Technical Guide No. 2

# EU Council Directives and Adjustable Speed Electrical Power Drive Systems

# *Contents*

# Chapter 1 - Introduction

## This guide's purpose

The aim of this Technical Guide No.2* is to give a straightforward explanation of how the various EU Council Directives relate to Power Drive Systems (PDSs). For an explanation of the terminology of PDSs, see pages 18 and 19.

While Electromagnetic Compatibility (EMC) is the subject of most concern within the industry, it must be realised that the EMC Directive is only part of the overall EU initiative on common safety standards.

It is the intention of this Guide to offer users of AC or DC power drive systems - whether Machine Builders, System Designers, Distributors, OEMs, End-Users or Installers - some clear practical guidelines and courses of action.

***Notes**

1 The content of this Technical Guide is ABB Industry Oy's interpretation of events as of November 1999. However, we reserve the right to develop and evolve these interpretations as more details become available from Competent Bodies (see Chapter 6), Competent Authorities (see Chapter 6), organisations and from our own tests.

2 Other Technical Guides available in this series include:

**Technical Guide No.1** -
Direct Torque Control
(3BFE 58056685 R0125 REV B).

**Technical Guide No.3** -
EMC Compliant Installation and Configuration for a Power Drive System
(3BFE 61348280 R0225).

**Technical Guide No.4** -
Guide to Variable Speed Drives
(3BFE 61389211 R0125 REV A).

## *How to Use this Guide*

The Guide is divided into 9 Sections.

Section 4 looks at **Purchasing Decisions for PDSs**. Please note the following about the structure of this section:

***Responsibilities and actions***

Each type of purchaser is offered an explanation of their **Responsibilities**. This is for awareness. No action is needed.

Following the **Responsibilities** is a set of **Actions**. If the purchaser follows these **Actions**, step-by-step, then conforming to the relevant Directives will be straightforward.

***Tickboxes***

Alongside the **Actions** are tickboxes. Purchasers can photocopy the relevant pages and use them as a checklist with each item being ticked off as it is achieved.

***Cross-referencing***

Because of the complexity of conforming to each Directive, this Guide inevitably carries a lot of cross-references to other sections. In the margin you will come across:

**Defined on page XX**
You are **advised** to turn to the page number reference.

You will also notice other references within the text. These can be referred to if the item is unclear but is not essential for achieving compliance.

***KEY POINTS:***

Within the text you will see:

**Key Point**
These are key observations that **must be** observed.

# Chapter 2 - General questions and answers

## What is all the fuss about?

**I have had no problems with drives in the past so why do I need to be concerned with EMC now?**

Beware! Electromagnetic Compatibility (EMC) is only one of a number of EU Council Directives relating to common safety standards for electrically powered equipment like Power Drive Systems.

***KEY POINT:*** It is very important that users of PDSs fully understand all the various rules and regulations and how they apply to PDSs. That is the purpose of this Guide.

***What are these EU Council Directives?*** It is important to realise that EMC cannot be divorced from other European legislation. So before answering this question, we need to look at the **other** legislation and how it affects the purchase and installation of drives.

Quite simply there are **three Directives** that mainly affect a drive's safety against risks and hazards. These are:

| *Directive* | *Applicable* | *Mandatory* | *Page* |
|---|---|---|---|
| *Machinery Directive* | *1993-01-01* | *1995-01-01* | *pg 52* |
| *Low Voltage Directive* | *1995-01-01* | *1997-01-01* | *pg 53* |
| *EMC Directive* | *1992-01-01* | *1996-01-01* | *pg 54* |

But more on each of these Directives later. Let us first explain EMC and look at some concerns of the industry.

***How does EMC affect me?*** From January 1, 1996 the EU Council's Electromagnetic Compatibility Directive (89/336/EEC) has been compulsory. It applies to **all** electrical and electronic equipment sold within the EU and affects virtually all manufacturers and importers of electrical and electronic goods.

***KEY POINT:*** Electrical equipment that does not conform to the regulations may not be sold anywhere in the EEA (European Economic Area).

***What is EMC?*** EMC stands for **E**lectro**m**agnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate problem-free within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other products or systems within its locality.

***What is an electromagnetic environment?*** The electromagnetic environment is everywhere but it varies from place to place. The reason is that there are many different sources of disturbance which can be natural or man-made.

***Natural sources*** consist of electrical discharge between clouds, lightning or other atmospheric disturbances. While we cannot influence these sources we can protect our products and systems from their effects (see Installation, page 58).

***Man-made disturbances*** are those generated by, for example, electrical contacts and semiconductors, digital systems like microprocessors, mobile radio transmitters, walkie-talkies, portable car telephones and Power Drive Systems (see page 18).

Such a variety of equipment, each with its own emission characteristics, is often used so near to other electrical equipment that the field strengths they create may cause interferences.

***KEY POINT:*** It is important that all PDSs are immune to these natural and man-made disturbances. While drives manufacturers strive to make their products immune, the Directive lays down minimum standards for immunity, thereby ensuring all manufacturers achieve the same basic level.

***How does electromagnetic interference show up?*** Electromagnetic interference shows up in a variety of ways. Typical examples of interference include a poorly suppressed automobile engine or dynamo; an electric drill causing patterning on the TV screen; or crackling from an AM radio.

The microprocessor and power electronic component, switch rapidly and therefore, can cause interference at high frequencies, unless proper precautions are taken.

***What emissions can drives cause?***

The normal operation of any drive involves rapid switching of high voltages and this can produce radio frequency emission. It is this radiation and emission that have been seen to have the potential to disturb other circuits at frequencies below 200 MHz.

Modern equipment contains considerable communications and other digital electronics. This can cause considerable emissions at frequencies above 200MHz.

***How is this emission seen?***

The main emission is via conduction to the mains. Radiation from the converter and conducting cables is another type of emission and it is especially demanding to achieve the radiated emission limits.

***How do I avoid electromagnetic interference?***

You need to ensure two things:

- that the equipment generates minimum emission.
- that the equipment is immune to outside effects.

***KEY POINT:***

In the case of Power Drive Systems, a lot hinges on the quality of the installation. See Installation, page 58, for more details.

Electromagnetic interference needs to be conducted to earth (ground potential) and no system can work unless it is properly connected.

***Drives manufacturers must comply with EMC standards then?***

Unfortunately, the process is not that simple. Virtually everyone in the supply chain has a responsibility to ensure a product, a system and an installation complies with the essential requirements of the EMC Directive.

The key is to clearly understand who has responsibility for what. In the forthcoming pages we take a look at various types of purchasers and examine the steps each should take to meet all three Directives mentioned on page 9.

Everyone from manufacturer to installer to user has a responsibility in complying with EMC rules.

***If a drive is CE Marked, I need not worry. True?***

Again this is a big misconception. Just because a drive has CE Marking does not necessarily mean it meets the EMC Directive.

***KEY POINT:*** This will all become clear by referring to the section **Purchasing Decisions for PDSs**, page 18.

CE Marking according to the EMC-Directive cannot normally be applied to a module that is no more than a chassis with exposed terminals.

# Chapter 3 - CE Marking

## What is CE Marking and how relevant is it for drives?

CE Marking, shown below, is the official signature of the **Declaration of Conformity** (see pages 42 and 43) as governed by the European Commission. It is a very specific graphic symbol and must be separated from other marks.

CE Marking is a system of self-certification to identify equipment that complies with the relevant applicable Directives.

If a drive is the subject of several directives and, for example, conforms with the **Low Voltage Directive** (see page 53), then, from 1997, it is compulsory that it shows **CE Marking**. That marking shall indicate that the drive also conforms to the **EMC Directive** (page 54). CE marking shall indicate conformity only to the directive(s) applied by the manufacturer.

***KEY POINT:*** NOTE: If the standards route is used, then there must be a **Technical File** supporting the **Declaration of Conformity**. However, if standards cannot be complied with then a **Technical Construction File (TCF)** needs to be compiled.

For more on **Technical Construction Files** and **Technical Files**, please refer to pages 34 and 40.

### *What is CE Marking for?*

CE Marking is mainly for the benefit of Authorities throughout the EU and EEA countries who control the movement of goods. CE Marking shows that the product complies with the essential requirements of all relevant Directives, mainly in the area of technical safety and conformity assessment. There are three Directives that are relevant to drives, but CE Marking may be attached to indicate compliance with one (see the previous page).

***Is CE Marking a quality mark?***

Most definitely not. As CE Marking is self certification, you can be assured that certification has been carried out.

***What is the legal position regarding CE Marking?***

Anyone applying CE Marking is legally liable and must be able to prove the validity of his actions to the authorities. CE Marking confirms compliance with the Directives listed in the **Declaration of Conformity** (see pages 42 and 43).

***What is the importance of CE Marking for purchasers of drives?***

As far as a purchaser of a drive is concerned, anything that carries the CE Mark must have a functional value to him.

Thus, a complete drive product, which can be safely cabled and powered up on its own, may carry the CE marking.

***If I buy a CE marked drive, will I meet the technical requirements of the Directives?***

In practice, you will see drive products with CE Marking. But it is important to understand just why the product was given CE Marking in the first place.

Basically a drive has no functional value. It is only of practical use when connected to, say, a motor which in turn is connected to a load.

Therefore, as far as the **Machinery Directive** is concerned a drive cannot have CE Marking unless it is part of a “process” comprising the drive, motor and load.

As for the **EMC Directive**, the equipment that make up a “process” include cabling, drives and motor. CE Marking can only be affixed if all items forming such a “process” conform to the requirements of the Directive.

However, in the eyes of the **Low Voltage Directive**, a built drive does have functionality. That is, through the drive's Parameters you can program the drive and obtain an input and output signal. Thus, if a drive conforms to the **Low Voltage Directive** it can carry **CE Marking.** Refer to pages 52, 53 and 54 for explanations of the three Directives.

***What happens if, as an End-User, I put together a system - do I have to put CE Marking on?***

Yes. Anyone putting together a system and commissioning it is responsible for the appropriate CE Marking.

***KEY POINT:***

Turn to page 29 for more details about the **End-User's** responsibilities.

***What about spare parts that I buy for a drive? Do I negate the CE Mark if I replace a component?***

Equipment supplied before the application of the Directives, can be repaired and supplied with spare parts to bring it back to the original specification. However, it cannot be enhanced or reinstalled without meeting the Directives.

For equipment supplied after the application of the Directives, the use of the manufacturer's spare parts should not negate the CE Marking. However, the manufacturer or supplier should be consulted about upgrading, as some actions could affect the CE Marking criteria.

