

Impact of IEC 61800-5-1:2022 on variable frequency drives (VFD)



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Introduction

Customers have the legitimate expectation that products available on the market adhere to all relevant technical and legal requirements throughout their entire lifecycle. Generally, these assurances are embedded within market mechanisms and happen largely behind the scenes.

The latest edition of IEC 61800-5-1 is a notable exception to routine technical updates. This revision has significant implications for both manufacturers and market access. In Europe, where it has been adopted as EN IEC 61800-5-1, it serves as the main standard for the electrical safety of variable speed power drive systems. EN IEC 61800-5-1 is essential for demonstrating compliance with the European Low Voltage Directive (LVD).

With the former edition scheduled for withdrawal in October 2026, manufacturers should transition to the updated version to maintain conformity. Failure to do so can jeopardize the CE marking – ultimately making it unlawful to market drives within the European Union.

This white paper provides an overview of the new IEC 61800-5-1:2022 (Edition 3), highlighting key changes,

technical implications for products, and the resulting impact on European market access. It also discusses the potential benefits and considerations for users of drive systems.

In this document following convention is made for consistency and to ease readability:

Reference	Includes
IEC 61800-5-1:2007	IEC 61800-5-1:2007 (Edition 2.1). All later IEC amendments (e.g. IEC 61800-5-1:2007+AMD1:2016 CSV) and regional adoptions (e.g. EN IEC 61800-5-1:2007)
IEC 61800-5-1:2022	IEC 61800-5-1:2022 (Edition 3). All later IEC amendments (e.g. IEC 61800-5-1:2022/COR2:2025) and regional adoptions (e.g. EN IEC 61800-5-1:2023)

This document is intended to provide clarity on the related technical and regulatory landscape; however, it does not constitute legal advice.

Executive summary

Technical updates but legal challenge

The transition from IEC 61800-5-1:2007 to IEC 61800-5-1:2022 introduces additional complexity for manufacturers, machine builders, and system integrators compared to previous changes in standards. The main challenge lies in legal concerns, while the technical updates result in product and compliance benefits. The main good to know topics are:

- Installed IEC 61800-5-1:2007 drives can still be used in the field
(see [IEC 61800-5-1:2022 Impact and upsides](#))
- EN IEC 61800-5-1:2007 drives run the risk of being potentially unlawful in the European Union (EU), after the withdrawal date
(see [Impact on CE Mark](#))
- IEC 61800-5-1:2022 creates cost-saving opportunities in certification process
(see [Reduced compliance efforts](#))
- IEC 61800-5-1:2022 paves the way for reducing external components to mitigate risks
(see [Cost savings in installations](#))
- IEC 61800-5-1:2022 lowers the effort for designing machines globally
(see [Global relevance](#))

Recommendation

As user of drives you should consider taking following actions

- Check if you refer to EN IEC 61800-5-1:2007 in your CE declaration or Type test, and act if required
- Check with your drives manufacturer if there are any IEC 61800-5-1:2022 impacts on their drives affecting your products
- Evaluate savings due to IEC 61800-5-1:2022 in certification and by reducing components
- Ensure IEC 61800-5-1:2022 is added in your tenders starting 20 October 2026

The last point is particularly important in the EU, where it can affect both local production and imports. Using a withdrawn standard may also cause customs issues worldwide.

When on the EU market, specifying compliance with EN IEC 61800-5-1:2023 or later version ensures a more reliable approach.

The role of standards in product compliance

The following explanation provides high-level insight into the general principle of how standards are utilized. The section does not claim completeness or legal liability.

Standards, compliance and *State of the Art*

Global technical standards provide a common framework for designing, manufacturing, testing, and operating products, systems, and services across countries and industries. They ensure products meet recognized requirements, fostering trust and efficiency in international collaboration. Examples include:

- **ISO** – International Organization for Standardization (e.g., ISO 9001)
- **IEC** – International Electrotechnical Commission (e.g., IEC 60601)
- **IEEE** – Institute of Electrical and Electronics Engineers (e.g., IEEE 802)

Countries require products to meet safety, health, and environmental criteria for market access, often defined by standards. Standards typically reflect the *State of the Art* at publication, but technology evolves faster than the standardization process. As a result, the *State of the Art* may surpass existing standards, and compliance may require exceeding them to meet current technical expectations.

Referencing standards in legislation can be challenging when updates occur, making it essential to monitor revisions and ensure products remain aligned with both global standards and the latest *State of the Art*.

