1.5.2 The second edition

The second edition of the Directive was drafted, revised and re-revised several times in 2000, and at the time of writing the process is not over. Certain features have emerged and look to be reasonably well agreed, though.

Environments

A re-definition or elaboration of EM environments has not found its way into the new version.

Electromagnetically benign equipment

Equipment which is inherently non-emissive and immune is explicitly excluded from the scope.

Fixed installations

Installations must meet the protection requirements. They should be installed and maintained applying good engineering practice and respecting the information on the intended use of their components, but are not subject to conformity assessment.

Information requirements

There is substantially more to be provided to the user in the way of mandatory EMC-related information, in particular advice on precautions needed to meet the protection requirements, and restrictions on use in particular environments.

EMC assessment

The essential requirements mandate an EMC assessment which confirms that the apparatus meets the protection requirements, and to document this in a technical file available to the enforcement authorities. Note that this brings the EMCD more into line with other Directives which call for a technical file, and is different from the current TCF route, which is abandoned.

Harmonized standards

Applying harmonized standards is equivalent to carrying out the EMC assessment – so, in essence, there is no change for the standards route, although there is discussion over how thoroughly a standard must be applied. Selection of the appropriate standard(s) should be based on the provisions of the relevant standardization documents.

Definitions

There are formal definitions for apparatus, component or sub-assembly, and fixed installation. There is also a proposal to include "ready made connecting devices", i.e. cable sets, as apparatus under the Directive.

Competent or notified bodies

There is no provision for the TCF route in the new version. What were called competent bodies are now "notified bodies", but it has yet to be decided whether or not their involvement by a manufacturer is entirely voluntary.

Enforcement action

Greater limits are placed on the freedom of action of enforcement agencies to pursue withdrawal, prohibition or restriction of products.

Chapter 2

Standards

2.1 The standards making bodies

The structure of the bodies which are responsible for defining EMC standards for the purposes of the EMC Directive is shown in Figure 2.2 on page 53.

2.1.1 The International Electrotechnical Commission

The IEC operates in close co-operation with the International Standards Organization (ISO) and in 1990 had 41 member countries. It is composed of National Committees which are expected to be fully representative of all electrotechnical interests in their respective countries. Work is carried out in technical committees and their sub-committees addressing particular product sectors, and the secretariat of each technical committee is the responsibility of one of the 41 National Committees, which appoints a Secretary with the necessary resources. The IEC's objectives are "to promote international co-operation on all questions of standardization.... (this is) achieved by issuing publications including recommendations in the form of international standards which the National Committees are expected to use for their work on national standards."[83]

Two IEC technical committees are devoted full time to EMC work, although nearly forty others have some involvement with EMC as part of their scope. The two full time committees are TC77, *Electromagnetic compatibility between equipment including networks*, and the *International Special Committee on Radio Interference* or CISPR, which is the acronym for its French title. Co-ordination of the IEC's work on EMC between the many committees involved is the responsibility of ACEC, the Advisory Committee on EMC, which is expected to prevent the development of conflicting standards.

IEC standards themselves have *no legal standing* with regard to the EMC Directive. If the National Committees do not agree with them, they need not adopt them; although in the UK, 85% of IEC standards are transposed to British Standards. The real importance of the IEC standards is that they may either be transposed directly into harmonized EN standards, in which case they become applicable for the self-certification route, or they may be referred to by product-specific or generic harmonized standards.

2.1.1.1 TC77

TC77 has been characterized as "The United Nations for EMC" [95]; certainly it attempts to cover most aspects of the subject on a worldwide basis. The structure of TC77 is shown in Figure 2.1. It is a large and influential group, and liaises with several other product-related committees within IEC including CISPR, as well as with outside bodies such as CENELEC, ITU and several electric power related groups.

Table 2.1 Plan of IEC 61000 [95]

IEC 61000-1	Part 1: General General considerations (introduction, fundamental principles, functional safety) Definitions, terminology
IEC 61000-2	Part 2: Environment Description of the environment Classification of the environment Compatibility levels
IEC 61000-3	Part 3: Limits Emission limits Immunity limits (if not the responsibility of product committees)
IEC 61000-4	Part 4: Testing and measurement techniques Measurement techniques Testing techniques
IEC 61000-5	Part 5: Installation and mitigation guidelines Installation guidelines Mitigation methods and devices
IEC 61000-6	Part 6: Generic Standards
IEC 61000-9	Part 9: Miscellaneous

IEC 61000 is published in separate parts by IEC TC77 according to the above plan. Each part is further subdivided into sections which can be published either as international standards or as Technical Reports.

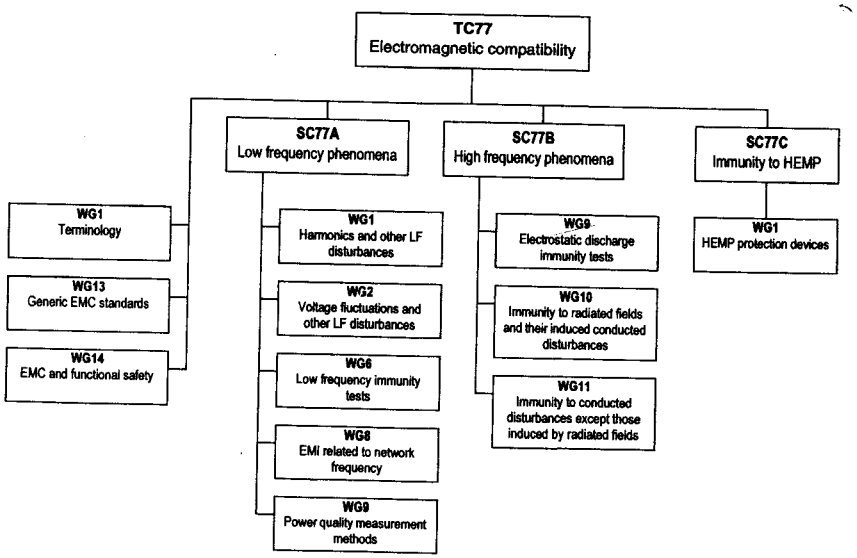

Figure 2.1 Structure of IEC TC77

The major output of TC77 now is the various parts of IEC Publication 61000, *Electromagnetic Compatibility*. This document has been published in stages as defined by the plan shown in Table 2.1, and incorporates all non-CISPR and non-product specific EMC material. Previous standards such as IEC 555 and IEC 801 have been subsumed within IEC 61000. A detailed description of some sections of IEC 61000 parts 3 and 4 can be found later in this chapter under section 2.4, but meanwhile, a complete list of the parts of this mammoth standard that have been published or are in the advanced stage of voting up to autumn 2000 is given in Table 2.3.

2.1.1.2 CISPR

CISPR publications deal with limits and measurement of the radio interference characteristics of potentially disturbing sources, and look set to continue to co-exist with IEC 61000. There are a number of sub-committees as shown in Table 2.2. Most of these relate to particular product groups and have a historical basis; before the advent of pan-European legislation these products were the major ones subject to legislative control on their emissions. CISPR/A has a particularly important role as the developer and guardian of common test methods and instrument specifications.

Although all the output of CISPR sub-committees is nominally product related, several of the emissions standards – particularly CISPR 11, 14 and 22 – have assumed wider importance since their limits and test methods are referenced in many more product standards. In general, the limits versus frequency are harmonized into two classifications, A and B (see section 2.7), which are common across most of the standards. Although CISPR is not in general interested in immunity standards, two anomalous instances exist: CISPR 20 for broadcast receivers and associated apparatus, and CISPR 24 for information technology equipment.

Table 2.2 Structure of CISPR

Committee	Title/Scope	Main publications
CISPR/A	Radio interference measurements and statistical methods	CISPR 16, CISPR 17
CISPR/B	Industrial, Scientific and Medical radio-frequency apparatus	CISPR 11, CISPR 19, CISPR 23, CISPR 28
CISPR/C	Overhead power lines, high-voltage equipment and electric traction systems	CISPR 18
CISPR/D	Electrical/electronic equipment on vehicles and internal combustion engine powered devices	CISPR 12, CISPR 21, CISPR 25
CISPR/E	Broadcast receivers	CISPR 13, CISPR 20
CISPR/F	Household appliances, tools, lighting equipment and similar apparatus	CISPR 14, CISPR 15
CISPR/G	Information technology equipment	CISPR 22, CISPR 24
CISPR/H	Limits for the protection of radio services	-

2.1.1.3 The IEV

One further important document is Chapter 161 of IEC Publication 60050 [146], the International Electrotechnical Vocabulary. This contains definitions of EMC terminology in English, French and Russian, with equivalent terms in Dutch, German, Italian, Polish, Spanish and Swedish.

