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Whitepaper

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Edition
2020

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NEMA 1 ≠ UL Type 1
UL Type 1 > NEMA 1

A short prospectus

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In this paper, the author examines the various characteristics of electric drive enclosures labeled NEMA 1 and UL Type 1, detailing the differences and similarities, with an explanation of why the NEMA enclosure rating does not equate to the apparently similar UL enclosure rating, while products with the UL rating do indeed meet and exceed all relevant requirements of the NEMA specification for use in the U.S. industrial and building markets.

Enclosed drive market overview and comparison of NEMA vs. UL type rating requirements

Enclosed drives are estimated to represent between 45–55% of the total drives market worldwide. While NEMA1 (IP21) drives constitute the majority, others include NEMA12 (IP54), NEMA4 (IP66) and NEMA3R (IP24) versions. Many are for new installations, but many others are used in retrofit installations ranging from across-the-line start to variable frequency drive (VFD) control.

Because the NEMA enclosure type rating is self-certifying, this means the rating is dependent upon the manufacturer's compliance with published standards for enclosure protection.

By contrast, for UL enclosure type rating and listings (whether for indoor or outdoor applications), certification / compliance testing must occur in a very rigorous method and following a rigid protocol to ensure product safety, by the third-party certification agency such as UL or any other NRTL*.

For an add-on kit or enclosure to have "UL Type" enclosure rating and to use it to convert a UL open type variable frequency drive (VFD) into an enclosed UL Type 1 VFD, UL testing is performed not only according to UL enclosure standards (UL 50 / 50E), but also according to new standard UL 61800-5-1 (which recently replaced UL 508C**) for VFDs, with respect to electrical, thermal and energy safety considerations. Such enclosed UL Type 1 VFDs are typically wall- mounted and found on centrifugal pumps, radial / axial fans, compressors, screw pumps, hydraulic pumps, dosing pumps and all types of conveyorized equipment, plus hoists, cranes, test stands, mills, mixers, centrifuges, extruders, winders, printing presses, machine tools and packaging machinery, in both continuous and discontinuous motion applications. These kinds of wall-mounted UL Type 1 VFDs are also widely used in infrastructure, building automation and construction industries for HVAC/R, and water and wastewater applications.

Why is a UL Type 1 rated outer enclosure or add-on kit required for UL open type (IP20) drives?

For a UL open type (IP20) drive, protection must be provided against direct or indirect contact of hazardous parts as well as electrical, thermal and energy hazards potentially present in the end-use equipment. This is also to ensure product and personnel safety, and to avoid property damage due to electrical failure or fire. VFD manufacturers routinely provide either a standard approved enclosure or a mechanical adapter kit for converting a UL open type drive into an enclosed version, and attach conduit, and other hardware as required during the final installation as per the NEC and / or the local electrical codes and regulations.

Often in retrofit applications, especially when traditional electro-mechanical controls are being replaced with VFDs, there is frequently no space in the existing enclosure for a VFD or any additional hardware or components—meaning a mounting must occur outside and external to the equipment enclosure—for example, a panel, motor control center (MCC) or HVAC equipment.

*Nationally Recognized Testing Laboratory

**UL 508C for VFD has been withdrawn by UL as of Feb 1, 2020 and replaced with UL 61800-5-1. To learn more, follow these UL links:.https://collateral-library-production.s3.amazonaws.com/uploads/nfp/nfp_asset/attachment/1373/UL_508C_WD.pdf
https://connect.ul.com/Webinar-508C-MotorDriveStandard-OnDemand_TY.html

In such cases, a wall-mount enclosed VFD with a minimum "UL Type 1" rating (and not just a "NEMA Type 1" or "Type 1" rating) is required according to NEC or local electrical installation codes and regulations.

In a new machine or mobile electrical power unit—for example, whether the enclosure is stationary or portable, which could be found in a process industry location such as oil field operations or spill recovery systems—it is often necessary to mount the drive separately from other controls, the power supply, PLC, etc. This further facilitates easier maintenance; however, in such cases, the additional protection level using at least the UL Type 1 cabinet becomes more critical.

To comply with the requirements of local electrical codes and regulations for installation and wiring of "UL open type or IP20 drives", as well as the requirements of UL and NEC for overall "listed" equipment, such kits or enclosures used to install UL open type drives must be at least rated "UL Type 1", and the use of "NEMA 1" or "NEMA Type 1" or simply "Type 1" rated enclosures or kits is not permitted. This is also mandatory for the compliance with OSHA for the safety of workers. Therefore, the desired minimum installation requirement is a UL-Listed open type drive + UL Type 1 enclosure / kit.

These UL enclosure / kit ratings (UL Type 1, 12, 3R, etc.) comply with construction and performance (testing) in accordance with UL 50 and UL 50E + End Product Standard (in the case of VFDs—it is UL 61800-5-1).

