Overcurrent protection, SCCR and a new VFD UL Standard

Presented by Nikunj Shah (Mar 2020)
A little about Nikunj Shah

Responsibilities
- R&D and product certification
- Product management
- Standardization
  - **UL** Standards Technical Panel (STP)
    - UL 61800-5-1 (old UL 508C), UL61800-5-2, UL1741 & UL62109-1, UL508A
  - **NEMA** 1IS SC7 - Adjustable Speed Drives
  - **IEC** USNC SC22G TAG - NEMA appointed **US Expert** of IEC 61800-5-1, IEC 61800-5-2, IEC 61800-9-1 & -9-2, IEC 62477-1
  - Member of **IEEE** Standards Association and in the **Working Group of IEEE 519 & 519.1**
  - **NFPA 70 (NEC), NFPA 79, CSA** standards for drives (C22.2 No 274, C22.2 No 14)
Disclaimer of liability

The illustrations and text included in this presentation are selected as examples, and there is no claim as to their completeness in regard to conceivable configurations and applications. These are meant to give an orientation to accomplishing typical tasks.

The application of the standards and directives is based upon the interpretation of Siemens Industry, Inc. Siemens assumes no liability and responsibility for the correctness and completeness of their interpretation. Users of these standards and directives (equipment builders and owners) are responsible for checking whether their equipment (e.g. industrial control panel, motor control center etc.) and its application comply with the applicable standards and directives. Also, equipment builders and/or owners are responsible for its safe and proper installation and for making its safe commissioning, use and maintenance.

The tables and texts in this presentation have been used from the relevant standards and technical datasheets when the presentation was created. The standards & technical datasheets are subject to regular revisions. For this reason, each user of this presentation should check the cited passages for the correctness and latest revision.

Siemens Industry, Inc. reserves the right to make changes to this presentation at any time and without prior notice. Reproduction and distribution of this presentation or any of its content to third parties are not permitted.
Overcurrent protection, SCCR and a new VFD UL Standard

Introduction

For LV drives, there is frequent confusion about topics related to
• SCCR (Short circuit current rating)
• Short circuit protection - what devices are needed
• Compliance with the UL and NEC / NFPA70
• Compliance with IEC standards
• UL listing

Sometimes incomplete information in the available product documentation from product manufacturers also contributes to this confusion

The intent here is to explain the fundamental concepts and requirements to clarify this topic better and to hopefully eliminate any confusion
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

Protective devices concept

NEC, UL and IEC requirements of motor circuits

Short-circuit current rating

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
Overcurrent protection, SCCR & A New VFD UL Standard

Definitions

- Protective devices concept
- NEC, UL and IEC requirements of motor circuits
- Short-circuit current rating
- UL 61800-5-1: A New UL Standard for Drives
- SCCR of Siemens VFDs
Overcurrent protection and SCCR
Definitions

What is Overcurrent (OC)?

Any current in excess of the rated current of equipment or the ampacity of a conductor

• The excessive current may result from overload, short-circuit or ground fault

What is Overcurrent (OC) protection?

A protection provided by a device which is intended to protect an electric circuit or parts of an electric circuit over the full range of overcurrents between its rated currents and its interrupting rating – includes overload (OL) and short-circuit (SC) protection

• Non-motor circuit: A single device can provide the overcurrent protection, i.e. SC and OL protection

• Motor circuit: Separate devices are required for the SC and OL protection

Exception: a very small motor
Overcurrent protection and SCCR
Definitions

What is Overload (OL)?

An operation or operating condition of any equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating

- Represented by inverse time curve
- Typically up to 6 (or 10) times rated current
- A fault, such as a short circuit or ground fault is not an overload
- Overload condition for motor circuit:
  - Failure to start
  - Running overload
Overcurrent protection and SCCR
Definitions

What is Overload (OL) protection?
A protection provided by a device which is intended to protect an electric circuit or parts of an electric circuit to prevent excessive heating when a current in the circuit exceeds a predetermined value above the rated current for a specified duration.

