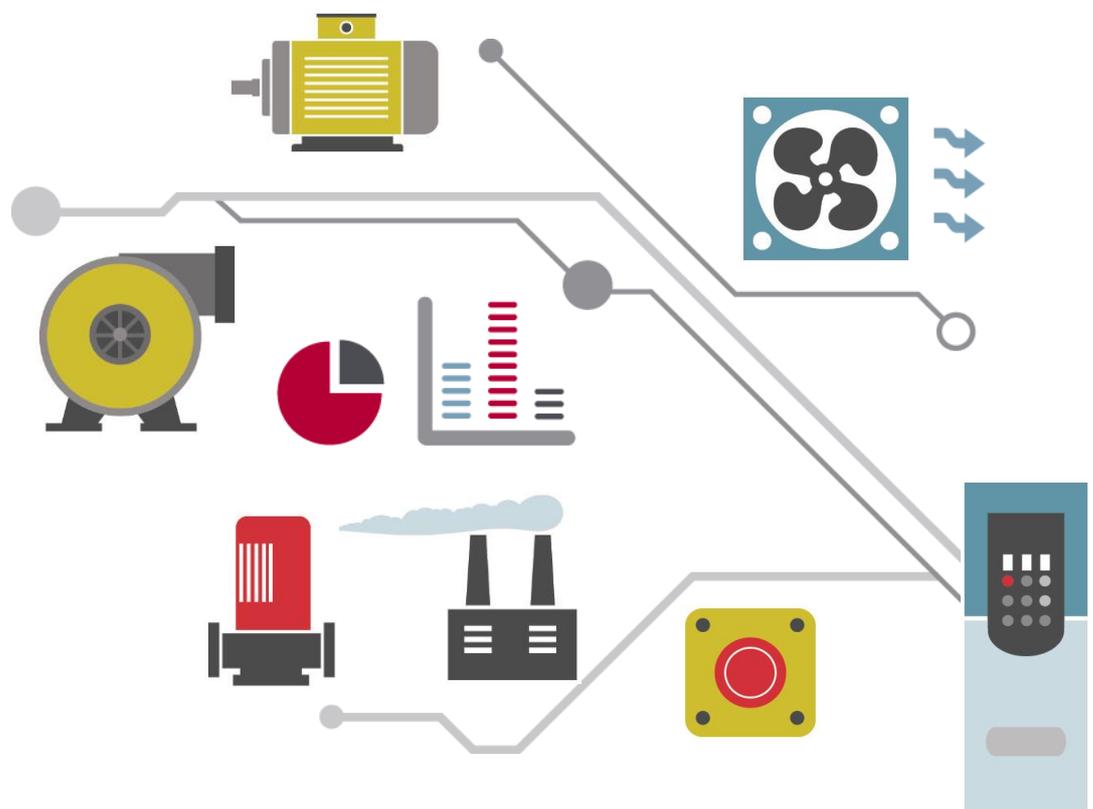


CE MARKING AND TECHNICAL STANDARDISATION

Guidelines for application to Electrical Power Drive Systems



CE Marking and Technical Standardisation Guidelines for application to Electrical Power Drive Systems

Foreword

The fifth edition of this guide has been prepared by the GAMBICA Variable Speed Drives Technical Working Group. It is an update of the fourth edition, taking into account recent changes in standards and directives, in particular the new Low Voltage Directive and EMC Directive which are aligned with the EU New Legislative Framework.

This guide represents the views of the group on the requirements applicable to variable speed power drive systems. However, this guide has no legal force, and readers are advised to consult the text of the appropriate European Directives and national enabling legislation, together with the appropriate European Commission guidance documents.

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1 Introduction

Electrical Power Drive Systems (PDSs), including Complete Drive Modules (CDMs) and Basic Drive Modules (BDMs), are inherently complex items of power electronic equipment (see Figure 1).

They can exist in different classes, which range from components, sold either to the general public or to professional assemblers, through to products fully incorporated into an apparatus or an installation.

