Chapter 4

Commercial standards

4.1 The standards making bodies

The structure of the international bodies which are responsible for defining EMC standards for commercial purposes and for use in EU Directives 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). It is composed of National Committees which are expected to be fully

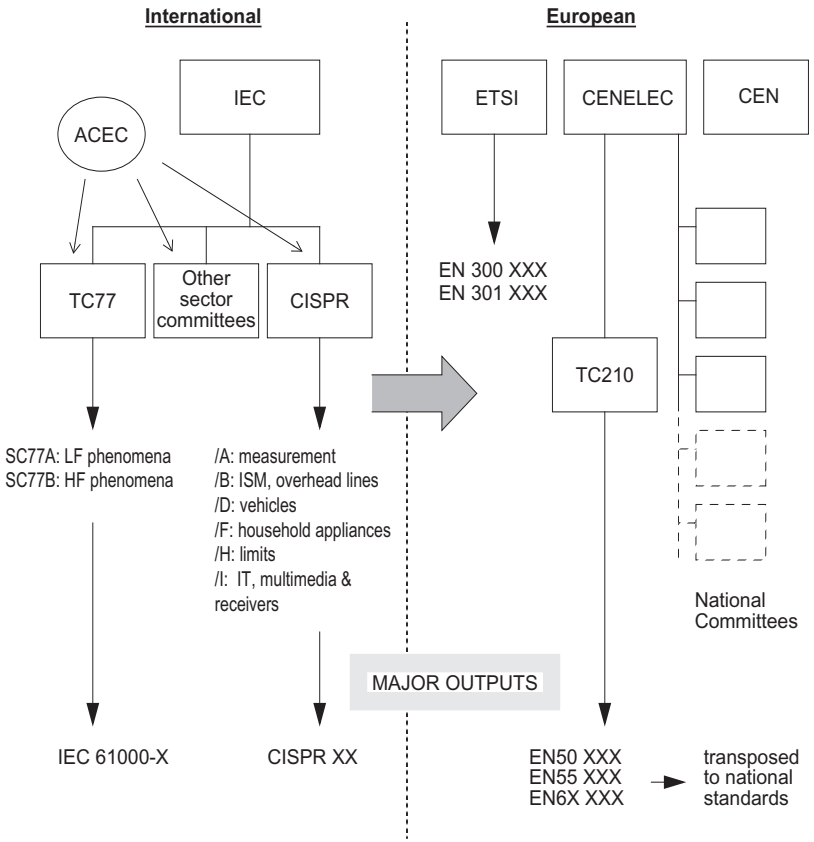

Figure 4.1 EMC standards structure

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"[92].

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 of themselves have *no legal standing* with regard to EU Directives. They are, legally speaking, entirely voluntary. 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. And many countries other than the EU will transpose the IEC documents into their own system and then refer to these for mandatory compliance.

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" [105]; 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

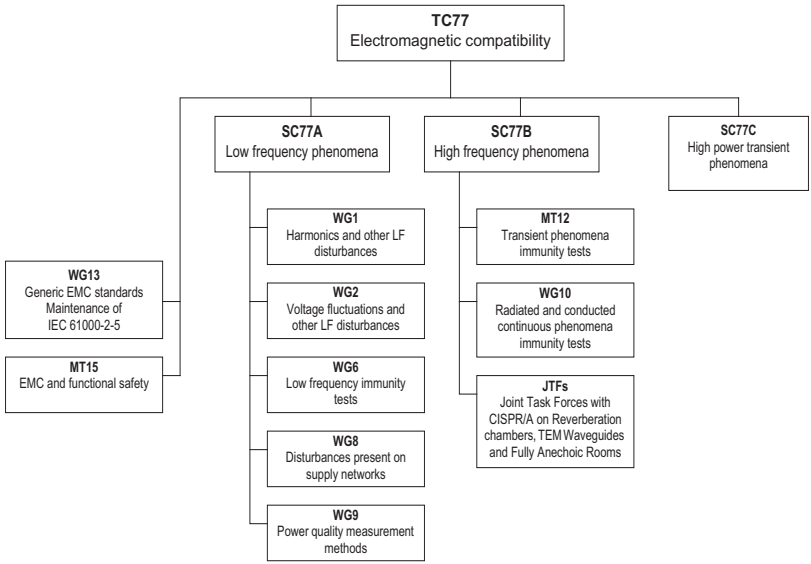

Figure 4.2 Structure of IEC TC77

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. 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 shortly 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, anomalous instances exist: CISPR 20 for broadcast receivers and associated apparatus, CISPR 24 for information technology equipment and CISPR 35, yet to be published, which combines the two. A guidance document is available [190] for free download to help in the selection of the appropriate standard.