***If drives are classed as components, they cannot be EMC certified or carry a CE Mark. Is this true?***

You need to first understand the terminology now being applied to drives. See below and page 18 for this.

A Complete Drive Module (CDM) is normally a component in a system and as such has no functional value unless it is connected to the motor when it becomes a PDS.

The CDM shall be CE-marked if it is to be installed with simple connections and adjustments that do not require any EMC-knowledge.

If awareness of the EMC implication is needed in order to install a CDM, it is not considered as an apparatus. Thus, it shall not be CE-marked according to the EMC-directives.

If a CDM or BDM is intended for incorporation in PDS by professional manufacturers only (panel builders, machine builders), it shall not be CE-marked, nor is declaration of conformity given by the CDM/BDM manufacturer. Instead installation instructions shall be supplied in order to help the professional manufacturers.

***In Summary***

Under the Directives, **Components with direct function** available without further adjustment other than simple ones**, Apparatus** and **Systems** have to be **CE marked**. **Components with direct function** not available without simple adjustments and **Components without direct function** and **Installations**, while required to satisfy various elements of the Directives, shall not be **CE marked.**

***Component***

In this context the interpretation of component can be divided into two main categories. The component can either deliver a 'direct function' or not.

Direct function:
*Any function of the component itself, which fulfils the intended use, specified by the manufacturer in the instruction for use for an end user.*

***Components with direct function***

Components with a direct function can be divided into two sub-groups:

1) *The direct function **is available** without further adjustment or connections other than simple ones, which can be performed by any person not fully aware of the EMC implications. Such a component is an 'apparatus' and it is subjected to all provisions of the EMC Directive.*

2) *The direct function **is not available** without further adjustment or connections other than simple ones, which can be performed by any person not fully aware of the EMC implications. Such a component is not an 'apparatus'. The only requirement for such a component is to provide it with instructions for use for the professional assembler or manufacturer of the final apparatus into which the component will be incorporated. These instructions should help him to solve any EMC problems with his final apparatus.*

If a component performs a direct function without further adjustment other than simple ones, the component is considered equivalent to apparatus. Some variable speed power drive products fall into this category, e.g. a drive installed into a cabinet or drive with enclosure and sold as a complete unit (CDM). All provisions of the EMC Directive apply.

If a component performs a direct function that is not available without further adjustment other than simple ones, it is considered as a component. Some variable speed power drive products fall into this category, e.g. basic drive module (BDM). These are meant to be assembled by a professional assembler

(e.g. panel builder or system manufacturer) into a cabinet not in the scope of delivery of the manufacturer of the BDM. According to the EMC Directive, the requirement **for the BDM supplier** is instructions for installation and use.

According to the EMC Directive the system manufacturer or panel builder is resonsible for CE-mark, Declaration of Conformity and Technical Construction File.

***Components without direct function***

Components with no direct function are not considered as apparatus within the meaning of the EMC Directive. The EMC Directive does not apply to these. These components include resistors, cables, terminal blocks, etc.

***Apparatus***

A finished product containing electrical and/or electronic components and intended to be placed on the market and/or taken into service as a single commercial unit.

***Systems***

Several items of apparatus combined to fulfil a specific objective and intended to be placed on the market as a single functional unit.

***Installation***

A combination of items of apparatus, equipment and/or components put together at a given place to fulfil a specific objective but **not** intended to be placed on the market as a single functional unit.

# Chapter 4 - Purchasing decisions for PDSs

## *What you need to know and do*

**Starting on page 20, we offer a step-by-step guide relating to your purchasing requirements for Power Drive Systems.**

***KEY POINT:*** Before turning to page 20, you **need to know** the following IEC terms for PDSs and their component parts, which may be unfamiliar to many users.

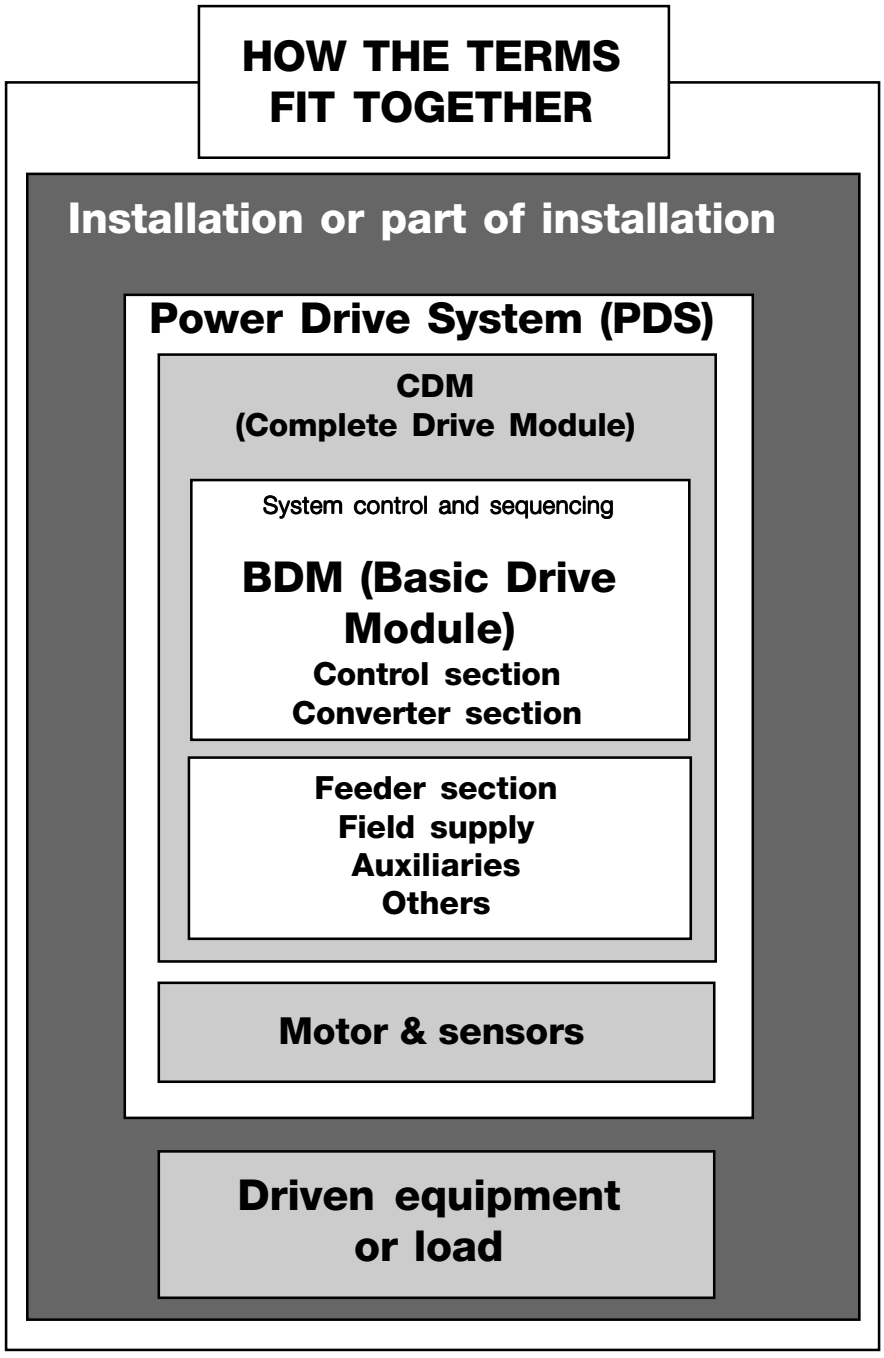
### TERMS THAT YOU MUST KNOW

**1. Basic Drive Module (BDM)** consists of the converter section and the control circuits needed for torque or speed. A BDM is the essential part of the Power Drive System taking electrical power from a 50 Hz constant frequency supply and converting it into a variable form for an electric motor.

**2. Complete Drive Module (CDM)** consists of the drive system without the motor and the sensors mechanically coupled to the motor shaft. The CDM also includes the Basic Drive Module (BDM) and a feeder section. Devices such as an incoming phase-shift transformer for a 12-pulse drive are considered part of the CDM.

**3. Power Drive System,** or PDS, is a term used throughout this Technical Guide. A PDS includes the frequency converter and feeding section (the CDM and BDM), motors, sensors, all cabling, filters, panels and any other components needed to make the PDS work effectively.

**Note:** The load is not considered part of the PDS, but the CDM can incorporate the supply sections and ventilation.




***Now we strongly advise you turn to page 20, to discover the type of person you are.***

**To make this Technical Guide easy to use, we have also identified certain types of people who will be involved in the purchasing of drives.**

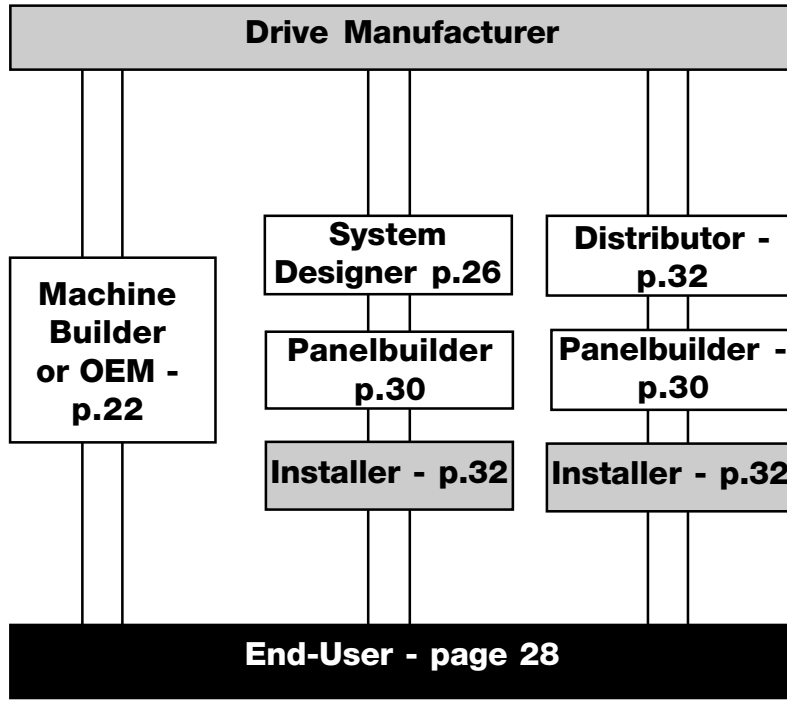
Please identify the type nearest to your job function and turn to the relevant section.

