Chapter 4

Commercial standards

4.1 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 4.1.

4.1.1 The International Electrotechnical Commission

The IEC operates in close co-operation with the International Standards Organization (ISO), and in 2006 had 68 member countries including 16 associate members. It is

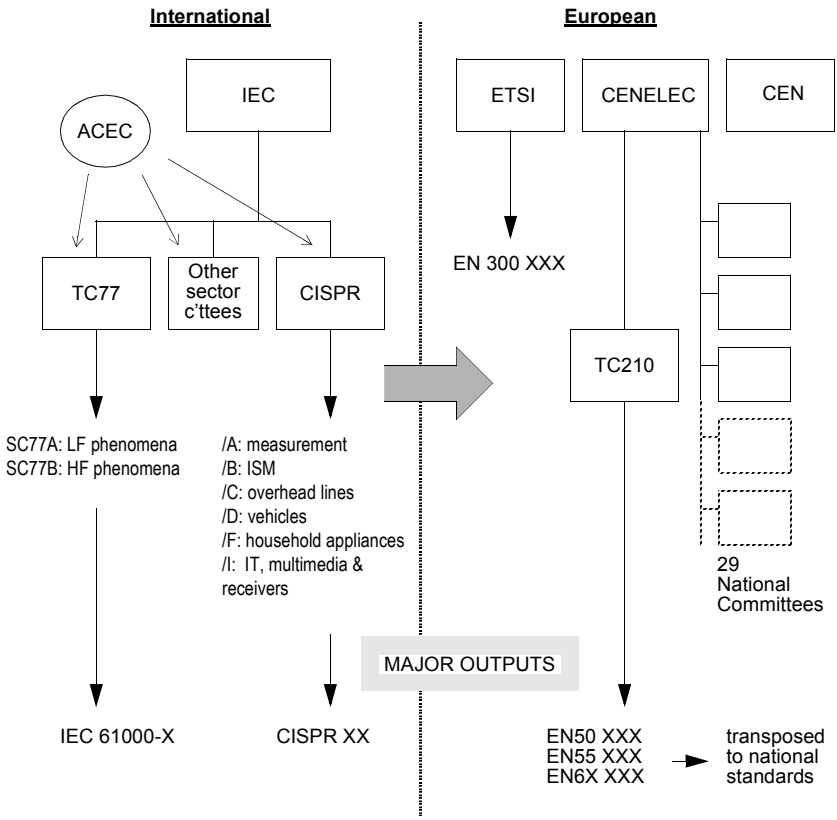

Figure 4.1 EMC standards structure

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 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."[88]

Two IEC technical committees are devoted full-time to EMC work, although nearly 40 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. There is also the Advisory Committee on EMC (ACEC), 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 harmonised EN standards, in which case they become applicable for the self certification route, or they may be referred to by product-specific or generic harmonised standards.

Table 4.1 Plan of IEC 61000

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 (none published to date)

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.

4.1.1.1 TC77

TC77 has been characterized as "The United Nations for EMC" [99]; certainly it attempts to cover most aspects of the subject on a worldwide basis. The structure of TC77 is shown in Figure 4.2. It is a large and influential group, and liaises with several

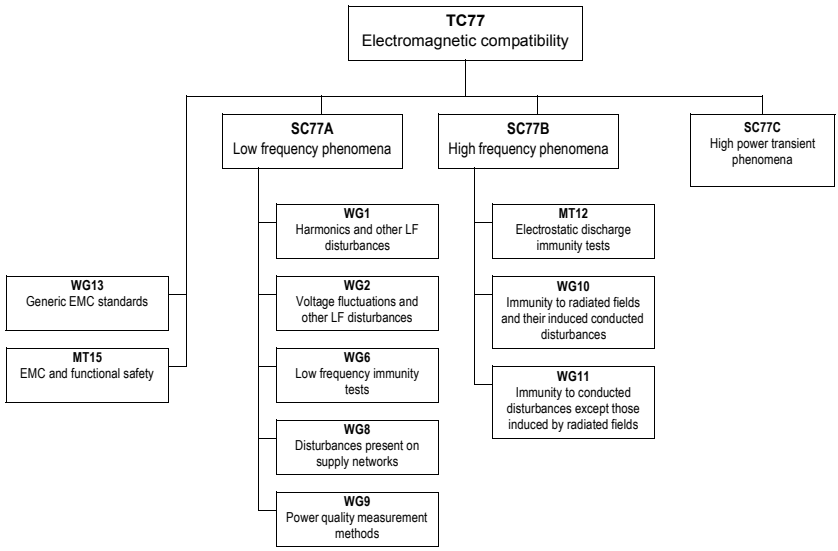

Figure 4.2 Structure of IEC TC77

other product-related committees within IEC including CISPR, as well as with outside bodies such as CENELEC, ITU and several electric power-related groups.