Table 2.3 Published and planned parts of IEC 61000
(Shaded sections were not yet published in autumn 2000)

Part	Section	Title
1	General	
	1	Application and interpretation of fundamental definitions and terms
		Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena
2	Environment	
	1	Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems
	2	Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems
	3	Radiated and non-network-frequency-related conducted phenomena
	4	Compatibility levels in industrial plants for low-frequency conducted disturbances
	5	Classification of electromagnetic environments
	6	Assessment of the emission levels in the power supply of industrial plants as regards low-frequency conducted disturbances
	7	Low frequency magnetic fields in various environments
	9	Description of HEMP environment. Radiated disturbance
	10	Description of HEMP environment. Conducted disturbance
	11	Classification of HEMP environments
3	Limits	
	2	Limits for harmonic current emissions (equipment input current <= 16 A per phase)
	3	Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current <= 16 A
	4	Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A
	5	Limitation of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current greater than 16 A
	6	Assessment of emission limits for distorting loads in MV and HV power systems
	7	Assessment of emission limits for fluctuating loads in MV and HV power systems
	8	Signalling on low-voltage electrical installations. Emission levels, frequency bands and electromagnetic disturbance levels
		Limits for interharmonic current emissions (equipment with input power <=16 A per phase and prone to produce interharmonics by design)
	11	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems for equipment with rated current <= 75A and subject to conditional connection.
4	Testing and measurement techniques	
	1	Overview of immunity tests
	2	Electrostatic discharge immunity test
	3	Radiated radio frequency electromagnetic field immunity test
	4	Electrical fast transient/bursts immunity test
	5	Surge immunity test
	6	Immunity to conducted disturbances induced by radio frequency fields
	7	General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
	8	Power frequency magnetic field immunity test
	9	Pulse magnetic field immunity test
	10	Damped oscillatory field immunity test
	11	Voltage dips, short interruptions and voltage variations immunity test
	12	Oscillatory waves immunity test

Table 2.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in autumn 2000)

Part	Section	Title
		Harmonics, interharmonics including mains signalling at AC power port immunity test
	14	Voltage fluctuations immunity test
	15	Flickermeter – functional and design specifications
	16	Conducted disturbances in the frequency range 0 Hz to 150 kHz immunity test
	17	Ripple on DC input power port immunity test
		Emission and immunity testing in transverse electromagnetic (TEM) waveguides
		Guidance on emission and immunity testing using reverberation chambers
	23	Test methods for protective devices for HEMP radiated disturbance
	24	Test methods for protective devices for HEMP conducted disturbance
		HEMP immunity test methods for equipment and systems
	27	Unbalance immunity test
	28	Variation of power frequency immunity test
	29	Voltage dips, short interruptions and voltage variations on DC input power port immunity test
		Power quality measurement methods
		Measurements in the frequency range 2kHz to 9kHz
5	Installation and mitigation guidelines	
	1	General considerations
	2	Earthing and cabling
	3	HEMP protection concepts
	4	Specification for protective devices against HEMP radiated disturbance
	5	Specification of protective devices for HEMP conducted disturbance
		Mitigation of external EM influences
		Degrees of protection by enclosures against electromagnetic disturbances (EM code)
6	Generic standards	
	1	Immunity for residential, commercial and light-industrial environments
	2	Immunity for industrial environments
CISPR	3	Emission standard for residential, commercial and light-industrial environments
	4	Emission standard for industrial environments
		Immunity for power station and substation environments

2.1.2 CENELEC and ETSI

CENELEC (the European Committee for Electrotechnical Standardization) is the European standards making body, which has (among many other things) been mandated by the Commission of the EC to produce EMC standards for use with the European EMC Directive. For telecommunications equipment ETSI (the European Telecommunications Standards Institute) is the mandated standards body. ETSI generates standards for telecoms network equipment that is not available to the subscriber, and for radio communications equipment and broadcast transmitters.

CENELEC and ETSI use IEC/CISPR results wherever possible as a basis for preparation of drafts for such standards, and the committee charged with the duty of preparing the EMC standards is TC210. Representatives of National Committees meet in TC210 about once a year to discuss the technical implementation of the drafts. TC210 has a sub-committee, SC210A, which is concerned specifically with immunity of Information Technology Equipment (ITE), and three other working groups, one of which is responsible for the Generic Standards (section 1.3.5.1 on page 42).

CENELEC is made up of the National Committees of each of the EEA countries;

adoption of standards is based on a qualified weighted voting by the 18 National Committees [42][130]. Of these member committees France, UK, Germany and Italy have 10 votes, Spain has 8 votes and the other countries have between 3 and 5 votes. Unlike the position with international standards, a country must accept a new CENELEC standard even if it voted against it. Formal national conditions may be attached to the standard to ameliorate this situation, such as the occasion when CENELEC decided to harmonize on a 230V mains supply, and the UK declared to stay at 240V as a special national condition.

In the UK the BSI committee GEL210 generates the British position on TC210 papers. The BSI has an obligation to invite all organizations which have an interest in EMC to be members of GEL210 – in practice this is done mostly through representation by trade organizations.

Once CENELEC has produced and agreed a European EMC standard (prefixed with EN or HD) all the CENELEC countries are required to implement identical national standards. The EN will be transposed word for word, while the HD (harmonization document) does not need to be reproduced verbatim as long as it reflects the technical content. In the context of European Directives, the standard is notified to the Commission and the reference number of the EN and the equivalent national standards will then be published in the *Official Journal of the European Communities* (OJEC), and once this is done the standard is deemed to be a "relevant standard" for the purpose of demonstrating compliance with the appropriate Directive. Conflicting national standards must be withdrawn within a limited time frame.

Draft standards and amendments to existing standards are made available for public comment (through the National Committees) for some time before the standard is actually published. Apart from being the mechanism by which industry can influence the content of the standards, this has the further advantage of permitting manufacturers to make an informed decision on the testing and limit levels to which they may choose to submit their products in advance of the actual publication date, even though it is not possible to make an official declaration of compliance with an unpublished standard. There is of course some risk that the final published version will differ in detail, and sometimes quite substantially, from the draft.

2.1.2.1 Product standards

As mentioned in section 1.3.5, the intent of the EMC Directive is that the self-certification route should be serviced primarily by a whole range of product standards. When published and harmonized, these take precedence over the generic standards and may either be drafted specifically to cover the EMC aspects of a particular range of product types, or they could be EMC sections added to an existing product performance standard. The general intention is that these standards should refer to basic standards (such as the IEC 61000-4-X series or their EN equivalent) for test methods wherever possible, and the product-specific aspects should consist mainly in defining what tests to carry out, with what levels or limits, and what operating conditions and performance criteria to apply. The impetus to develop such standards should come from the industry sectors themselves.

Since this approach means that non-EMC committees can (and indeed are expected to) contribute, there is a wide range of standards organizations that can participate in generating such documents. It includes CEN, CENELEC and ETSI product committees as well as IEC and ISO committees – the latter feeding into the European regime through the process of parallel voting, whereby a draft is circulated within both

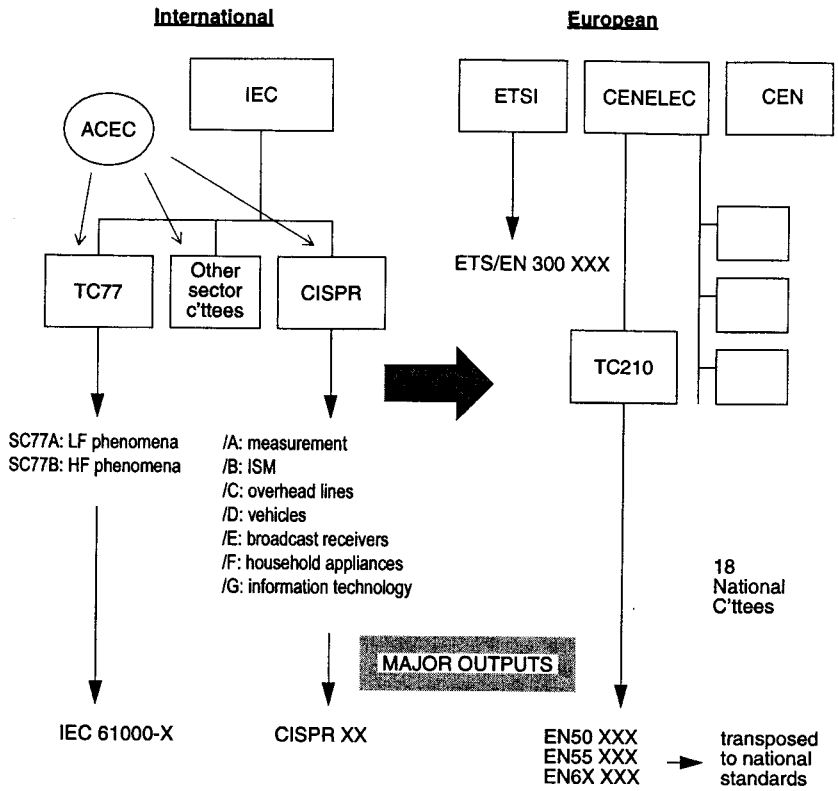

Figure 2.2 EMC standards structure

CENELEC and IEC for consideration at the same time. To be sure whether there is or will be an EMC product standard which covers your particular activities, you need to be continually monitoring the standards development process – trade associations, and the web sites of the standards agencies, are usually the most useful route for this purpose.