## WHO ARE YOU?

| | IF THIS IS YOU, TURN NOW TO PAGE..... |
|---|---|
| **Machine Builder**<br>is a person who buys either a PDS, CDM or BDM **and** other mechanical or electrical component parts, such as a pump, and assembles these into a machine.<br>*Note: A **machine** is defined as an assembly of linked parts or components, at least one of which moves. It includes the appropriate actuators, control and power circuits joined together for a specific application, in particular for processing, treatment, moving or packaging of a material.* | **22** |
| **System Designer**<br>carries out all the electrical design of the Power Drive System, specifying all component parts which comprise a PDS. | **26** |
| **End-User**<br>is the final customer who will actually use the machine, PDS or CDM/BDM. | **28** |
| **Panelbuilder**<br>constructs enclosures into which a panelbuilder will install a variety of components, including a CDM/BDM and sometimes the motor. However, the built enclosure does not constitute a machine. | **30** |

## WHO ARE YOU?

| | IF THIS IS YOU, TURN NOW TO PAGE..... |
|---|---|
| **Distributor**<br>acts as the sales distribution channel between the CDM/ BDM manufacturer and the End-User, Machine Builder, OEM, Panelbuilder or System Designer. | **32** |
| **Installer**<br>carries out the entire electrical installation of the PDS. | **32** |
| **Original Equipment Manufacturer (OEM)**<br>For the purposes of purchasing drives, an OEM will normally fall into the category of a **Machine Builder, System Designer** or **Panelbuilder**. Therefore, if you identify yourself as an OEM, refer to the relevant pages for each of these job functions. | **22**<br>**26**<br>**30** |



**NOTE: Before reading this section we strongly urge you to familiarise yourself with the terms explained on pages 16-19.**

## *If you are a Machine Builder buying a PDS...*

**...You have the following responsibilities:**

1. Because you are building a complete machine, which includes coupling up the motors to the PDS and providing the mechanical guarding and so on, you are liable for the total mechanical and electrical safety of the machine as specified in the **Machinery Directive.**

   Therefore, the PDS is ultimately your responsibility. You need to ensure that the entire PDS meets the **Machinery Directive**. Only then can **CE Marking** be applied to the whole machine.

2. You are also responsible for the electrical safety of all parts of the PDS as specified in the **Low Voltage Directive.**

3. You must ensure electrical parts are manufactured in accordance with the **EMC Directive**. The manufacturer of these parts is responsible for EMC for that particular part. Nevertheless you are responsible for EMC for the machine. You may choose electrical parts not in accordance with the EMC directive, but then you have the responsibility for compliance of parts.

   *Note: Be aware that combining CE-marked sub-assemblies may not automatically produce an apparatus that meets the requirements.*

4. You must ensure that the PDS or its component parts carry **Declarations of Conformity** in accordance with the electrical safety requirements of the **Low Voltage Directive.**

5. You must be able to assure a **Competent Authority** and customers that the machine has been built according to the **Machinery Directive,** the **Low Voltage Directive** and the **EMC Directive**. It may be necessary to issue a Technical File and a Technical Construction File to demonstrate compliance. You must keep in mind that you and only you have responsibility for compliance with directives.

6. A **Declaration of Conformity** according the directives above must be issued by the **Machine Builder** and **CE Marking** must then be affixed to the machine or system.

7. Any machine that does not comply must be withdrawn from the market.

***Actions you must take***

1. To meet the **Machinery Directive** (see page 52) you need to:

a. Comply with the following mechanical safety checklist.
*The aim is to eliminate any risk of accident throughout the machinery's life. This is not a complete list, the detailed list is contained within the **Machinery Directive**:*

- ☐ Eliminate risk as far as possible, taking the necessary protective measures if some risks cannot be eliminated.
- ☐ Inform users of the residual risks; indicate whether any training is required and stress the need for personal protective equipment.
- ☐ Machinery design, construction and instructions must consider any abnormal use.
- ☐ Under the intended conditions of use, the discomfort, fatigue and stress of the operator must be reduced.
- ☐ The manufacturer must take account of the operator's constraints resulting from the use of personal protective equipment.
- ☐ Machinery must be supplied with all essential equipment to enable it to be used without risk.

Detailed instructions relating to materials, lighting, controls, protection devices are given in Annex 1 of the **Machinery Directive**.

b. Comply with the following electrical safety checklist:
*To ensure the electrical safety of all parts of the PDS as specified in the **Low Voltage Directive** (refer to page 53) you need to comply with the following safety checklist, which is not necessarily complete.*

*Note: the detailed list is given in EN 60204-1. This can be obtained from CENELEC or the National Standardisation Association.*

☐ The electricity supply should be equipped with a hand-operated disconnecting device and with emergency devices for switching off the supply in the event of an unexpected start-up.

☐ The equipment shall provide protection of persons against electric shock from direct or indirect contact.

The equipment is protected against the effects of:

☐ overcurrent arising from a short circuit.

☐ overload current.

☐ abnormal temperatures.

☐ loss of, or reduction in, the supply voltage.

☐ overspeed of machines/machine elements.

☐ The electrical equipment is equipped with an equipotential bonding circuit consisting of the:

- PE terminal.
- conductive structural parts of the electrical equipment and the machine.
- protective conductors in the equipment or the machine.

☐ The control circuits and control functions ensure safe operation including the necessary interlockings, emergency stop, prevention of automatic re-start, etc.

**Defined on page 38**

☐ c. Compile a **Technical File** for the machine, including the PDS.

***KEY POINT:*** Generally, must carry **CE Marking** and have a **Declaration of Conformity.**

For machines that pose a high risk of accident, a **Type Certification** (see page 45) is required from a **Notified Body** (see page 46). Such machinery is included in Annex IV of the **Machinery Directive**.

The **Type Certificate** issued should be included in the **Technical File** for the Machine or Safety Component. Refer now to page 38.

☐ **2. Declarations of Conformity** from each of the component suppliers whose products make up the PDS and incorporate them into the **Technical File**, referring to all three Directives. If buying a PDS from a **System Designer** (see below), he should be able to provide all Declarations. If system designer or component supplier cannot provide **Declaration of Conformity**, the responsibility of demonstrating compliance according to **EMC Directive** or **Low Voltage Directive** lies on Machine Builder. Refer to pages 30-32 in this case.

☐ 3. Pass this **Technical File** to a **Competent Body** (refer to page 46). The Machine Builder SHOULD NOT pass the **File** on to an **End-User**. Based on the **Technical File**, obtain a **Certificate of Adequacy** or **Technical Report** from a **Competent Body**.

**Defined on pages 42 and 43**

☐ 4. Issue a **Declaration of Conformity** for the entire machine. Only then can you apply **CE Marking** (see page 13).

☐ 5. Pass the **Declaration of Conformity** related to all three directives on to the **End-User** of the machine (refer to page 28).

☐ 6. Apply **CE Marking** to the machine.

☐ 7. Congratulations! You have successfully complied with the main requirements for safe and efficient operation of a machine.

**NOTE: Before reading the next section, we strongly urge you to familiarise yourself with the terms explained on pages 16 - 19.**

***If you are a System Designer buying a PDS...***

**...You have the following responsibilities:**

1. The PDS is a complex component of the machine. Therefore, the **Machinery Directive** has to be complied with by issuing a **Declaration of Incorporation**.

2. Because a PDS is not a machine, the only Directives which need to be complied with are the **Low Voltage Directive** and the **EMC Directive**.

3. The responsibility for **Declaration of Conformity** and applying **CE Marking** rests with both the System Designer and the supplier of the component parts which make up the Power Drive System.

The System Designer has to decide if he is going to place his delivery on the market as a single functional unit or not

- if the answer is YES, the delivery shall be classified as a system (refer to page 16 - 17).

- if the answer is NO , the delivery shall be classified as an installation (refer to page 16 - 17).

**A.** If the delivery is classified as a system, the system designer has to choose one of two paths to follow:

***Path 1*** **All components have EMC compliance**

**1. EMC behaviour is based on a component's performance.**

2. Responsibility lies with the **Component Suppliers** for CE Marking of individual **complex** components

3. PDS is an **System** according to the **EMC Directive** (as placed on the market as a single funtional unit).

4. The **Declaration of Conformity** as well as the instructions for use must refer to the system as whole. The system designer assumes responsibility for compliance with the Directive.

   *Note 1: The system designer is responsible for producing the instructions for use for the particular system as whole.*

*Note 2: Be aware that combining two or more CE-marked sub-assemblies may not automatically produce a system that meets the requirements.*

5. No **CE Marking** is required for a system as whole, as long as each part bears the CE-mark.

***Actions you must take***

- ☐ 1. Follow all **Installation Guidelines** issued by each of the component suppliers.
- ☐ 2. Issue **instructions for use** in order to operate the system.
- ☐ 3. Issue a **Technical Construction File** for the System.
- ☐ 4. Issue a **Declaration of Conformity.**
- ☐ 5. **DO NOT** issue a **CE Mark.**

***Path 2*** **Components without EMC compliance**

1. EMC behaviour is designed at the system level (no accumulated cost by device specific filters etc).
2. Responsibility lies with the **System Designer** who decides the configuration (place or a specific filter etc).
3. PDS is a **System** according to the **EMC Directive** (as placed on the market as a single functional unit)**.**
4. **Declaration of Conformity** and **CE Marking** are required for the **System**.

***Actions you must take***

- ☐ 1. Follow the **Installation Guidelines** issued by each of the component suppliers.
- ☐ 2. Optimise the construction of the installation to ensure the design meets the required EMC behaviour, i.e. the location of filters.

Defined on pages 34 - 40

- ☐ 3. Issue **instructions for use** in order to operate the system.
- ☐ 4. Issue a **Technical Construction File** for the **System**.
- ☐ 5. Issue a **Declaration of Conformity** and **CE Mark**.

**B.** If the delivery is an installation, the system designer has one path to follow:

***Path 3*** **All components have EMC compliance**

1. **EMC behaviour is based on a component's performance.**
2. Responsibility lies with the **Component Suppliers** for CE Marking of individual **complex components.**
3. PDS is an **Installation** according to the **EMC Directive.**
4. No **Declaration of Conformity** or **CE Marking** is required for a fixed Installation, (such as an outside broadcast radio station) DOC and CE marking are needed.