Sometimes OL condition is desirable for certain applications for a short period within the thermal limit of a component/conductor.

Effects
• Excessive heating may cause “Slow burn”
• Damaged conductors and components, deteriorated insulation causing risk of SC and/or electric shock and/or fire

Designed for → Slow current rise - Long duration - Slow response time (Slow operating speed)
What is a Short-Circuit (SC)?

An abnormal connection (including arc) of relative low impedance, whether made accidentally or intentionally, between two points of different potentials.

Symmetrical or Asymmetrical

Typically >10-20 times the rated current
Overcurrent protection and SCCR
Definitions

What is Short-Circuit (SC) protection?
A protection provided by a device which is intended to protect an electric circuit or parts of an electric circuit against short-circuit currents by interrupting them.

Effects
- Very high fault currents lead to
  - Electromagnetic forces deform or break conductors and supports
  - Rapid and extreme overheating causing damages to the insulation, wires, busbars, components, supports etc.
- Saturate core of reactor or transformer leading to further overheating and damages
- Create resonance by interaction with other power system components
- High risk of electric shock or fire

Designed for → Fast current rise - Short duration - Quick response time (Fast operating speed)
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

**Protective devices concept**

NEC, UL and IEC requirements of motor circuits

Short-circuit current rating

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
Protective devices concept
Characteristics of Over Current Protective Devices (OCPD)

Represented by tripping (or time-current) and let-through characteristics

Performance is determined by comparison of peak let-through current ($I_p$ in Ampere) and let-through thermal energy ($I^2t$ in A$^2$ sec)
### NEC and UL requirements of motor circuits

#### UL – fundamental differences among OCPD types

<table>
<thead>
<tr>
<th>UL standards</th>
<th>Non-semiconductor fuse</th>
<th>Semiconductor fuse</th>
<th>Circuit Breaker</th>
<th>Manual Motor Controller &amp; Type E CMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has standard physical size?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Available with standard characteristic?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Max ( I_p ) &amp; Max ( I^2t ) defined for each type?</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Is substitution allowed for UL?</td>
<td>Yes</td>
<td>1) No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

1) Same class fuse from any manufacturer only if UL certification is done using UL umbrella (test limiter) fuse

Unrestricted © Siemens 2020

Page 14
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

Protective devices concept

**NEC, UL and IEC requirements of motor circuits**

Short-circuit current rating

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
NEC, UL and IEC requirements of motor circuits
NEC Article 430

...specifies requirements for motors, motor branch / feeder / control circuits, conductors & their protection, motor overload & over temperature protection, and motor controllers

**Feeder Circuit:** Conductors and circuitry on the supply side of the branch circuit overcurrent protective device

**Branch Circuit:** Conductors and components following the last overcurrent protective device protecting a load

Per the NEC the **motor** is the device being protected – the presence of a motor controller (e.g. a ASD) for OC protection was largely irrelevant few code cycles back

**Now can be sized per input current of ASD (430.128 & .130)**

ASD – Adjustable Speed Drive
NEC, UL and IEC requirements of motor circuits

NEC requirements – Motor branch circuits

**NEC Article 430.109** permits use of OCPDs such as Circuit breakers, Self-Protected Combination Controller, non-semiconductor fuses with fuse disconnects as main disconnect

*Note:* Typically standalone UL recognized IEC fuses are NOT suitable for use as a main motor circuit disconnect

**NEC Article 430.110** specifies minimum rating of main disconnect as 115% of motor FLA and per **NEC Article 430.128** 115% of input current of ASD

**NEC Article 430.52** specifies maximum ratings or settings of motor branch circuit short-circuit and ground fault protective devices, for different types of power supply and motors e.g. Inverse time (thermal magnetic) circuit breaker max. 250% of FLA of a typical squirrel cage induction motor

**NEC Article 430.130** – Maximum rating shall not exceed ASD manufacturer’s specified value for a given & approved OCPD type

**NEC Article 210.20(A)** requires the motor branch circuit short-circuit and ground fault protective devices shall be rated or set at minimum 125% of the FLA
NEC, UL and IEC requirements of motor circuits

UL requirements – Motor branch circuits

End product UL standards for ASD e.g. **UL 508A, UL 845, UL 1995** etc. follows NEC requirements, for e.g. sizing and selection of main disconnect, OCPD, field wiring conductors, connectors etc.