Regional adoptions of standards

IEC, ISO, or other international standards are voluntary by nature and have no legal force until they are adopted by national or regional standardization bodies. Such adoption grants them official status within a specific market and can directly link them to regulatory compliance.

In the European Union, IEC standards must be adopted by the European Committee for Electrotechnical Standardization (CENELEC) to become European Standards (EN). The EN IEC designation indicates that the IEC standard has been formally adopted by CENELEC as a European Standard, making it applicable across all EU and European Free Trade Association (EFTA) member states. The content of the standard remains identical to the original IEC text.

The same principle applies in many other regions, where international standards are adopted into local or regional versions to ensure legal recognition and alignment with regulatory frameworks.

The role of standards in product liability

Product compliance ensures a product meets all relevant laws, regulations, standards, and certifications before market release, addressing safety, environmental, and quality requirements. It is distinct from product liability, which applies if a product causes harm. Standards are central to both, serving as a basis for compliance and for assessing liability.

Courts often examine whether the latest standards were applied and if the product met the *State of the Art* or *State of Science and Technology*, which goes beyond standards. Manufacturers should monitor market and scientific developments and use the most recent standard revisions whenever possible.

Consult local legal experts for jurisdiction-specific guidance.

CE mark in the European Union

Products sold in the European Union must comply with the mandatory safety, health and environmental demands of the EU. Manufacturers must check the relevant regulations for their product and confirm compliance with a self-declaration. The process is described in detail here: www.europe.eu.

Standards are often used for proving compliance with the various demands. To make this assessment easier, the EU implemented the concept of harmonized standards. A harmonized standard has typically been adopted from an ISO or IEC (see [Regional adoptions of standard](#)).

When the harmonized standard is listed in the Official Journal and the underlying standard is still valid, it can be used to presume conformity. This process is outlined in the EU blue guide.

Standards which are harmonized, cited and still recognized by the European Standardization Organization (ESO) can be used for this legal presumption even if there is a newer version of the standard available. However, this does not release the manufacturer from the obligation to monitor and apply latest technical developments including latest revision of the standard. A detailed assessment ¹⁾ has been initiated by the German Association of machine builder (VDMA).

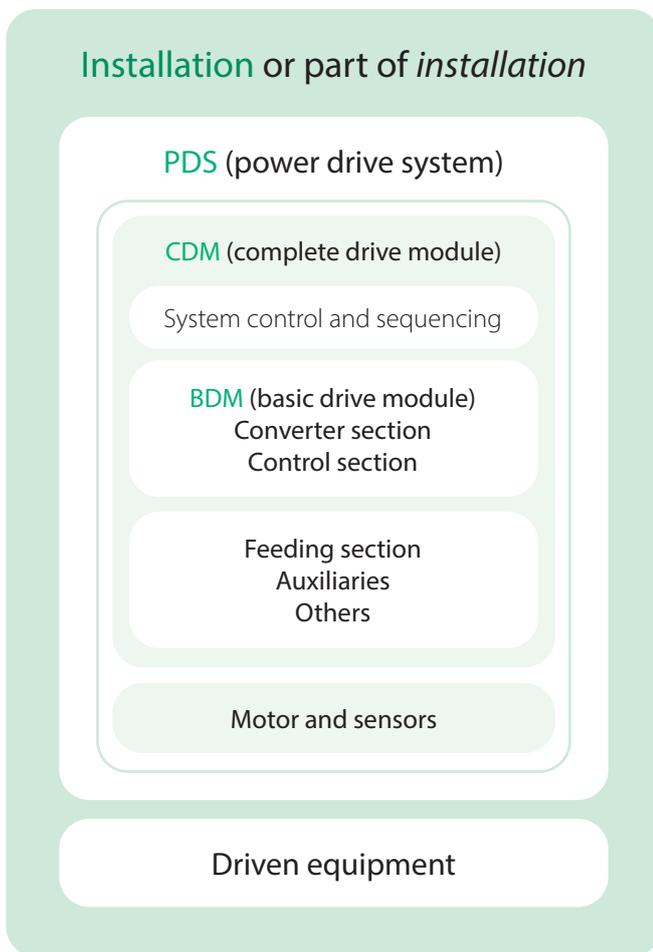


¹⁾ [VDMA, 2022, "Stand der Technik" - was Hersteller wissen müssen](#)

IEC 61800-5-1 in general

What is a PDS?