***Actions you must take***

- ☐ 1. Follow all **Installation Guidelines** issued by each of the component suppliers.
- ☐ 2. Transfer all **Installation Guidelines** and **Declaration of Conformity** (see page 42) for each of the components, as issued by suppliers, to the **Machine Builder.**
- ☐ 3. **DO NOT** issue a **Declaration of Conformity** or **CE Marking** as this is not allowed for **fixed installations.**

N**OTE: Before reading the next section, we strongly urge you to familiarise yourself with the terms explained on pages 16 - 19.**

## *If you are an End-User buying a CDM/ BDM or PDS*

***KEY POINT:*** An **End-User** can make an agreement with the drive's supplier so that the supplier acts as the **Machine Builder**. However, the **End-User** is still responsible for the machine's safety.

The supplier who acts as the **Machine Builder** will issue a **Declaration of Conformity** when the work is complete.

Once an intermediary **Panelbuilder** incorporates a CDM/BDM into a panel, he creates a part of a PDS.

The Panelbuilder then has the same responsibilities as the drive's manufacturer.

***...You have the following responsibilities***

1. For the total mechanical and electrical safety of the machine of which the drive is part of, as specified in the **Machinery Directive** (see page 52).

2. For the electrical safety of the drive as specified in the **Low Voltage Directive** (see page 53).

3. To ensure the drive carries a **Declaration of Conformity** in accordance with the electrical safety requirements of the **Low Voltage Directive**.

4. To be able to demonstrate to the Authorities that the machine to which the drive is being fitted has been built to both the **Machinery Directive** and **Low Voltage Directive**.

5. The manufacturer of the drive is responsible for determining the EMC behaviour of the drive.

6. The resulting EMC behaviour is the responsibility of the assembler of the final product, by following the manufacturer's recommendations and guidelines.

***Actions you must take***

The following needs to be completed by either the **End-User** directly or the third party engaged to build the machine.

1. To meet the **Machinery Directive** (refer to page 52) you need to **follow the Actions listed for a Machine Builder on pages 22-25.**

2. Follow installation instruction issued by manufacturers in order to fulfill the requirements of the **EMC Directive** and the **Low Voltage Directive**.

3. Ensure that equipment (CDM/BDM/PDS) is operated according to manufacturer's instruction in order to guarentee right way of operation.

**NOTE: Before reading the next section, we strongly urge you to familiarise yourself with the terms explained on pages 16 - 19.**

## *If you are a Panelbuilder buying a CDM/ BDM*

**...You have the following responsibilities:**

1. The Panelbuilder has two options:

**Option A - To buy non-CE marked components**

This could save the Panelbuilder money because he buys components which are not tested for EMC. However, the responsibility for EMC is then the Panelbuilder's and this will incur considerable costs as the entire panel needs to be tested.

If the Panelbuilder buys non-CE marked components, the drive may be made to conform without further testing if the components themselves have been tested. However, tested components do not carry the CE mark but must carry suitable instructions for installation. It is these instructions which must be demonstrably met.

**Option A - Actions to meet these responsibilities**

☐ 1. Follow the **Installation Guidelines** issued by each of the component suppliers.

☐ 2. Optimise the construction of the installation to ensure the design meets the required EMC behaviour, i.e. the location of filters.

☐ 3. Issue a **Technical Construction File** for the **System.**

**Defined on pages 47 to 54**

☐ 4. If you choose to test yourself you must make reference to EMC Directives:

89/336/EEC;
91/263/EEC;
92/31/EEC;
93/68/EEC.

Harmonised standard:

EN 61800-3.

**Defined on pages 34-40**

- [ ] 5. Once testing is completed, the results need to be included in the **Technical Construction File (TCF)** for the panel.

- [ ] 6. If testing is incomplete or full compliance cannot be demonstrated, a **TCF** must be created and results included for approval by a **Competent Body**.

- [ ] 7. You must then issue the **Declaration of Conformity** and **CE Marking** for the panel (refer to page 13).

**Option B - To buy CE marked components**

**Option B - Actions to meet these responsibilities**

- [ ] 1. Buying CE marked components creates a system or an apparatus (refer to page 16-17) depending on the nature of the panel.

- [ ] 2. Although the Panelbuilder does not have to carry out tests, he must ensure he conforms to the **installation guidelines** given by each of the component manufacturers.
*Note: Be aware that combining two or more CE-marked components may not automatically produce a system, which meets the requirements.*

- [ ] 3. Beware! These guidelines could differ greatly from those given for normal installation purposes because the components will be in close proximity to each other.

- [ ] 4. Issue **instructions for use** in order to operate the system or **apparatus.**

- [ ] 5. Issue a **Technical Construction File.**

- [ ] 6. Issue a **Declaration of Conformity.**

- [ ] 7. Apply **CE Marking** to your panel in the case of an apparatus. In the case of a system **DO NOT** apply **CE Marking.**

***Additional actions***

The Panel can be either sold on the open market or use as part of a machine. For each option there is a different requirement:

☐ 1. If you know that the panel is to be used as part of a machine then you must request from the CDM/BDM manufacturer a **Declaration of Incorporation**.

☐ 2. The **Declaration of Incorporation** must be supplied with the panel to the **Machine Builder**, but **CE Marking** MUST NOT be affixed. This is because **CE Marking** always needs a **Declaration of Conformity**.

***KEY POINT:*** The **Declaration of Incorporation** CANNOT be used to apply **CE Marking.**

☐ 3. The **Machine Builder** will need this **Declaration of Incorporation** because he has to construct a **Technical Construction File (TCF)** for the machine and in that file all the declarations need to be included.

***If you are a Distributor buying a CDM/ BDM...***

**...You have the following responsibilities:**

1. If a Distributor is selling boxed products, like CDM/BDMs (drives), direct from the manufacturer, his only responsibility is to pass on the **Installation Guidelines** to the **End-user, Machine Builder** or **System Designer**. In addition, the **Declaration of Conformity** must be passed to the **Machine Builder** or **System Designer.**

2. Both the **Installation Guidelines** and the **Declaration of Conformity** are available from the manufacturer.

**Actions you must take to meet these responsibilities**

1. Pass all **Installation Guidelines** and **Declaration of Conformities** to either the **End-User**, **Machine Builder** or **System Designer**.

***If you are an Installer buying a CDM/ BDM or PDS...***

**...You have the following responsibilities:**

1. You must ensure that the **Installation Guidelines** of the **Machine Builder** and/or **System Designer** are adhered to.

**Actions you must take to meet these responsibilities**

1. Follow **Machinery Builder** and/or **System Designer Installation Guidelines**.

2. Turn to page 58, Chapter 8 for recommended installation guidelines.

## Technical Construction File (TCF)

**APPLIED TO:** Electrical equipment

**RESPONSIBILITY:** Electrical Equipment Manufacturer

**REQUIRED BY:** EMC Directive

***What is a Technical Construction File?***

A **Technical Construction File (TCF)** must be provided for the entire equipment or system and if required is to show a **Competent Authority** that you have met the essential requirements of the **EMC Directive** (see page 54).

The TCF consists of three parts:

1. A description of the product.
2. Procedures used to ensure conformity of the product to the requirements.
3. A report or certificate from a Competent Body.

***KEY POINT:*** The full contents of the TCF are given on pages 36-38.

***When do I use a TCF?***

A TCF is needed if you are:

a. claiming compliance without necessarily meeting the standards.

b. or where suitable standards do not exist.

c. or where the system may be complex and involve the inclusion of more than one equipment.

d. or where the Equipment can have several variants.

***Why is a TCF deemed to be important?***

Anyone placing a product onto the market within the EU must be able to show that the product meets the requirements of the appropriate EU Council Directive and must be able to demonstrate this to a **Competent Authority** without further testing.

This may be by a Technical File to show that the standards route has been complied with (see page 38). Alternatively the **Technical Construction File (TCF)** route is necessary.

A TCF allows the appropriate **Declaration of Conformity** to be drawn up.

If there is any doubt in the manner of compliance, the TCF is the preferred route.

***Will customers always receive a TCF copy?***

The content of the TCF file is meant for the Authorities, and thus the electrical equipment manufacturer does not have to give the TCF or any part of it to the customer.

However, as the customer needs to know whether the product is in conformance, he will obtain this assurance from the documentation delivered with the product. It is not required to supply a declaration of conformity with the product, but the end-user may ask for this from the manufacturer.

***What is the shelf life of a TCF?***

Any TCF must be accessible to the appropriate Authorities for 10 years from the last relevant product being delivered.

***Is there any way I can avoid the TCF?***

Yes. Use the standards route to compliance.

Although TCFs may appear onerous and time consuming there is often no way of avoiding their use. Even soft starters, PLCs, intelligent motor protection relays and a host of other microprocessor based devices are subject to TCFs, if the manufacturer opts for that route.

***How do I ensure that tests are always carried out?***

The whole system is based on self certification and good faith. In various parts of Europe the methods of ensuring compliance will vary. Supervision of these regulations is achieved through market control by a Competent Authority. If the equipment fails to meet the requirements of the EMC-directive, Competent Authorities can use the safeguard clause of the EMC-directive (withdraw the product from the market, take legal action).

***Can drive manufacturers help more?***

Manufacturers accept that there is a need to work more closely with OEMs and Machine Builders where the converter can be mounted on the machine. A standard assembly or design should be achieved so that the TCF does not have to be repeated.

However, the idea of mounting drives in motor control centres (MCCs) must be much more carefully thought out by system specifiers.

For a straightforward single drive application, it may well be possible to demonstrate compliance by the standards route and evidence of type tests using specified types and lengths of cable with fixing methods and segregation.

This would only need a **Technical File** (see page 38), otherwise the **Technical Construction File** route is still needed.

However, the concept of mounting several drives in a motor control centre must be more carefully thought out, as the summing of high frequency emissions to determine the effects at the MCC terminals is a complex issue and the possibilities of cross coupling are multiplied.

## *How to make up a TCF*

### *1. Description of the product*

(Note: You can photocopy these pages and use as a tickbox checklist)

**i. identification of product**

☐ a. brand name.

☐ b. model number.

☐ c. name and address of manufacturer or agent.

☐ d. a description of the intended function of the apparatus.

☐ e. any limitation on the intended operating environment.

**ii. a technical description**

☐ a. a block diagram showing the relationship between the different functional areas of the product.

☐ b. relevant technical drawings, including circuit diagrams, assembly diagrams, parts lists, installation diagrams.

☐ c. description of intended interconnections with other products, devices, etc.

☐ d. description of product variants.

***2. Procedures used to ensure product conformity***

**i. details of significant design elements**

☐ a. design features adopted specifically to address EMC problems.

☐ b. relevant component specifications (e.g. the use of cabling products known to minimise EMC problems).

