.
+ Combination rating is used for Sweep 1. For Sweep 2 IR = 5kA (default value)
<table>
<thead>
<tr>
<th>Power Distribution Block (PDB)</th>
<th>Class CC, J, L, R, or T Fuse Holder</th>
<th>Busbar</th>
<th>Magnetic Motor Starter</th>
<th>Type E Self Protected Starter</th>
<th>Instantaneous Trip Circuit Breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>10kA</td>
<td>200kA*</td>
<td>10kA</td>
<td>5kA***</td>
<td>5kA***</td>
<td>+</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fuse Holder</th>
<th>UL508 Manual Motor Starter</th>
<th>UL508 Switch</th>
<th>Drives</th>
<th>Contactors</th>
<th>Receptacle</th>
</tr>
</thead>
<tbody>
<tr>
<td>10kA</td>
<td>5kA***</td>
<td>5kA***</td>
<td>5kA***</td>
<td>5kA***</td>
<td>10kA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GFCI Receptacle</th>
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<tbody>
<tr>
<td>2kA</td>
</tr>
</tbody>
</table>

* Class CC, J, L, R and T UL248 branch circuit type fuses.
** When used in conjunction with Class CC, J, L, R and T UL248 branch circuit type fuses.
*** 50Hp or less 480V
**** Default value increases to 10kA when protected by fuses.
+ Combination rating is used for Sweep 1. For Sweep 2, 1IR = 5kA (default value)
Find It, Fix It...Forget It

How To Get A Higher SCCR So An Assembly Isn’t Limited?
Once these **weakest links** are found, and if the desired assembly short-circuit current rating is not achieved, there are options to fix these weak links. By fixing these weak links, higher short-circuit current ratings can be achieved. In general there are three options that can be used to fix weak links encountered in a panel.

Options For Fixing Weak Links
1. **Use Overcurrent Protective Devices With Higher Interrupting Ratings**
Overcurrent protective devices with low interrupting ratings often become the **weakest link** and limit the short-circuit current rating of the assembly. The interrupting ratings of the overcurrent protective devices used directly affects the assembly rating. The only fix is to use devices with higher interrupting ratings.

SCCR = 14kA  
SCCR = 50kA

2. **Use Current Limitation To Fix Low Rated Components**
It only takes one component with a low short-circuit current rating to limit the entire assembly. Many of the components used in industrial control applications have low short-circuit current ratings. Fix these low rated components and the assembly rating by using current limitation. Since current-limiting fuses reduce high level short-circuit currents to a minimal level they can allow the use of these lower rated devices while providing a higher assembly short-circuit current rating. Type 2 protection, using fuses, can be used to achieve high branch SCCR.

SCCR = 100kA  
SCCR = 10kA

CAUTION: Combination ratings are often limited by the interrupting ratings of the overcurrent protective devices used.

3. **Buy More Expensive Components With Higher Ratings**
A 65kA circuit breaker will more than double the cost compared to a 14kA circuit breaker. The fusible solution provides a rating as high as 200kA, at a comparable or lower cost to an existing design, making it the most economical solution.

Modern current-limiting fuses have:
- The highest interrupting ratings of any overcurrent protective devices, and
- Current limitation to fix low-rated components.

Circuit breakers add unnecessary cost, while fuses are economical.
Find It, Fix It...Forget It

Don’t Be Limited By These Weak Links
Additional benefits exist with the use of Cooper Bussmann modern current-limiting fuses. Not only can modern current-limiting fusible solutions fix undesired weak links and obtain a high assembly short-circuit current rating, they can also provide enhancements to a design in the areas of flexibility of installation, increased workplace safety, and enhanced protection through the life of the equipment. These enhancements take care of the hassle associated with equipment with limited ratings so one can **FORGET IT!**

Benefits of Straight Voltage Ratings
Straight voltage ratings allow for more systems where equipment can be installed. Straight voltage rated equipment can be installed in any type of grounded, ungrounded, or impedance grounded system. Devices with slash voltage ratings, as found on some circuit breakers, and all self-protected starters, and limited to installation in only solidly grounded WYE systems.

Benefits of High Assembly SCCRs:
- High short-circuit current ratings allow for more installations where equipment can be installed.
- Meets the UL508A and NEC® requirements for short-circuit current rating marking.

Additional Benefits Which Provide Enhancements To A Design...

Increased Flexibility In Panel Use And Installation
Valuable time that was spent gathering information for proper application is drastically reduced with fuses since modern current-limiting fuses can provide high assembly short-circuit current ratings and straight voltage ratings because modern current-limiting fuses have:
- High interrupting ratings of 200,000A or more.
- Excellent current limitation to protect low rated components at high short-circuit current levels.
- Straight voltage ratings so they can be installed in any type of installation independent of the grounding scheme used, unlike devices with a slash voltage rating which are limited to installation in ONLY a solidly grounded WYE type system.

Enhanced Protection
- Type 2 “No Damage” protection of motor starters when applied properly.
- Reliable protection throughout the life of the installation. After a fault occurs, fuses are replaced with new factory calibrated fuses assuring the same level of protection that existed previous to the fault.
- Superior current limitation provides protection of circuit components for even the most susceptible components such as equipment grounding conductors.
- Fuses do not vent. Therefore fuses will not affect other components in the panel while clearing a fault. Additional guards or barriers which isolate devices that vent from other components are not required.
- Achieving selective coordination is simple. Typically, selective coordination can be achieved between fuses by simply maintaining a ratio between upstream and downstream fuses.
- Fuses have rejection features, unlike other overcurrent protective devices, assuring replacement with a device of the same voltage rating and equal or greater interrupting rating. In addition, rejection features restrict the fuses used for replacement to ones of the same class or type.