There are many names used for frequency converters. Most often the names *Variable Speed Drive (VFD)* or *Variable Frequency Drives (VFD)* or just *drives* are used. In related standardization they are defined as Complete Drive Module (CDM) consisting of a feeding section and one or many Basic Drive Modules (BDM). In connection with a motor the combination is called Power Drive System (PDS).



IEC 61800 standard family

In standardization two main categories can be distinguished: Horizontal and vertical product related standards. Horizontal standards apply across multiple products, sectors, or industries. They provide a common framework or test method that product-specific standards can reference to.

Vertical product related standards apply to a specific product or product category. They define detailed technical requirements, performance criteria, and safety measures for that product.

The general principle is that product standards have higher priority than horizontal standards as they are more specific to the product type.

For CDM, BDM and PDS the requirements are defined in the IEC 61800 standard family. As electrical motors play a vital role in a PDS there is a close interlink to the related IEC 60034 series.

IEC 61800-5-1 – electrical safety

Electrical safety for CDM/PDS is covered by the IEC 61800-5-1. It is the safety backbone standard for variable frequency drives, ensuring that the electrical, thermal, and energy aspects are designed and tested to protect users and equipment.

It aims to ensure that drives are designed and constructed to protect people, property, and the environment during installation, operation, maintenance, and disposal.

IEC 61800-5-1 addresses:

- Electrical Safety
- Thermal Safety
- Energy-related Safety
- Installation and Maintenance

Even though some products are excluded from the scope of this standard (traction and electrical vehicle BDM/CDM, household appliances with dedicated standards, etc.), the standard has a very high relevance for speed-controlled motors in industrial applications and commercial buildings.

IEC 61800-5-1:2022 (Edition 3)

Major changes in Edition 3.0

Edition 3.0 of IEC 61800-5-1, released in 2022 as IEC 61800-5-1:2022, is the latest major update. Local adoptions or subsequent amendments may carry different years, but the core content remains unchanged. For consistency, this document primarily refers to IEC 61800-5-1:2022, even in the context of the EU, where EN IEC 62800-5-1:2023 should be referenced. Edition 3 builds on Edition 2.1 and introduces several important changes that impact both manufacturers and users.

- Expanded Hazard Coverage
- Scope Adjustments
- Technical Refinements
- Documentation and Compliance

Furthermore, the use of a risk-based assessment concept is enforced.

Risk-based assessment

The concept of risk-based assessment was initiated through joint work by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) in the late 1980s and early 1990s. It was driven by the need to replace inflexible safety rules with a performance-based, hazard-focused approach adaptable to evolving technologies.

The landmark was ISO 12100 (safety of machinery – general principles for design – Risk assessment and risk reduction), which became the template for hazard identification and risk reduction. IEC adopted similar principles for electrical/electronic products (e.g., IEC 61010, IEC 60601, IEC 62368, IEC 61508) and is closely aligned with the ISO 12100 risk assessment principles, having the following core steps:

- Hazard Identification
- Risk estimation, evaluation and reduction
- Verification and validation
- Documentation

Detailed comparison

The following table contains the risks considered in IEC 61800-5-1:2022 in comparison with the previous edition.

Clause	IEC 61800-5-1: 2022	IEC 61800-5-1: 2007
4 Design requirement (Optimized for risk assessment process)	✓	(✓)**
4.1-4.2 Risk assessment (covering all hazards) considering	✓	÷
Normal operating conditions	✓	÷
Abnormal operating conditions	✓	÷
Single fault conditions (circuit analysis)	✓	÷
Advantage VFD manufacturers must now include all operating and fault conditions in their risk assessments, both during the initial design phase and any changes throughout the product's lifetime.		
4.3 Short circuit and overload protection	✓	÷
Conditional short circuit rating (ICC) (max.)	✓	÷
Minimum required short circuit rating ($I_{cp,min}$) (min.)	✓	÷
Available output short circuit current	✓	÷
Motor overload control (ETR, sensors, etc.)	✓	÷
Advantage Ensuring compliance with IEC 61439 for low-voltage switchgear and control gear assemblies, particularly regarding common circuit ratings, helps simplify cabinet design and streamline approvals.		
4.4 Protection against electrical shock	✓	✓
Safe to touch voltages (Wet and salt water wet conditions)	✓	÷
Open type / IP1X / IP0X in add. enclosure	✓	÷
Extensive design requirement for terminal for PE	✓	÷
Determination of all relevant voltages for insulation coordination (clearance and creepage)	✓	÷
Design requirements for printed wiring board.	✓	÷
Advantage Products compliant with IEC 61800-5-1:2022 Edition 3.0 offer enhanced protection for personnel due to updated design requirements for insulation, touch voltage, and grounding.		
4.5 Energy hazards	✓	(✓)**
Limited power sources	✓	÷
Advantage Mitigation of fire and other hazards based on power source energy level limitation.		
4.6 Fire hazard	✓	✓
Open type / IP1X / IP0X in add. enclosure	✓	÷
Advantage Enforcement actions ensure that cabinet builders mitigate potential hazards from open enclosure types in accordance with VFD manufacturer's recommendations.		
4.7 Mechanical hazards	✓	÷
Liquid cooling	✓	÷
Rotating parts, expelled parts, sharp edges,	✓	÷
Advantage IEC 61800-5-1:2022 Edition 3.0 now includes VFD designed with liquid cooling. It also provides protection against hazards from mechanical parts.		
4.8 Multiple sources of supply	✓	÷
Advantage Power sources other than the mains supply are now covered by IEC 61800-5-1:2022 Edition 3.0 and, consequently, also included in risk assessments.		