☐ c. an explanation of the procedures used to control variants in the design together with an explanation of the procedures used to assess whether a particular change in the design will require the apparatus to be re-tested.

☐ d. details and results of any theoretical modelling of performance aspects of the apparatus.

☐ e. A list of standards applied in whole or part.

☐ f. The description of the solution adopted in order to comply with the directive.

**ii. test evidence where appropriate**

☐ a. a list of the EMC tests performed on the product, and test reports relating to them, including details of test methods, etc.

☐ b. an overview of the logical processes used to decide whether the tests performed on the apparatus were adequate to ensure compliance with the directive.

☐ c. a list of the tests performed on critical sub-assemblies, and test reports or certificates relating to them.

***3. A report or certificate from a Competent Body***

This will include:

☐ i. reference to the exact build state of the apparatus assessed, cross-referencing with Part I of the basic requirements of a TCF.

☐ ii. comment on the technical rationale.

☐ iii. statement of work done to verify the contents and authenticity of the design information in the TCF, cross referenced with part 2 (ii) of the basic requirements of a TCF.

☐ iv. comment, where appropriate, on the procedures used to control variants, and on environmental, installation and maintenance factors that may be relevant.

☐ v. an analysis of the tests performed either by the manufacturer, an authorised third party, or the **Competent Body** itself, and the results obtained. This analysis will determine whether the tests show that the apparatus should comply with the essential requirements of the directive.

***4. Actions by the Competent Body***

The **Competent Body** (see page 46) will study the TCF and issue the **Technical Report** or **the Certificate** and this should be included in the TCF.

**Note:**
When compiling the TCF you may need all Declarations from suppliers, i.e. **Declaration of Conformity** and **Declaration of Incorporation** depending on the parts, to ensure they carry **CE Marking.**

## TECHNICAL FILE (for mechanical safety aspects)

**APPLIED TO:** Machines and Safety Components

**RESPONSIBILITY:** Machine Builder/ System Designer

**REQUIRED BY:** Machinery Directive

***What is a Technical File?***

A **Technical File** is the internal design file which should show how and where the standards are met and is all that is needed if self certifying the equipment by the standards compliance route.

If a **Declaration of Incorporation** (see page 43) is included in a set of papers and this claims to meet the appropriate parts of the standards and simply instructs the user to meet the standards with other parts of his machine, it is possible to use this as a part of a **Technical File**.

## *How to make up a Technical File*

***Drawings and diagrams***

1. Overall drawings of the machine.
2. Control circuit diagrams.

***Health and safety***

1. All drawings, calculations and test results used to check the machine's conformity with essential health and safety requirements.

***Machine design***

1. Lists of the essential health and safety requirements, **Harmonised Standards**, other standards and technical specifications used when designing the machine.
2. Description of methods used to eliminate hazards presented by the machine.

***Other certificates required***

1. A technical report or certificate issued by a **Notified Body** (see page 46) - if required.
2. If required by a **Harmonised Standard** (see page 47) to which conformity is declared, a technical report is issued by a **Competent Body** (see page 46). This technical report shall include test results.
3. A copy of the instructions for the machine.
4. For series produced machines, the control measures that are used to ensure that subsequent manufacture remains in conformity with the Directive.

## TECHNICAL FILE (for electrical safety aspects)

**APPLIED TO:** Electrical equipment

**RESPONSIBILITY:** Drive Manufacturer/System Designer/Panelbuilder/OEM/ Installer

**REQUIRED BY:** Low Voltage Directive

***What is a Technical File?***

A **Technical File** is the internal design file which should show how and where the standards are met and is all that is needed if self certifying the equipment by the standards compliance route.

If a **Declaration of Conformity** (see page 42) is included in a set of papers and this claims to meet the appropriate parts of the standards and simply instructs the user to meet the standards with other parts of his equipment, it is possible to use this as a part of a **Technical File**.

### *How to make up a Technical File*

***Drawings and diagrams***

1. A general description of the electrical equipment, or electrical equipment of machines.
2. Conceptual design and manufacturing drawings and schemes of components, sub-assemblies, circuits, etc.,
3. Descriptions and explanations necessary for the understanding of said drawings and schemes and the operation of the electrical equipment.

***Standards***

1. A list of the standards applied in full or in part, and descriptions of the solutions adopted to satisfy the safety aspects of this Directive where standards have not been applied.

***Electrical Safety Aspect***

1. Description of methods used to eliminate hazards
2. Results of design calculations made, examinations carried out, etc
3. Test reports
4. A technical report issued by a **Notified Body** or **Competent Body** (see page 46) - if used.

***Other requirements***

1. For series produced equipment, the control measures that are used to ensure that subsequent manufacture remains in conformity with the Directive.

## CERTIFICATE OF ADEQUACY

**APPLIED TO:** Machines/Safety Components

**RESPONSIBILITY:** Notified Body/Machine Builder

**REQUIRED BY:** Machinery Directive

***What if standards cannot be wholly implemented?***

In this case the adequacy of the **Technical File** (see page 38) is proved by a **Certificate of Adequacy** issued by a **Competent Body.**

### *How to obtain a Certificate of Adequacy*

The **Certificate of Adequacy** is a document drawn up by a **Competent Body** (see page 46). Once the Body has established that the **Technical File** contains all the necessary information, the **Certificate of Adequacy** will be issued.

***KEY POINT:*** The **Certificate of Adequacy** provided should be included in the **Technical File.**

## TECHNICAL REPORT OR CERTIFICATE

**APPLIED TO:** Electrical equipment

**RESPONSIBILITY:** Competent Body

**REQUIRED BY:** EMC Directive

***What if standards cannot be wholly implemented?***

In this case the adequacy of the **Technical Construction File** (see page 34) is proved by a **Technical Report** or **Certificate** issued by a **Competent Body**.

### *How to obtain the Technical Report or Certificate*

The **Technical Report** or **Certificate** is a document drawn up by a **Competent Body** (see page 46). Once the Body has established that the **Technical Construction File** contains all the necessary information, the **Technical Report** or **Certificate** will be issued.

***KEY POINT:*** The **Technical Report** or **Certificate** provided should be included in the **Technical Construction File**.

## REPORT

**APPLIED TO:** Electrical equipment

**RESPONSIBILITY:** Notified Body/Competent Body

**REQUIRED BY:** Low Voltage Directive

***What if standards cannot be wholly implemented?***

In the event of a challenge the manufacturer or importer may submit a **Report** issued by a **Notified Body**. This report is based on the **Technical File** (see page 38).

### *How to obtain a Report*

The **Report** is a document drawn up by a **Notified Body** (see page 46). Once the Body has established that the **Technical File** contains all the necessary information and the equipment fulfils the requirements of the **Low Voltage Directive**, the **Report** will be issued.

***KEY POINT:*** The **Report** provided should be included in the **Technical File**.

## DECLARATION OF CONFORMITY (for EMC and electrical safety aspects)

**APPLIED TO:** Electrical equipment and electrical equipment of machines

**RESPONSIBILITY:** Equipment manufacturer

**REQUIRED BY:** Machinery Directive, Low Voltage Directive and EMC Directive

### *How to obtain a Declaration of Conformity*

As a **Machine Builder**, you must ensure you obtain all the **Declarations of Conformity** from each equipment supplier. The **Declaration of Conformity** must contain:

- ☐ 1. Manufacturer's details and/or his authorised EU representative.
- ☐ 2. Equipment description including name, type and serial number.
- ☐ 3. Safety function offered by the component, if not obvious from the description.
- ☐ 4. Details of the **Competent Body** and number of **Type Certification** - if required.
- ☐ 5. Details of the **Competent Body** to which the **Technical File** was sent - if required.
- ☐ 6. Details of the **Notified Body** which carried out the verification - if required.
- ☐ 7. A list of **Harmonised Standards,** other standards and specifications used.
- ☐ 8. Details of the person authorised to sign on behalf of the responsible person.

## DECLARATION OF CONFORMITY (for mechanical safety aspects)

**APPLIED TO:** Machines

**RESPONSIBILITY:** Machine Builder

**REQUIRED BY:** Machinery Directive

### *How to obtain a Declaration of Conformity*

You need to provide the following:

- ☐ 1. Name and address of the responsible person.
- ☐ 2. Machinery description including the name, type and serial number.
- ☐ 3. All regulations complied with including, if appropriate, a statement of conformity with the relevant health and safety requirements or with the example that underwent **Type Certification**.
- ☐ 4. Details of any **Competent Body** used and number of **Type certification.**
- ☐ 5. Details of the **Competent Body** holding the **Technical File** - if required.
- ☐ 6. Details of the **Competent Body** which has drawn up a **Certificate of Adequacy** - if required.
- ☐ 7. A list of **Harmonised Standards** used or the other standards and technical specifications used.
- ☐ 8. Identification of the Authorised signatory.

## DECLARATION OF INCORPORATION

**APPLIED TO:** Machines or equipment intended for incorporation into other machinery

**RESPONSIBILITY:** Drives Manufacturer/Machine Builder/Panelbuilder

**REQUIRED BY:** Machinery Directive

### *What is a Declaration of Incorporation?*

Drives manufacturers must meet the appropriate parts of the **Machinery Directive** and provide a **Declaration of Incorporation** which states that the drive does not comply on its own and must be incorporated in other equipment.

This Declaration will show the standards that have been applied to the parts of the system within the manufacturer's scope.

This Declaration includes a statement restricting the user from putting the equipment into service until the machinery into which it is to be incorporated, or of which it is to be a component, has been found, and declared, to be in conformity with the provisions of the **Machinery Directive** and the national implementing legislation, i.e. as a whole including the equipment referred to in this Declaration.

The Declaration then lists the standards relating to the **Machinery** and **Low Voltage Directives** which the manufacturer has met.

It concludes that the entire equipment must meet the provisions of the Directive.

Quite simply, the manufacturer passes on the responsibility to the machine or system builder.

***Is there no way out of this type of Declaration?***

No. You must understand that because the manufacturer may be supplying only one part in a machinery, such as the inverter, the manufacturer is legally obliged to ensure that whoever puts the system together must check that it is safe.

Only then can the **Machine** or **System Builder** use the **Declaration of Incorporation** in his **Technical File** of the machine.

***KEY POINT:***

Most manufacturers will include a **Declaration of Incorporation** covering the **Machinery Directive** for all built PDS products.

## *What a Declaration of Incorporation contains*

- ☐ 1. Name and address of the responsible person.
- ☐ 2. Machine description.
- ☐ 3. Details of the **Notified Body** and the number of the **Type Certification** - if required.
- ☐ 4. Details of the **Notified Body** to which the **Technical File** has been sent - if required.
- ☐ 5. Details of the **Notified Body** which has drawn up a **Certificate of Adequacy** - if required.
- ☐ 6. A list of the **Harmonised Standards** (see page 47) used - if required.