The following sections (2.2 *et seq*) outline those standards which form harmonized standards or basic standards for the purposes of the EMC Directive, which have been announced in the Official Journal of the EC [169]. They only briefly refer to the ETSI radio standards, which form a large group in themselves.

2.1.2.2 ETSI radio standards

The listing in the OJEC includes 47 standards for radio equipment. These appeared in the latter half of the 90s and with the implementation of the R&TTE Directive have been re-drafted and re-organized. Because ETSI were able to start from scratch in developing EMC standards, there is much greater consistency and co-ordination between and within these documents than is the case for the other product standards, which come from several sources and often carry a great deal of historical baggage.

If your product involves a radio device then you will need to have regard to one of these standards, and it can normally be used as a stand-alone document since it will typically cover both emissions and immunity. It will also cover the particular issues, such as exclusion bands, that arise when a general EMC requirement is applied to a radio receiver or transmitter.

2.1.2.3 CEN

A few harmonized EMC standards are published by CEN, which is the European standards body for non-electrotechnical subjects. These can be recognized by their numbering, which although prefixed by EN does not fit into the 50XXX, 55XXX or 6XXXX series used by CENELEC.

2.1.2.4 The timescale for adoption of standards

Because standards are introduced or amended frequently, there has to be a formal mechanism for deciding by what date changes become mandatory. Clearly it would be impossible for a change to be enforced on the date of publication in the OJEC. The method is implemented by a column in the table published in the OJEC and headed "Date of cessation of presumption of conformity of the superseded standard". Generally the date of cessation of presumption of conformity will be the date of withdrawal (DOW), set by the European standards body and published in the EN version of the standard, but in certain exceptional cases this can be otherwise. The DOW will be typically 2–3 years after the date of publication of the new standard or amendment.

In the period between the publication of the new version and the DOW, you are entitled to choose either old or new versions for your self-certification. By the time of the date published in the OJEC, you should be sure to have updated your declaration of conformity, including carrying out any new testing that the new version requires (it is very rare for new standards to be more relaxed!). Figure 2.3 illustrates this graphically.

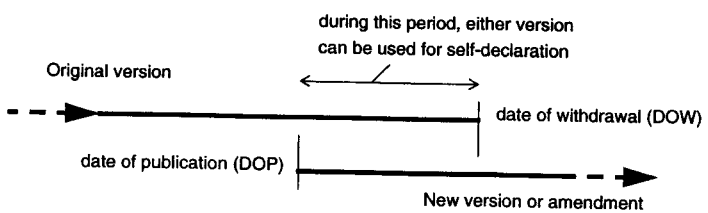

Figure 2.3 Applying changes in standards

If the new standard has a narrower scope than the superseded standard, on the date stated the (partially) superseded standard ceases to give presumption of conformity for those products that fall within the scope of the new standard. Presumption of conformity for products that still fall within the scope of the (partially) superseded standard, but that do not fall within the scope of the new standard, is unaffected. In the case of amendments, the referenced standard is EN XXXXX:YY, its previous amendments, if any, and the new, quoted amendment. The superseded standard therefore consists of EN XXXXX:YY and its previous amendments, if any, but without the new quoted amendment. On the date stated, the superseded standard ceases to give presumption of conformity with the essential requirements of the directive.

Warning: do not rely solely on the following information in this book to make a legal declaration of conformity. Obtain and refer to the appropriate standard directly.

2.2 Generic standards – emissions

CENELEC put great urgency on the development of generic standards, but they are now being gradually superseded by a whole raft of new product standards. There is a particular significance to ENs 55011, 55014 and 55022: as well as being product standards in themselves, they also specify RF emissions test methods that are applied very much more widely, and they are included here in the same section as the generics.

2.2.1 EN 50081 part 1: 1992

Title Generic emission standard, part 1: Residential, commercial and light industry environment

Scope All apparatus intended for use in the residential, commercial and light industrial environment for which no dedicated product or product-family emission standards exist

NB equipment installed in the residential, commercial and light industry environment is considered to be directly connected to the public mains supply or to a dedicated DC source. Typical locations are residential properties, retail outlets, laboratories, business premises, outdoor locations etc.

Tests Enclosure: radiated emissions from 30 to 1000MHz as per EN 55022 Class B; applicable only to apparatus containing processing devices operating above 9kHz

AC mains port: conducted emissions from 150kHz to 30MHz as per EN 55022 Class B

Discontinuous interference on AC mains port measured at spot frequencies as per EN 55014, if relevant

Mains harmonic emission measured as per EN 60555 part 2 (note that application is limited by the scope of EN 60555-2)

NB an informative annex references tests which will be proposed for inclusion in the standard when the relevant reference standards are published. This includes tests on signal, control and DC power ports: conducted current from 150kHz to 30MHz. In fact, this test was published in 1998 (EN 55022 third edition) but EN 50081-1 has not been revised, and it will most probably be superseded eventually by an EN version of CISPR 61000-6-3

2.2.2 EN 50081 part 2: 1993

Title Generic emission standard, part 2: industrial environment

Scope Apparatus intended for use in the industrial environment, for which no

dedicated product or product-family immunity standard exists, but excluding radio transmitters

NB equipment installed in the industrial environment is not connected to the public mains network but is considered to be connected to an industrial power distribution network with a dedicated distribution transformer

Tests Enclosure: radiated emissions from 30 to 1000MHz as per EN 55011

AC mains port: conducted emissions from 150kHz to 30MHz as per EN 55011; impulse noise appearing more often than 5 times per minute is also covered. Applicable only for apparatus operating at less than $1000V_{rms}$ AC

NB an informative annex references tests which will be proposed for inclusion in the standard when the relevant reference standards are published; but see previous note to EN 50 081-1. This standard will most probably be superseded eventually by an EN version of IEC 61000-6-4

2.2.3 EN 55011: 1998 + A1: 1999

Title Industrial, scientific and medical (ISM) radio-frequency equipment – Radio disturbance characteristics – Limits and methods of measurement

Equivalents CISPR 11 third edition

Scope Equipment designed to generate RF energy for industrial, scientific and medical (ISM) purposes, including spark erosion; excluding applications in telecomms and IT or covered by other CISPR publications

Class A equipment is for use in all establishments other than domestic; Class B equipment is suitable for use in domestic establishments

Group 1 equipment is that in which the RF energy generated is necessary for its internal functioning; Group 2 equipment is that in which RF energy is generated for material treatment and spark erosion

Tests Mains terminal disturbance voltage from 150kHz to 30MHz measured on a test site using 50Ω/50μH CISPR artificial mains network; Group 2 Class A equipment, including equipment with mains supply currents exceeding 100A per phase subject to less stringent limits

Radiated emissions from 30MHz to 1000MHz on a test site (Class A or B) or in situ (Class A only); Group 2 Class A equipment to be measured from 0.15 to 1000MHz but with relaxed limits, below 30MHz measurement performed with loop antenna

Specific limits for magnetic field strength from induction cooking appliances from 0.15 to 30MHz, and for emissions between 1 and 18GHz from Group 2 Class B equipment operating above 400MHz

2.2.4 EN 55014-1: 1993 + A1: 1997 + A2: 1999

Title Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission – Product family standard

Equivalents CISPR 14-1 third edition; NB the fourth edition of CISPR 14-1 was published in 2000 but its EN equivalent was not referenced in the OJEC by the end of 2000

Scope Appliances whose main functions are performed by motors and switching or regulating devices

Excluding apparatus covered by other CISPR standards (except for multi-function equipment), semiconductor regulating controls of more than 25A per phase, stand-alone power supplies. *In situ* measurements are under consideration

Tests Mains terminal disturbance voltage, quasi-peak and average detection from 148.5kHz to 30MHz measured using 50Ω/50μH CISPR artificial mains network; less stringent limits for electric tools and the load terminals of regulating controls. Discontinuous interference (clicks) must also be measured at spot frequencies for appliances which generate such interference through switching operations

Interference power from 30MHz to 300MHz on mains lead, quasi-peak and average detection, measured by means of the absorbing clamp; battery-operated appliances which cannot be mains connected, regulating controls incorporating semiconductor devices, rectifiers, battery chargers and convertors excluded

2.2.5 EN 55022: 1998

Title Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement

Equivalents CISPR 22 third edition

Scope Equipment whose primary function is either (or a combination of) data entry, storage, display, retrieval, transmission, processing, switching or control, and which may be equipped with one or more terminal ports typically operated for information transfer, and with a rated supply voltage not exceeding 600V