For the benefit of manufacturers, integrators, installers and users alike, this document describes each class of PDS and provides clear guidelines as to the application of three relevant European Directives:

- Low Voltage Directive (LVD) – 2014/35/EU
- Machinery Directive (MD) – 2006/42/EC
- Electromagnetic Compatibility Directive (EMCD) – 2014/30/EU

NOTE Other CE Marking Directives (specifically the ATEX Directive ¹, Ecodesign Directive, RoHS Directive, and Radio Equipment Directive) are not addressed in this document.

For each Directive and, where appropriate, for each class of PDS, these guidelines define:

- Application of the Directive
- Responsibilities
- Harmonised Standards to be used
- Requirements for Declarations of Conformity and CE marking
- Recommendations for the system integrator responsible for the installation.

While the focus of this document is low voltage (LV) equipment, the requirements for the EMC Directive and the Machinery Directive are also relevant for high voltage (HV) equipment.

¹ GAMBICA/REMA Technical Guide No 4 covers the requirements of ATEX.

2 Power Drive Systems

The concept of a power drive system (PDS) is used to describe an electric motor drive system within an overall installation.

The terminology is used throughout IEC and EN standards relating to electrical variable speed drives to describe a combination of components, including a power converter and motor.

The conventional illustration of a PDS and its component parts is shown in Figure 1.

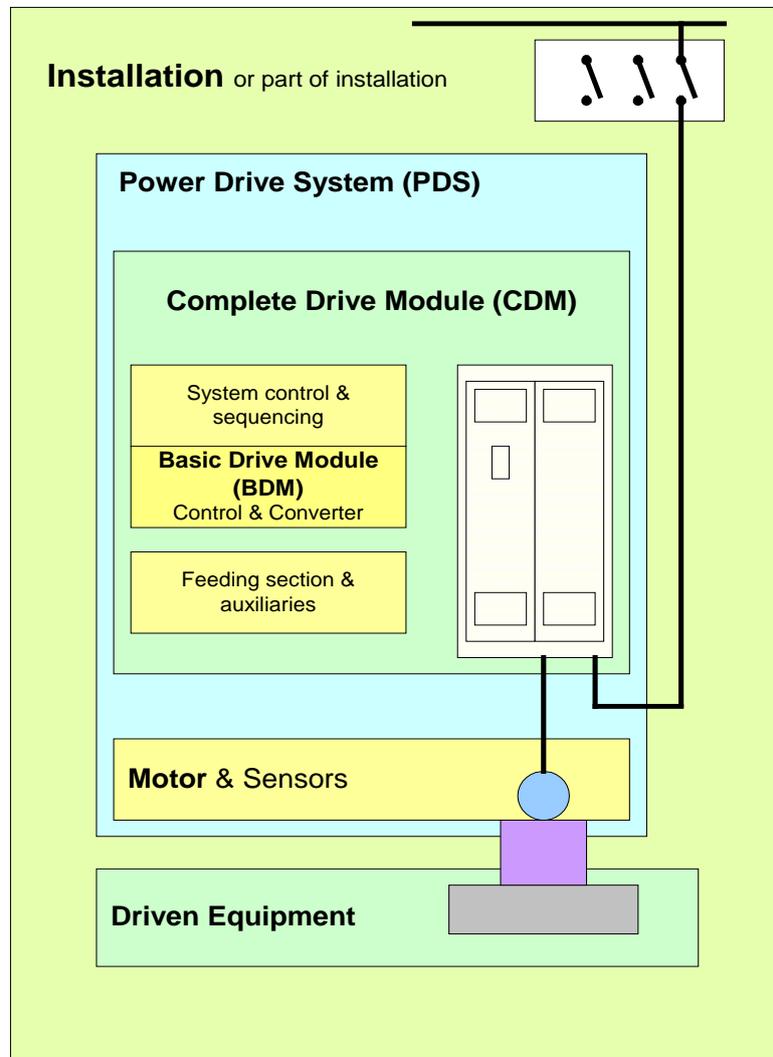


Figure 1 – The Power Drive System

BDM: Basic drive module consisting of power input, control, & power output sections

CDM: Complete drive module consisting of BDM and auxiliary sections, including devices such as incoming switches, input and output transformers and filters, etc. but excluding the motor, cables and motor-coupled sensors

PDS: Power drive system consisting of CDM, motor and sensors, excluding the driven equipment and sensors.