☐ 7. A warning that the machinery must not be put into use unless the machine into which it is to be incorporated is the subject of a **Declaration of Conformity.**

☐ 8. Details of the person authorised to sign on behalf of the responsible person.

## TYPE CERTIFICATION

**APPLIED TO:** Machines and Safety Components

**RESPONSIBILITY:** Machine Builder/Approved Body

**REQUIRED BY**: Machinery Directive

### *How to obtain Type Certification*

**Type Certification** is carried out by an **Notified Body** (see page 46) who will establish that the unit supplied, along with a **Technical File**, may be used safely and that any **Standards** have been correctly applied.

Once the **Type Certification** has established this, a **Type Examination Certificate** will be issued.

# Chapter 6 - Authorities and Bodies

The responsibility for product conformity is given to the manufacturer. If there is any doubt about conformity, then the Authorities can demand technical documentation to show that a product complies with the directives concerning the product.

When assessing product conformity, a manufacturer can use a third party to examine the conformity.

The following types of Authorities and Bodies exist:

### *Competent Authority*

A **Competent Authority** in any EU or EEA country supervises markets to prevent hazardous products being sold and marketed. They can also withdraw such products from markets.

To find a suitable **Competent Authority** or **Notified Body** you can contact: **EU Commission, Rue de la Loi 200,b, 1049 Brussels**
**Ph: +32 2 296 45 51**

### *Competent Body*

A **Competent Body** is a third party which can be used to assess a product's conformity. They also issue the **Technical Report** or **the Certificate** for the product's **Technical Construction File** (see page 34).

To find a suitable **Competent Body** contact your local **Competent Authority** or:
**EU Commission, Rue de la Loi 200,b, 1049 Brussels**
**Ph: +32 2 296 45 51**

### *Notified Body*

A **Notified Body** issues Type Certificates for products, which have their own Directives and/or require type testing.

The use of standards is voluntary, but compliance with Directives without the use of **Harmonised Standards** is extremely difficult.

There are two ways to show that a Power Drive System or part of it conform:

- Use of **Harmonised Standards** (EN).
- By way of a **Technical Construction File** when no **Harmonised Standards** exist, or if all parts of a **Harmonised Standard** cannot be applied.

***KEY POINT:*** It is recommended to use a TCF even when standards are harmonised as it makes it easier to show conformity afterwards, if required by Authorities.

## *Directive or Standard?*

The legislation of the European Union is defined by different Directives.

The Directives concerning Power Drive Systems are known as **New Approach Directives**, which means that they do not include exact figures or limits for products. What they do include is essential requirements mainly for Health and Safety which make the application of the relevant **Harmonised Standards** mandatory.

The requirements of Directives are firmly established in Standards. Standards give exact figures and limits for products.

The responsibility for defining standards in Europe rests with three committees: CEN, for areas of common safety, CENELEC, for electrical equipment and ETSI, for telecommunications.

## *Harmonised Standards for PDSs*

To remove technical barriers to trade in EU or EEA countries, the standards are **Harmonised** in Member States.

In the harmonisation procedure, all Member States are involved in developing the Committee's proposals for their own national standard. A standard becomes harmonised when published in the Official Journal of the EU.

The idea is that if a product conforms to the **Harmonised Standard**, it is legally manufactured and when placed onto the market in one country, it must be freely marketed in other member countries.

***How to recognise a European Standard***

Harmonised Standards come in the following format:

**XX EN 60204-1**

where

XX = the national prefix (eg BS = UK; SFS = Finland)
EN = the abbreviation of Euronorm
60204-1 = an example of a standard number

The first number in each standard index tells the origin of the standard:

2 = standards based on ISO
40 = standards from CENELEC
50 = standards from CISPR
(a committee dealing with radio interference)
60 = IEC based standards

There is also some clue as to a standard's status:

prEN 50082-2 = proposal for standard sent to Member States
ENV 50 = pre-standard which is in force for 3 years to obtain practical experience from Member States.

## *Your questions answered*

***Which standards directly relate to drives?***

At the moment, there is a **Product Specific Standard** (see page 50) covering EMC from Power Drive Systems.

The important standard for PDSs is EN 60204-1, *Electrical Equipment of Machines*, which, in addition to being a **Low Voltage Directive** standard for all electrical equipment, is also an electrical safety standard under the **Machinery Directive**. Other important standards are EN 50178 according to Low Voltage Directive and EN 61800-2, which gives rating specifications for Power Drive Systems.

***What are the issues of EN 61800-3 and drives?***

For emissions there are two main aspects to consider:

***Conducted emissions:*** these are seen on the power supply cables and will also be measured on the control connections, while radiated emissions are air borne.

Conducted emissions at low frequencies are known as harmonics which have been a familiar problem to many users of a PDS. Where harmonics are concerned EN 61800-3 refers to EN 61000-3-2 which does apply for equipment under 16 A per phase and after 1.1.2001.

At the moment two groups can be separated

- Professional, over 1kW => No limits.
- Other > The limits specified.

Conformity with conducted emissions can be helped by good product design and is readily achieved, in most situations, using filters, providing this is for a single drive.

***Radiated emissions:*** These are more problematic. While it is possible to make the drive enclosure into a Faraday cage and thereby have all radiation attenuated to earth, in practice it is the outgoing connections where inadequate cabling radiates emissions and cross couples with other cables in the vicinity. Important attenuation methods are shielded cables and 360° earthing.

***What are the solutions to radiated emissions?***

The most important solutions are good installation practice, tight enclosure, shielded cables and 360° earthing. (See page 58 for tips and advice).

***Do I have to conform to the standards?***

The use of standards is voluntary, but compliance with a Directive without the use of **Harmonised Standards** is difficult in the majority of cases.

There are two ways to show that a Power Drive System conforms:

- use of **Harmonised Standards** - EN 61800-3.
- if the **Harmonised Standards** cannot be applied, it is necessary to use a TCF. This does, however, involve third party (**Competent Body**) scrutiny of the file and a **Certificate** or a **Technical Report** from this body, which will incur additional costs (See pages 34-38 for a full explanation of how to use TCFs).

It is recommended to use the TCF where the **Harmonised Standards** are applied as it makes it easier to show conformity afterwards if required by the authorities.

***Can I be fined for not conforming?***

Yes. Failure to comply with any of the Directives will be a criminal offence.

## *The Product Specific Standard EN 61800-3*

This standard defines the required emission and immunity levels of PDSs and the test methods to measure the levels.

In Europe, the standard takes precedence over all generic EMC standards previously applicable.

The standard defines two modes of sales distribution and applies them to the PDS. It puts PDSs and their component parts into four modes depending on the functional characteristics.

***Mode 1:*** ***A PDS with unrestricted distribution***
***Complex component (PDS/CDM) sold "as built" to the End-User***

**Description**
Placed on the market. Free movement based on compliance with the EMC Directive. **EC Declaration of Conformity required. CE Marking required.**

The PDS manufacturer is responsible for EMC behaviour of the PDS under specified conditions. Additional EMC measures are described in an easy-to-understand way and can be implemented by a layman.

When PDS/CDM is going to be incorporated with another product, the resulting EMC behaviour of that product is the responsibility of the assembler of the final product, by following the manufacturer's recommendations and guidelines.

***Mode 2:*** ***Restricted distribution***
***A PDS (or CDM/BDM) sold to be incorporated into an apparatus, system or installation.***

**Description:**
Intended only for professional assemblers who have the level of technical competence of EMC necessary to install a PDS (or CDM/BDM) correctly. The manufacturer of the PDS (or CDM/BDM) is responsible for providing **Installation Guidelines.** The **EC Declaration of Conformity** and **CE Marking** are required.

When a PDS/CDM is to be incorporated with another product,

the resulting EMC behaviour of that product is the responsibility of the assembler of the final product.

**Standard assembly:**
The manufacturer restricts the supply of equipment to suppliers, manufacturers or users who separately or jointly have technical competence of the EMC requirements for the application of drives.

***Mode 3:*** ***Installation***
***One or more PDSs, either Restricted or Unrestricted, brought together at a given place, in or with an apparatus, system or other components.***

**Description:**
Not intended to be placed on the market as a single functional unit. Each apparatus or system included is subject to the provisions of the **EMC Directive**. No **Declaration of Conformity** or **CE Marking** of the installation. The manufacturer of the PDS (or CDM/BDM) is responsible for the provision of **Installation Guidelines.** Resulting EMC behaviour is the responsibility of the **Installer** (e.g. by following an appropriate EMC plan). Essential protection requirements of the **EMC Directive** apply regarding the neighbourhood of the installation.

***Mode 4:*** ***Apparatus or system***
***Includes one or more PDS(s) (or CDM/BDM).***

**Description:**
Has an intrinsic function for the final user and placed on the market as a single commercial unit. EC **Declaration of Conformity** and **CE Marking** required (for the apparatus or system). Resulting EMC behaviour is the responsibility of the manufacturer of the apparatus or system.

## *Applications of different Modes*

1. *BDM used in domestic or industrial premises, sold without any control of the application.*
   The manufacturer is responsible that sufficient EMC will be achieved even by a layman. Although components are excluded from the Directive, it states that when sold without any control over the application (Unrestricted components), components must have a sufficient degree of EMC. Thus, if members of the public (**End-Users**) buy a component off the shelf, they will not have to worry about compliance when they fit it to their machine. Therefore, the responsibility for **CE Marking** such components under EMC lies with the manufacturer.

2. *PDS or CDM/BDM for domestic or industrial purposes.* This is sold as a sub-assembly to a professional assembler who incorporates it into a machine, apparatus or system.

   Conditions of use are specified in the manufacturer's documentation. Exchange of technical data allows optimisation of the EMC solutions.

   Inverters come under the second category of components - Restricted distribution. On their own they do not have an intrinsic function for the **End-User**, but are sold to professional **Installers** who incorporate them into a machine, apparatus or system. They are not on sale directly to the **End-User**.

3. *PDS for use in installations.*
   The conditions of use are specified at the time of the order, consequently an exchange of technical data between supplier and client is possible. It can consist of different commercial units (PDS, mechanics, process control etc).

   The combination of systems in the installation should be considered in order to define the mitigation methods to be used to limit emissions. Harmonic compensation is an evident example of this, both for technical and economical reasons.