Table 4.2 Structure of CISPR

Committee	Title/Scope	Main publications
CISPR/A	Radio interference measurements and statistical methods	CISPR 16, CISPR 17, IEC 61000-4-22
CISPR/B	Industrial, Scientific and Medical radio-frequency apparatus; Overhead power lines, high-voltage equipment and electric traction systems	CISPR 11, CISPR 18, CISPR 28
CISPR/D	Electrical/electronic equipment on vehicles and internal combustion engine powered devices	CISPR 12, 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, generic emission standards	CISPR/TR 31, CISPR/TR 16-4-4, IEC 61000-6-3, -6-4
CISPR/I	Information technology, multimedia equipment and receivers	CISPR 13, CISPR 20, CISPR 22, CISPR 24, CISPR 32; future 35

4.1.1.3 The IEV

One further important document is Chapter 161 of IEC Publication 60050 [169], 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 early 2016)

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 systems including 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
	6	Guide to the assessment of measurement uncertainty
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	Description and classification of electromagnetic environments

Table 4.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in early 2016)

Part	Section	Title
	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
	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	
	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 the connection of distorting installations to MV, HV and EHV power systems
	7	Assessment of emission limits for the connection of fluctuating installations to MV, HV and EHV 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
	14	Assessment of emission limits for harmonics, interharmonics, voltage fluctuations and unbalance for the connection of disturbing installations to LV power systems
	15	Assessment of low frequency electromagnetic immunity and emission requirements for dispersed generation systems 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

Table 4.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in early 2016)

Part	Section	Title
	10	Damped oscillatory magnetic field immunity test
	11	Voltage dips, short interruptions and voltage variations immunity test
	12	Ring wave immunity test
	13	Harmonics and interharmonics including mains signalling at AC power port, low frequency immunity tests
	14	Voltage fluctuation immunity test for equipment with input current not exceeding 16A per phase
	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	Damped oscillatory wave immunity test
	19	Test for immunity to conducted, differential mode disturbances and signalling in the frequency range 2kHz to 150kHz at AC power ports
	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 for equipment with input current not exceeding 16A per phase
	28	Variation of power frequency immunity test for equipment with input current not exceeding 16A per phase
	29	Voltage dips, short interruptions and voltage variations on DC input power port immunity tests
	30	Power quality measurement methods
	31	AC mains ports broadband conducted disturbance immunity test
	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 mains current more than 16 A per phase
	35	HPEM Simulator Compendium
	36	IEMI immunity test methods for equipment and systems
	37	Calibration and verification protocol for harmonic emission compliance test systems
	38	Test, verification and calibration protocol for voltage fluctuation and flicker compliance test systems
	39	Radiated fields in close proximity – immunity test
	40	Digital methods for the measurement of power quantities under non stationary conditions
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
	10	Guide to the Application of HEMP and IEMI Publications
6	Generic standards	
	1	Immunity for residential, commercial and light-industrial environments

Table 4.3 Published and planned parts of IEC 61000 (Continued)
(Shaded sections were not yet published in early 2016)

Part	Section	Title
	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 equipment used in power station and substation environments
	6	HEMP immunity for indoor equipment
	7	Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations

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 European Commission to produce EMC standards for use with the 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.

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 33 National Committees [43][147]. Of these member committees France, UK, Germany and Italy have 10 votes, Spain has 8 votes and smaller countries have 1 or 2 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 associations.

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 2.4.5.4). 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 and generic standards

In the early days of European standardisation there were few standards available, and these covered only a limited variety of types of product. To plug the gaps, a set of generic standards were developed by CENELEC (EN 50081-1,2 and EN 50082-1,2) and these very much set the framework for subsequent EMC standards development. So much so, in fact, that they were passed over to the IEC and re-published as components of the IEC 61000-6 series, where they have remained ever since.

But as mentioned in section 2.4.5, 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* [197]. 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 (now the Radio Equipment Directive) in the OJEU includes more than 30 EMC standards in the EN 301489 series for radio equipment. These began to appear 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 coordination 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 same as the date of withdrawal (DOW) of the old standard, 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.