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 4.1, and incorporates all non-CISPR and non-product-specific EMC material. Previous EMC 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 4.5, but meanwhile, a complete list of the parts of this mammoth standard that have been published or are in preparation up to autumn 2006 is given in Table 4.3.

4.1.1.2 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 4.2. 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 an important role as the developer and guardian of common test methods and instrument specifications. CISPR/E and /G were amalgamated into CISPR/I in 2001.

Although all the output of CISPR sub-committees (except A and H) 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 rationalised into two classifications, A and B (see section 4.8), 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 4.2 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/F	Household appliances, tools, lighting equipment and similar apparatus	CISPR 14, CISPR 15
CISPR/H	Limits for the protection of radio services	CISPR/TR 31, IEC 61000-6-3, -6-4
CISPR/I	Information technology, multimedia equipment and receivers	CISPR 13, CISPR 20, CISPR 22, CISPR 24; future CISPR 32, 35

4.1.1.3 The IEV

One further important document is Chapter 161 of IEC Publication 60050 [152], 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 4.3 Published and planned parts of IEC 61000
(Shaded sections were not yet published in autumn 2006)

Part	Section	Title
1	General	
	1	Application and interpretation of fundamental definitions and terms
	2	Methodology for the achievement of the functional safety of electrical and electronic equipment with regard to electromagnetic phenomena
	3	The effects of high-altitude EMP (HEMP) on civil equipment and systems
	4	Historical rationale for the limitation of power-frequency conducted harmonic current emissions from equipment, in the frequency range up to 2kHz
	5	High power electromagnetic (HPEM) effects on civil systems
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

Table 4.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in autumn 2006)

Part	Section	Title
	7	Low frequency magnetic fields in various environments
	8	Voltage dips and short interruptions on public electric power supply systems with statistical measurement results
	9	Description of HEMP environment. Radiated disturbance
	10	Description of HEMP environment. Conducted disturbance
	11	Classification of HEMP environments
	12	Compatibility levels for low-frequency conducted disturbances and signalling in public medium-voltage power supply systems
	13	High-power electromagnetic (HPEM) environments – Radiated and conducted
	14	Overvoltages on public electricity distribution networks
3	Limits	
	1	Overview of emission standards and guides – Technical Report
	2	Limits for harmonic current emissions (equipment input current <= 16 A per phase)
	3	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current <= 16 A per phase and not subject to conditional connection
	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
	9	Limits for interharmonic current emissions (equipment with input power <=16 A per phase and prone to produce interharmonics by design)
	10	Emission limits in the frequency range 2 ... 9 kHz
	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.
	12	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and <=75 A per phase
	13	Assessment of emission limits for the connection of unbalanced installations to MV, HV and EHV power systems
	15	Assessment of electromagnetic immunity and emission requirements for dispersed generation in LV networks
4	Testing and measurement techniques	
	1	Overview of IEC 61000-4 series
	2	Electrostatic discharge immunity test
	3	Radiated radio frequency electromagnetic field immunity test
	4	Electrical fast transient/burst 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 magnetic field immunity test
	11	Voltage dips, short interruptions and voltage variations immunity test
	12	Oscillatory waves immunity test (to become Ring wave immunity test, with damped oscillatory wave test moved to part 18)

Table 4.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in autumn 2006)

Part	Section	Title
	13	Harmonics, interharmonics including mains signalling at AC power port, low frequency immunity tests
	14	Voltage fluctuation immunity test
	15	Flickermeter – functional and design specifications
	16	Test for immunity to conducted, common mode disturbances in the frequency range 0 Hz to 150 kHz
	17	Ripple on DC input power port immunity test
	18	Oscillatory waves immunity test (new edition)
	20	Emission and immunity testing in transverse electromagnetic (TEM) waveguides
	21	Reverberation chamber test methods
	22	Radiated emissions and immunity measurements in fully anechoic rooms (FARs)
	23	Test methods for protective devices for HEMP and other radiated disturbances
	24	Test methods for protective devices for HEMP conducted disturbance
	25	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 tests
	30	Power quality measurement methods
	31	Measurements in the frequency range 2kHz to 9kHz
	32	High-altitude electromagnetic pulse (HEMP) simulator compendium
	33	Measurement methods for high-power transient parameters
	34	Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase
	35	Intentional Electromagnetic Interference (IEMI) Simulator Compendium
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
	6	Mitigation of external EM influences
	7	Degrees of protection by enclosures against electromagnetic disturbances (EM code)
	8	HEMP protection methods for the distributed civil infrastructure
	9	System-level susceptibility assessments for HEMP and HPEM
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
CISPR	4	Emission standard for industrial environments
	5	Immunity for power station and substation environments
	6	HEMP immunity for indoor equipment
	7	Generic emission standard for in-situ measurements

4.1.2 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, equipment not intended for the subscriber, in contrast to terminal equipment, which is – and for radio communications equipment and broadcast transmitters.