**UL 508A Cl. 30.1** also permits use of OCPDs e.g. Circuit breakers, Self-Protected Combination Controller, non-semiconductor fuses with fuse disconnects as main disconnect

**Note**: Like NEC, UL 508A does not permit use of UL recognized IEC fuses as a main motor circuit disconnect

**UL 508A Cl. 30.2** specifies minimum rating of main disconnect (& OCPD) as 115% of motor FLA or ASD input current. **Exceptions**: Allows breakers marked for 100% continuous use, and also self protected combination motor controller sized at 100% of motor FLA or ASD input current

**UL 508A Cl. 31 & Table 31.2** specifies maximum ratings of motor branch circuit protective devices very similar to NEC article 430.52
# NEC, UL and IEC requirements of motor circuits

## NEC & UL 508A

<table>
<thead>
<tr>
<th>Fuse &amp; Fuse Disconnect</th>
<th>Circuit Breaker</th>
<th>Manual Motor Controller Type E CMC</th>
<th>Overload Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes 1)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Yes 1/2)</td>
<td>Yes 2)</td>
<td>Yes 2)</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1) When used with UL98 fusible switch

2) Additional contactor with overload relay typically require

---

1) When used with UL98 fusible switch

2) Additional contactor with overload relay typically require
NEC, UL and IEC requirements of motor circuits

IEC approach – Motor branch circuit

Line side protection is selected based on the device that is connected to the supply, in this case a ASD.

A circuit breaker and/or fuses and fuse holders are selected on the basis of max. continuous nominal input current.

Overload currents must also be considered with respect to characteristics of OCPD (i.e. Time-current and $I^2t$) to appropriately size the OCPD and prevent its false operation.

The fact that a motor is connected to the output of the ASD is largely irrelevant; since there is no circuitry that would allow the motor to be started across the line, the across the line inrush current is not considered.
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

Protective devices concept

NEC, UL and IEC requirements of motor circuits

**Short-circuit current rating**

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
What is Short-Circuit Current Rating (SCCR)?

NEC and UL508A definition

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 acceptance criteria.

Equipment SCCR ≥ Available SC current from a supply source.

SCCR requirements effective NEC 2005.

NEC Articles 409 and UL508A state the requirements of ICP – Article 409.110 → SCCR marking on ICP.
What is Short-Circuit Current Rating (SCCR)?

SCCR per UL 508A Supplement SB

**Step 1** Determine marked SCCR of each *UL certified* component

**Step 2** Use SCCR from the tested component combinations (e.g. for fuse/CB + contactor + OL Relay combo)

**Step 3** Consider SCCR from Table SB4.1 for a *UL listed* component for which no SCCR information is available from its nameplate or product documentation