4.9 Environmental stresses	✓	(✓)*
Advantage IEC 61800-5-1:2022 Edition 3.0 defines the environmental operating conditions under which a VFD can be installed, transported, stored, and handled. These operating environmental conditions are categorized as Indoor Unconditional, and Outdoor Unconditional. The standard considers various environmental parameters, such as ambient temperature, humidity, pollution degree, and vibration. Please note that Indoor Conditional is included in IEC 62477-1:2022		
4.10 Acoustic noise hazard	✓	(✓)*
Advantage Acoustic noise is now part of the IEC 61800-5-1:2022 Edition 3.0 with a defined maximum level. If exceeded, the manufacturer shall provide measures against the acoustic noise.		
4.11 Wiring and connections	✓	✓
Extensive design requirement for terminals and cable	✓	÷
125% rule (IEC 61439-1 and NEC)	✓	÷
Installation type	✓	÷
Temperature rating	✓	÷
Copper / Aluminum	✓	÷
Advantage Compliance with National Electrical Code (NEC) requirements for terminals, temperature ratings, wiring size, and materials.		
4.12 Mechanical requirements for enclosures	✓	✓
Advantage Extended coverage and consideration of environmental conditions		
4.13 Component evaluation	✓	÷
Advantage Manufacturers to continuously improve safety by incorporating components representing <i>State of the Art</i> .		
4.14 Electro magnetic force (EMF) (Annex P)	✓	÷
Advantage Effective mitigation minimizes potential risks associated with electromagnetic fields (EMF) to safeguard human health.		
Cl. 5 – Test requirement: (Optimized to support verification of design requirement)	✓	(✓)***
5.2.4 Short circuit and component break down	✓	✓
Option for additional enclosure	✓	÷
Test at conditional short circuit rating (I_{cc}) (max.)	✓	÷
Minimum required short circuit rating ($I_{cp,rm}$)	✓	÷
Available output short circuit current	✓	÷
5.2.4 Protective equipotential bonding short-circuit test	✓	÷
Test at conditional short circuit rating (I_{cc}) (max.)	✓	÷
5.2.8 Electro magnetic force (EMF) test (Annex P)	✓	÷
Advantage VFD manufacturers are obligated to test and verify their designs according to specified requirements.		
Cl. 6 – Information and marking requirement: (Optimized to support risk assessment)	✓	(✓)***
Comments: Improve marking of user communication.		
Advantage VFD manufacturers are now required to provide more comprehensive information to ensure the safe selection, installation, commissioning, operation, and maintenance of their products.		

(✓)*: Only recommendations in IEC 61800-5-1:2007.

(✓)**: Significant update to support the risk assessment process considering design requirement and information/marketing requirement.