4. PDS combined with application device (machine) such as a vacuum cleaner, fan, pump or such like, i.e. ready to use apparatus.

## *Machinery Directive 98/37/EC*

***How does the Machinery Directive affect my drive?***

**89/392/EEC modified by 91/368/EEC, 93/44/EEC and 93/68/EEC has been replaced by a new numbering scheme which simply refers to 98/37/EC**

This Directive concerns all combinations of mechanically joined components, where at least one part is moving and which have the necessary control equipment and control and power input circuits.

The Directive concerns all machines but not those like lifts, which have a specific Directive.

***KEY POINT:*** As far as drives are concerned, the new version of EN 60204-1 will be in force after 1st October, 2000.

On its own, the Complete Drive Module (CDM) does not have a functional value to the user. It always needs its motor coupled to the driven load before it can function effectively. Thus, it cannot carry the **CE Marking** based on the **Machinery Directive**.

***Where can I obtain a Machinery Directive copy?*** To obtain a copy of the **Machinery Directive** you can contact a local Competent Authority or EU Commission, Rue de la Loi 200, b-1049 Brussels.

## *Low Voltage Directive*

***How does the LVD affect my drive?*** **73/23/EEC, modified by 93/68/EEC**

This Directive concerns all electrical equipment with nominal voltages from 50V to 1kV AC and 75V to 1.5kV DC.

The aim of the Directive is to protect against electrical, mechanical, fire and radiation hazards. It tries to ensure only inherently safe products are placed on the market.

All parts of a PDS from converters and motors to control gear must conform with the **Low Voltage Directive**.

To guarantee that a product complies, the manufacturer must provide a **Declaration of Conformity**. This is a Declaration that the product conforms to the requirements laid down within this Directive.

If a product conforms to the Directive and has a **Declaration of Conformity**, then it **must** carry the **CE Marking** (for more on CE Marking, see page 13).

In the case of a Power Drive System, the **Declaration of Conformity** is needed for each of its component parts. Thus, the **Declaration of Conformity** for the Complete Drive Module (CDM) (see pages 18 and 19) and for the Motor have to be given separately by the manufacturer of each product.

***KEY POINT:*** Most manufacturers will include a **Declaration of Conformity** covering the **Low Voltage Directive** for all built PDS/CDMs. These are drives built into an enclosure, which can be wired up to the supply and switched on without any further work being undertaken. This is in contrast to an open chassis (BDM), which is a component and needs an enclosure.

***Why is the Declaration of Conformity important?***

***KEY POINT:*** Without the **Declaration of Conformity** the CDM could not carry the **CE Marking** and therefore it could not be used legally in any system.

## *EMC Directive*

***How does the EMC Directive affect my drive?***

**89/336/EEC modified by 91/263/EEC, 92/31/EEC and 93/68/EEC**

The intention of the **EMC Directive** is, as its name implies, to achieve EMC compatibility with other products and systems. The Directive aims to ensure emissions from one product are low enough so as not to impinge on the immunity levels of another product.

There are two aspects to consider with the EMC Directive:

- the ***immunity*** of the product.
- the ***emissions*** from that product.

Although the Directive expects that EMC should be taken into account when designing a product, in fact EMC cannot be designed - it can only be measured quantitively.

***KEY POINT:*** **CE Marking** CANNOT be given automatically on the basis of this Directive. This is because the drive is not a final functional product to the customer, but is always part of a machine or process.

The **Machine Builder**, therefore, has the final responsibility to ensure that the machine including any VSD and other electrical devices, meets the EMC requirements.

At each stage of the manufacturing process, from component to system, each manufacturer is responsible for applying the appropriate parts of the Directive. This may be in the form of

instructions on how to install or fit the equipment without causing problems. It does not imply that there is a string of **Declarations of Conformity** to be compiled into a manual.

***Who has the responsibility to ensure CE Marking?***

A frequency converter is likely to be only a part of a Power Drive System.

Yet it is the entire system or machinery that must meet the requirements of the **EMC Directive**.

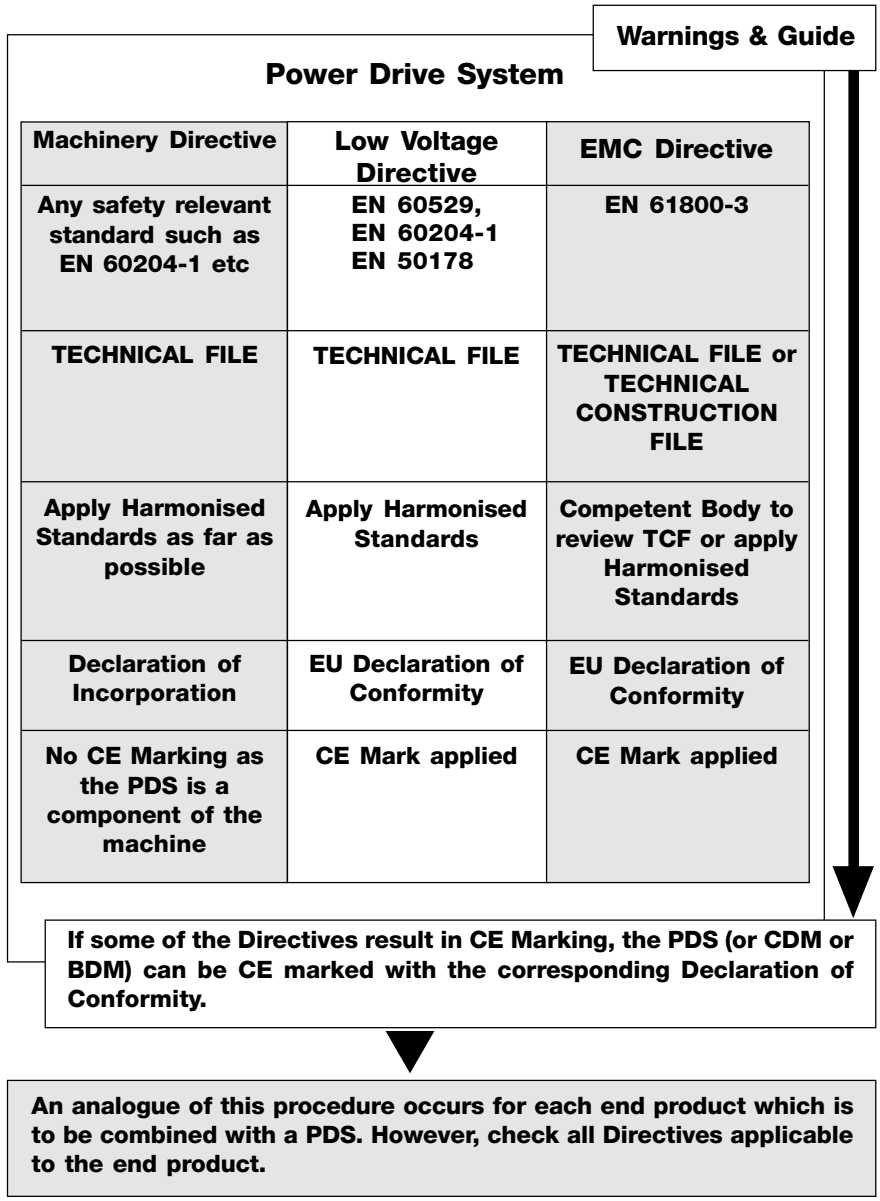
So, drives manufacturers are in a position to choose whether to put **CE Marking** on to a frequency converter to indicate compliance with the **EMC Directive** or to deliver it as a component without CE marking.

***KEY POINT:***

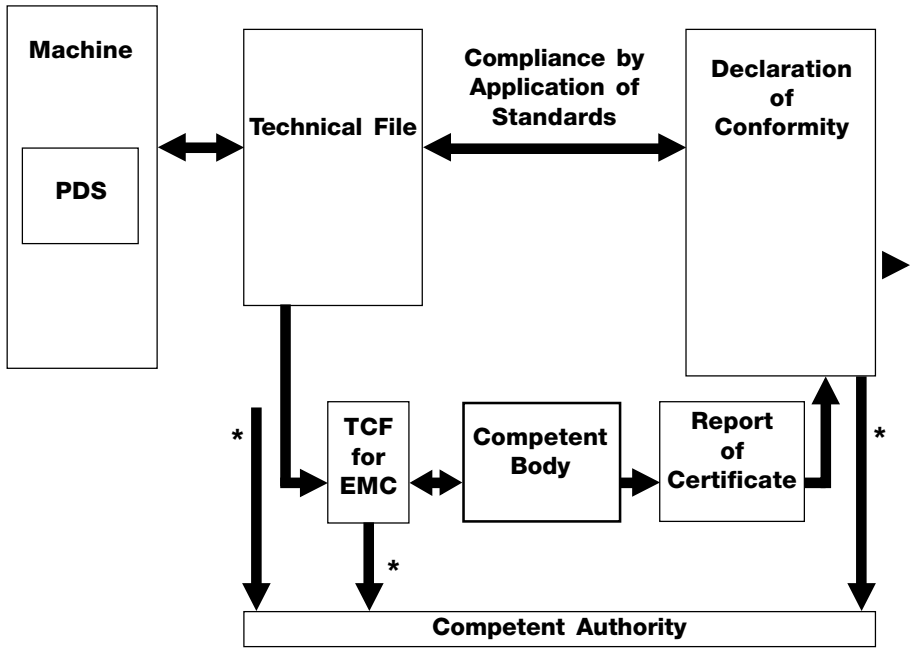
It is the responsibility of the person who finally implements the system to ensure EMC compliance.

Either the **Machine Builder** or **System Supplier** has the final responsibility that the machine or system including the drive and other electrical and electronic devices will meet the EMC requirements.

***Summary of responsibilities*** Summary of Manufacturer's responsibilities in the application of EC Directives to systems containing a PDS:



***Achieving conformity with EC Safety Directives***




**** Only if required during market surveillance.***

# Chapter 8 - Installation

## General installation concerns

The aim of this section is to provide general installation guidelines to ensure the Power Drive System functions in accordance with the legislation detailed previously.
It is worth highlighting some of the problems which industry now faces as a result of the EMC legislation. For example,

- To avoid EMC problems it is now important that motor cables should be terminated in the inverter - not at a terminal board in a motor control centre. They certainly must not be run in parallel with unshielded conductors where some pick up is inevitable.
- Implementing features like by-passes becomes difficult to prevent cross-coupling.
- Where a panel builder puts a converter into a secondary enclosure, the ventilation louvres can quite easily become waveguides, if poorly designed or finished.
- In theory, every small installation needs a **Technical Construction File (TCF)** (see pages 34-38) to confirm compliance with the **EMC Directive** and a Technical File for the **LVD**. This means that the idea of mounting drives into motor control centres must be much more carefully thought out by system specifiers.
- Testing on site is likely to be needed on large installations.
- In theory, the manufacturer can deliver, in conjunction with a **Machine Builder**, a perfectly good CE marked system which can be installed, and due to site problems we can still get problems of radiation blotting out someone's radio.