---

Table SB4.1

<table>
<thead>
<tr>
<th>Component</th>
<th>Short circuit current rating, kA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus bars</td>
<td>10</td>
</tr>
<tr>
<td>Circuit breaker (including OFCI type)</td>
<td>5</td>
</tr>
<tr>
<td>Current meters</td>
<td>5</td>
</tr>
<tr>
<td>Current shunt</td>
<td>10</td>
</tr>
<tr>
<td>Fuselink</td>
<td>10</td>
</tr>
</tbody>
</table>
| Industrial control equipment:  
  a. Auxiliary devices (overload relay) | 5                  |
  b. Switches (other than mercury tube type) | 5                 |
  c. Mercury tube switches:  
    Rated over 60 amperes or over 250 volts | 5                |
    Rated 250 volts or less, 60 amperes or less, and over 2 kVA | 3.5              |
    Rated 250 volts or less and 2 kVA or less | 1                |
| Motor controller, (including combination motor controllers, float and pressure operated motor controllers, power conversion equipment and solid state motor controllers), rated in horsepower (kW):  
  a. 0–50 (0–37.3) | 100                         |
  b. 51–200 (38–149) | 5                           |
  c. 201–400 (150–266) | 10                          |
  d. 401–600 (296–447) | 30                          |
  e. 601–900 (486–671) | 42                          |
  f. 901–1000 (792–1150) | 85                          |
| Meter socket base | 10                          |
| Miniature or miscellaneous fuse | 10                        |
| Receptacle (OFCI type) | 2                           |
| Receptacle (other than OFCI type) | 10                          |
| Supplementary protector | 0.2                       |
| Switch unit | 5                            |
| Terminal block or power distribution block | 10                        |
| Multi point interconnection power cable assembly | 6                          |

* A short circuit current rating is not required when connected via a current transformer or current shunt. A directly connected current meter shall have a marked short circuit current rating.

* The use of a miniature fuse is limited to 125-volt circuits.

* Standard fault current rating for motor controller rated within specified horsepower range.

* Highest rated horsepower of motor controller.
What is Short-Circuit Current Rating (SCCR)?

Overall SCCR of ICP – example

= Smallest SCCR of all power circuit components and control circuit OCPDs

Standard SCCR of unmarked motor controllers

<table>
<thead>
<tr>
<th>Motor Controller Rating (Hp)</th>
<th>SCCR, kA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 50 (0 – 37.3)</td>
<td>5</td>
</tr>
<tr>
<td>51 – 200 (38 – 149)</td>
<td>10</td>
</tr>
<tr>
<td>201 – 400 (150 – 298)</td>
<td>18</td>
</tr>
<tr>
<td>401 – 600 (299 – 447)</td>
<td>30</td>
</tr>
<tr>
<td>601 – 900 (448 – 671)</td>
<td>42</td>
</tr>
<tr>
<td>901 – 1600 (672 – 1193)</td>
<td>85</td>
</tr>
</tbody>
</table>

Main disconnect
Motor branch circuit protection
Motor controller
Motor overload protection
Motor

Overall SCCR = 5kA

\[ I_c = 65\text{kA}, \quad 480V \]

\[ I_c = 100\text{kA}, \quad 480V \]

SCCR = 5kA
SCCR = 10kA

Ic = 65kA, 480V

Ic = 100kA, 480V

SCCR = 5kA
SCCR = 10kA
What is Short-Circuit Current Rating (SCCR)?
“Standard” and “High” SCCR Values

**Standard SCCR** - Minimum UL Shot-circuit current test requirements *(per UL)*

**High SCCR** - High fault current at which equipment are additionally tested *(per Manufacturer)*

<table>
<thead>
<tr>
<th>Output Power of the Electric Drive “Motor Controller” (kW)</th>
<th>Standard SCCR per UL508A [kA]</th>
<th>UL Approved High SCCR [kA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 50 (0 – 37.3)</td>
<td>5</td>
<td>65</td>
</tr>
<tr>
<td>51 – 200 (38 – 149)</td>
<td>10</td>
<td>65</td>
</tr>
<tr>
<td>201 – 400 (150 – 298)</td>
<td>18</td>
<td>65</td>
</tr>
<tr>
<td>401 – 600 (299 – 447)</td>
<td>30</td>
<td>65</td>
</tr>
<tr>
<td>601 – 900 (448 – 671)</td>
<td>42</td>
<td>84</td>
</tr>
<tr>
<td>901 – 1600 (672 – 1193)</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

So what is the significance of the standard SCCR values?