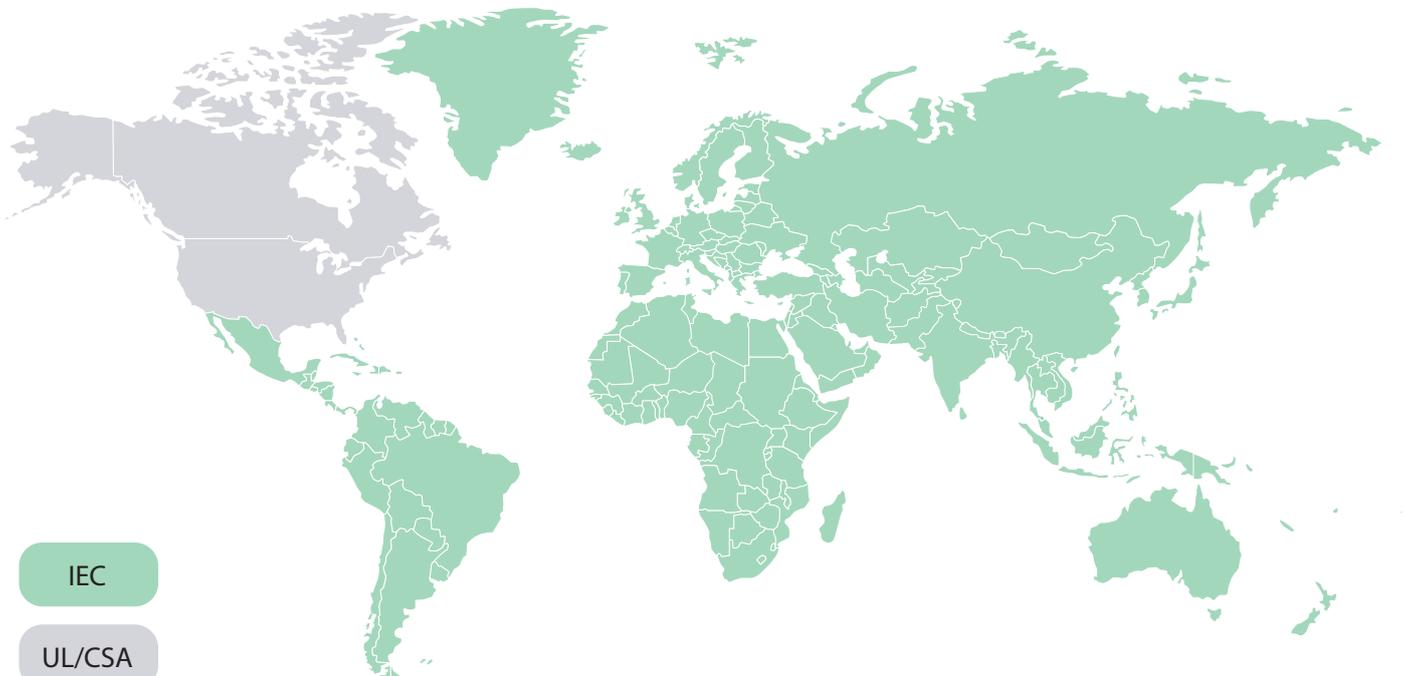
(✓)***: Significant update to support the design requirement in clause 4 and confirm the intended risk mitigation.

Global relevance

The alignment with other standards like IEC 62477-1:2022 (Safety requirements for power electronic converter systems and equipment) increased the global relevance of the standard even further. Remarkable is the effort to align with UL 61800-5-1 and CSA C22.2 No. 274 for North American requirements.

The alignment between UL 61800-5-1 and IEC 61800-5-1 has not finished but brings remarkable benefits:

- **Global market access:** Improved alignment between IEC, UL, and CSA standards allows manufacturers to design products that meet multiple regulatory requirements, facilitating easier access to global markets.
- **Consistency in safety:** Ensuring that safety requirements are consistent across different standards and helps to maintain a high level of safety for PDS worldwide.
- **Simplified certification:** Aligned standards streamline the certification process, reducing the need for multiple tests and evaluations, and saves time and resources for manufacturers.



Impact on CE mark

The IEC 61800-5-1:2022 (Edition 3) was published in 2022. The EN was adopted and published in 2023. Following the common procedure the previous IEC standard will be withdrawn after a transition period. This transition period ends on the 20th of October 2026. The European Standard EN IEC 61800-5-1 follows the same timeline.

As a harmonized standard, the EN IEC 61800-5-1:2007 has often been applied to prove the conformity of variable frequency drives (VFD) with requirements of the EU low voltage directive (LVD).