3 Low Voltage Directive (2014/35/EU)

3.1 Introduction

Directive 2014/35/EU (the "new" Low Voltage Directive) replaced Directive 2006/95/EC (the "old" Low Voltage Directive) on 20 April 2016.

3.2 Application

The Low Voltage Directive (LVD) applies to electrical equipment designed for use with a voltage rating of between 50 V and 1000 V a.c. and between 75 V and 1500 V d.c.

The Directive covers all risks arising from the use of electrical equipment, including not just electrical risks but also mechanical, chemical (such as, in particular, emission of aggressive substances) and all other risks.

3.3 EU Declaration of Conformity

Manufacturers of the BDM, CDM or PDS should affix the CE marking for conformity to the LVD to their equipment and provide a Declaration of Conformity relating to their scope of supply.

3.4 Harmonised standards

The principal harmonised standards that are listed in the Official Journal of the European Union (OJ) and confer a presumption of conformity with the corresponding essential requirements of the Directive are listed in Table 1.

Table 1 – Standards conferring a presumption of conformity with the LVD

BDM/CDM	PDS
EN 61800-5-1 or EN 50178	EN 61800-5-1 or EN 50178, and/or EN 60204-1

A combination of standards may be necessary to ensure that all the essential requirements are addressed.

NOTE 1 Some of the requirements in EN 60204-1 are relevant to a machine, but not to the PDS. Machines may have other requirements, outside the scope of this guide.

NOTE 2 HV equipment is outside the scope of the LVD and therefore cannot have a Declaration of Conformity or be CE marked for conformity to the LVD. However, technical guidance is available in EN 61800-5-1.

NOTE 3 EN 50178 is expected to be withdrawn soon. It is unlikely to be used for new products.

4 Machinery Directive (2006/42/EC)

4.1 Introduction

Directive 2006/42/EC (the "new" Machinery Directive) replaced Directive 98/37/EC (the "old" or "existing" Machinery Directive) on 29 December 2009.

4.2 Application

Article 1(1) of Directive 2006/42/EC states that it applies to the following:

- a) machinery;
- b) interchangeable equipment;
- c) safety components;
- d) lifting accessories;
- e) chains, ropes and webbing;
- f) removable mechanical transmission devices;
- g) partly completed machinery.

Its objective is to lay down the essential health and safety requirements in relation to design and manufacture in order to improve the safety of machinery placed on the market.

4.3 EC Declaration of Conformity and Declaration of Incorporation

There are three equipment categories which require consideration:

4.3.1 Partly completed machinery

Such equipment (as defined in Article 2(g) of Directive 2006/42/EC) requires a “Declaration of Incorporation” but no CE marking for conformity to Directive 2006/42/EC. In practice this may be a PDS which has specific functionality, but not a BDM or CDM.

4.3.2 Application independent equipment

This category typically relates to a general purpose BDM or CDM, which is application independent – such equipment does not require a Declaration of Incorporation or Declaration of Conformity and does not require a CE mark for conformity to Directive 2006/42/EC.

4.3.3 Safety components

A safety component could be a particular BDM, CDM or PDS provided it meets the following definition as given in Article 2(c) of Directive 2006/42/EC:

- “which serves to fulfil a safety function,
- which is independently placed on the market,
- the failure and/or malfunction of which endangers the safety of persons, and
- which is not necessary in order for the machinery to function, or for which normal components may be substituted in order for the machinery to function.”

This would apply where the drive includes features which are specifically intended to carry out machinery safety functions. Such equipment requires both a Declaration of Conformity and a CE mark for conformity to Directive 2006/42/EC.

Annex B of this guide gives an explanation of the status of drives with safety functions in respect of the directive, and the separate GAMBICA Technical Guide “Variable Speed Drives and Functional Safety of Machinery”² gives more detailed guidance concerning the application of drives in safety functions of machines.

4.4 Harmonised Standards

For electrical control systems of machinery, the principal harmonised standards that are listed in the OJ and confer a presumption of conformity with the corresponding essential requirements of Directive 2006/42/EC are:

- EN ISO 13849-1
- EN 60204-1
- EN 60204-11
- EN 62061
- EN 61800-5-2

EN 61508 is the basic standard for functional safety of electrical/electronic/programmable safety-related systems which underlies standards such as EN 62061 and EN 61800-5-2. It is not in itself listed in the OJ under the Machinery Directive.