Certification processes require that the design be thoroughly evaluated and additionally tested by a third-party certification agency or NRTL (e.g. UL).

When a kit is deemed to be UL Type 1, it provides users with the following:
■ Design per UL 50 and UL 50E + UL 61800-5-1 for drives
■ Comprehensively tested by an independent third-party certification agency such as UL, ensuring the highest level of product safety
■ UL-Listed "Open / IP20" drive + UL Type 1 kit compliant with overall UL Type 1 equipment listing
■ Elimination of potential hazards and associated OSHA non-conformities in the final installation
■ Reduction in liability and property insurance

Figure 1
UL Type 1 kit benefits

What to look for in available kits in the market today and consequences of using only NEMA rated kits or enclosures

Most of the add-on enclosures or kits currently available in the market are rated "NEMA Type 1 or NEMA 1" or simply mentioned as "Type 1" in the product documentation supplied by manufacturers. These may not be true "UL Type 1" kits or enclosures as required to comply with UL listing requirements or installation requirements of NEC. Moreover, such NEMA rated kits or enclosures are not typically tested either by third-party certification agency such as UL or even by VFD manufacturer to ensure that they provide adequate product and personal safety, and also do not pose a risk of property damage.

Additionally, even if marked as "UL Type 1" kit, many such kits currently available in the market are tested and listed according to the old, obsolete and withdrawn UL standard for drives, namely UL 508C. Currently, UL 61800-5-1 is the only UL standard available for the safety of the VFD and VFD + UL type 1 kits.

How to make sure that kits are truly UL Type 1?

Before purchasing or using such kits for the VFD in their application, users are encouraged to ensure the compliance of these kits and the associated VFD by carefully checking the listing of their part numbers on the UL website. Alternatively, users may also request the UL file number of the kit and VFD to a manufacturer to ensure their proper UL compliance by carefully checking the listing of their part numbers on the UL website as mentioned above.

Siemens made UL type 1 kits already compliant with the latest and the most rigorous UL standard of the VFD—UL 61800-5-1, and this UL listing of kits and associated VFD can be easily validated by checking the kit part numbers on the UL website or using the UL file numbers E121068 (for kits 1–4) and E192450 (for kits 5–7).

Using unevaluated or only NEMA-rated kits will not only violate UL and NEC requirements, but also pose a severe risk of personnel injury or property damage, and associated OSHA non-conformities. This will result in significant financial risks and disciplinary actions by the government including, but not limited to, penalties, litigations, as well as defamation.

References to the old and withdrawn UL 508C standard are being replaced with the new UL 61800-5-1 standard in all UL documents and equipment standards, which includes but is not limited to UL 508A (Industrial Control Panels), UL 845 (Motor Control Centers), UL 1995 (Heating and Cooling Equipment) and many others where VFD is being used.

To avoid using products that are certified according to outdated, obsolete technology and using old and withdrawn UL 508C, users should ensure that the new equipment they are using meet the latest technology and enhanced safety requirements according to the new

Figure 2
Example of a Siemens UL Type 1 kit, which provides easier access for installation, wiring and maintenance.

Figure 3
Example of the Siemens UL Type 1 kits from fractional to 200 hp.

standard UL 61800-5-1. The old UL 508C standard was neither maintained to meet the latest technology and application requirements of VFDs, nor was it kept up-to-date with constantly changing safety requirements of the NEC / NFPA 70. UL 61800-5-1 is the latest standard for VFDs and has more stringent construction and testing requirements, which are also in alignment with the latest electrical code requirements (NEC / NFPA 70).

What and why is there a new drive standard UL 61800-5-1?

The new standard UL 61800-5-1 was developed with a single global set of requirements for the design of low-voltage VFD products. Originally, this new standard was created taking requirements from UL 508C, IEC 61800-5-1 and the CSA standard for drives CSA C22.2 No. 274. However, additional new requirements have also been added in to the final published version of this new UL 61800-5-1 to fill the gaps which existed in the parent UL, IEC and CSA standards.

The result is the most stringent new global standard for the safety of VFDs. Therefore, UL 61800-5-1 calls out a more stringent construction and performance (testing) requirements as compared to obsolete and withdrawn UL 508C.

Contrary to old UL 508C, the short-circuit tests according to UL 61800-5-1 are now required at standard fault currents (5, 10, 18, 42kA, etc.), as well as high fault currents (65kA, 100kA, etc.) on all output terminals available to the customer (including DC terminals).

Moreover, according to this new UL 61800-5-1, various breakdown-of-component tests by simulating the component failures within the drive are also carried out at the standard fault currents (5, 10, 18, 42kA, etc.) as well as high fault currents (65kA, 100kA, etc.). This is to ensure that the VFD together with these add-on UL Type 1 enclosures / kits meet enhanced product safety requirements.