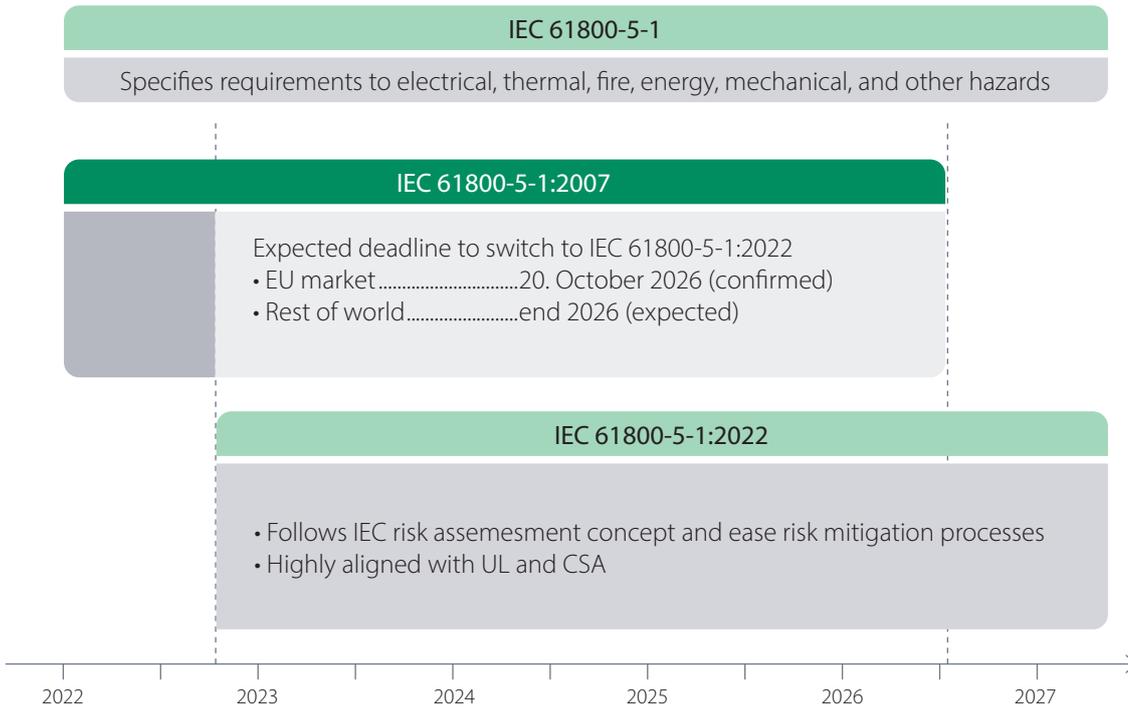
According to the European Blue Guide – a reference document explaining how EU product legislation works in practice – the withdraw makes it difficult using the Edition 2 for presuming CE marked conformity (see [CE mark in the European Community](#)) to the low voltage directive:

“When it is evident that a harmonised standard is not anymore recognised as a standard by the relevant ESO itself or where the standard is not anymore revised or available as a national standard such a document cannot be, as a rule, used anymore to provide presumption of conformity” (European Commission, Blue Guide, 2022, p. 43 / ESO = European Standardization Organization, CEN, Cenelec & ETSI))²⁾

It is possible to prove LVD conformity with other measures³⁾ like the type-tests. But this comes with a high effort and cost to prove and document, compliance.

Applying EN IEC 61800-5-1:2023 is a suitable way to prove *State of the Art* and thereby compliance with EU LVD.

Direct reference makes it easy for users, importers⁴⁾ and customs to identify that the *State of the Art* has been applied.



Picture: Timeline IEC 61800-5-1 editions

²⁾ European Commission, 2022, The ‘Blue Guide’, 4.1.2.5 Withdrawal, restriction or prevention of the presumption of conformity

³⁾ European Commission, 2022, The ‘Blue Guide’, 4.1.3 Conformity with the essential requirements: other possibilities

⁴⁾ European Commission, 2022, The ‘Blue Guide’, 3.3. Importer

IEC 61800-5-1:2022 impact and upsides

IEC 61800-5-1:2007 drives are safe

It's important to be clear that VFDs designed according to IEC 61800-5-1:2007 are safe and can still be used. The new edition provides additional options for the user to ensure or even enhance electrical, thermal and energy-related safety in the installation.

Impact on products

VFD manufacturers must review their existing designs to ensure they meet the requirements of IEC 61800-5-1:2022. Increased insulation, wider air gaps or improved gaskets are some of the measures that may be needed. Additional hardware testing is also required.

Typical impacts for the customer resulting from the improvements and re-testing are:

- No changes to form, fit and function.
Although there might be some changes to the hardware design, the customer will not notice any changes to the product. IEC 61800-5-1:2022 drives can be used as the IEC 61800-5-1:2007 products before them.
- Specification adjustments
In some cases, not all original specifications may be met anymore. For example, the max. altitude must be lowered or limit the use of circuit breakers on the line side of the VFD.
- Product phase-out
Depending on the effort and position in a product life cycle, manufacturers will decide on phase-out of products
- Issues at customs
References to withdrawn standards may lead to products being rejected during import into a country or region.