- Can we use the standard SCCR for a non-UL listed (or untested) device?
- OCPDs which were used for a drive UL certification & specified by a drive manufacturer, are required **only** when we would like to use high SCCR *(Correct or Incorrect?)*
What is Short-Circuit Current Rating (SCCR)?
“Standard” and “high” SCCR Values, cont’d

Those are common misconceptions

Basically, the standard SCCR is the minimum value that UL would expect a particular type and rating of device to be tested at

For that reason, when determining the SCCR of a circuit, the standard SCCR can be used if the “high” SCCR of a UL listed device or component is unknown

So in summary:

• If the **actual SCCR** value of a listed device is known, the standard SCCR is of no significance

• **Standard as well as high SCCR** – The value is only valid in combination with specific OCPDs which are listed in the operating manual
  And if those protective devices are not listed for motor branch circuit protection, then additional devices are needed to comply with NEC!
Short-circuit current rating per IEC

Until Ed 2.1 which was published in Mar 2017 as a result of NEMA, UL and IEC harmonization efforts, IEC std did not have any SCCR marking requirement, nor did they use or define the term SCCR.

However, previous editions of IEC 61800-5-1 before Ed 2.1 did require short-circuit tests as part of type testing of a drive product, to confirm the maximum permissible short circuit current the device may be exposed to.

Now the short-circuit test requirements of IEC 61800-5-1 Ed 2.1 and UL 61800-5-1 (or its predecessor UL508C) are very similar, and hence now, the SCCR (per UL) and max. short circuit current (per IEC) are the same.

Values published for IEC drives (CE mark) actually use the results from the UL short-circuit tests.

SINAMICS OCPD & SCCR information sheet specifies list of European OCPDs for IEC applications.
Overcurrent protective devices (OCPD) need to protect equipment from
• High short circuit currents
• Overload currents applied for too long a duration

However, they must allow typical duty cycle overloads
• OCPDs have a current vs. time characteristic which is used to select them
• If the supply system is weak (high source impedance) fault currents (short circuit current) will be lower than expected, and in extreme cases the fault current may be too low to cause the fuse or circuit breaker to trip

Therefore, to ensure that the OCPD will function in normal operating condition and isolate the drive circuit as expected during over current condition within an acceptable time period, minimum available short circuit current values are provided

Rule of thumb: \( I_{SC\ min} \approx I_N \times 15 \)
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

Protective devices concept

NEC, UL and IEC requirements of motor circuits

Short-circuit current rating

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
UL 61800-5-1: NEW UL Standard for Drives

Background

Motivation:
• Create a **single global set of requirements** for the design of low voltage (LV) drive products
• **Reduce design, testing & certification burden** for drives which otherwise would require compliance with at least two different sets of requirements i.e. UL 508C (for UL marking typically in North America) and EN / IEC 61800-5-1 (for CE marking typically in Europe and rest of the world)
• Help create a **single design of LV drive products** which can be used **globally**

Requirements:
• Develop a **new global UL standard** for LV drives by bringing UL 508C & IEC 61800-5-1 closer together **through harmonization** of their requirements
• UL 508C + IEC 61800-5-1 + **Additional UL requirements** (incl. CSA C22.2 No. 274) = **UL 61800-5-1**
• **Most rigorous** construction & performance requirements to ensure **improved product safety**

Development:
• Standard harmonization and development efforts are on going
• 1st harmonized version **UL 61800-5-1 Ed 1.0** was **published on Jun 8, 2012**
• **UL 508C** has been **withdrawn** and **replaced by UL 61800-5-1** as of **Feb 1, 2020**
UL 61800-5-1: NEW UL Standard for Drives
Major differences: UL 61800-5-1 (New) vs UL 508C (Old)

UL 508C has been obsolete & withdrawn by UL as of Feb 1, 2020 and replaced by UL 61800-5-1

UL 61800-5-1 is now the only valid UL standard available for UL certification of the low voltage drives

• A reference to obsolete UL 508C is being replaced with NEW UL 61800-5-1 in ALL UL standards including UL 508A (Panels), UL 845 (MCC), UL 1995 (Heating & Cooling equipment) & others

UL 61800-5-1 has more stringent construction and performance (testing) requirements than UL 508C

UL 61800-5-1 requires short-circuit tests at:

• Standard (e.g. 5kA, 10kA, etc.) as well as
• High-fault currents (e.g. 65kA, 100kA, etc.)
• On ALL output terminals (including DC terminals)

Note: This is only a list of most significant differences between UL 61800-5-1 and UL 508C and not a complete list.
UL 61800-5-1: NEW UL Standard for Drives
Major differences: UL 61800-5-1 (New) vs UL 508C (Old), cont’d

UL 61800-5-1 also requires **Breakdown of Component (BoC) tests** at:

- **Standard** (e.g. 5kA, 10kA, etc.) as well as
- **High-fault currents** (e.g. 65kA, 100kA, etc.)
- Contrary to the tests in withdrawn UL 508C, the **internal components** of a drive are **truly experiencing the actual let-through current at these fault currents**

Overall **UL 61800-5-1** requires more number of rigorous destructive tests on more number of test samples representing real life drive operations / applications in contrast with obsolete & withdrawn UL 508C

Contrary to UL 508C, **UL 61800-5-1 has been maintained and kept up-to-date** with the changes in the National Electrical Code (NEC/NFPA 70) as well as through the **updates of existing requirements** and **addition of new requirements** with new emerging technologies and drive applications

Ultimately **UL 61800-5-1 ensures a safer and more robust product**

---

**Note:** This is only a list of most significant differences between UL 61800-5-1 and UL 508C and not a complete list.
UL 61800-5-1: NEW UL Standard for Drives
Major differences: UL 61800-5-1 (New) vs UL 508C (Old), cont’d

Additional technical information on major differences available on UL and NEMA websites
UL 61800-5-1: NEW UL Standard for Drives
UL 508C to UL 61800-5-1 transition timeline

UL process of withdrawal of UL 508C and implementation of NEW UL 61800-5-1 for drives

UL 61800-5-1 Ed. 1.0 Published
Jun 8, 2012

UL 61800-5-1 is MUST for NEW drive products
Feb 1, 2016

UL 508C WITHDRAWN & replaced with UL 61800-5-1
Feb 1, 2020


UL 61800-5-1
Manufacture’s choice – can be used for existing or NEW drive products

UL 61800-5-1
MUST for NEW drive products

UL 508C
Manufacture’s choice – can be used for existing or NEW drive products

UL 508C
ONLY for legacy/existing drive products

UL 508C
WITHDRAWN

UL process of withdrawal of UL 508C and implementation of NEW UL 61800-5-1 for drives
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – To drive end users/customers, cont’d

What does this UL change mean to the drive end customers / users?

Many industrial customers/equipment owners/users (e.g. in automobile, water / waste water, infrastructure, construction, oil & gas, metals, pulp & paper etc.)

• already have been specifying UL 61800-5-1 listed drives in their requirement / bid specifications,

• DO NOT allow use of UL 508C certified drives anymore

Customer specifications have already started demanding the OEMs/system builders & consequently, the drive manufacturers to supply UL 61800-5-1 listed drives
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – To drive end customers / users

What does this UL change mean to the drive end customers / users? [Cont’d]

UL 508C is withdrawn & UL 61800-5-1 is the only UL standard for drives, and UL announced removal of references to UL 508C & their replacement with UL 61800-5-1 in ALL UL standards e.g. UL 508A, UL 845, UL 1995 etc.

It becomes prudent to use latest technology drives in equipment (i.e. panel, MCC or chiller etc.) which are designed with the latest & most rigorous safety requirements according to UL 61800-5-1

• **DO NOT** want to use obsolete & outdated technology drive product that is designed with safety requirements that have not been up to date with NEC/NFPA 70

AHJ / electrical inspectors in many counties and cities have already been increasingly demanding UL 61800-5-1 listed drives in equipment or panels at the end customers’ / users’ or equipment owners’ sites
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – To OEMs and system/panel builders

What does this UL change mean to OEMs & system / panel builders?
Following the UL withdrawal of old UL 508C, although, OEMs and system or panel builders using drives (e.g. Panels, MCC, HVAC, Chiller etc.) will have some time to change design of their products and switch to UL 61800-5-1 listed drives in their equipment,