CENELEC and ETSI use IEC/CISPR documents wherever possible as a basis for preparation of such standards, through a mechanism known as "parallel voting". This is so that European standards do not stray far out of line with international requirements, which would create difficulties for global trade. The committee charged with 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 other working groups.

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 29 National Committees [44][136]. Of these member committees France, UK, Germany and Italy have 10 votes, Spain has 8 votes and smaller countries have one or two votes. There are two requirements for a standard to be approved: the vote must yield a majority of National Committees in favour, and at least 71% of the weighted votes cast must be positive.

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 (harmonisation 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 Union* (OJEU), and once this is done the standard is deemed to be a "relevant standard" for the purpose of demonstrating compliance with the appropriate Directive (section 2.3.4.4). 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 (if it has sufficient resources and interest) 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.

4.1.2.1 Product standards

As mentioned in section 2.3.4, the intent of the EMC Directive is that self certification should be serviced primarily by a whole range of product standards. When published and harmonised, 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 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 have to continually monitor the standards development process – trade associations, and the websites of the standards agencies, are usually the most useful route for this purpose.

The following sections (4.2 *et seq*) outline those standards which form harmonised standards or basic standards for the purposes of the EMC Directive, which have been announced in the *Official Journal of the EU* [185]. They only briefly refer to the ETSI radio standards, which form a large group in themselves.

4.1.2.2 ETSI radio standards

The listing for the R&TTE Directive in the OJEU includes 25 EMC standards in the EN 301489 series for radio equipment. These appeared in the latter half of the 1990s, and with the implementation of the R&TTED were redrafted and reorganized. 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.

4.1.2.3 CEN

A few harmonised EMC standards are published by CEN, which is the European standards body for non-electrotechnical subjects. The main products covered by these documents are machines that have some electrical aspect. They can be recognized by their numbering, which although prefixed by EN does not fit into the 50XXX, 55XXX or 6XXXX series used by CENELEC.

4.1.2.4 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 OJEU. The method is implemented by a column in the table published in the OJEU 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 OJEU, 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 4.3 illustrates this graphically.

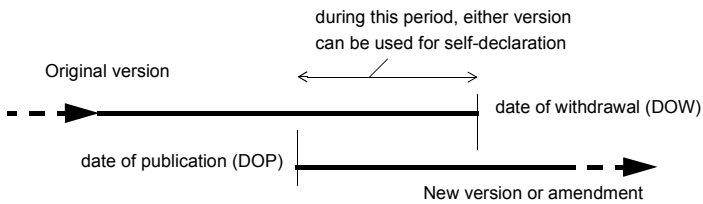

Figure 4.3 Applying changes in standards

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.

4.1.2.5 Dated references

The structure of the standards that are harmonised for the EMC Directive is, as explained above, two-tier: the product and generic standards list the tests and levels, but refer to basic standards for the test method. This means that to get the complete picture you must build up a library of documents, easily exceeding 10 and sometimes 20 separate standards, in order to cover all your requirements. But each of these documents is subject to change, and you must then keep up with all the amendments and revisions as well. Since CENELEC/IEC standards are expensive, this process can consume a not insignificant budget. But just as importantly, it introduces a potentially serious source of confusion, because a basic standard may change but this change will not be immediately reflected in the product standards which reference it.

To attempt to deal with the confusion, CENELEC created the distinction between dated and undated references. Each CENELEC standard includes an Annex ZA,

entitled "Normative references to international publications with their corresponding European publications". This cross-references the IEC documents referred to in the text (which is usually word-for-word the same as the IEC text) with those documents which are to be used in a European context. Hence, even if the text refers to an IEC standard, say IEC 61000-4-3, you should actually use the EN version, i.e. EN 61000-4-3 as quoted in Annex ZA. Importantly, Annex ZA may quote dates against the EN standard, and it includes a standard phrasing which says:

> For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

This therefore should resolve the question, when you are using a particular product or generic standard, of whether to pay attention to later revisions to the test methods in the basic standards – which can have potentially dramatic consequences for your compliance position, for instance when a later revision extends the frequency range or tightens up the specification of a test waveform. If the reference is undated, you should use the latest version; if it is dated you should stick with the specified version.

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.

4.2 Generic standards – emissions

CENELEC put great urgency on the development of generic standards [128][129], but they are now being gradually superseded by a whole raft of new product standards. There is a particular significance to ENs 55011, 55014-1 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. The generic standards listed below all claim to represent essential EMC emissions or immunity requirements.