Class A equipment is for use in other than class B environments; Class B equipment is suitable for use in domestic establishments

Tests Mains terminal interference voltage, quasi-peak and average detection from 150kHz to 30MHz measured using 50Ω/50μH CISPR artificial mains network

Radiated interference field strength using quasi peak detection from 30MHz to 1000MHz measured at 10m on an open area test site

Conducted current or voltage (limits related by a common mode

impedance of 150Ω) from 150kHz to 30MHz at telecommunication ports, defined as those "which are intended to be connected to telecommunications networks (e.g. public switched telecommunications networks, integrated services digital networks), local area networks (e.g. Ethernet, Token Ring) and similar networks". Various measurement methods are defined for different types of cable connections

NB the third edition has a date of cessation of presumption of conformity (i.e. it finally supersedes the second edition, which did not include telecom port tests) on 1st August 2001

2.3 Generic standards – immunity

2.3.1 EN 50082 part 1: 1997

Title Generic immunity standard, part 1: residential, commercial and light industry environment

Equivalents IEC 61000-6-1

Scope All apparatus intended for use in the residential, commercial and light industrial environment for which no dedicated product or product-family immunity standards exist

NB such apparatus is intended to be directly connected to the public mains supply or to a dedicated DC source. It also includes battery-operated apparatus. Typical locations are residential properties, retail outlets, laboratories, business premises, areas of public entertainment, outdoor locations etc.

Tests Electrostatic discharge to enclosure as per EN 61000-4-2, at 8kV (air discharge) or 4kV (contact discharge)

Radiated RF field from 80MHz to 1000MHz as per EN 61000-4-3, at 3V/m; also pulse modulated at 900MHz spot frequency as per ENV 50204, for testing digital phone immunity

Electrical fast transients 5/50ns common mode as per EN 61000-4-4, applied to all functional earth and power ports and some I/O ports, amplitude 0.5 or 1kV dependent on type of port and method of coupling

Surge as per EN 61000-4-5, applied to AC power input ports at 2kV line to earth and 1kV line to line, and to some DC power input ports at 0.5kV

Radio frequency in common mode applied to all power ports and the earth port and some I/O ports, amplitude 3V rms from 150kHz to 80MHz as per EN 61000-4-6

Power frequency magnetic field, 50Hz at 3A/m as per EN 61000-4-8, only for apparatus containing magnetically susceptible devices

Voltage dips and interrupts on the AC power input ports, as per EN 61000-4-11

NB the applicability of many of the above tests depends on the allowable length of line that may be connected to the port in question

Criteria Three performance criteria for test results are proposed:

- the apparatus continues to operate as intended with no degradation below a performance level specified by the manufacturer;
- the apparatus continues to operate as intended after the test, but during the test some degradation of performance is allowed;
- temporary loss of function is allowed, provided that it is self- or operator-recoverable

2.3.2 EN 50082 part 2: 1995 (EN 61000-6-2: 1999)

Title Generic immunity standard, part 2: industrial environment

Scope Apparatus intended for use in the industrial environment, for which no dedicated product or product-family immunity standard exists, but excluding radio transmitters

NB equipment installed in the industrial environment is not connected to the public mains network but is considered to be connected to an industrial power distribution network with a dedicated distribution transformer. Battery powered equipment intended for this environment is also covered

Tests Electrostatic discharge to enclosure as per EN 61000-4-2, at 8kV (air discharge) or 4kV (contact discharge)

Radiated RF field from 80MHz to 1000MHz as per ENV 50140 (see IEC 61000-4-3), at 10V/m except in the broadcast bands, 87–108MHz, 174–230MHz and 470–790MHz, where the level is 3V/m; also pulse modulated at 900MHz spot frequency as per ENV 50204, for testing digital phone immunity

Power frequency magnetic field, 50Hz at 30A/m as per EN 61000-4-8, only for apparatus containing magnetically susceptible devices

Electrical fast transients 5/50ns common mode as per EN 61000-4-4, applied to all I/O and power ports, amplitude 1 or 2kV dependent on type of port and method of coupling

Radio frequency in common mode applied to all I/O and power ports and the earth port, amplitude 10V rms from 150kHz to 80MHz, except in the broadcast band 47–68MHz where the level is 3V rms, as per ENV 50141

NB an informative annex references tests which will be proposed for inclusion in the standard when the relevant reference standards are published (but see below under "equivalents"). This includes:

- AC 50Hz common mode voltage of 10V or 20Vrms depending on type of port, on signal and control lines

- supply voltage deviations, interruptions and fluctuations, and low frequency harmonics on supply ports
- Surges on power ports and process, measurement and control ports, common and differential mode, amplitude depending on type of port, as per EN 61000-4-5

NB the applicability of many of the above tests depends on the allowable length of line that may be connected to the port in question

Criteria Three performance criteria for test results are proposed:

- the apparatus continues to operate as intended with no degradation below a performance level specified by the manufacturer;
- the apparatus continues to operate as intended after the test, but during the test some degradation of performance is allowed;
- temporary loss of function is allowed, provided that it is self- or operator-recoverable

Equivalents EN 50082-2 is superseded by EN 61000-6-2:1999 with a date of cessation of presumption of conformity of 1st April 2002. The principal differences occurring as a result of this change are:

References to ENV 50140 and 50141 are replaced by EN 61000-4-3 and EN 61000-4-6 respectively, and the separate test to ENV 50204 is deleted; the distinction between process control and other I/O ports is removed; surge testing to EN 61000-4-5 is added for all AC power ports and some DC and I/O ports; voltage dips and interrupts tests to EN 61000-4-11 are added for AC power ports; the reference in the scope to battery powered apparatus is deleted

2.4 Basic standards – IEC 61000

There are several parts of IEC 61000 (see Table 2.3). This section only considers those parts which are directly relevant for testing equipment. Part 2 (The EM environment) is useful for understanding the many environmental aspects of EMC but does not specify tests. Part 5 (Installation and mitigation guidelines) is primarily aimed at systems installers. Note that the European equivalent number of any IEC standard is obtained by writing EN 6XXXX instead of IEC 6XXXX. The standards are (mostly) technically equivalent – there may be so-called European "common modifications" – but the European versions have an additional foreword which specifies how the standard is to be applied for certification purposes.

2.4.1 IEC 61000-3

Title Electromagnetic compatibility – Part 3: Limits†

Equivalents EN 61000-3-X; IEC 555-X (EN 60555-X) was the previous standard defining requirements for household appliances, which has been superseded

† Although IEC 1000-3 has the all-inclusive title of "Limits", it does not (yet) refer to radio frequency emission limits, which are the province of CISPR.

Scope (Sections 2 and 3) Electrical and electronic equipment having an input current up to and including 16A per phase, and intended to be connected to public low-voltage distribution systems (nominal voltage 220V or higher). These two sections have a date of cessation of presumption of conformity of 1st January 2001

Section 2: 1995 Limits for harmonic current emissions

Tests Measurement of 50Hz harmonic currents up to 2kHz using a wave analyser and current shunt or transformer (see section 3.2)

Limits Class A (balanced 3-phase equipment and everything outside Classes B, C or D): absolute limits on even and odd harmonics up to the 40th harmonic
Class B (portable tools): as Class A but 1.5 times higher
Class C (lighting equipment, including dimmers): relative limits expressed as a percentage of the input current for odd harmonics only, up to the 39th harmonic; dimmers must meet Class A limits; lighting equipment with an active input power ≤25W must either meet class D limits or specific limits on 3rd and 5th harmonics as a percentage of the fundamental current
Class D (equipment with specially-defined waveshape, see Figure 3.20 on page 117, and an active input power between 75 and 600W; most electronic power supplies will fall into this category): limits expressed in mA per watt for odd harmonics only, up to the 39th harmonic
Transitory harmonics are allowed a relaxation of 1.5 times under certain restricted conditions

A14 Substantial changes to the standard have been introduced with the publication of amendment A14: 2000, which was harmonized in the OJEC on 14th December 2000, just in time for the mandatory introduction of the harmonics standard on 1st January 2001. A major change is that Class D requirements under this amendment only apply to personal computers and televisions, and checking for the special waveshape is not required. The changes are discussed in more detail in section 3.2.3 on page 116.