Many manufacturers will actively communicate product changes to the market. Nevertheless, users should consider reaching out to their suppliers if there are any changes to form, fit and function.

Machine builders and machine engineers should check if they refer IEC 61800-5-1:2007 in their product documentation. If yes, the reference must be updated before the withdrawal date of the standards, provided all components comply.

A high-level assessment clearly indicates that the impact of the IEC 61800-5-1:2022 is minimal on existing installations, machine or plant designs. For new developments, the standard enables a more efficient certification process and offers potential cost savings.

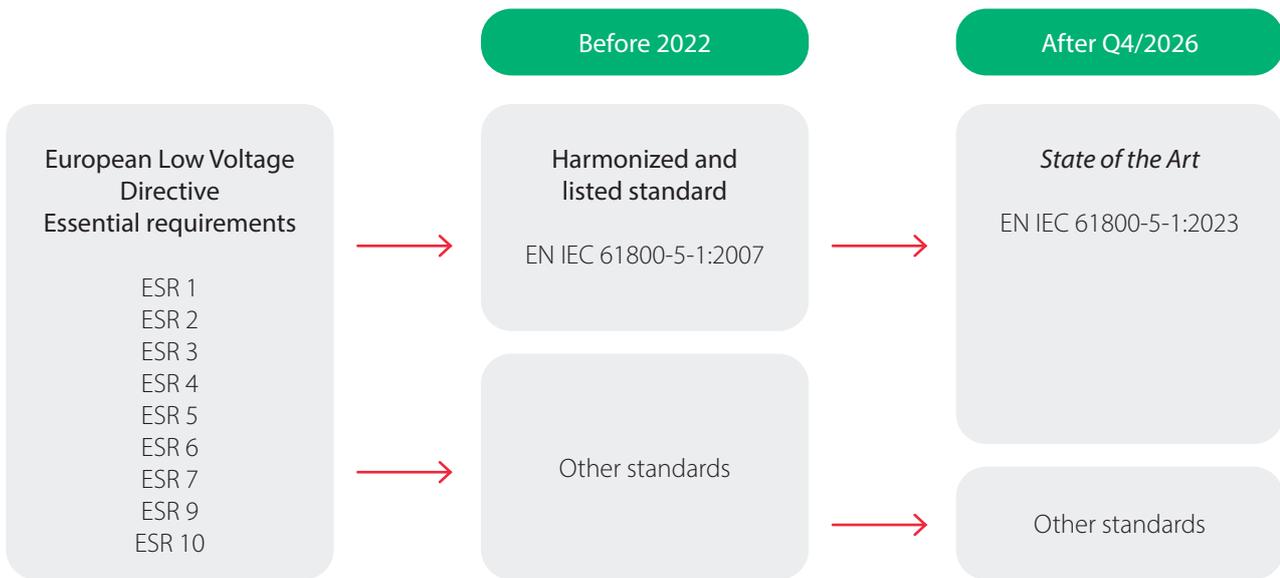
	Existing designs	Re-design	New designs
Machine Builder	98.9% No changes 1% Minor changes 0.1% Update type certificate	Potential upsides <ul style="list-style-type: none"> • Faster risk assessment / certification • Fewer external components • Save installation costs 	
System Integrator	95% No changes 5% Minor changes		
End user		No changes	

 High level impact assessment

Reduced compliance efforts

IEC 61800-5-1:2022 simplifies aligning PDS compliance with risk assessments by covering more electrical safety risks through integrated measures. For the European Low Voltage Directive, the latest edition addresses more essential requirements than previous versions. See section [Detailed comparison](#) for areas which are now covered.

Covering more requirements with less standards reduces the effort in certification, documentation and maintenance of compliance documents. In addition, the higher global acceptance (see [Global relevance](#)) reduces the effort, not only locally.