4.2.1 EN 61000-6-3: 2001 + A11: 2004

Title Generic emission standard: Residential, commercial and light industrial environment

Equivalents IEC 61000-6-3

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 55014-1, if relevant

Mains harmonic emission measured as per EN 61000-3-2, mains flicker measured as per EN 61000-3-3

Signal, control and DC power ports: conducted current from 150kHz to 30MHz using current probe, according to EN 55022 Class B

4.2.2 EN 61000-6-4: 2001

Title Generic emission standard: industrial environment

Equivalents IEC 61000-6-4

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 Class A

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

4.3 Main product standards: emissions

4.3.1 EN 55011: 1998 + A1: 1999 + A2: 2002

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 intentionally generated and/or used for material inspection, analysis or treatment, and spark erosion

Comment The scope of EN 55011/CISPR 11 is the subject of some confusion; it is sometimes applied more widely than was intended, and there is an amendment pending to clarify the intent

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

4.3.2 EN 55014-1: 2000 + A1: 2001 + A2: 2002

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

Equivalents CISPR 14-1 fourth edition

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.

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

Radiated tests 30MHz to 1000MHz, as per EN 55022, for toys only

4.3.3 EN 55022: 1998 + A1: 2000 + A2: 2003

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

This standard is particularly widely referenced by other product standards, outside its own scope

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 (preferred) or 3m (alternative) on an open area or alternative test site. Tests above 1GHz are covered in an amendment to the fifth edition which is pending at the time of writing; see also Table 4.4 on the US FCC rules for testing above 1GHz, and section 6.4.3. Amendment 1 added the requirement for ferrite absorbers on leads leaving the test site, which provoked a storm of protest and has been omitted from later drafts

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

Comment EN 55022 and CISPR 22 have suffered considerable disarray over the last few years. At the time of writing they have to be regarded as two separate standards; the fifth edition of CISPR 22 has been published in IEC, but the similar but non-equivalent fifth edition of EN 55022 has not yet been accepted in CENELEC. Hence the above review refers to the third edition (the fourth edition of CISPR 22 didn't make it to an EN) which although published in 1998 is still current in the OJ listing. Various amendments to the fifth edition are in train which are intended to allow the CISPR and CENELEC documents to re-synchronize, but these are not yet finalized. The date of withdrawal of EN 55022: 1994 (the second edition) has been put back several times because of perceived difficulties with the third edition, at present (August 2006) it is August 2007; so that manufacturers have the

option of complying with 1994 plus amendments or 1998 plus amendments (including ferrites) or the fifth edition when it appears. In 2007 the option of compliance with the 1994 version should cease. But experience suggests that you should treat all predictions about the future course of development of this standard with some scepticism. An added difficulty is that experience also suggests that, whatever the intentions of the CENELEC committee responsible for the standard, they can easily be disrupted by the demonstrated inability of the European Commission to publish updated lists in the OJEU to a predictable timetable.

4.4 Generic standards – immunity

4.4.1 EN 61000-6-1: 2001

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

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, as per EN 61000-4-8, 50 or 60Hz at 3A/m, 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

4.4.2 EN 61000-6-2: 2005

Title Generic immunity standard, Part 2: industrial environment

Equivalents IEC 61000-6-2

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 EN 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 from 1.4 to 2.0GHz at 3V/m and 2.0 to 2.7GHz at 1V/m, all 80% AM 1kHz. Testing of small EUTs to IEC 61000-4-20, in a GTEM or other TEM cell, is also allowed as an option

Power frequency magnetic field, as per EN 61000-4-8, 50 or 60Hz at 30A/m, only for apparatus with magnetically susceptible devices

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

Radio frequency in common mode applied to some signal and all power ports, amplitude 10V rms from 150kHz to 80MHz with 80% AM 1kHz, except in the broadcast band 47–68MHz where the level is 3V rms, as per EN 61000-4-6

Surges as per EN 61000-4-5, to signal ports with long cables and some DC power ports at 500V, and AC power ports at 1kV or 2kV

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

4.5 Basic standards – EN 61000-3-X and -4-X

This section only considers those parts of IEC/EN 61000 which are directly relevant for testing equipment (Table 4.3 gives the full picture). 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.

Currently, EN 61000-3-2, -3, -11 and -12 are harmonised under the EMCD and therefore can and should be applied directly, according to their scope. Those in the EN 61000-4 series are not harmonised and only describe general test methods, but are applied widely through reference in the generic or product standards.

4.5.1 EN 61000-3-X

Title Electromagnetic compatibility – Part 3: Limits†

Equivalents IEC 61000-3-X

Section 2: 2006 Limits for harmonic current emissions

Scope 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)

Tests Measurement of 50Hz harmonic currents up to 2kHz using a wave analyser and current shunt or transformer (see section 8.1.1)

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 and non-professional arc welding equipment): as Class A but 1.5 times higher
Class C (lighting equipment, excluding dimmers which are Class A): relative limits expressed as a percentage of the input current for odd harmonics and the second harmonic only, up to the 39th harmonic; discharge 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, with a waveform restriction
Class D (personal computers and their monitors, and TV receivers, with a specified power less than 600W): 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. No limits apply to:

- equipment with a rated power of 75W or less, other than lighting equipment;
- professional equipment with a total rated power > 1kW;
- symmetrically controlled heating elements with a rated power less than or equal to 200W;

† Although EN 61000-3 has the all-inclusive title of "Limits", it does not refer to radio frequency emission limits, which are the province of CISPR, but only to LF emissions.