Section 3: 1994 Limitation of voltage fluctuations and flicker in LV supply systems

Tests Measurement of voltage fluctuations using an IEC868 flickermeter or by analytical methods, with the EUT supplied from a defined reference impedance (see section 3.2.4)

Limits Limits apply to magnitude of maximum permissible percentage voltage changes (d) with respect to number of voltage changes per second or per minute (P_{st})

An amendment published in early 2001 revises some of the voltage change limits and makes it clearer that they apply to the voltage fluctuation at the moment of switch-on, i.e. the standard places a limit on allowable inrush current

Section 4: 1998 Limitation of emission of harmonic currents in LV supply systems for equipment with rated current greater than 16A

Published as a technical report

Section 5: 1994 Limitation of voltage fluctuations and flicker in LV supply systems for equipment with rated current greater than 16A

Published as a technical report

Section 11: 2000 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

This is the equivalent standard to IEC 61000-3-3 for higher powered equipment than 16A per phase. It was harmonized on 14th December 2000 with a date of cessation of presumption of conformity of 1st November 2003. It applies the limits of IEC 61000-3-3 but with greater freedom to set the test source impedance, with the actual requirement for conditional connection subject to the result. It is based on IEC 61000-3-4 which is still relevant for equipment with a rated input current >75A

Section 12: Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current ≤75A per phase and subject to restricted connection

Not yet published; will be the equivalent standard to IEC 61000-3-2 for higher powered equipment than 16A per phase. Will replace IEC 61000-3-4.

2.4.2 IEC 61000-4

Scope Testing and measurement techniques for immunity of electrical and electronic equipment: basic EMC standards

Criteria Test results to be classified as follows:

- normal performance within specification limits
- temporary degradation or loss of function or performance which is self recoverable
- temporary degradation or loss of function or performance which requires operator intervention or system reset
- degradation or loss of function which is not recoverable due to hardware or software damage or loss of data

NB some of the earlier parts of IEC 61000-4-X were originally written to apply to process measurement and control equipment, and published as parts of IEC 801

Section 1: Overview of immunity tests

Not a test standard itself, its intention is to give "a general and comprehensive reference to the technical committees of IEC or other bodies, users and manufacturers of

electrical and electronic equipment on EMC immunity specifications and tests, and to give general guidance on selection and application of these tests."

Section 2: 1995 Electrostatic discharge

Equivalent EN 61000-4-2

Tests At least ten single discharges to preselected points, accessible to personnel during normal usage, in the most sensitive polarity. Contact discharge method to be used unless this is impossible, in which case air discharge used. Also ten single discharges to be applied to a coupling plane spaced 0.1m from the EUT

Levels Severity levels from 2kV to 15kV (8kV contact discharge) depending on installation and environmental conditions

Section 3: 1995 Radiated radio frequency field

Equivalent EN 61000-4-3 (which has common modifications)

Tests Radiated RF field generated by antennas in a shielded anechoic enclosure using the substitution method (pre-calibrated field), swept from 80MHz to 1000MHz at slower than $1.5 \cdot 10^{-3}$ decades/s, or with a step size not more than 1% of fundamental and dwell time sufficient to allow the EUT to respond. Eight (twelve) tests are needed, one in each polarization with the antenna facing each of the four sides of the EUT (and top and bottom if these might be affected). Field uniformity within –0/+6dB over 12 out of 16 points within a 1.5 x 1.5m square area at the front face of the EUT is required of the chamber

Alternative methods such as a stripline or TEM cell can be used provided that field homogeneity requirements are met and that the EUT and wires can be arranged as specified

Amendment A1: 1998 has revised the field uniformity calibration method and added testing from 1.4 to 2GHz

Levels Severity levels of 1, 3 or 10V/m unmodulated (or greater) depending on the expected EMR environment; the actual applied signal is modulated to 80% with a 1kHz sinewave

Section 4: 1995 Electrical fast transient burst

Equivalent EN 61000-4-4

Tests Bursts of 5ns/50ns pulses at a repetition rate of 5kHz with a duration of 15ms and period of 300ms, applied in both polarities between power supply terminals (including the protective earth) and a reference ground plane, or via a capacitive coupling clamp onto I/O circuits and communication lines

Levels Severity levels of 0.5, 1, 2 and 4kV on power supply lines, and half these values on signal, data and control lines, depending on the expected environmental and installation conditions

Section 5: 1995 Surge

Equivalent EN 61000-4-5

Tests At least 5 positive and 5 negative surges, at a repetition rate no faster than 1 per minute, of 1.2/50μs voltage or 8/20μs current waveshape surges from a surge generator of 2Ω output impedance, line to line on ac/dc power lines; 12Ω output impedance, line to earth on ac/dc power lines; 42Ω output impedance, capacitively coupled or via gas-filled arrestors line to line and line to earth on I/O lines

Levels Severity levels of 0.5, 1, 2 and 4kV, selected according to installation conditions and type of line; all lower test level voltages must also be applied

Section 6: Conducted disturbances induced by radio frequency fields

Equivalent EN 61000-4-6

Tests RF voltage swept at slower than $1.5 \cdot 10^{-3}$ decades/s, or with a step size not more than 1% of fundamental and dwell time sufficient to allow the EUT to respond, over the frequency range 150kHz to 80MHz (possibly 230MHz), applied via coupling/decoupling networks (CDNs) to cable ports of the EUT. When CDNs are not suitable or are unavailable, the alternative methods of EM-clamp or current injection probe can be used (except on supply lines)

NB: applicability of tests over the frequency range 80MHz to 230MHz overlaps with IEC 61000-4-3 and may be used instead of the tests specified in that document, depending on the EUT dimensions

Levels Severity levels of 1, 3 or 10V emf unmodulated depending on the EMR environment on final installation; the actual applied signal is modulated to 80% with a 1kHz sinewave

Section 8: 1993 Power frequency magnetic field

Equivalent EN 61000-4-8

Tests Continuous and short duration power frequency magnetic field, applied via an induction coil adequately sized to surround the EUT in three orthogonal positions

Levels Continuous: 1, 3, 10, 30 or 100 A/m; short duration (1 to 3s): 300 or 1000A/m, for the higher severity levels only

Section 9: 1993 Pulse magnetic field

Equivalent EN 61000-4-9

Tests Mainly applicable to electronic equipment to be installed in electrical plants. At least 5 positive and 5 negative 6.4/16μs pulses applied via an induction coil adequately sized to surround the EUT in three orthogonal positions, repetition period no less than 10s

Levels 100, 300 and 1000 A/m

Section 10: 1994 Damped oscillatory magnetic field

Equivalent EN 61000-4-10

Tests Mainly applicable to electronic equipment to be installed in electrical plants. Oscillatory wave of 0.1 or 1MHz damped to 50% of peak after three to six cycles at a repetition rate of 40 or 400 per second, applied via an induction coil adequately sized to surround the EUT in three orthogonal positions for 1 second

Levels 10, 30 and 100 A/m

Section 11: 1994 Voltage dips, short interruptions and voltage variations

Equivalent EN 61000-4-11

Scope Electrical and electronic equipment fed by low voltage power supply networks and having an input current not exceeding 16A per phase, but not equipment which is connected to DC networks or 400Hz AC networks

Tests Dips and short interruptions initiated at any phase angle of the input voltage, to a level of 0%, 40% and 70% of the nominal voltage for a duration of 0.5 to 50 periods

Short term variations to a level of 40% and 0% of nominal voltage, taking 2.0 seconds to reach the test level and to recover from it, and 1 second at the test level

Section 12: 1995 Oscillatory waves

Equivalent EN 61000-4-12

Tests Ring wave: 100kHz decaying at 60% per peak, initial voltage rise time 0.5μs, applied at a rate of 1 to 6 transients per minute from a generator with output impedance of 12, 30 or 200Ω via a coupling-decoupling network in common or differential mode to power supply, signal and control ports
Damped oscillatory wave: same characteristics as damped field of IEC 61000-4-10, applied for not less than 2 seconds from a generator with output impedance 200Ω via CDNs as for ring wave

Levels Ring wave: 0.5, 1, 2 and 4kV common mode, half these values for differential mode
Damped oscillatory wave: 0.5, 1 and 2kV common mode, half these values for differential mode

2.5 Product standards

A variety of standards (with the exceptions of ENs 55011, 55014-1 and 55022, see sections 2.2.3 to 2.2.5) are listed here, separated into "principal" and "other". This is of course an entirely arbitrary distinction; a taxi driver would quite naturally regard EN 50148 as the most important EMC standard in the world. The somewhat shaky basis for listing "principal" standards in more detail than "others" is simply that they would

appear to cover a fairly large range of products, by value or quantity. All non-radio standards that appear in the current (at the time of writing) OJEC listing [169] are included, either in the main part of this section or in short form at the end of the section.

Choice of product standard

When you choose a product standard for use in self certification, you can only do so initially on the basis of its title. Sometimes this is enough, but sometimes it is not at all obvious which of several is the most likely. Without consulting an expert, the only way to proceed is to obtain all of the likely ones, read at least through their scopes (more often than not you will have to persevere to the annexes at the back) and then make your selection from a more informed standpoint. ETSI standards are freely available for download on the web, but because of copyright issues IEC-based standards are not, and you have to pay for them. With sustained pressure from concerned standards-users, this situation might change in the future.