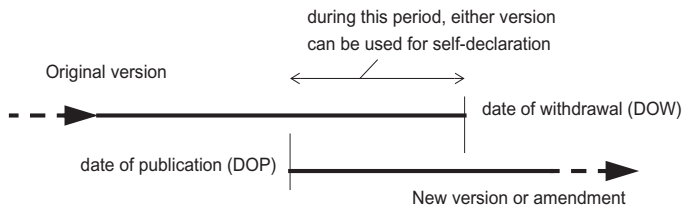

Figure 4.3 Applying changes in standards

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 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 [138][139], but they have now been largely superseded by a whole raft of new product standards. Nevertheless, many such new product standards have looked to the generics for their basic approach. The generic standards listed below all claim to represent essential EMC emissions or immunity requirements.

4.2.1 EN 61000-6-3: 2007 + A1: 2011

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 method of CISPR 16-2-3, Class B limits, in OATS or SAC; for apparatus containing processing devices operating above 9kHz, test only up to 230MHz; small battery powered equipment without cables may alternatively be tested in a TEM cell according to IEC 61000-4-20; some table top equipment may alternatively be tested in a FAR

Enclosure: radiated emissions from 1 to 6GHz as per method of CISPR 16-2-3, Class B limits, in OATS, SAC or FAR; top frequency of test conditional on highest internal frequency (see section 4.8.1)

AC mains port: conducted emissions from 150kHz to 30MHz as per CISPR 16-2-1, 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 or -12, mains flicker measured as per EN 61000-3-3 or -11

DC power ports, intended for connection to a local DC network, or a battery via a cable longer than 30m: conducted emissions from 150kHz to 30MHz as per CISPR 16-2-1, Class A

Telecommunications/network ports: conducted voltage or current from 150kHz to 30MHz using ISN or current probe, according to EN 55022 Class B

4.2.2 EN 61000-6-4: 2007 + A1: 2011

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 method of CISPR 16-2-3, Class A limits, in OATS or SAC at 10m; for apparatus containing processing devices operating above 9kHz, test only up to 230MHz; small battery powered equipment without cables may alternatively be tested in a TEM cell according to IEC 61000-4-20; some table top equipment may alternatively be tested in a FAR

Enclosure: radiated emissions from 1 to 6GHz as per method of CISPR 16-2-3, Class A limits, in OATS, SAC or FAR; top frequency of test conditional on highest internal frequency (see section 4.8.1)

AC mains port: conducted emissions from 150kHz to 30MHz as per CISPR 16-2-1 Class A; impulse noise appearing more often than five times per minute is also covered.

Telecommunications/network ports: conducted voltage or current from 150kHz to 30MHz using ISN or current probe, according to EN 55022 Class A

4.3 Main product standards – emissions

There is a particular significance to ENs 55011, 55014-1 and 55022: as well as being product (or "product family") standards in themselves, they also specify RF emissions test methods and limits that have been applied very much more widely.

4.3.1 EN 55011: 2009 + A1: 2010

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

Equivalents CISPR 11 fifth edition (modified)

Scope Equipment designed to generate and/or use locally RF energy for industrial, scientific, medical (ISM), domestic or similar purposes; excluding applications in telecomms and IT, or covered by other CISPR publications

Class A equipment is for use in all establishments other than domestic and may be measured on a test site or *in situ*; Class B equipment is suitable for use in domestic establishments and may only be measured on a test site

Group 1 equipment is everything in the scope of the standard which is not Group 2; Group 2 equipment is that in which RF energy is intentionally generated and/or used for material inspection, analysis or treatment

Comment The scope of EN 55011/CISPR 11 has been the subject of some confusion, particularly the distinction between Group 2 equipment (which is allowed higher limits) and Group 1. The fifth edition was noticeably revised to try and clear up the confusion. The limits structure was changed to allow more relaxation for high power equipment, and introduce an allowance for a 3m measuring distance for small equipment. Unfortunately there are some product standards which make reference to EN 55011 for emissions requirements without any guidance or comment on which classification to select

Tests Mains terminal disturbance voltage from 150kHz to 30MHz measured on a test site using 50Ω/50μH CISPR artificial mains network or a voltage probe if the AMN cannot be used; Group 1 Class A has standard limits for rated input power ≤ 20kVA, relaxed limits at the lower frequencies for > 20kVA with conditions; Group 1 Class B, no power distinction, standard Class B limits; Group 2 Class A equipment, higher than Class A limits for rated input power ≤ 75kVA, even more relaxed limits for > 75kVA; Group 2 Class B, no power distinction, standard Class B limits