A combination of standards may be necessary to ensure that all the essential requirements are addressed.

² <http://www.gambica.org.uk/resourceLibrary/gambica-guide-to-variable-speed-drives-and-functional-safety-of-machinery.html>

5 EMC Directive (2014/30/EU)

5.1 Introduction

Directive 2014/30/EU (the "new" EMC Directive) replaced Directive 2004/108/EC (the "old" EMC Directive) on 20 April 2016.

5.2 Application

The Electromagnetic Compatibility Directive (EMCD) applies in principle to all electrical and electronic equipment. Its purpose is to ensure an acceptably low level of occurrences of electromagnetic interference. At each stage of the entire life cycle, from the apparatus³ to the system or installation, each manufacturer or installer of a fixed installation has the responsibility to apply the EMC Directive.

5.3 EU Declaration of Conformity

5.3.1 BDM/CDM/PDS

5.3.1.1 BDM, CDM or PDS for general sale

These products may be sold either to an end-user or to a professional assembler.

NOTE Generally an end-user is deemed to have no qualifications in the field of electromagnetic compatibility.

The EMC Directive treats such products as apparatus (see Article 3.2(1) of the EMCD) because they could be installed by a person with little knowledge of EMC.

The manufacturer is responsible to ensure that sufficient EMC can be achieved by any (potentially unknown) customer or layman (plug-in, switch-on).

CE marking and a Declaration of Conformity are required.

5.3.1.2 BDM, CDM or PDS for professional assemblers

This is sold as a sub-assembly to a professional assembler who incorporates it into other equipment such as a machine, or system.

This BDM, CDM or PDS is excluded from the EMC Directive, so it need not be CE marked nor have a Declaration of Conformity. Exchange of technical data allows optimisation of the EMC solution.

The BDM/CDM/PDS manufacturer should provide the relevant instructions which indicate the EMC aspects to be considered by the manufacturer of the final apparatus to help him to achieve EMC conformity at the final apparatus level.

5.3.1.3 BDM, CDM or PDS for fixed installations

Apparatus intended for incorporation in fixed installations is within the scope of the directive.

For apparatus that is intended for a particular fixed installation, and is not otherwise commercially available, the manufacturer may choose to apply the procedure described in Article 19.1 of the EMCD. The BDM, CDM or PDS does not require a CE mark or Declaration of Conformity provided that the accompanying documentation identifies the fixed installation for which it is intended, and includes the information referenced in Article 19.1 of the EMCD.

It is envisaged that manufacturers may use this option for equipment produced in low quantities for specific customers/applications e.g. large drive panels, or certain high power drives.

NOTE The requirements for apparatus not intended for a particular fixed installation are described in 5.3.1.1 or 5.3.1.2 of this document.

5.3.2 Drive Systems

In the variable speed drives industry, the term "Drive System" is generally used to refer to an assembly of BDM/CDM/PDS and other equipment intended for incorporation into a particular fixed installation, and that is not otherwise commercially available. The provisions of 5.3.1.3 apply to such a "Drive System".

³ The EMCD considers 'components' or 'sub-assemblies' intended for incorporation into an apparatus by the end-user, which are liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance, to be "apparatus".

5.3.3 Installations

5.3.3.1 Fixed Installations

Fixed installations are within the scope of the directive, but do not require CE marking or a Declaration of Conformity.

The types of BDM/CDM/PDS that can be directly used in a fixed installation are:

- any CE marked BDM/CDM/PDS that is suitable for the intended environment (see 5.3.1.1);
- any BDM/CDM/PDS that is intended for incorporation in the particular fixed installation (see 5.3.1.3).

Other types of BDM/CDM/PDS (e.g. non-CE marked products as described in 5.3.1.2) may be incorporated in other equipment, provided that the equipment meets all applicable requirements of the directive.

The person responsible for the compliance of the fixed installation shall consider the combination of the various items in the installation in order to ensure EMC.

EXAMPLE Harmonic compensation should be considered at the installation level (e.g. rolling mill, paper machine, crane, etc.) for both technical and economic reasons.