- independent dimmers for incandescent lamps with a rated power less than or equal to 1kW;
- incandescent lamp luminaires with no electronic transformer or dimming device, which are deemed to fulfil the requirements without testing.

Section 3: 1995 + A1: 2001 + A2: 2005 Limitation of voltage changes, voltage fluctuations and flicker in public LV supply systems

Scope 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)

Tests Measurement of voltage fluctuations using a flickermeter as per IEC 61000-4-15 or by analytical methods, with the EUT supplied from a defined reference impedance (see section 8.1.4)

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})

A1: 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 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 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: 2005 Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16A and ≤75A per phase

This is the equivalent standard to IEC 61000-3-2 for higher-powered equipment than 16A per phase. It has three classes of harmonic current limits, corresponding to three "stages" of connection: Stage 1 allows connection with no need to contact the supply utility company; Stage 2 is based on availability of supply network and equipment data and requires the user to consult with the supply utility; Stage 3 does not apply limits but requires the user to seek supply utility acceptance for connection. It becomes mandatory under the EMCD in February 2008.

4.5.2 EN 61000-4-X

This section merely covers those parts of EN 61000-4 which are in widespread use for testing; many more parts are published (see Table 4.3 on page 68).

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.

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." A third edition is expected to be published in 2006.

Section 2: 1995 + A1: 1998 + A2: 2001 Electrostatic discharge

Equivalent IEC 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 horizontal and vertical coupling planes

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

Section 3: 2006 Radiated radio frequency field

Equivalent IEC 61000-4-3

Tests Radiated RF field generated by antennas in a shielded anechoic enclosure using the substitution method (pre-calibrated field), swept from 80MHz to 1000MHz with a step size not more than 1% of preceding frequency and dwell time sufficient to allow the EUT to respond, minimum 0.5 seconds. 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

Testing from 800 to 960MHz and 1.4 to 6GHz (though not necessarily the whole of this range) is included for protection against digital mobile phones.

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: 2004 Electrical fast transient burst

Equivalent IEC 61000-4-4

Tests Bursts of 5ns/50ns pulses at a repetition rate of 5kHz or 100kHz 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 + A1: 2001 Surge

Equivalent IEC 61000-4-5 (NB there was a second edition of this standard in 2005 but it had not been accepted in CENELEC by mid-2006)

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: 1996 + A1: 2001 Conducted disturbances induced by radio frequency fields

Equivalent IEC 61000-4-6 (NB there was a second edition of this standard in 2005 but it had not been accepted in CENELEC by mid-2006)

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 + A1: 2001 Power frequency magnetic field

Equivalent IEC 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 + A1: 2001 Pulse magnetic field

Equivalent IEC 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: 1993 + A1: 2001 Damped oscillatory magnetic field

Equivalent IEC 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: 2004 Voltage dips, short interruptions and voltage variations

Equivalent IEC 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%, 70% and 80% of the nominal voltage for a duration of 0.5 to 250 50Hz cycle periods

Short-term variations (optional test) to a level of 70% nominal voltage

Section 12: 1995 + A1: 2001 Oscillatory waves

Equivalent IEC 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

4.6 Product standards

A variety of standards (with the exceptions of ENs 55011, 55014-1 and 55022, discussed separately because they operate by default more like basic standards, see sections 4.3.1 to 4.3.3) 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 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) OJEU listing [185] 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. So far, the only concession has been for the IEC to make the scopes of its standards available for preview on its website.

Many of the product standards had dates of cessation of presumption of conformity of the superseded standard (usually the generic standard) in 2000 or 2001. Experience suggests that while a few forward-thinking manufacturers were testing their products to the newer product standards in advance, most were 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, by EN 61000-6-1 in 2004, and maybe by a new product standard after that, 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.

4.6.1 Broadcast receivers and associated equipment

Emissions: EN 55013: 2001 + A1: 2003

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
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; A1 adds methods for digital receivers
	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 EN55014-1. Radiated field limits for local oscillator and harmonics are 12–20dB higher than equivalent Class B emissions limits for other products

Immunity: EN 55020: 2002 + A1: 2003 + A2: 2005

Title	Sound and TV broadcast receivers and associated equipment – immunity characteristics – limits and methods of measurement
Related to	CISPR 20 (Not equivalent)
Scope	Broadcast sound and television receivers, including direct-to-home satellite 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 and VTRs 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; 900MHz 3V/m modulated by 217Hz keyed carrier, to EN 61000-4-3