- Due to specifications from industrial users / customers demanding the latest & new technology UL 61800-5-1 listed drives, the OEMs and system or panel builders will have to adapt to this change sooner than later, and
- Need to start modifying their equipment design to use UL 61800-5-1 listed drives to become ahead of the curve and hence ahead of their competition

Which means, demand from OEMs and system or panel builders for latest & new technology UL 61800-5-1 listed drives will increase for use in their equipment (e.g. Panels, MCC, HVAC, Chillers etc.)
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – To drive manufacturers

What does this UL change mean to drive manufacturers?

According to UL test & certification group within UL LLC, any drive products which are listed according to UL 508C will remain UL listed until those will be modified (i.e. typically requiring changes to construction or design of a drive)

However, following the UL withdrawal of old UL 508C, the drive manufactures are now expected to supply **UL 61800-5-1** listed drives ONLY, and **will face extreme difficulty** in convincing customers, system or panel builders, OEMs to use drives certified according to outdated, obsolete technology & already withdrawn UL 508C in their equipment

Ultimately, drive manufactures who have not followed the UL process of transition from UL 508C to **UL 61800-5-1** within last almost 8 years timeline allowed by UL, and if are significantly behind in modifying & certifying their drive products according to **UL 61800-5-1** will face great challenges now to respond to the market requirements & demand
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – To retrofit or repair projects

Retrofit or repair of equipment comprised of UL 508C listed drives

UL compliance of an electrical system / equipment after retrofit or repair at the end customer / equipment owner site does not fall under UL’s responsibility / jurisdiction unless being specified in equipment retrofit or repair specifications

• UL field inspection group (or any other NRTL) needs to be engaged to carry out field inspection and approval of the finished equipment after retrofit or repair

• In such cases, whether to use the same old UL 508C listed drive or its UL 61800-5-1 listed successor is solely at discretion of end customer / equipment owner

• However, following UL announcement of UL 508C withdrawal, AHJs / electrical inspectors and hence, end customers / equipment owners have already started specifying UL 61800-5-1 listed drives for a retrofit or repair of their equipment / panel

• OEMs / system or panel builders already ahead of the curve and adapted to this UL change by modifying their equipment design using UL 61800-5-1 listed drives & ready to offer replacement in the field per customer specs, will certainly have better chances of winning such retrofit or repair opportunities
UL 61800-5-1: NEW UL Standard for Drives
Impact to industry – Key takeaways

UL 61800-5-1 has more stringent construction and performance (testing) requirements

- Requires more number of destructive tests → Represent real life drive operation / applications
- Requires more rigorous testing of more number of drive test samples as compared to old & withdrawn UL508C

UL 61800-5-1 is the ONLY valid UL standard for low voltage drives as UL 508C has been obsolete & withdrawn from Feb 1, 2020

- References to old & withdrawn UL 508C are being replaced with NEW UL 61800-5-1 in ALL UL standards including UL 508A (Panels), UL 845 (MCC), UL 1995 (HVAC/R)

End customers have already started specifying use of UL 61800-5-1 listed drives

OEMs / System or Panel Builders:

- Need to adapt this UL change (UL 61800-5-1 listed drives) sooner than later
- Should be proactive and start modifying the design of your equipment / panel quickly to replace old UL 508C listed drives with their equivalent UL 61800-5-1 listed drives
- Faster implementation of such design change will help address the new customer requirements more effectively & get better market exposure

Ultimately end customers will get the latest technology, safer & more robust drive products
Overcurrent protection, SCCR and a new VFD UL Standard

Definitions

Protective devices concept

NEC, UL and IEC requirements of motor circuits

Short-circuit current rating

UL 61800-5-1: A New UL Standard for Drives

SCCR of Siemens VFDs
UL Testing and Certification mostly with specific fuses
And according to old standard, UL508C