5.3.3.2 Mobile Installations

Mobile installations are deemed to be apparatus, requiring CE marking and a Declaration of Conformity - see Article 3.2(2) of the EMCD.

5.4 Harmonised Standards

Compliance with the following harmonised European Standards that are listed in the OJ confers a presumption of conformity with the corresponding essential requirements of the EMC Directive:

Table 2 – Standards conferring a presumption of conformity with 2014/30/EU

BDM/CDM/PDS	Apparatus incorporating BDM/CDM/PDS
EMC product standard for PDS: EN 61800-3	Either (a) A relevant product specific standard for the apparatus or (b) A generic standard for immunity, EN 61000-6-1 or EN 61000-6-2 and either EN 55011 for emission from equipment within its scope or a generic standard for emission, EN 61000-6-3 or EN 61000-6-4 Also, where applicable: EN 61000-3-2 or EN 61000-3-12 (for harmonic emissions) EN 61000-3-3 or EN 61000-3-11 (for flicker)

5.5 Categories of PDS defined in EN 61800-3

EN 61800-3 recognizes two EMC environments (first and second):

- first environment
includes domestic premises; it also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes;
- second environment
includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes;

and sub-divides PDS into four categories (C1 - C4) which are defined as follows:

- C1
PDS of rated voltage less than 1 000 V, intended for use in the first environment;
- C2
PDS of rated voltage less than 1 000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional;

- **C3**
PDS of rated voltage less than 1 000 V, intended for use in the second environment and not intended for use in the first environment;
- **C4**
PDS of rated voltage equal to or above 1 000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

NOTE This is further clarified as having specific technical requirements such as networks isolated from earth, or where dynamic performance will be limited as a result of filtering.

The relationship between these environments and categories and the application types described in 5.3 is shown in Table 3 below:

Table 3 – Relationship between categories, environments, and 2014/30/EU

Category	BDM, CDM or PDS for general sale See 5.3.1.1		BDM, CDM or PDS for professional assemblers See 5.3.1.2		BDM, CDM or PDS for fixed installations See 5.3.1.3	
	Environment		Environment		Environment	
	1 st	2 nd	1 st	2 nd	1 st	2 nd
C1	Allowed	Depends on immunity ^a	Allowed	Depends on immunity ^a	Allowed	Depends on immunity ^a
C2	Not Allowed	Allowed	Allowed	Allowed	Allowed	Allowed
C3	Not Allowed	Allowed	Not Allowed ^b	Allowed	Not Allowed ^b	Allowed
C4	Not Allowed	Not Allowed	Not Allowed ^b	Allowed	Not Allowed ^b	Allowed

^a Allowed only if 2nd environment immunity requirements are met either inherently or by means of additional mitigation measures

^b Can be “Allowed” if additional mitigation measures are applied to achieve 1st environment emissions limits.

6 Summary of responsibilities for the application of European Directives to a PDS

PDS or CDM or BDM									
		LVD	MD				EMCD		
Responsibility of the manufacturer of the PDS, CDM or BDM	Application	All LV equipment	Partly Completed Machinery		Application independent equipment	Safety Component (i.e. drive with safety function)	For General Sale	For Professional Assemblers	For Fixed Installations
	Equipment	PDS, CDM or BDM	PDS	CDM or BDM	CDM or BDM	PDS, CDM or BDM with safety function	PDS, CDM or BDM	PDS, CDM or BDM	PDS, CDM or BDM
	Declaration	Declaration of Conformity	Declaration of Incorporation	Not Required	Not Required	Declaration of Conformity	Declaration of Conformity	Not Required	Not Required
	CE Marking	Yes	No	No	No	Yes	Yes	No	No

If one or more of the Directives requires CE marking, the PDS, CDM or BDM should be CE marked and have a corresponding Declaration of Conformity

The information to be provided by the PDS/CDM/BDM manufacturer includes:
 - instructions for installation, use and maintenance to ensure safety and EMC compliance
 - identification of the specific fixed installation (where applicable for EMCD)

A procedure similar to that outlined above follows for every endproduct into which a PDS, CDM or BDM is incorporated.
 The installer or end user is responsible for the conformity of the final application with all relevant Directives and/or other legislation.