Electrostatic discharge to EN 61000-4-2, 4kV contact, 8kV air

Electrical fast transient bursts to EN 61000-4-4, 1kV to the AC mains power input port

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

Amendment A1 covers broadcast receivers for digital signals; A2 covers objective evaluation of picture quality

4.6.2 Household appliances, electric tools and similar apparatus

Emissions: EN 55014-1

See 4.3.2 on page 76

Immunity: EN 55014-2: 1997 + A1: 2001

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

Amendment A1 expands requirements for toys, as well as making other changes

4.6.3 Lighting equipment

Emissions: EN 55015: 2000 + 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 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 + A1: 2000

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

4.6.4 Information technology equipment

Emissions: EN 55022: 1998

See 4.3.3 on page 77

Immunity: EN 55024: 1998 + A1: 2001 + A2: 2003

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

Equivalent 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.

4.6.5 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.

4.6.6 Equipment for measurement, control and laboratory use

Emissions and immunity: EN 61326-1: 2006

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

Equivalents IEC 61326-1

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. Particular requirements are found in sub-parts of Part 2 of the standard for equipment intended for use in specific applications, such as sensitive test and measurement equipment for EMC unprotected applications, e.g. oscilloscopes, logic analysers, etc., transducers with signal conditioning, or in-vitro diagnostic medical equipment

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 also on the particular requirements in Part 2.

4.6.7 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 + A2: 2003

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 extend to 2GHz and require an extra set of sweeps with 1Hz pulse modulation. For each test, fairly explicit performance criteria are provided.

4.6.8 Telecommunication network equipment

Emissions and immunity: EN 300386

Title Electromagnetic compatibility and radio spectrum matters (ERM); Telecommunication network equipment; Electromagnetic compatibility (EMC) requirements

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 and optical amplifiers. The definition of a telecommunications network excludes terminal equipment beyond the network termination points.

Tests Emissions: mains port and DC power port conducted RF 150kHz–30MHz, telecom port conducted RF 150kHz–30MHz, harmonics and flicker according to EN 61000-3-2, -3, radiated RF 30MHz–1000MHz

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.

Comment This standard illustrates perfectly the volatile nature of product standards. Version 1.3.1 is listed in the OJEU with a date of cessation of presumption of conformity of the superseded standard (Version 1.2.1) of 31st August 2005. In the same listing, version 1.3.2. is listed with exactly the same date of cessation; and version 1.3.3 is listed with a date of cessation of 31st January 2006.

4.6.9 Radio equipment

Emissions and immunity: EN 301489-1

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 (Chapter 3), the radio standards listed under the EMC Directive migrated to parts of EN 301489 where they were rewritten 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

4.6.10 Marine navigation equipment

Emissions and immunity: EN 60945: 2002

Title Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results

Related to IEC 60945

Scope Shipborne radio and navigational equipment forming part of the global maritime distress and safety system required by the International Convention for Safety of Life at Sea (SOLAS); for EMC only, all other bridge-mounted equipment, equipment in close proximity to receiving antennas, and equipment capable of interfering with safe navigation of the ship and with radiocommunications (i.e., most marine electronics)

Tests This standard specifies general performance requirements, of which EMC is only a part. It is harmonised under the EMCD for its EMC provisions. These are:

• RF emissions, conducted on the AC or DC supply port from 10kHz to 30MHz using a CISPR 16-1 LISN; radiated, from 150kHz to 30MHz using a magnetic field loop; radiated, 30MHz to 2GHz at 3m on a CISPR 16-1 compliant test site; the limits do not correspond to any other CISPR limits, and from 156 to 165MHz (the VHF marine band) the limits are much tighter than other CISPR limits. The standard also defines other aspects of the measurement methods

• immunity: conducted RF, 3V 150kHz–80MHz plus certain spot frequencies at 10V, to EN 61000-4-6; radiated RF, 10V/m 80MHz–2GHz to EN 61000-4-3; fast transient bursts to EN 61000-4-4, 1kV or 2kV; surges to EN 61000-4-5, 1kV/0.5kV on AC power lines only; power supply short-term variation and failure, to EN 61000-4-11; ESD at 6kV contact, 8kV air, to EN 61000-4-2

4.6.11 Medical electrical equipment

Emissions and immunity: EN 60 601-1-2 : 2001

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 all such equipment; requirements for particular classes of equipment are contained in the particular requirements of Part 2 of this standard, which is fundamentally a safety standard. NB it is not a harmonised standard for the EMC Directive, since EMC of medical electrical equipment is covered by the Medical Devices Directive and not the

EMC Directive; this standard is only harmonised for the MDD. Being a safety standard, it is considerably more comprehensive than, and has a different format to most EMC standards

Tests

RF emissions as per CISPR 11 (EN 55011) with some modifications, using the classifications of Group 1 or 2 and Class A or B