Radiated emissions from 30 to 1000MHz on a test site; Group 1 Class A has standard limits for rated input power ≤ 20kVA, relaxed limits for > 20kVA; Group 1 Class B, no power distinction, standard Class B limits; Group 2 Class A equipment to be measured from 0.15 to 1000MHz but with relaxed limits; Group 2 Class B equipment to be measured from 0.15 to 1000MHz with spot frequency relaxations, average limits for magnetron equipment; below 30MHz measurement performed with loop antenna; radiated measurements are allowed at a reduced distance of 3m but only for equipment which, including cables, fits in a cylindrical test volume of 1.2m diameter and 1.5m above the ground plane

Specific limits for magnetic field strength from induction cooking appliances from 0.15 to 30MHz (but these have now been extracted to EN 55014-1), relaxed limits for spark erosion and arc welding equipment up to 230MHz, and limits for emissions between 1 and 18GHz from Group 2 equipment operating above 400MHz; separate radiated limits 0.15–1000MHz for Class A equipment measured *in situ*, no conducted measurements required

4.3.2 EN 55014-1: 2006 + A1: 2009 + A2: 2011

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

Equivalents CISPR 14-1 fifth edition

Scope Appliances whose main functions are performed by motors and switching or regulating devices. Amendment A2 added induction cooking appliances

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, class B limits; less stringent limits for electric tools and the load terminals of regulating controls. Discontinuous interference (clicks, which have a complex time-domain definition) must also be measured at spot frequencies for appliances which generate such interference through switching operations

Either: Disturbance power test from 30 to 300MHz on mains lead, quasi-peak and average detection, measured by means of the absorbing clamp; if there is no clock frequency† above 30MHz, and the emissions are lower than the original limits less an increasing margin above 200MHz, then no further testing is needed;

Or: Radiated test 30 to 1000MHz, method as per CISPR 16-2-3 on OATS, SAC or FAR, standard radiated class B limits. TEM cell measurement to IEC 61000-4-20 also allowed for battery powered appliances without cables. If the disturbance power test has been done successfully to the original limits but compliance with the margin isn't achieved, then radiated measurements from 300MHz to 1GHz must be done

All battery operated appliances except those not containing active electronics or motors must submit to the radiated test

Regulating controls incorporating semiconductor devices, electric fence energizers, rectifiers, battery chargers and convertors with no frequency higher than 9kHz are excluded

Comment For many years this standard was regarded as inadequate because, almost alone out of the CISPR canon, it had no radiated testing and no testing above 300MHz. Amendment A1: 2009 finally rectified this with the results as shown above. It's evident that the industry fought tooth and nail to avoid having to do more than they were used to, and the eventual compromise which allows them to carry on with the old disturbance power test (as long as there is a margin to the limit from 200 to 300MHz, varying from 0 to 10dB) is a classic standards fudge. The assumption seems to be that if there's a margin in this frequency range and there are no high frequency clocks, then there's no need to worry about emissions above 300MHz.

4.3.3 EN 55022: 2010

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

Equivalents CISPR 22 sixth edition (modified)

† Defined as "the fundamental frequency of any signal used in the device excluding those which are solely used inside integrated circuits" (see page 105).

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 B equipment is intended primarily for use in the domestic environment; Class A equipment is that which doesn't satisfy the Class B limits and requires a warning notice in the user instructions. Note that there is no explicit prohibition in this standard *against* using Class A equipment in the domestic environment.

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 30 to 1000MHz measured at 10m (preferred) or 3m (alternative) on an open area or alternative test site. Tests from 1 to 6GHz with peak and average limits at 3m are required according to the conditional testing procedure described in section 4.8.1.

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 "for direct connection to multi-user telecommunications networks (e.g. PSTN, ISDN, xDSL etc.), local area networks (e.g. Ethernet, Token Ring) and similar networks". Various measurement methods are defined for different types of cable connections – see section 7.2.2.5

Comment EN 55022 and CISPR 22 have suffered considerable disarray over their later life. For various reasons, at one time in the European regime any edition from the second through to the fifth could be used for compliance declarations, in defiance of the tidy concept of an orderly transition from one revision to the next. Since the end of 2013, the sixth edition seems to have sorted this out. But this standard itself is set to be superseded in March 2017 by EN 55032/CISPR 32. Nevertheless, it will still be referenced by many product standards, and it seems like the end of the line for CISPR 22 is a long way off yet.

4.3.4 EN 55032: 2015

Title Electromagnetic compatibility of multimedia equipment – Emission requirements

Equivalents CISPR 32 second edition

Scope Multimedia equipment, including that primarily for professional use, defined as ITE, audio or video equipment, broadcast receivers, entertainment lighting control equipment or combinations thereof, with a supply voltage not exceeding 600V. Equipment that has historically been within the scopes of CISPR 13 or 22 is now explicitly within this scope, so this standard takes over from them

Tests

An amalgamation and revision of those that were specified in CISPR 13 and 22, so Class A or B limits apply as appropriate: but note that, in contrast to CISPR 22, this standard states that "equipment intended primarily for use in a residential environment shall meet the Class B limits. All other equipment shall comply with the Class A limits".