Annex A

Further information

A.1 Links

The following are links to official web sites that provide the text of each Directive together with official guidelines, a list of the harmonised Standards that confer a presumption of conformity with the essential requirements, details of any proposed revisions, and other relevant information.

Low Voltage Directive:

http://ec.europa.eu/growth/sectors/electrical-engineering/lvd-directive_en

EMC Directive:

http://ec.europa.eu/growth/sectors/electrical-engineering/emc-directive_en

Machinery Directive:

http://ec.europa.eu/growth/sectors/mechanical-engineering/machinery/index_en.htm

A.2 Glossary

BDM	Basic Drive Module (See also Clause 2)
CDM	Complete Drive Module (See also Clause 2)
EMCD	Electromagnetic Compatibility Directive
LVD	Low Voltage Directive
MD	Machinery Directive
OJ	Official Journal of the European Union
PDS	Power Drive System (See also Clause 2)

A.3 Standards referenced in this document

NOTE: A complete list of Standards relevant to each Directive is available on the European Commission's web-pages (see links above).

EN ISO 13849-1	Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
EN 50178	Electronic equipment for use in power installations
EN 55011	Industrial, scientific and medical equipment — Radio-frequency disturbance characteristics — Limits and methods of measurement
EN 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
EN 61000-3-2	Electromagnetic compatibility - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
EN 61000-3-3	Electromagnetic compatibility — Part 3-3: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection

- EN 61000-3-11 Electromagnetic compatibility — Part 3-11: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems — Equipment with rated current ≤ 75 A and subject to conditional connection
- EN 61000-3-12 Electromagnetic compatibility - Part 3-12: Limits - Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase
- EN 61000-6-1 Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
- EN 61000-6-2 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
- EN 61000-6-3 Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
- EN 61000-6-4 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
- EN 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems (7 parts)
- EN 61800-3 Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods
- EN 61800-5-1 Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
- EN 61800-5-2 Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
- EN 62061 Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems

Annex B

The status of variable speed drives in respect of EU Machinery Directive 2006/42/EC

Background

The revised Machinery Directive (2006/42/EC) gives a broader definition of a safety component than its predecessor - it also provides an indicative list of safety components (Annex V) and lists certain safety components (see Annex IV) that require specific conformity assessment procedures. Meanwhile, manufacturers of electronic variable speed drives are increasingly offering safety-related control functions in their products, resulting in the following questions being asked:

- Does a variable speed drive with safety functions fall within the definition of “safety component” according to Directive 2006/42/EC, and if so, does it fall within one of the categories listed in Annex IV?
- What is the status of a variable speed drive which offers safety functions as an option through the addition of a module which is available for sale separately?
- What requirements apply with regard to an EC Declaration of Conformity and CE marking?

Terminology

The term “Power Drive System” (PDS) was introduced by the EN 61800 series of standards to refer to a variable speed drive with its associated motor and peripheral equipment. Within this series the EN 61800-5-2:2007 harmonised standard applies to a PDS(SR), which is essentially a PDS with the safety-related capability to perform one or more safety functions. The basic electronic drive in a PDS is referred to as the Basic Drive Module (BDM), which is more generally called a variable speed drive. So in relation to a PDS(SR), the BDM will be referred to as a “safety-related variable speed drive” in this document.

A safety-related variable speed drive can be implemented in various ways, as outlined in the following situations:

- a) If the variable speed drive offers integral safety functions, then the entire drive is a safety component.
- b) If the variable speed drive does not offer integral safety functions, but an optional safety module is available that provides safety functions, then the optional safety module is a safety component.
- c) If the variable speed drive offers integral safety functions and an optional safety module is available that provides additional safety functions, then both items are safety components.

Position - Summary

- A safety-related variable speed drive⁴ is a safety component within the meaning of Directive 2006/42/EC. Furthermore, some safety-related variable speed drives¹ may be considered “Logic units to ensure safety functions” according to Annex IV of Directive 2006/42/EC (see section (d) in the annex to this document).
- A safety-related variable speed drive⁵ requires both an EC Declaration of Conformity (DoC) and CE marking in accordance with Directive 2006/42/EC.