Many of the product standards have dates of cessation of presumption of conformity of the superseded standard (which is usually the generic standard) in 2000 or 2001. Experience to date suggests that while a few forward-thinking manufacturers have been testing their products to the newer product standards in advance, most have not. There seems to be a commonly-held misconception that once you have settled on a particular set of standards, you can use them in perpetuity. It is all too usual to find declarations of conformity of new products boasting compliance to, say, EN 50082-1:1992, when this standard was superseded by a second edition in 1997, and its tests are limp-wristed by comparison with the later version and the product standards. There will be three possibilities to correct this situation:

- companies may be actively keen to make the best use of the new standards;
- their more aware customers will demand compliance with the new standards;
- rigorous market surveillance, by enforcement officers familiar with the significance of the dating of standards, may happen.

2.5.1 Broadcast receivers and associated equipment

Emissions: EN 55013: 1990 + A12, A13, A14

Title — Limits and methods of measurement of radio disturbance characteristics of broadcast receivers and associated equipment

Equivalents — CISPR 13

Scope — Broadcast sound and television receivers, and associated equipment intended to be connected directly to these or to generate or reproduce audio or visual information, for example audio equipment, video cassette recorders, compact disc players, electronic organs. Information technology equipment as defined in EN55022 is excluded

NB EN55013:1990 removes audio equipment from the scope of EN55014

Tests — Mains terminal interference voltage from 150kHz to 30MHz measured using 50Ω/50μH CISPR artificial mains network

Antenna terminal disturbance voltage over the range 30–1000MHz due to local oscillator and other sources, higher limits for car radios

Radiated disturbance field strength of local oscillator and harmonics in the range 80 to 1000MHz measured on an open area test site at a distance of 3m; A14 adds standard CISPR limits for radiated emissions caused by digital processing, with three-year relaxation

Disturbance power of associated equipment excluding video recorders on all leads of length 25cm or more, over the range 30 to 300MHz, measured by means of the absorbing clamp

Limits — Limits for mains terminal disturbance voltage and disturbance power are the same as those in EN55014. Radiated field limits for local oscillator and harmonics are 12–20dB higher than equivalent Class B emissions limits for other products

Immunity: EN 55020: 1994 + A11, A12, A13, A14

Title — Immunity from radio interference of broadcast receivers and associated equipment

Related to — CISPR 20 (Not equivalent)

Scope — Broadcast sound and television receivers, and associated equipment intended to be connected directly to these or to generate or reproduce audio or visual information, for example audio equipment, video cassette recorders, compact disc players, electronic organs. Information technology equipment as defined in EN 55022 is excluded

No immunity requirements apply (they are "under consideration") to battery powered sound and tv receivers or those without an external antenna connection

Tests — Immunity from unwanted signals present at the antenna terminal: VHF band II receivers tested with in-band and out-of-band signals up to 85dBμV; tv receivers tested with adjacent channel modulated signals up to 80dBμV

Immunity from conducted voltages at the mains input, audio input and output terminals of receivers (except AM sound and car radios) and multi-function equipment over the range 150kHz to 150MHz; audio input & output terminals have less stringent low frequency levels than mains, loudspeaker and headphone terminals; the tuned channel and IF channel frequencies are excluded

Immunity from conducted currents of receivers (including car radios and AM sound) and multi-function equipment over the range 26 to 30MHz applied to the antenna terminal

Immunity from radiated fields from 150kHz to 150MHz of receivers and multi-function equipment, as tested in an open stripline test set-up, at 125dBμV/m except at IF and in-band frequencies

Amendment A12: 1999 adds electrostatic discharge, electrical fast transients, and a 3V/m pulsed RF field test at 900MHz

Criteria Wanted to unwanted audio signal ratio of ≥40dB, or just perceptible degradation of a standard picture

2.5.2 Household appliances, electric tools and similar apparatus

Emissions: EN 55014-1

See 2.2.4 on page 57

Immunity: EN 55014-2: 1997

Title Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: immunity – product family standard

Scope Electromagnetic immunity of appliances and similar apparatus for household and similar purposes as well as electric toys and tools. This standard is the immunity counterpart to EN 55014-1

Tests Apparatus is classified into four categories:

Category I: Apparatus containing no electronic control circuitry

Category II: Mains powered appliances containing electronic control circuitry with no internal frequency higher than 15MHz

Category III: Battery powered apparatus containing electronic control circuitry with no internal frequency higher than 15MHz

Category IV: All other apparatus within the scope

Levels for ESD, electrical fast transients, conducted RF, radiated RF, surges, and voltage dips and interruptions are defined with the test methods as per the basic standards. Permissible performance criteria are also defined. For each category, applicable tests and criteria are then specified. Category I apparatus is deemed to fulfil the requirements without testing

2.5.3 Lighting equipment

Emissions: EN 55015: 1996 + A1, A2

Title Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment

Equivalents CISPR 15

Scope Conduction and radiation of radio frequency disturbances from all lighting equipment with a primary function of generating and/or

distributing light intended for illumination purposes, including the lighting part of multi-function illumination equipment and independent auxiliaries exclusively for use with lighting equipment; but excluding aircraft and airport lighting and apparatus explicitly covered by other IEC/CISPR standards, e.g. built-in lighting devices in other equipment, photocopiers or slide projectors

Tests For luminaires intended for fluorescent lamps, insertion loss is measured between 150kHz and 1605kHz between terminals on a dummy lamp (construction specified in the standard) and the mains terminals of the luminaire

All other types of lighting equipment, including independent auxiliaries and self-ballasted fluorescent lamps, must meet quasi-peak and average limits for mains terminal disturbance voltage in the range 9kHz to 30MHz

In addition, lighting equipment with lamp operating frequencies in excess of 100Hz must meet quasi-peak limits for radiated magnetic field in the range 9kHz to 30MHz, measured with a Van Veen loop

Incandescent lamps are deemed to fulfil all requirements without testing

Uniquely among CISPR-based standards, there is a "chimney" of + 17dB in the conducted mains emission limits between 2.51 and 3MHz (except in Japan), and more in the radiated limits, between 2.2MHz and 3MHz. No explanation is provided in the standard for this departure, but a 1995 draft proposing the change makes clear that it is intended to allow the marketing of RF compact fluorescent lamps, on the grounds that "no broadcasting exists in this frequency band", and "a relaxation would allow the introduction of a relatively cheap energy saving lamp of light weight and smaller dimensions".

Immunity: EN 61547: 1995

Title Equipment for general lighting purposes – EMC immunity requirements

Equivalent IEC 61547

Scope Lighting equipment within the scope of IEC TC 34, such as lamps, auxiliaries and luminaires; exclusions similar but not identical to those of CISPR 15

Tests Levels for ESD, electrical fast transients, conducted RF, radiated RF, surges, and voltage dips and interruptions are defined with the test methods mostly as per the basic standards. Lighting-related performance criteria are also defined. For self-ballasted lamps, independent auxiliaries and luminaires, applicable tests and criteria are then specified. Non-electronic lighting equipment (except emergency lighting luminaires) is deemed to fulfil the requirements without testing

2.5.4 Information technology equipment

Emissions: EN 55022: 1998

See 2.2.5 on page 57

Immunity: EN 55024: 1998

Title Information technology equipment – Immunity characteristics – Limits and methods of measurement

Equivalents CISPR 24

Scope Information technology equipment as defined in CISPR 22

Tests Electrostatic discharge, electrical fast transients, radiated RF, conducted RF, power frequency magnetic field, surge, voltage dips and interruptions. There are some differences quoted from the basic test methods, for instance the ESD requirement is for at least 200 discharges to a minimum of four points. More than half of the standard is taken up with annexes giving particular test conditions and performance criteria for different types of apparatus.

2.5.5 Professional AV and entertainment lighting equipment

Emissions: EN 55103-1: 1996

Title Electromagnetic compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use – Part 1: Emission

Scope Professional audio, video, audio-visual and entertainment lighting control apparatus, intended for use in the residential, commercial and light industrial, urban outdoors, controlled EMC and rural, and heavy industrial environments. Consumer and security system apparatus is specifically excluded. The emphasis is on the word "control", so that for instance dimmers and luminaires (even if designed for stage use) are excluded. Annex G of the standard clarifies the scope in more detail.

Tests RF radiated emissions 30MHz–1GHz, magnetic fields 50Hz–50kHz, harmonics and flicker as given by EN 61000-3-2, -3, -4 or -5, AC power port conducted RF emissions and discontinuous interference 150kHz–30MHz, inrush currents on the AC power port, conducted emissions 30–1000MHz on the antenna terminals of broadcast receivers according to EN 55013, conducted emissions 150kHz–30MHz on signal, control and DC power ports. Applicability and limits vary depending on the environment.

Immunity: EN 55103-2: 1996

Title Electromagnetic compatibility – Product family standard for audio, video, audio-visual and entertainment lighting control apparatus for professional use – Part 2: Immunity

Scope As given above for EN 55103-1

Tests RF radiated field 80–1000MHz, electrostatic discharge, magnetic fields 50Hz–10kHz, fast transients and conducted RF 150kHz–80MHz on all ports, voltage dips, interruptions and surge on AC power input ports, AF common mode 50Hz–10kHz on signal and control ports. Applicability and levels vary depending on the environment.