Conducted emissions on the mains port, quasi-peak and average detection from 150kHz to 30MHz measured using 50Ω/50µH CISPR artificial mains network, method according to the standard's Annex C and CISPR 16-2-1

Common mode (asymmetric mode) conducted emissions on wired network ports, optical fibre ports with metallic shield or tension members, and antenna ports, also broadcast receiver tuner ports (Class B only): 150kHz to 30MHz measured using an asymmetrical artificial network (AAN or ISN), or current probe, or combination of current probe and capacitive voltage probe: method according to the standard's Annex C and CISPR 16-2-1, see discussion in section 7.2.2.5

Differential mode voltage emissions on broadcast receiver tuner ports and RF modulator output ports from 30 to 2150MHz

Radiated emissions from 30MHz to 1GHz on a SAC, OATS or FAR test site; from 1 to 6GHz on a free space OATS according to the conditional measurement procedure described in section 4.8.1; whatever test site is chosen must be validated against the relevant requirement in CISPR 16-1-4; method according to CISPR 16-3-2, in each case there are certain limitations, particularly on the test volume

Local oscillator emissions from FM receivers and outdoor units of home satellite receiving systems have their own radiated emissions requirements

Comment

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 the development of this standard, 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.

A number of features have emerged which are worth mentioning:

- It is based on the current best practice for EMC measurements rather than on the older standards. Hence anyone familiar with CISPR 13 in particular may not find all of the anachronistic tests described in that document, and there is extensive reference to the many parts of CISPR 16.
- Some tests allow alternative measurement methods 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. If a re-measurement is needed to prove compliance, the measurement method originally chosen is to be used in order to achieve consistency.

- The structure is more like the generic standards, that is a relatively short main body with the more general requirements; this is followed by Annex A giving tables on a port-by-port basis with the limits and their conditions, and other normative or informative annexes describing the test methods in detail; this perhaps makes the document easier to use, but it is still a very complex piece of work and needs careful study.
- Tolerances are given for relevant measurement parameters: a small point perhaps, but important for establishing measurement uncertainty.

4.4 Generic standards – immunity

4.4.1 EN 61000-6-1: 2007

Title Generic standards Part 6-1: Immunity for residential, commercial and light industry environments

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 IEC 61000-4-2, at 8kV (air discharge) or 4kV (contact discharge)

Radiated RF field from 80 to 1000MHz as per IEC 61000-4-3, at 3V/m; 1.4–2GHz, 3V/m, and 2.0–2.7GHz, 1V/m; TEM cell testing as per IEC 61000-4-20 may also be used for small EUTs only

Electrical fast transients 5/50ns common mode as per IEC 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 IEC 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 IEC 61000-4-6

Power frequency magnetic field, as per IEC 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 IEC 61000-4-11: half cycle and one cycle to zero, criterion B; half second to 70%, five seconds to zero, criterion C

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 standards Part 6-2: Immunity for industrial environments

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 80 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 1 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: 2014 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 9.1.1)

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 incandescent lamp 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

† 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.

Class D (personal computers and their monitors, TV receivers, and refrigerators and freezers with variable-speed drives to control compressors, with a specified power less than 600W): limits expressed in mA per watt for odd harmonics only, up to the 39th harmonic

Average values of harmonics over the observation period must comply with the limits; individual 1.5 second measurements are allowed a relaxation of 1.5 times or 2 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 greater than 1kW;
- symmetrically controlled heating elements with a rated power less than or equal to 200W;
- 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.

Irrespective of the above exemptions, there are specific restrictions on the use of asymmetrical control and half-wave rectification. A simplified test method is allowed for equipment which undergoes minor changes or updates as long as it has previously shown a margin to the limits in full compliance tests

Section 3: 2013 Limitation of voltage changes, voltage fluctuations and flicker in public LV supply systems, for equipment with rated current ≤16A per phase and not subject to conditional connection

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 220–250V)

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 9.1.4)

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}). Some of the voltage change limits apply to the voltage fluctuation at the moment of switch-on, i.e. the standard places a limit on allowable inrush current. However, para 6.1 of the standard says that "for voltage changes caused by manual switching, equipment is deemed to comply without further testing if the maximum rms input current (including inrush current) evaluated over each 10ms half-period between zero-crossings does not exceed 20A, and the supply current after inrush is within a variation band of 1.5A". Also, "tests need not be made on equipment which is unlikely to produce significant voltage fluctuations or flicker".