Enhanced Workplace Safety
- Superior current limitation provides enhanced workplace safety and reduced arc-flash levels.
- Eliminates invitation to reset into a fault and potential OSHA violation. Resetting or manually re-energizing a circuit without investigating the cause is prohibited in OSHA CFR29:1910-334. Fuses are not resettable and eliminate the invitation to reset.
**Industrial Control Panel Example**

The following is an example of an industrial control panel assembly along with a one line diagram of the circuitry. The components, their ratings and any special conditions associated with their use is shown in the components list to the left.

**Components List**

1. Fusible disconnect with LPJ-100SP fuses IR = 300kA. SCCR of disconnect with fuses installed = 200kA.
2. Unmarked power distribution block SCCR = 10kA default.
3. Fusible disconnect with LP-CC fuses (IR = 200kA) SCCR = 200kA.
4. Motor starter marked 50kA when protected by fuses or circuit breaker.
5. UL489 instantaneous trip circuit breaker (MCP) used in conjunction with appropriate motor controller and overload relay as a listed and labeled assembly with a *combination* SCCR = 25kA. MCP not marked with an interrupting rating.
6. Self protected Type E combination controller marked with a 50kA SCCR.
7. Motor controller (contactor) marked with a 5kA SCCR.
8. Drive marked with a 10kA SCCR
9. LP-CC fuses marked with a 200kA IR in a fuse holder with a marked SCCR = 200kA.
10. Molded case circuit breaker marked with a 10kA IR.
11. Lighting contactor marked with a 2kA SCCR.
12. Unmarked UL1077 supplemental protector. SCCR = 200A by default.
13. Unmarked GFCI receptacle SCCR = 2kA by default.
14. Molded case circuit breaker marked with a 14kA IR.
15. 5kVA transformer (480:120V).
16. 10kVA isolation transformer (480:480V).
17. Motor controller (contactor) marked with a 50kA SCCR.

*IR = Interrupting rating*

*SCCR = Short-circuit current rating*
Weak Links and Improving SCCR

The following table highlights the weak links encountered in the example on the previous page and provides Cooper Bussmann solutions, along with the added benefits that these solutions can provide for a design. This is an example of how Cooper Bussmann can help Find the weakest link, Fix the weakest link and Forget about any future worries or aggravations in a design. Cooper Bussmann will provide the most versatile and reliable design for any overcurrent protection need.

<table>
<thead>
<tr>
<th>Weak Link</th>
<th>Component</th>
<th>Fix It</th>
</tr>
</thead>
</table>
| A         | UL1077 Supplementary Protectors (component #12) | Increase the Interrupting Rating:  
  - Use Cooper Bussmann current-limiting fuses to achieve higher SCCRs by replacing the low short-circuit rated UL1077 supplementary protector with modern current-limiting fuses with high IRs of up to 300kA. |
|           | Assembly Limited To 200A. | |
| B         | UL489 Instantaneous Trip Circuit Breaker (component #5) | Increase the Interrupting Rating:  
  - Use Cooper Bussmann current-limiting fuses to achieve higher short-circuit current ratings by replacing the low interrupting rated instantaneous trip circuit breaker with modern current-limiting fuses with high interrupting ratings of up to 300kA. |
|           | Assembly Limited To 5kA:  
  - If weak link A is fixed. | |
| C         | Power Distribution Block in Feeder Circuit (component #2) | Use Current Limitation:  
  - If the PDB is fed by a Cooper Bussmann modern current-limiting LPJ, JJS, or LP-CC fuse rated 60A or less upstream, the current limitation of the fuse can be used to raise the rating of the PDB to 100kA or more.  
  - Use NEW PDB Series of Power Distribution Blocks with High Short-Circuit Current Rating:  
  - Cooper Bussmann has introduced a line of power distribution blocks Listed to UL1953 with high SCCRs of 200kA or more. By replacing a present low rated power distribution block with the new Cooper Bussmann PDBs, a panel can achieve the high ratings desired!! |
|           | Assembly Limited To 10kA:  
  - If weak links A and B are fixed. | |
### Weak Links and Improving SCCR

<table>
<thead>
<tr>
<th>Weak Link</th>
<th>Component</th>
<th>Fix It</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D</strong></td>
<td>Molded Case Circuit Breakers with Low Interrupting Ratings (component #14)</td>
<td>Increase the Interrupting Rating: Use Cooper Bussmann current-limiting fuses to achieve higher short-circuit current ratings by replacing the low interrupting rated circuit breaker with modern current-limiting fuses with high interrupting ratings of up to 300kA.</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>Molded Case Circuit Breakers with Low Interrupting Ratings (component #14)</td>
<td>Increase the Interrupting Rating: Use Cooper Bussmann current-limiting fuses to achieve higher SCCR by replacing the low interrupting rated circuit breaker with modern current-limiting fuses with high interrupting ratings of up to 300kA.</td>
</tr>
<tr>
<td><strong>F</strong></td>
<td>Type E Self Protected Combination Starter (component #6)</td>
<td>Use Device With Straight Voltage Rating: Use Cooper Bussmann current-limiting fuses with straight voltage ratings to allow for installation on any type of system grounding.</td>
</tr>
</tbody>
</table>

If weak links A, B, C, D, E and F are fixed through the use of Cooper Bussmann current-limiting fuses, and if a new Cooper Bussmann power distribution block is used, the new short-circuit current rating is now 200kA.

For further information contact your local Cooper Bussmann sales engineer, Cooper Bussmann Application Engineering, or visit [www.cooperbussmann.com](http://www.cooperbussmann.com).
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