Annex B1

The impact of international and European standards upon power quality

Paper taken from ERA Report 99-0009 *Quality and Security of Supply in Electrical Networks*,
Conference Proceedings, 16th – 17th February 1999, London, UK, ISBN 0 7008 0693 8,
available from ERA Technology Ltd, Cleeve Road, Leatherhead, Surrey, KT22 7SA, UK.
Details of the full report are available from www.era.co.uk

Abstract

This annex describes the typical disturbances covered both by EMC and mains supply standards, and highlights the differences between these different types of standards.

The summaries provided here are a useful reference for manufacturers unsure of what disturbances their apparatus might be exposed to.

The conclusion is that whilst EMC standards are useful, equipment complying with them will not necessarily be immune enough to function correctly under many of the disturbances that can be considered normal, if infrequent, on their mains power supply.

Voltage dips, dropouts, and interruptions are especially poorly covered by standards.

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B1- 1 Introduction

Power quality can be defined in a number of ways. Some authors have linked it with power supply reliability, service quality and supply quality (Ref. 1). However, to the end user, power quality is largely a perception that is coloured by the operating performance of the equipment or process plant. Reliable, trouble free performance is equated with a supply of high quality. However, equipment performance has as much to do with its susceptibility to supply disturbances as it has with the actual characteristics of the supply that it operates on. It is also the case that supply characteristics will be influenced by the 'quality' of the load connected to it.

IEC and European electromagnetic compatibility (EMC) Standards have done much to improve the perception of power quality. However, the end user should be aware that gaps still exist between certain power quality disorders and typical levels of immunity specified by the EMC standards. This paper considers the range of IEC and EMC power quality standards that exist, the impact they have had and highlights where improvements could yet be made.

B1- 2 The relationship between the EMC Directive, IEC standards and European Standards

Since the first introduction of electrical power feeding simple electrical equipment, the electromagnetic environment in which we live has changed dramatically. Not only has the electromagnetic spectrum become saturated with telecommunication and broadcasting transmissions, the equipment within installations has become increasingly sensitive to interference both from internal and external sources, primarily because of digital technology. If this trend were to continue without guidance or legislation, the likelihood of serious network disturbance in the future becomes disturbingly real. There is a real need for control of the electromagnetic environment if electronic systems are to be reliable and safe in use. For this reason, combined with the harmonisation of trade in electrical goods within the European Community, the EMC Directive (89/336/EEC) has been drafted and implemented.

The main objectives of the EMC directive are to guarantee the free movement of electrical equipment and to create an acceptable electromagnetic environment in the European Economic Area (EEA) territory. In order to achieve this, a harmonised and acceptable level of protection is requested in the Directive, based on Article 100a of the Union Treaty, leading to full harmonisation in the EEA.

In order to support the EMC Directive with relevant technical standards, CENELEC, the European standards organisation, received a mandate from the European Commission to ensure that all products and systems coming within the scope of the directive were adequately covered. CENELEC was further charged with relying only on internationally published standards, i.e. CISPR for emissions standards and IEC for immunity standards. When the directive was first published in 1989 it was recognised that at the time of coming into force in 1992 (there then followed a four year transition period before full implementation) there were only a few product standards covering both emissions and immunity. Generic standards, which were appropriate for particular environments, were drafted to supplement the deficiency. These cover emissions and immunity for the residential, commercial and light industry and industrial environments respectively. These generic standards drew heavily on the CISPR and IEC standards, which had themselves been harmonised in Europe and published in the Official Journal (OJ) of the European Community (EC) as Euronorms (ENs).

The standards published by the IEC's Central Office in Geneva are the results of the work of the technical committees. The committees dealing with basic EMC standards are:

IEC TC77A	Low frequency phenomena; harmonics and voltage fluctuations
IEC TC77B	High frequency phenomena; electrostatic discharge (esd), radio frequency (rf) fields, transients and surges etc
IEC TC77C	Electromagnetic Pulse (EMP) phenomena

At each stage in the process of developing a standard there is a significant input from various sources: technical experts (from industry, comprising both manufacturers and users), test laboratories, and regulatory authorities. For the electricity supply industry conditions vary considerably in distribution networks and systems, say between those in South Africa and those in Switzerland. Every attempt was made to achieve a consensus view on what was relevant and acceptable to all national interests. In this way the IEC standards have achieved world-wide recognition and many national authorities are moving to adopt IEC standards in order to promote international trade and to support their indigenous industry.

In recent years there has been a considerable amount of co-operation between CENELEC and IEC, resulting in parallel voting procedures. This has provided the added benefit of consideration of the standards within the context of legally enforced conformity assessment requirements.