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: 2011 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. See section 9.1.3.3 for a description.

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 76).

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: 2007 Overview of IEC 61000-4 series

Not a test standard itself, its intention is to give "applicability assistance to the technical committees of IEC or other bodies, users and manufacturers of electrical and electronic equipment on EMC standards within the IEC 61000-4 series, and to provide general recommendations concerning the choice of relevant tests".

Section 2: 2009 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 2 to 15kV (8kV contact discharge) depending on installation and environmental conditions

Section 3: 2006 + A1: 2008 + A2: 2010 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 80 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 amplitude modulated to 80% with a 1kHz sinewave

Section 4: 2012 Electrical fast transient burst

Equivalent IEC 61000-4-4

Tests Bursts of 5ns/50ns pulses at a repetition rate of 5 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: 2014 Surge

Equivalent IEC 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. A separate Annex describes surge testing on unshielded outdoor communication lines with the 10/700 waveform. The third edition also has several new informative Annexes

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: 2014 Conducted disturbances induced by radio frequency fields

Equivalent IEC 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 80 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: 2010 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: 2006 Ring wave

Equivalent	IEC 61000-4-12
Tests	100kHz ring wave decaying at 60% per peak, initial voltage rise time 0.5μs, applied at a rate of 1 to 60 transients per minute from a generator with output impedance of 12 or 30Ω via a coupling-decoupling network in common or differential mode to power supply, signal and control ports
Levels	0.5, 1, 2 and 4kV 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. The main part of this section mentions a few documents which have some characteristics not found in other areas. The rest of the standards which have been harmonized for the EMCD at the time of writing are listed 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. (Not quite true: the CISPR Guide [190], freely available, describes the scopes of the CISPR-based standards; and the New Approach website www.newapproach.org lists available standards, but with no more detail than you would find out from the title in the OJ list.) 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 (often 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. The only concession has been for the IEC to make the scopes of its standards available for preview on its website, and some of the CENELEC suppliers have followed suit.

Many of the product standards have been updated or superseded in the last ten years. 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 still – perhaps unsurprisingly,

considering the cost and complexity of proper diligence in keeping up with the standards regime – possible 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 (*cf* section 2.2.7.3).

A fourth possibility is that pigs might fly.

4.6.1 Telecommunication network equipment

Emissions and immunity: EN 300 386 V 1.6.1

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

Scope Equipment intended to be used within a public 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 61000-3-2/12 and -3/11, radiated RF 30MHz–1GHz and 1–6GHz with EN 55022 conditional testing procedure

Immunity: electrostatic discharge, radiated RF, conducted RF, voltage interruptions, electrical fast transient bursts, surge. The 10/700µs surge applies 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 1.4.1 is listed in the OJEU with a date of cessation of presumption of conformity of the superseded standard (Version 1.3.3) of 31st July 2011. In the same listing, version 1.5.1. is listed with a date of cessation of 31st January 2014; and version 1.6.1. is listed with 30th November 2015. At least in this case, all versions are easily available without payment.

4.6.2 Radio equipment

Emissions and immunity: EN 301 489-1 V1.9.2

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. Spectrum management and safety issues are not covered. A normative annex B gives requirements for aftermarket automotive subassemblies in respect of the Automotive EMC Directive 2004/104/EC. Normative annex C gives instructions for how to assess equipment which includes radio and non-radio functions in the context of the R&TTE Directive (now the Radio Equipment Directive, section 2.3) – crucial now that virtually every IT product, for instance, has Wi-Fi, Bluetooth etc. connectivity. Part 1 gives common technical requirements, while other parts give information relating to particular product types.

Tests RF conducted and radiated emissions as per EN 55022, including modified application to DC power input/output ports; harmonics and flicker according to EN 61000-3-2/12 and -3/11

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

4.6.3 Medical electrical equipment

Emissions and immunity: EN 60 601-1-2 : 2015

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

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

This collateral standard defines the general EMC requirements and tests for all such equipment; requirements for particular classes of equipment are contained in Part 2 of the main document, 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; particularly, it incorporates guidance on EMC risk management principles (see Chapter 6)

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 to EN 61000-4-2
Radiated RF to EN 61000-4-3
Electrical fast transients: as per EN 61000-4-4
Surge: as per EN 61000-4-5
Conducted RF: as per EN 61000-4-6 in general
Voltage dips and interruptions: as per EN 61000-4-11, to the AC power input
Power frequency magnetic field: to EN 61000-4-8

A new test for immunity to proximity fields from RF wireless communications equipment is included

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. Test levels are categorized according to locations of intended use, being the professional healthcare facility, the home healthcare environment, and special environments

4.6.4 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, 1 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

4.6.5 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. While this looks pretty comprehensive, you are advised to consult the current version of the OJEU list (easily accessible via the web) for more up-to-date detail including version dates.