UL 61800-5-1 requires a greater number of rigorous destructive tests on a greater number of test samples representing real-life drive operations / applications in contrast to the obsolete and withdrawn UL 508C. As a result, VFDs that are certified according to UL 61800-5-1 ensure a higher level of product safety and increased robustness.

To make certain that our customers comply to the latest standards and with a higher level of protection, Siemens offers kits for their SINAMICS G120C, SINAMICS G120 PM240-2 and PM240P-2 drives that are:

- Certified UL Type 1, according to UL 50 + UL 50E + UL 61800-5-1
- Certified NEMA Type 1, according to NEMA 250
- Designed by Siemens R&D, evaluated and fully tested by UL
- Rated with Short-Circuit Current Rating (SCCR) of 100kA

Conclusion

For maximum protection of property, equipment and personnel, it is highly advisable to consider the differences between NEMA 1 and UL Type 1 enclosures/kits for low-voltage electric drives. These ratings are not equivalent, and the independent lab testing done by UL ensures NEC/NFPA 70/OHSA installation compliance when sourcing products for a wide variety of new construction, new equipment and retrofit upgrades—both for stationary and mobile equipment.

Figure 4
Comparison of UL Certification types

	UL 61800-5-1	UL 508C
Construction Requirements		
Clearances and Creepage Distances NEW	✓ YES	✕ NO
Multiple Motor Control Application NEW	✓ YES	✕ NO
Across-the-Line Capacitors per UL 60384-14 NEW	✓ YES	✕ NO
Plenum Rating NEW	✓ YES	✕ NO
Motor Overload and Overtemperature Protection*	✓ YES	✕ NO
Performance Requirements		
Short-Circuit Tests on DC Output Terminals NEW	✓ YES	✕ NO
At standard fault currents (5, 10, 18kA etc.)	✓ YES	✕ NO
At high fault currents (65 or 100kA)	✓ YES	✕ NO
Breakdown of Component Tests NEW	✓ YES	✕ NO
At standard fault currents (5, 10, 18kA etc.)	✓ YES	✕ NO
At high fault currents (65 or 100kA)	✓ YES	✕ NO
Protective Bonding Tests NEW	✓ YES	✕ NO
Multiple Motor Control Application NEW	✓ YES	✕ NO
Fire Test for Plenum Rating per UL 2043 NEW	✓ YES	✕ NO
Tests for Motor Overload and Overtemperature Protection*	✓ YES	✕ NO
Line to Ground Short-Circuit Tests*	✓ YES	✕ NO
At standard fault currents (5, 10, 18kA etc.)	✓ YES	✕ NO
At high fault currents (65 or 100kA)	✓ YES	✕ NO

**Coming soon*

Additional resources

More technical details and information about the major differences between the new UL 61800-5-1 and old / withdrawn UL 508C can be found on the UL and NEMA websites.

Readers are encouraged to refer to these standards to see some serious and major differences in requirements between them, as well as the benefits of using UL 61800-5-1 VFDs.

- **UL webinar recording about the impact of withdrawal of UL 508C**
  This on-demand UL webinar recording is available to provide major differences between UL 508C and UL 61800-5-1, and how the VFD certification according UL 61800-5-1 helps reduce costs and time-to-market for product releases in global markets.
  Click here

- **UL notice of withdrawal of UL 508C**
  This UL notice was sent out to all UL subscribers (manufacturers) to inform them about the withdrawal of UL 508C references from all UL standards and their replacement with UL 61800-5-1.
  Click here

- **UL bulletin about the implementation of UL 61800-5-1**
  This UL bulletin provides details of UL STP (Standards Technical Panel) approved withdrawal plan of UL 508C and its replacement with new UL 61800-5-1 for continuing certification of adjustable speed drives.
  Click here

- **UL FAQ about implementation of UL 61800-5-1**
  This UL document presents frequently asked questions related to the UL STP- (Standards Technical Panel) approved withdrawal plan of UL 508C and its replacement with new UL 61800-5-1 for continuing certification of adjustable speed drives.
  Click here

- **NEMA paper on "New UL Variable-Frequency Drive Standard and its Effects on Unit Short-Circuit Rating"**
  This NEMA paper focuses on the impact of the new UL Standard UL 61800-5-1 on safety requirements for adjustable speed drives with respect to certification of these devices. Specifically, it addresses changes in the evaluation of short circuit ratings assigned by the drive manufacturer.
  Click here

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Published by
Siemens Industry, Inc.

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Order No. DRWP-ULN1X-0720

Printed in USA

usa.siemens.com/motioncontrol