Mains harmonics and flicker to EN 61000-3-2 and -3

Immunity tests:
ESD: 6kV contact, 8kV air discharge to EN 61000-4-2
Radiated RF: 3V/m from 80MHz to 2.5GHz, except for life-support equipment and systems, tested at 10V/m; to EN 61000-4-3
Electrical fast transients: 1kV for signal and interconnecting cables, 2kV for AC and DC power lines, as per EN 61000-4-4
Surge: 1kV line to line, 2kV line to ground, at the mains port, as per EN 61000-4-5
Conducted RF: 3V rms from 150kHz to 80MHz as per EN 61000-4-6 in general; some equipment may enjoy a higher start frequency; life-support equipment should also be tested to 10V rms in the ISM frequency bands
Voltage dips and interruptions: as per EN 61000-4-11, to the AC power input
Power frequency magnetic field: 3A/m to EN 61000-4-8.

NB all the above immunity tests, whilst referring to the EN 61000-4 basic standards, are subject to extensive modifications and clarifications which must be carefully considered

4.6.12 Future multi-media

Before leaving this section, it is worth looking ahead to what is arguably the greatest change in CISPR-based standards for a decade or more. CISPR 32 and 35, for emissions and immunity respectively of multi-media equipment, are being created by CISPR/I as an amalgamation of, and replacements for, CISPRs 13, 20, 22 and 24. The development of consumer products which are a combination of information technology and entertainment technology – the "convergence" of functions previously seen as separate – has driven this move, but the committee's working groups have seized on it as an opportunity to inject a number of needed changes into the test regime that might otherwise have foundered through inertia.

The pair of standards are at the first draft stage for public comment at the time of writing of this book, but are likely to be published during its lifetime, hence their inclusion here. It is too early to be specific about their contents, but a number of features have emerged which are worth mentioning:

- They are based on the current best practice for EMC measurements rather than on the older standards. Hence anyone familiar with CISPR 13 and 20 in particular may not find all of the anachronistic tests described in those two documents in the new drafts.
- The radiated emissions tests allow alternative measurement methods – a classical OATS, a screened room meeting the NSA requirements, a fully anechoic room, or a reverberation chamber as per IEC 61000-4-21 – with

different limits as appropriate. In other words, the principle is of equivalent protection of the radio spectrum rather than strict equivalence of test methods and results. It is explicitly stated in both drafts that if different methods give different results (as they might), any method which results in compliance is acceptable.

- The drafts are structured more like the generic standards, that is a relatively short main body with tables on a port-by-port basis giving the requirements, and normative annexes describing the test methods in detail; this makes the documents easier to use.
- For the immunity tests, particular performance criteria are to be determined, and are given in normative annexes on a function-oriented rather than equipment-oriented basis.
- Tolerances are given for relevant measurement parameters: a small point perhaps, but important for establishing measurement uncertainty.

4.6.13 Other product standards

The following list details other product EMC standards not covered above which have been harmonised in the OJEU at the time of writing.

Standard	Product sector	Comment
EN 50065-1, -2	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 50148	Electronic taximeters	
EN 50240	Resistance welding equipment	
EN 50263	Measuring relays and protection equipment	
EN 50270	Gas detection and measurement equipment	
EN 50293	Road traffic signal systems	
EN 50295	LV switchgear and control gear	
EN 50370-1, -2	Machine tools	
EN 55012	Vehicles, boats and internal combustion engine devices	
EN 60034-1	Rotating electrical machines	
EN 60204-31	Sewing machines, units and systems	
EN 60439-1	Low-voltage switchgear and control gear assemblies	
EN 60669-2-X	Switches for household etc. fixed electrical installations	Various parts
EN 60730-X	Automatic electrical controls for household etc. use	Various parts
EN 60870-2-1	Telecontrol equipment and systems	
EN 60947-X	Low-voltage switchgear and control gear	Various parts

Standard	Product sector	Comment
EN 60974-10	Arc welding equipment	
EN 61008-1	Residual current operated circuit breakers (RCCBs)	
EN 61009-1	Residual current operated circuit breakers (RCBOs)	
EN 61037	Electricity metering – electronic ripple control receivers	Replaced by EN 62052, EN 62054
EN 61038	Electricity metering – time switches	
EN 61131-2	Programmable controllers	
EN 61204-3	Low voltage DC power supplies	
EN 61543	Residual current-operated protective devices (RCDs)	
EN 61800-3	Adjustable speed electrical power drive systems	
EN 61812-1	Specified time relays for industrial use	
EN 62052, 53, 54	Electricity metering equipment	
EN 617 – 620	Continuous handling equipment and systems	CEN
EN 12015, 12016	Lifts, escalators and passenger conveyors	
EN 12895	Industrial trucks	
EN 13241-1	Garage doors and gates	
EN 13309	Construction machinery	
EN 14010	Equipment for power driven parking of motor vehicles	
EN ISO 14982	Agricultural and forestry machines	

4.7 Other standards not related to the EMC Directive

4.7.1 FCC Rules

In the USA, 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 applies to unintentional and intentional radiators.