B1- 3 EMC standards and power quality

From the perspective of the Electricity Supply Industry (ESI) in Europe, the IEC and CENELEC standards assist in achieving adequate power quality and in controlling power quality. They achieve this by providing a framework within which the supply environment (i.e. power quality), the susceptibility of equipment to adverse power quality, and the emissions from equipment (which can influence power quality) are all defined. In addition the standards provide protocols to allow disturbances and emissions to be measured. Thus a coherent family of standards such as the IEC 61000 series establishes a means of promoting power quality.

The compatibility levels for low frequency conducted disturbances on low voltage networks are defined by IEC 61000-2-2. To ensure compatibility, LV equipment must have immunity levels that exceed the compatibility levels. Also the cumulative effect of emissions should not result in disturbances that exceed the compatibility levels. At present compatibility levels have not been provided for anything other than LV supplies. Thus arguably it is only IEC 61000-2-2 that could be used as a comparison with the quality of power delivered by the ESI. However, it is not a standard for power quality. Essentially, within Europe, it is the CENELEC standard EN 50160 that the ESI uses to define the power quality, in terms of voltage characteristics, that can be expected under normal supply conditions. EN50160 defines maximum acceptable levels for Medium (<35kV) and Low (<1kV) voltage systems.

In general the compatibility levels set by IEC 61000-2-2 are comparable to, or slightly less stringent than, those defined by EN50160. Table B1-1 shows a comparison between the two standards for LV systems.

B1- 3.1 Applicable standards for terminating equipment

The IEC 61000 series is applicable to much of the EMC Directive and is structured in the following manner:

Part 1	Deals with general considerations and the fundamental principles behind the directive as well as the definitions and terminology
Part 2	Lays down a description and classification of the environment inclusive of compatibility levels
Part 3	Presents the emission and immunity limits for terminating equipment, in so far as they do not fall under responsibility of the product committees
Part 4	Defines the generic testing and measurement techniques used to assess product compliance
Part 5	Describes installation and mitigation guidelines specifically for building installation systems
Part 6	Contains the generic standards
Part 9	Reports on miscellaneous issues

IEC 61000-3-2 and IEC 61000-3-3 refer to harmonics and voltage fluctuations respectively. They are essentially emissions requirements for equipment to be connected to the electricity supply. They were preceded by IEC 555-2 and IEC 555-3, which were adapted as harmonised standards by Europe and published as EN 60555-2 and EN 60555-3. The scope of these latter standards was restricted to household appliances, but the later versions, EN 61000-3-2 and EN 61000-3-3 based on the newer IEC standards, are much broader in scope. These cover IT equipment and have more stringent requirements for televisions. The new versions will be mandatory in Europe in 2001.

Part 4 of IEC 61000 contains basic standards for test and measurement. At present the latest versions of the generic standard for the Residential, Commercial and Light Industry environment, EN 50082-1, references seven separate basic standards from part 4:

61000-4-2 Electrostatic discharge immunity test, 1997

61000-4-3 Radiated RF electromagnetic field immunity test, 1997

61000-4-4 Electrical fast transient immunity test, 1995

61000-4-5 Surge immunity test, 1995

61000-4-6 Immunity to conducted disturbances induced by RF fields, 1996

61000-4-8 Power frequency magnetic field immunity test, 1993

61000-4-11 Voltage dips, short interruptions and voltage variations immunity tests, 1994

Table B1-2 details the relevant standards used by equipment manufacturers to ensure that their products comply with the essential requirements of the EMC Directive. Therefore, it can be said that all new End User terminating equipment will have similar emission and immunity characteristics as the levels stated in the relevant standards. The EMC Directive defines that it is the responsibility of the manufacturer of the equipment to ensure that the product for sale meets relevant emissions and immunity parameters of the standards. The level of protection this affords not only reduces the susceptibility of terminating equipment to a localised adverse power quality issue, but also reduces the equipment's contribution to that localised disturbance.

Theoretically, the reduction of conducted emissions from various loads should improve the power quality of the overall supply system. Unfortunately, the problems associated with load switching and the resultant dips or distortions are unaffected by these controls and remain the responsibility of the electricity supplier. Similarly, frequency and voltage control are also the responsibility of the supplier and control is not exercised at the load.

B1- 3.2 Comparison of maximum allowed delivered disturbance characteristics defined in EN 50160 and generic immunity for terminating equipment as specified in IEC 61000-6-1 and 61000-6-2

For a comparison of the voltage characteristic levels and terminating equipment immunity (taken from IEC 61000-6-1 and 61000-6-2 the Generic Immunity Standards for Residential, Commercial and Light Industry, and Industrial environments) table B1-1 presents the limits defined in EN 50160 against the expected immunity of terminating equipment.