Fuse type and rating used for testing is required to achieve SCCR, and is therefore mandatory for UL listing.
Without this fuse the UL listing is invalid, and SCCR = 0

UL 508C has been withdrawn by UL from Feb 1, 2020 – Click here

VFD SCCR Prevalent in North America
65kA or 100kA @ 480V
UL 508C Listed

Fuse types:
- Class J
- Semiconductor

A typical non-Siemens VFD
UL applications: **No other option** for OC protection of a non-Siemens VFD

Specific fuse always required – **No flexibility** in panel design & construction, & also in the field

“Semiconductor” fuse can’t be used as main BCP for enclosed panels, hence additional main BCP (CB or MSP) with disconnect function is required for Lock-Out Tag-Out (LOTO) per OSHA → **Redundant OCPD**

• If “semiconductor fuse” then single supply chain can interrupt process / plant continuity in case of no spares and unavailability of fuses from manufacturer

Class J or T fuse can be used as main BCP however, an **additional fuse disconnect** is required for disconnect function → typically larger and more expensive than equivalent CB or MSP

Requires more cabinet space, i.e. **bigger enclosure**

Increased product cost

Makes the panel / end product **non-competitive and unsuitable**

Requires fuses in spare stock to maintain process continuity

Increases overall cost of ownership
SCCR of Siemens VFDs
Example: SINAMICS G120/G120C/G120X

Determined by testing with many different types of Over Current Protective Device (OCPD) – i.e. breakers, MSPs and fuses

UL Testing and Certification according to **new** standard **UL61800-5-1**

<table>
<thead>
<tr>
<th>SINAMICS G120 VFD SCCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 100kA (^1) @ 240V, 480V and 600V</td>
</tr>
<tr>
<td>UL61800-5-1 listed</td>
</tr>
</tbody>
</table>

Any OCPD from a wide variety of Siemens breakers or MSPs or fuses (non-semiconductor or semiconductor) may be used to achieve the desired SCCR

\(^1\) SCCR of 100kA can be achieved using Siemens SENTRON current limiting breakers, certain types of NEW 3VA breakers and fuses (Class J, CC, CF, T, etc.)
SCCR of Siemens VFDs
Advantages of more OCPD choices with Siemens VFDs

Wide choice of UL approved Over Current Protective Devices (OCPD)
- Almost all types of UL-listed Siemens circuit breakers and motor starter protectors (e.g. 3RV type) for US market
- Significantly increases flexibility of panel design & construction, & also in the field
- Easy retrofit possible → Existing Siemens circuit breaker or MSP or non-semiconductor fuses may be used
- Eliminates need for redundant OCPDs and improves protective device coordination
- Reduces overall product (panel) & manufacturing costs

High SCCR up to 100kA according to UL 61800-5-1
- Improves product safety from destructive fault currents
- Provides better protection and reduces risks of property damage & personnel injury
- Helps mitigate or eliminate incidents and hence OSHA non-conformances
- Potentially helps reduce insurance costs, PPE requirements
- Reduces overall cost of ownership
### SCCR of Siemens VFDs

SCCR of UL Open Type SINAMICS Drives

<table>
<thead>
<tr>
<th>SINAMICS V20</th>
<th>SINAMICS G120X / G120 / G120C / G120D</th>
<th>SINAMICS S120 Booksize Line Module</th>
<th>SINAMICS S210</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
</tbody>
</table>

- **up to 100kA**
- **SIOS Link**
- **SCCR lower than shown here is possible depending upon the drive rating, type of OCPD used**

**Product information on Siemens Industry Online Support (SIOS)**

---

1) SCCR lower than shown here is possible depending upon the drive rating, type of OCPD used
Overcurrent protection, SCCR and a new VFD UL Standard
Thank you for attending today’s presentation!

Nikunj Shah
Development and Certification Manager

Siemens Industry, Inc.
Digital Factory — Motion Control
5300 Triangle Parkway, Suite 100
Norcross, GA 30092

nikunj.shah@siemens.com

usa.siemens.com/lv-drives