## Technical requirements of the legislation

There are several technical requirements of the proposed legislation:

- ☐ There must be an on-load disconnecting device in each supply, unless an auxiliary contact switches off the load (except for units up to 3kW/16A where a plug and socket connection is used). The isolator must be between 600 and 1900mm from the floor.

- ☐ Means of preventing unexpected start, for example during maintenance, is required, i.e. padlocking the isolator in the off position.
- ☐ Electrical equipment has to be protected against direct and indirect contact. Doors must be locked by a tool or IP2X protection fitted internally with warning labels.
- ☐ The voltage inside must be below 60V after 5 seconds from switching off, otherwise special labels stating the time must be fitted (i.e. for DC-link capacitors).
- ☐ Every machine must be equipped to allow stopping by removing voltage from a circuit unless it is dangerous to do this. Programmable electronic equipment shall not be used for this function.
- ☐ The Stop and Emergency Stop function has to be selected by a risk assessment of the machine.
- ☐ Drawings must use standard IEC formats and symbols.
- ☐ Motors must comply with IEC 34-1/EN 60034-1 standards.
- ☐ Warning flash symbols shall be fitted to covers to show they contain electrical equipment.

### *How can EMC be improved?*

***KEY POINT:*** The best way is to follow good installation practice and to thoroughly read the Product Specific Manuals.

This way you can be assured that the motor drive installation is within the limits of EN 61800-3.

There are four main approaches to improving the electromagnetic compatibility (EMC) of drives and thereby reduce the emissions of susceptible equipment. These are :

- good general installation practices.
- good earthing.
- good shielding.
- good filtering.

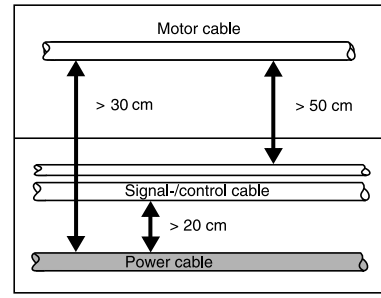
## *General installation practice*

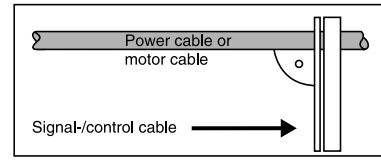
***Cabling*** Motor cabling is a source of interference. Other cables also become sources if they run parallel with motor cables. Therefore, separate motor cables from other cables by 500mm. Otherwise, the use of the RFI filter is almost useless.

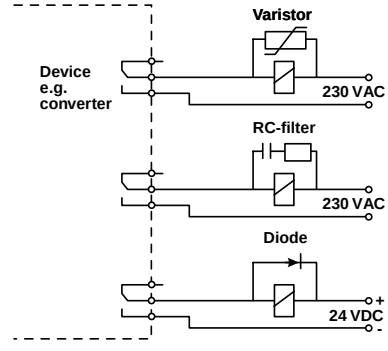
Power and signal cables should cross each other at right angles.

***Relay Outputs*** Relays, contactors and magnetic valves must be equipped with spark suppressors.

This is also necessary when these parts are mounted outside the frequency converter cubicle.

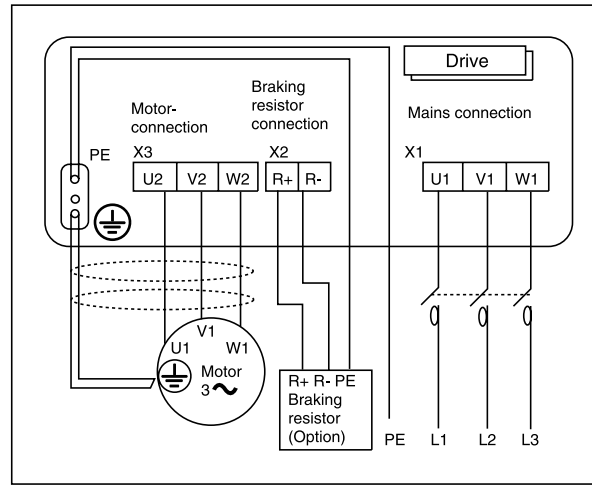


***Earthing*** You need to note that, just because there is a good safety earth at DC or at power frequencies, this does not imply a good earth at radio frequencies. There are several steps to ensuring good earthing improves EMC:

- ☐ Follow all local safety regulations on earthing.
- ☐ The largest possible area should be used as the earth conductor, e.g. the cabinet wall construction.
- ☐ The parts of the earth system should be connected together using low impedance connections. Flat braided wires have a much lower high frequency impedance than round wires. Earth connections should be kept as short as possible.
- ☐ Choose one central earthing point to which the wires can be star-connected.
- ☐ Paint or other insulating coatings must be removed from the area of the bond to achieve a low impedance connection.
- ☐ Low impedance earthing bonds should be checked as part of standard maintenance and service procedures.



***Shielding*** The principle of Faraday Cage is an attempt to provide a shield around a system to prevent radiated signals from entering or leaving. For a drive, this shield consists of three elements:

a. the tight drive cabinet.

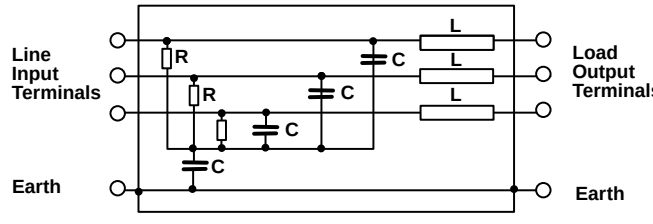
b. shielded supply, motor and signal cables with 360° earthing.

c. the motor housing.

To make the Faraday Cage effective, all these elements must be connected together to form one shield. This means that:

- ☐ There should be no breaks in the cable shields.
- ☐ The shield connections should have low impedance in the MHz range.
- ☐ The separate panels of the cabinet should be bonded together and have low impedance at high frequencies.
- ☐ To achieve low impedance bonding it may be necessary to use additional screws, remove paint from the surface of cabinets or use EMC gaskets.
- ☐ The cable between the drive and the motor must be shielded. This cable carries more conducted noise than the input cabling of the drive and although it is a closed loop, it will act as an excellent transmitting aerial.
- ☐ Ensure that the shield is intact along the full length of the cable and that each end is bonded to earth through 360° terminations.

**Circuit diagram of a typical High frequency filter**



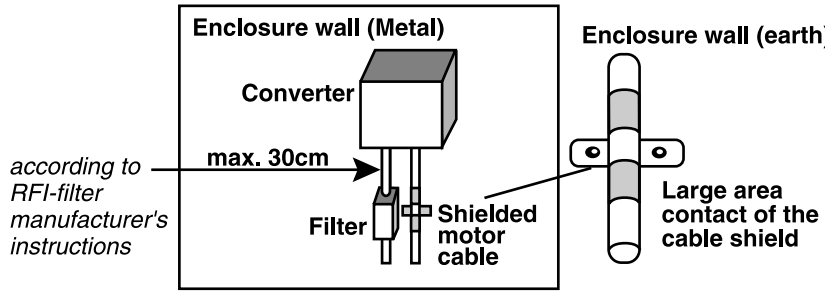
***Filtering*** Filters are installed on the drive's power supply lines to prevent interference currents reaching the mains and affecting other equipment. **You cannot achieve first environment (domestic) levels without using a filter on the line terminals.**

Many drives incorporate filter components as part of their basic design. Other drives have filters as standard options and these should avoid any problems of installation.

Here are a few tips to improve your filtering:

- ☐ A good quality filter must be mounted as close as possible to the drive input (Refer to the RFI filter manufacturer's instructions).
- ☐ Before mounting the filter, remove any paint or other protective coating from the area of the panel that will be in direct contact with the filter.
- ☐ Bond the filter to the same conductive panel as the drive.
- ☐ Always segregate the input and output cabling of the filter and drive.
- ☐ In installations incorporating multiple drives in one enclosure, filters should be fixed to each drive. Also, a general purpose filter should be fitted at the housing cable to attenuate any additional coupled signals.

*Also note that a static shield between the windings of a transformer provides a very effective RF shielding and will help provide de-coupling between the conducted RF in interconnected circuits.*



***Testing and installation***

There are basically two items that need to be tested when the electrical equipment is fully connected to the machine:

1. Electrical safety aspects

   a) Continuity of the protective bonding circuit for example, according to IEC 60364-6-61.

   b) Insulation resistance test.

   c) Voltage test (2 x $U_{nom,}$ 1s).

   d) Protection against residual voltages.

   e) Functional tests.

2. Electromagnetic Compatibility - these tests must be carried out in accordance with the product specific EMC-standard of the machine or in accordance with generic EMC-standards. The levels of interference used shall be selected in accordance with the environment in which the machine is intended to be used.

*Note: EMC for large complex machines cannot always be tested with the complete system working. In this case it is possible to test sub-assemblies of the system before they are mounted together.*

It may not be necessary to do the tests in 1(c) and 1(d) above if the machine is tested in sections.

## *Your technical concerns answered*

***What is the affect of varying impedance?***

You can reduce the conducted emissions by reducing the source impedance. The impedance of the connection cables has some “filter effect” (1,5uH) but this is usually not enough to reduce the conducted emission. Therefore, extra reactors and filters are required.

***What are the effects of multiple drives?***

The higher the number of drives in parallel, the higher the emissions. Filtering of the conducted emissions is recommended at the point of common supply input. The common panel of the multiple drives must be bonded together as one Faraday Cage and the shields of all cables in and out of the panel must be bonded to the panel.

***Large installations with many drives can take up to 3 months and be costly. What can we do?***

The practical approach should be agreed with a **Competent Body.** This should be such that the worst case of larger panels are tested. The results shall be evaluated by the manufacturer. The basis of evaluation shall be assessed by a Competent Body. The same procedure and methods can then be used for the easier and smaller units.

# Chapter 9 - Index


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**ABB Industry Oy**
Drives
P.O. Box 184
FIN-00381 Helsinki
FINLAND
Tel: +358 10 222 000
Fax: +358 10 222 2681
Internet: http://www.abb.com/motors&drives