2.5.6 Equipment for measurement, control and laboratory use

Emissions and immunity: EN 61326: 1997 + A1: 1998

Title Electrical equipment for measurement, control and laboratory use – EMC requirements

Equivalents IEC 61326

Scope Electrical equipment operating from a supply of less than 1kV AC or 1.5kV DC, intended for professional, industrial process and educational use, for measurement and test, control or laboratory use. It includes accessories intended for use with the above. Amendment 1 adds specific annexes for equipment intended for use in industrial locations, controlled EM environments, and for portable test and measurement equipment. Amendment 2 (not harmonized at the time of writing) adds an annex for sensitive test and measurement equipment for EMC unprotected applications, e.g. oscilloscopes, logic analysers etc.

Tests Emissions: mains port conducted RF 150kHz–30MHz, harmonics and flicker according to IEC 61000-3-2, -3 (Class B only), radiated RF 30MHz–1000MHz

Immunity: Electrostatic discharge, radiated RF, voltage interruptions, electrical fast transient bursts, surge, conducted RF, power frequency magnetic field. Applicability and levels depend on the chosen annex.

2.5.7 Fire, intruder and social alarm systems

Emissions

There is no explicit emissions standard for this product family; use of the appropriate generic emissions standard is recommended

Immunity: EN 50130-4: 1995 + A1: 1998

Title Alarm systems – Part 4: Electromagnetic compatibility – Product family standard: Immunity requirements for components of fire, intruder and social alarm systems

Scope Components of the following alarm systems, intended for use in and around buildings in residential, commercial, light industrial and industrial environments: intruder alarm systems, hold-up alarm systems, fire detection and fire alarm systems, social alarm systems, CCTV systems and access control systems for security applications, and alarm transmission systems (the last added by Amendment 1).

Tests Mains supply voltage variations, dips and short interruptions, electrostatic discharge, radiated electromagnetic field, conducted RF, fast transient bursts and surge. There are some significant differences from the usual test requirements hidden in these specifications, for instance the RF tests require an extra set of sweeps with 1Hz pulse modulation. For each test, fairly explicit performance criteria are provided.

2.5.8 Telecommunication network equipment

Emissions and immunity: EN 300386-2: 1997

Title Electromagnetic compatibility and radio spectrum matters (ERM); Telecommunication network equipment; Electromagnetic compatibility (EMC) requirements; Part 2: Product family standard

Scope Equipment intended to be used within a telecommunications network including switching equipment, non-radio transmission equipment and ancillaries, power supply equipment and supervisory equipment. Excludes cable TV equipment, submarine cable systems and optical amplifiers. The definition of a telecommunications network excludes terminal equipment beyond the network termination points.

Tests Emissions: mains port conducted RF 150kHz–30MHz, harmonics and flicker according to IEC 61000-3-2, -3, radiated RF 30MHz–1000MHz; DC power ports have a conducted RF emissions requirement extending down to 20kHz

Immunity: Electrostatic discharge, radiated RF, conducted RF, voltage interruptions, electrical fast transient bursts, surge. Extra surge and power induction requirements apply to ports for outdoor signal lines. Two environments are defined with different emissions and immunity levels, one being "telecommunication centre", the other being "other than telecommunication centre". The standard defines specific performance criteria and operating conditions, and adds an extra performance criteria called "resistibility" which requires equipment to withstand the (more severe) test conditions without damage, but allowing the operation of protective devices which have to be replaced or reset.

This standard illustrates perfectly the volatile nature of product standards. It is listed in the OJEC with a date of cessation of presumption of conformity of the superseded standard (the generic standards) of 30th September 2001. In the same listing, it itself is superseded by EN 300386: 2000 by 31st May 2003.

2.5.9 Radio equipment

Emissions and immunity: EN 301489-1: 2000

Title Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements

Scope Radio communications equipment and any associated ancillary equipment operating in the residential, commercial, light industrial, telecommunications centre and vehicular environments, but not the maritime environment. With the inception of the R&TTE Directive (section 1.2.1.2), most of the radio standards listed under the EMC Directive have migrated to parts of EN 301489 where they are re-written to refer to that Directive. Part 1 gives common technical requirements, while other parts give product-related information.

Tests RF conducted and radiated emissions as per EN 55022, including modified application to DC power input ports

ESD, electrical fast transients, surges, supply voltage variation, dips and interruptions, vehicular supply transients, conducted and radiated RF: as per the basic standards. Three classes of equipment are established, for fixed, vehicular and portable use, and the various tests are applied as appropriate. The standard also establishes minimum performance criteria, and makes specific provision for input and output transmitter/receiver test signals, narrowband responses and exclusion bands for RF immunity testing. The antenna port is specifically excluded from EMC tests. Frequency spectrum utilization parameters such as spurious emissions and spurious responses are also excluded

2.5.10 Adjustable speed electrical power drive systems

Emissions and immunity: EN 61800-3: 1996 + A11: 2000

Title Adjustable speed electrical power drive systems – Part 3: EMC product standard including specific test methods

Related to IEC 61800-3

Scope Adjustable speed AC or DC motor drives for mains supplies up to 1kV AC rms, installed in industrial and residential environments, with the exception of traction applications and electric vehicles.

Tests EN 61800-3 is a highly unusual standard. It has the dubious distinction of having been the only harmonized standard referred to the European Commission for withdrawal. The EC preferred to press CENELEC for an amendment, which was published in 2000 as A11 and then swiftly harmonized with a DOW of 1st January 2002. The amendment makes substantial changes to the body of the standard; this description refers to the two taken together.

The standard defines a "first" and a "second" environment, broadly meaning domestic premises or their supplies on the one hand, everything else on the other. It also defines "restricted" or "unrestricted" distribution, the former meaning that the manufacturer restricts the supply of equipment to those who have technical competence in the EMC requirements of drives applications. These definitions allow the standard to define much higher limits of conducted and radiated RF emissions than is normal for the CISPR classes A and B (although there is a reference to CISPR 11 Group 2 Class A), especially for restricted distribution in the second environment. The un-amended standard originally said "Many PDSs are working correctly without filters in the industrial environment, and do not disturb other apparatus or equipment, therefore they are compatible", and went on to apply no limits at all in the second environment. The amendment expunges this remark and corrects the situation. (Variable speed drives are known as one of the worst offenders when it comes to actual cases of RF interference.)

The standard does explicitly refer to both emissions and immunity of commutation notches, harmonics and voltage fluctuations. For high frequency immunity, it applies the usual requirements of ESD, radiated RF, conducted RF, fast transient bursts and surge. The earlier document did not apply conducted RF at all, was equivocal about surge testing, and allowed an alternative "walkie-talkie" test in place of the standard IEC 61000-4-3 RF immunity test. This leniency has been suppressed by the amendment, although it is permitted to do the RF tests only on sensitive subcomponents of large systems.

2.5.11 Medical electrical equipment

Emissions and immunity: EN 60 601-1-2 : 1993

Title Medical electrical equipment – part 1: General requirements for safety – 2. Collateral Standard: Electromagnetic compatibility – requirements and tests

Scope Medical electrical equipment and systems, information technology equipment used in medical electrical application

This standard defines the general EMC requirements and tests for such equipment; requirements for particular classes of equipment are or will be contained in the particular requirements of part 2 of this standard, which is fundamentally a safety standard. NB it has been withdrawn as a harmonized standard for the EMC Directive, since EMC of medical electrical equipment is now covered by the Medical Devices Directive and not the EMC Directive; this standard is only harmonized for the MDD

Tests RF emissions as per CISPR 11 (EN 55011) with some modifications. Class A equipment is allowed in domestic establishments when used under the jurisdiction of a health care professional

ESD: 3kV contact, 8kV air discharge to IEC 801-2
Radiated RF: 3V/m amplitude modulated from 26MHz to 1GHz according to IEC 801-3 second edition. This provision is causing some problems since there is in fact no second edition of IEC 801-3, and the standard that should have been referred to (IEC 61000-4-3) specifies tests from 80MHz to 1GHz. For other than life support equipment, RF immunity need only be tested at the ISM frequencies (see Table 1.1 on page 18)
Electrical fast transients: 1kV for plug-connected mains ports, 2kV for permanently installed equipment, 0.5kV for interconnecting lines longer than 3m, as per IEC 801-4
Surge: 1kV differential mode, 2kV common mode, at the mains port, as per IEC 801-5 (now IEC 61000-4-5)

NB this standard was regarded as somewhat premature for various reasons and a revised edition is likely to be published in 2001

2.5.12 Automotive standards

The Automotive EMC Directive (see page 23) includes its own technical requirements, but there are a number of standards which make provision for some EMC aspects of the automotive environment. ISO 7637 in particular is referenced by a number of harmonized standards which cover equipment that might be used in a vehicle. Alternatively, these could be used for certification of automotive products against the EMC Directive via a TCF. They include:

CISPR 25

Title Limits and methods of measurement of radio interference characteristics for the protection of receivers used on board vehicles

ISO 7637 parts 1, 2 and 3

Title Road vehicles – Electrical disturbance by conduction and coupling

Defines transient coupling methods and waveforms for 12V power line (part 1), 24V power lines (part 2) and signal lines (part 3)

ISO 11451-X, ISO 11452-X

Title Road vehicles – electrical disturbances by narrow band radiated electromagnetic energy: vehicle test methods (11451-1, -2, -3, -4) and component test methods (11452-1, -2, -3, -4, -5, -7)

Defines test methods for absorber lined chamber, TEM cell, bulk current injection, stripline and direct RF power injection

2.5.13 Other product standards

The following list details other product EMC standards, most of which have been harmonized in the OJEC at the time of writing.