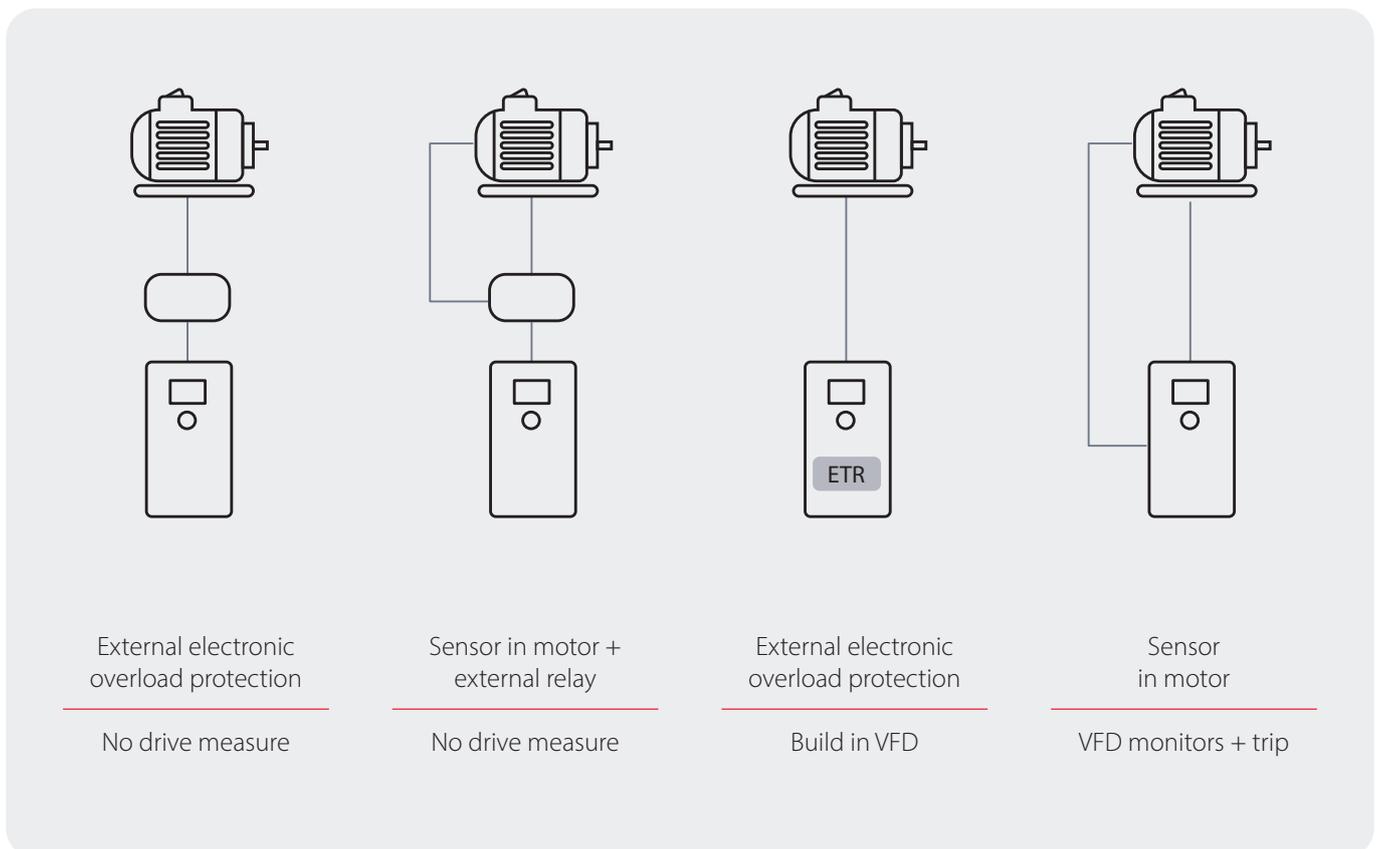
↑ IEC 61800-5-1:2022 enhances the number of Essential Requirements (ESR) which are covered by the PDS.

Cost savings in installations

Drives compliant with IEC 61800-5-1:2022 can lower installation costs by addressing more risks than earlier versions. The standard lists potential solutions for selected risks – e.g., thermal heat management – allowing machine builders to choose from these or apply other suitable measures.

Check section [Detailed comparison](#) for risks which can potentially be covered by drives. Mitigating risks within the VFD instead of using external components can result in cost savings in the installation. It is expected that these upsides will arise mainly in redesigns or new designs.

Please note that not all VFD on the market support all measures listed in the standard. Check the product documentation or reach out to the manufacturer if required. In general, the IEC 61800-5-1:2022 documentation requirements result in more precise information in the manuals. This opens for selecting the best fitting VFD for the application.



↑ IEC 61800-5-1 list potential measures for selected risks.

Disclaimer

This paper has been written with the best knowledge at the time of publication. This aims to explain how IEC 61800-5-1:2022 is connected and discuss its effects. It does not claim completeness. Be aware that there might be changes to legal interpretation or interpretation to the standard itself after publication of this document.

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