Standard	Product sector	Comment
CENELEC		
EN 50065-1, -2	Mains signalling equipment	
EN 50083-2	Cable sound and TV distribution network equipment	
EN 50121-X	Railway applications	See also 5.4.3
EN 50130-4	Fire, intruder, social etc. alarm systems – immunity	
EN 50148	Electronic taximeters	
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 50412-2-1	PLC apparatus and systems – immunity	
EN 50428	Switches for household installations	
EN 50470	AC electricity metering equipment	
EN 50490	Aeronautical ground lighting control and monitoring	
EN 50491-5	Home and Building Electronic Systems	
EN 50498	Aftermarket electronic equipment in vehicles	
EN 50512	Aerodrome advanced visual docking guidance systems	
EN 50529	Wire-line telecommunications networks	Various parts

Standard	Product sector	Comment
EN 50550	Power frequency overvoltage protective device	
EN 50557	Automatic reclosing devices for circuit breakers	
EN 50561-1	PLC apparatus – emissions	
CISPR (except 55103)		
EN 55012	Vehicles, boats and internal combustion engine devices	
EN 55013	Broadcast receivers and associated equipment – emissions	*
EN 55014-2	Household appliances – immunity	
EN 55015	Lighting equipment – emissions	
EN 55020	Broadcast receivers and associated equipment – immunity	#
EN 55024	Information technology equipment – immunity	#
EN 55103-1	Professional AV and entertainment lighting – emissions	*
EN 55103-2	Professional AV and entertainment lighting – immunity	#
Note: # – to be superseded by future EN 55035 * – superseded by EN 55032		
IEC		
EN 60034-1	Rotating electrical machines	
EN 60204-31	Sewing machines, units and systems	
EN 60255-26	Measuring relays and protection equipment	
EN 60439-1	Low-voltage switchgear and control gear assemblies	
EN 60669-2-1	Switches for household etc. fixed electrical installations	
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
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 61131-2	Programmable controllers	
EN 61204-3	Low voltage DC power supplies	
EN 61326	Measurement, control and laboratory equipment	Various parts
EN 61439	LV switchgear and controlgear assemblies	Various parts
EN 61543	Residual current-operated protective devices (RCDs)	
EN 61547	Lighting equipment – immunity	
EN 61557-12	LV distribution systems – monitoring of protective measures	
EN 61800-3	Adjustable speed electrical power drive systems	

Standard	Product sector	Comment
EN 61812-1	Time relays for industrial use	
EN 62020	Residual current monitors (RCMs)	
EN 62026	LV switchgear and controlgear – controller-device interfaces	Various parts
EN 62040-2	Uninterruptible power systems	
EN 62052, 53, 54	Electricity metering equipment	Various parts
EN 62135-2	Resistance welding equipment	
EN 62310-2	Static transfer systems	
EN 62423	Residual current operated circuit breakers	
EN 62586	Power quality measurement instruments	
EN 62606	Arc fault detection devices	
CEN		
EN 617 – 620	Continuous handling equipment and systems	
EN 1155	Electrically powered hold-open devices for swing doors	
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	
EN 16361	Power operated pedestrian doors	

4.7 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 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 7.1)

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 9.1.1)

IEC 61000-4-15 Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 15: Flickermeter – Functional and design specifications (see section 9.1.4)

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

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 most general Class A and B applications discussed above (see section 3.2 on page 65 for a discussion of FCC). 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 55014-1, and