Standard	Product sector	Comment
EN 50065-1	Mains signalling equipment	
EN 50083-2	Cable sound and TV distribution network equipment	
EN 50090-2-2	Home and building electronic systems	
EN 50091-2	Uninterruptible power systems	
EN 50121-X	Railway applications	Not harmonized
EN 50148	Electronic taximeters	
EN 50199	Arc welding equipment	
EN 50227	Proximity sensors	
EN 50263	Measuring relays and protection equipment	
EN 50270	Gas detection and measurement equipment	
EN 60118-13	Hearing aids – RF immunity	Not harmonized
EN 60204-31	Sewing machines, units and systems	
EN 60439-1	Low-voltage switchgear and control gear assemblies	
EN 60521	Class 0.5, 1 and 2 alternating-current watt-hour meters	
EN 60669-2-X	Switches for household etc. fixed electrical installations	
EN 60687	AC static watt-hour meters for active energy	
EN 60730-X	Automatic electrical controls for household etc. use	Various parts
EN 60870-2-1	Telecontrol equipment and systems	
EN 60945	Maritime navigation and radio-communication equipt.	
EN 60947-X	Low-voltage switchgear and control gear	Various parts
EN 61008-1	Residual current operated circuit breakers (RCCBs)	
EN 61009-1	Residual current operated circuit breakers (RCBOs)	
EN 61036	AC static watt-hour meters for active energy	
EN 61037	Electricity metering – electronic ripple control receivers	
EN 61038	Electricity metering – time switches	
EN 61131-2	Programmable controllers	
EN 61268	AC static var-hour meters for reactive energy	
EN 61543	Residual current-operated protective devices (RCDs)	
EN 61812-1	Specified time relays for industrial use	
EN 12015/12016	Lifts, escalators and passenger conveyors	CEN
EN ISO 14982	Agricultural and forestry machines	CEN

2.6 Other standards not related to the EMC Directive

2.6.1 FCC Rules

In the US, radio frequency interference requirements are controlled by the FCC (Federal Communications Commission), which is an independent government agency responsible for regulating inter-state and international communications by radio, television, satellite and cable. The requirements are detailed in CFR (Code of Federal Regulations) 47. Part 15 of these regulations until 1990 applied to restricted and incidental radiation devices, that is those devices which emit RF interference as a by-product of their operation, or at very low power. In 1990 the regulations were revised into a new format which distinguishes primarily between unintentional and intentional radiators. Further changes have appeared at a steady rate during the last decade.

Part 15 subpart B, applying to unintentional radiators, includes clauses which cover specific classes of device such as power line carrier systems, TV receivers and TV interface devices. Industrial, scientific and medical devices which intentionally generate RF energy are covered under Part 18 of the rules. But the major impact of Part 15 is on those products which incorporate digital devices.

2.6.1.1 Approval routes

A "digital device" (previously defined as a computing device) is any electronic device or system that generates and uses timing signals or pulses exceeding 9kHz and uses digital techniques. Two classes are defined, depending on the intended market: class A for business, commercial or industrial use, and class B for residential use. These classes are subject to different limits, class B being the stricter. Before being able to market his equipment in the US, a manufacturer must follow one of three routes:

- *verification*, which is totally a self-certification process;
- *declaration of conformity (DoC)*, similar to verification except that testing must be carried out in a US-accredited test laboratory;
- *certification*, where the manufacturer must send a package of information including test data, installation and operating instructions, and fees to a Telecoms Certification Body (TCB), which issues the approval.

Which route is to be followed depends on the type of product. (Note that the certification route applies to more than just telecom products.) Since June 2000, the FCC itself has declined to become involved directly in any of these routes. When the EU/US Mutual Recognition Agreement is finally operational, European laboratories will be capable of acting as TCBs for certification or as Certification Bodies for the DoC route.

There are some quite broad exemptions from the rules depending on application. These include digital devices used in transport vehicles, industrial plant or public utility control systems, industrial, commercial and medical test equipment, specialized medical computing equipment and a digital device used in an appliance.

2.6.1.2 Test requirements

Limits apply to conducted interference on the mains lead between 450kHz and 30MHz, and radiated interference measured either at 10m or 3m from 30MHz to 960MHz and above. The limits are similar but not identical to those laid down in CISPR-derived standards. The limits specified in CISPR 22 are also accepted, but the test procedures of ANSI C63.4: 1992 (which was revised in 2000) must be followed and the US mains

voltage must be used during the tests. The upper frequency limit is extended to a possible maximum of 40GHz, depending on the frequencies used within the device. The relationship between internal clock (or other) frequencies and the maximum measurement frequency is shown in Table 2.4. From this you can see that devices with clock frequencies exceeding 108MHz must be tested for emissions well into the microwave region.

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705–108	1000
108–500	2000
500–1000	5000
Above 1000	5th harmonic of highest frequency or 40GHz, whichever is lower

Table 2.4 Maximum measurement frequency for digital devices, FCC Rules Part 15 (1990)

2.6.2 Other non-harmonized standards

The BSI publishes some other standards which are not expected to be harmonized for the EMC Directive but which refer to electromagnetic compatibility. These are:

BS1597 Limits and methods of measurement of electromagnetic interference generated by marine equipment and installations

BS5049 Radio interference characteristics of overhead power lines and high voltage equipment (equivalent to CISPR 18)

BS6345 Method for measurement of radio interference terminal voltage of lighting equipment

BS7027 Limits and methods of measurement of immunity of marine electrical and electronic equipment to conducted and radiated electromagnetic interference

AU 243 Methods of test for electrical disturbance by conduction and coupling (automobile series, equivalent to ISO 7637)

BS EN 50160 Voltage characteristics of electricity supplied by public distribution systems (describes what the electricity consumer should be able to expect in terms of quality of supply)

There are also various standards for RF and transient immunity, in addition to those discussed earlier, which are written specifically for certain products or product sectors, or which are developed by large customers for in house or contractual use. Vehicle manufacturers usually have their own specifications, for instance, and, of course, there are a number of military and aerospace standards.

2.6.3 Measurement standards

Some very important EMC standards do not appear in the sections above because they do not refer to products and do not directly give measurement methods or limits. Instead they define measuring instrumentation, facilities or methods:

CISPR 16-1 Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus (see section 3.1)

CISPR 16-2 Specification for radio disturbance and immunity measuring apparatus and methods – Part 2: Methods of measurement of disturbances and immunity

CISPR 16-3 Specification for radio disturbance and immunity measuring apparatus and methods – Part 3: Reports and recommendations of CISPR (contains recommendations on statistics of disturbance complaints, on the significance and determination of CISPR limits, etc.)

IEC 61000-4-7 Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto (see section 3.2.1)

IEC 61000-4-15 Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications (see section 3.2.4)

EN 50147-1 Anechoic chambers, Part 1: Shield attenuation measurement

EN 50147-2 Anechoic chambers, Part 2: Alternative test site suitability with respect to site attenuation

pr EN 50147-3 EMC Basic Emission Standard, Part 3: Emission measurements in fully anechoic rooms (see section 3.1.3.3)

2.7 RF emissions limits

Most of the standards within the EN 550XX series have harmonized limit levels for conducted and radiated emissions. These standards derive from CISPR and the limit levels are set in each case for the same purpose, to safeguard the radio spectrum for other users. A minimum separation distance is assumed between source and susceptible equipment for this purpose.

Figure 2.4 and Figure 2.5 show the limits in graphical form for the emissions standards discussed above. FCC levels differ somewhat from the harmonized EN levels and are included for comparison. All radiated emission levels are normalized to a measuring distance of 10m.

In these figures, EN class A refers to EN 55011, EN 55022 Class A and EN 50081-2, and EN class B refers to EN 55011, EN 55022 Class B, EN 55013, EN 55014 (appliances, conducted only), and EN 50081-1. All values are measured with the CISPR 16 quasi-peak detector, but the standards also require conducted emissions to be measured with an average detector. The limits for the average measurement are 13dB (Class A) and 10dB (Class B) below the quasi-peak limits.