⁴ Or an “optional safety module” as set out in b) and c) of the preceding paragraph.

⁵ Or an “optional safety module” as set out in b) and c) of the preceding paragraph.

Justification

(a) Safety Component

Article 2(c) gives the following definition of a safety component:

‘Safety component’ means a component:

1. which serves to fulfil a safety function,
2. which is independently placed on the market,
3. the failure and/or malfunction of which endangers the safety of persons, and
4. which is not necessary in order for the machinery to function, or for which normal components may be substituted in order for the machinery to function

For either a variable speed drive with integral safety functions, or an optional safety module for use with a variable speed drive, points 1 to 3 are clearly satisfied. The fact that either of these variants might also perform normal operational functions in addition to its specific safety function(s) does not compromise compliance with point 1.

In relation to point 4:

- a) For a variable speed drive with integral safety functions, the entire drive satisfies the second alternative in point 4 because it could be completely replaced by an ordinary variable speed drive in order for the machinery to function.
- b) For a variable speed drive in which all safety functions are provided by an optional safety module, the optional safety module satisfies the first alternative in point 4 because it is not necessary in order for the machinery to function.

(Note: In this situation the variable speed drive is not a safety component, but the optional safety module is a safety component).

Note that the list of safety components in Annex V of the Directive is indicative only, so the absence of a safety-related variable speed drive does not mean that it is not a safety component. Furthermore, it is probable that the broad classification of “logic units to ensure safety functions” in Annex V of the Directive (and also Annex IV of the Directive - see section (d) of this document) would be considered to include a safety-related variable speed drive.

(b) EC Declaration of Conformity and CE marking

A safety-related variable speed drive is a safety component within the meaning of Directive 2006/42/EC. It therefore requires both an EC Declaration of Conformity (DoC) and CE marking in accordance with Directive 2006/42/EC. A manufacturer can of course decide not to market their product as a safety component according to Directive 2006/42/EC, in which case it can only be regarded as an ‘ordinary’ variable speed drive that is unsuitable for implementing safety functions.

A safety-related variable speed drive can offer a variety of safety functions, as well as non-safety functions. In some cases, the manufacturer may choose to list the safety functions on the DoC, but regardless of this, full details, specifications and instructions for use for each of these safety functions must be provided in the user documentation.

(c) Declaration of Incorporation

As explained in (b) above, a safety-related variable speed drive is a safety component within the meaning of Directive 2006/42/EC and therefore requires an EC Declaration of Conformity (DoC). A Declaration of Incorporation is therefore not appropriate.

(d) Conformity Assessment procedures

Article 12 specifies conformity assessment procedures for Directive 2006/42/EC.

If a safety-related variable speed drive is not considered to fall within one of the categories (e.g. “logic units to ensure safety functions”) listed in Annex IV of the Directive, then the manufacturer shall apply the procedure for assessment of conformity with internal checks on

the manufacture of machinery described in Annex VIII of the Directive (often referred to as self-certification). In this case, the safety-related variable speed drive shall not have an EC type-examination Certificate, but this does not preclude the manufacturer from offering some other form of independent certification or assessment report.

If the safety-related variable speed drive is considered to fall within one of the categories (e.g. “logic units to ensure safety functions”) listed in Annex IV of the Directive, then the manufacturer shall apply one of the procedures referred to in Article 12(3) or (4) of the Directive:

- If the EC type-examination procedure provided for in Annex IX is applied, then the manufacturer shall obtain an EC type-examination certificate and shall also undertake the internal checks on the manufacture of machinery provided for in Annex VIII, point 3 of the Directive.
- However, if the safety-related variable speed drive is manufactured in accordance with a suitable harmonised standard that is listed in the Official Journal and which covers - by itself or in conjunction with its normative references - all relevant essential health and safety requirements, then the manufacturer can apply the procedure for assessment of conformity with internal checks on the manufacture of machinery provided for in Annex VIII of the Directive (often referred to as self-certification), and an EC type-examination certificate is not required. Although harmonised standard EN 61800-5-2 can be used for this purpose in many cases, in some circumstances it might not cover all relevant essential health and safety requirements.
- A 3rd option “Full Quality Assurance” is provided for in Annex X of the Directive, but this is rarely used.

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