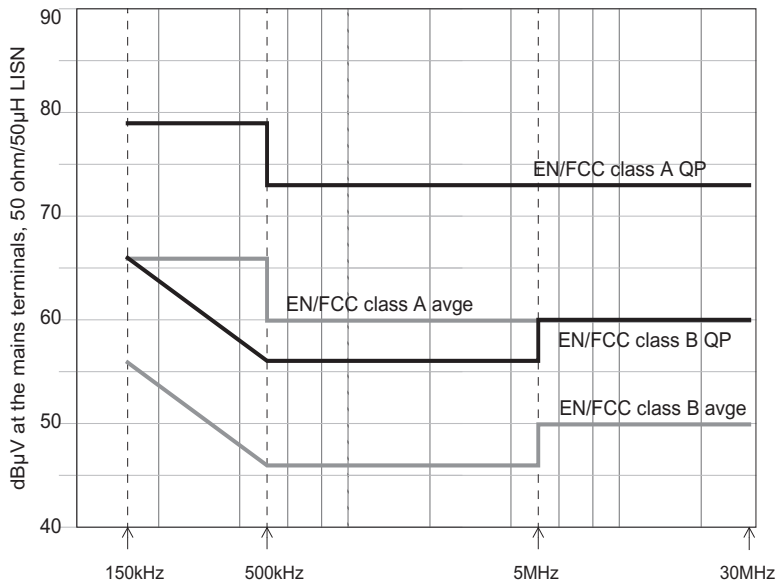

Figure 4.4 Conducted emission limits
(QP = quasi-peak, avge = average)

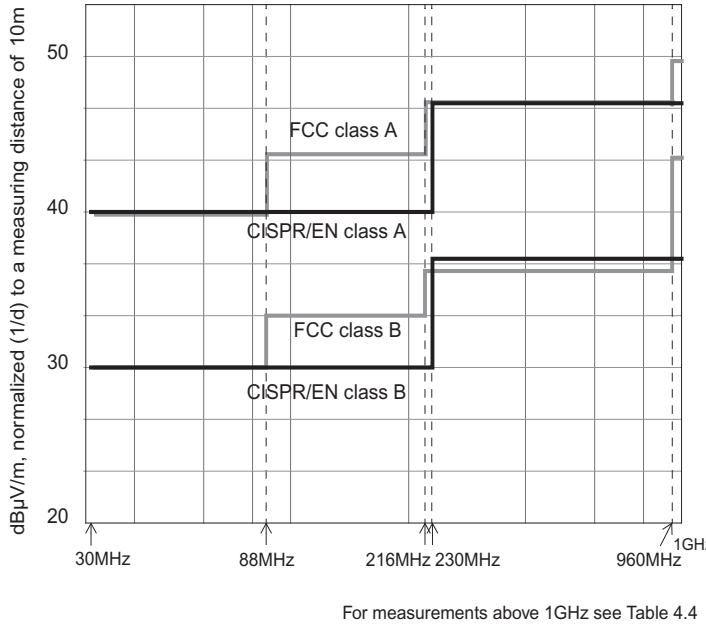

Figure 4.5 Radiated emission limits

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 for Class A and 10dB for Class B below the quasi-peak limits.

4.8.1 Limits above 1GHz

Above 1GHz, limit values are as shown in Table 4.4 with peak and average detectors at 3m.

Table 4.4 Limits above 1GHz

Frequency GHz	Class A		Class B	
	Average dBµV/m	Peak dBµV/m	Average dBµV/m	Peak dBµV/m
1–3	56	76	50	70
3–6	60	80	54	74
FCC 1–40	60	80	54	74

The method in CISPR 22 and its replacement CISPR 32 is based on the approach of conditional testing depending on the highest frequency generated or used within the EUT or on which the EUT operates or tunes [184]:

> If the highest frequency of the internal sources of the EUT is less than 108 MHz, the measurement shall only be made up to 1 GHz.

> If the highest frequency of the internal sources of the EUT is between 108 MHz and 500 MHz, the measurement shall only be made up to 2 GHz.
>
> If the highest frequency of the internal sources of the EUT is between 500 MHz and 1 GHz, the measurement shall only be made up to 5 GHz.
>
> If the highest frequency of the internal sources of the EUT is above 1 GHz, the measurement shall be made up to 5 times the highest frequency or 6 GHz, whichever is less.

This almost aligns with the FCC requirements for unintentional radiators in Part 15.33 of the FCC rules (section 3.2). The US requirement carries on going above 6GHz to the 5th harmonic of the highest frequency or 40GHz, whichever is the lower, and also allows for tests only up to 30MHz if the highest internal frequency is below 1.705MHz.

The actual definition of "highest internal frequency" has been vague for some time, the question being whether it refers in particular only to actual clock (or other) oscillators, or to frequencies developed by such clocks but multiplied up within an IC – now a common practice in FPGAs and processors. CISPR 32 now explicitly states in its definitions that this "includes frequencies which are solely used within an integrated circuit". So that's clear then? Well, unfortunately not quite: for CISPR 14-1's purposes, "clock frequency" (which determines the application of the radiated emissions test) is defined as "the fundamental frequency of any signal used in the device *excluding those which are solely used inside integrated circuits*" (italics added). The lesson being: under no circumstances should you assume consistency between standards.