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.

4.7.1.1 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 USA, 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. Under the EU/US Mutual Recognition Agreement, European laboratories are 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.

4.7.1.2 Test requirements

Limits apply to conducted interference on the mains lead between 150kHz and 30MHz, and radiated interference measured either at 10m or 3m from 30MHz to 960MHz and above. The limits were similar but not identical to those laid down in CISPR-derived standards, and the conducted limits have now been aligned with CISPR 22; but the test procedures of ANSI C63.4 [206] 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 4.4. 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 4.4 Maximum measurement frequency for digital devices, FCC Rules Part 15

† In early 2006 the FCC fined a German company $1m for non-compliance with the Rules, despite the company's claim that its products were "CE-compliant". The FCC says that "such testing neither is the equivalent of nor demonstrates compliance with the Commission's technical standards".

4.7.2 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-X Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus (see section 6.1)

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

CISPR 16-3-X 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.)

CISPR 16-4-X Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC measurements

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 8.1.1)

IEC 61000-4-15 Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications (see section 8.1.4)

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

4.8 RF emissions limits

Most of the standards within the EN 550XX series have harmonised limit levels for conducted and radiated emissions. Since they derive from CISPR, 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.

Figure 4.4 and Figure 4.5 show the limits in graphical form for the emissions standards discussed above. FCC levels are now the same as the CISPR levels. 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 61000-6-4, and EN Class B refers to EN 55011, EN 55022 Class B, EN 55013, EN 55014-1, and EN 61000-6-3. All values are measured with the CISPR 16-1-1 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.

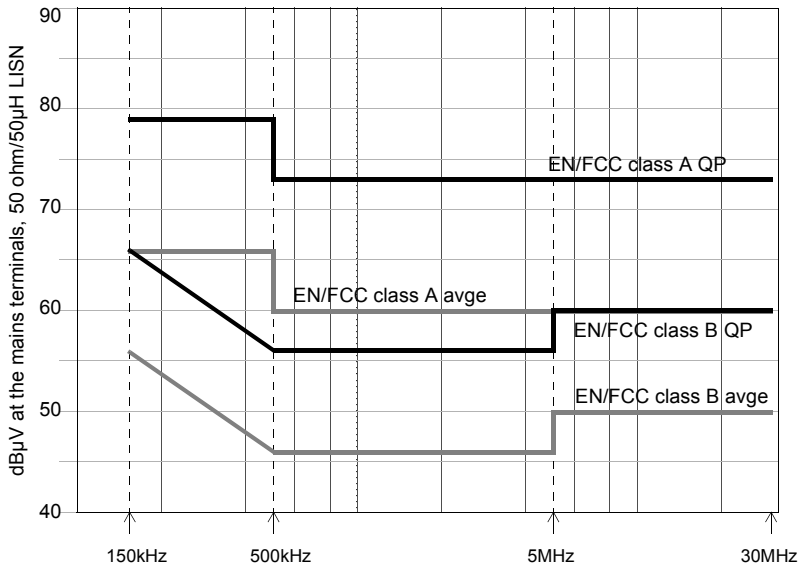

Figure 4.4 Conducted emission limits
(QP = quasi-peak, avge = average)

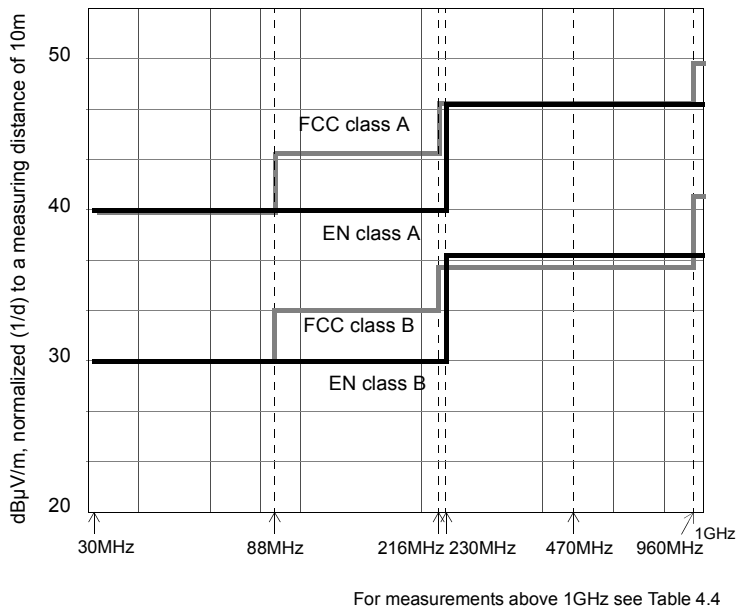

Figure 4.5 Radiated emission limits