As can be seen, the level of immunity for some power quality phenomena would be insufficient to adequately protect terminating equipment from the disturbances defined in EN 50160. In practice, the actual level of disturbance is likely to be equal or less than the immunity levels defined by the generic standards of IEC 61000-6-1 and 61000-6-2. Therefore, the likelihood of a disturbance affecting compliant terminating equipment is greatly reduced.

B1- 4 Deregulation and other factors that influence power quality

Deregulation of the electricity supply industry within Europe started with the privatisation of fossil fuelled generation, transmission and distribution in the UK and is still evolving in other European countries. Within the UK it occurred against the backdrop of the publication of the EMC Directive in 1989 and the subsequent transitional period for the introduction of the Directive. During the intervening period a European Directive (published in 1995) has stated that the term ‘product’ can be used to describe electricity.

In 1994 the European Commission published a Directive entitled ‘Amended proposal for a European Parliament and Council Directive concerning common rules for the internal electricity market in electricity’. This proposed the following:

i. The system operator to draw up and publish annual reports on the quality of supply and the quality of service.

ii. The commission to establish appropriate criteria for the report in order to ensure their compatibility at Community level.

UNIPEDE has proposed that power quality be assessed in terms of availability of supply and has defined three indices with the aim of characterising long interruptions (i.e. greater than 3 mins), interruption frequency (interruptions per year), supply unavailability (minutes per year) and interruption duration (minutes per interruption). For shorter power interruptions and other power quality indices UNIPEDE makes reference to the European standard EN50160. Within the UK the regulating body is the Office of Electricity Regulation (OFFER). The licensing regime and price regulation are implemented by the Regulator who is appointed by the UK Government to enforce the various conditions and regulations in the Electricity Act and the licences. The Regulators’ roles are to ensure that competition develops smoothly and effectively and that, when competition is inappropriate, adequate safeguards are in place to protect customers.

To ensure that customer service is maintained and improved, a series of performance standards have been agreed with the Regulator. They were first introduced in July 1991, revised in 1993, and further improvements took effect in 1995. There are two types of standard: Guaranteed Standards and Overall Standards. These Standards relate to Service Quality but do not include Supply Quality. However, customer surveys are occasionally conducted to assess how customers perceive the reliability of the supply. Using market research and by monitoring complaints, OFFER has noted an increase in customer complaints due to inconvenience caused by losses of supply for a minute or less. Sometimes these complaints are attributed to operation of auto-reclose mechanisms. In the October 1997 report by OFFER entitled ‘Standards of Performance for Public Electricity Suppliers (PESs)’ it is noted that such interruptions are currently not covered by the Standards. However, OFFER will be discussing with the PESs whether the existing system of power quality reporting can be developed to provide a basis for standards covering frequent interruptions.

All licensees in England, Scotland and Wales who operate transmission or distribution systems are required by OFFER to report annually on their performance in maintaining system availability and quality of service. This information is used to provide a picture of continuity and quality of supply experienced by final customers. Annual reports have been required since the year 90/91. The power quality indices used are as follows:-

Distribution systems (14 systems)

- Supply interruptions per 100 customers
- Minutes lost per connected customer
- Percentage of interruptions not restored in 3hrs and 10hrs

- Number of faults per 100km of distribution system
- Verified voltage complaints (per 10,000 connected customers)

Transmission systems (3 systems: NGC, Scottish Power, Hydro-Electric)

- Number of incidents per year that cause loss of supply
- Un-supplied energy per incident
- Transmission system unavailability expressed as a percentage per month
- Reasons for unavailability (defined in terms of maintenance, construction, user connection, faults)
- System frequency excursions outside statutory limits (times and durations declared)
- System voltage excursions outside the Electricity Supply Regulations and Grid Codes

As in other parts of Europe, and in other parts of the world, OFFER is encouraging PESs to report transient voltage fluctuations within the quality of service publications that each PES circulates annually to their customers. However, a related power quality index has not yet been rigorously defined. More importantly there is currently insufficient power quality instrumentation connected to the networks to enable data to be collected and indices to be calculated and compared.

B1- 5 The impact of power quality standards on the ESI and end user equipment

The degree to which the evolution of standards in Europe since the introduction of the EMC Directive has impacted upon power quality, if at all, cannot be quantified in detail. However, a useful perspective is to consider the impact in the following terms:

Has the cost or performance of equipment used by the ESI within Europe been influenced by EMC standards?

- Have emissions from end user equipment been reduced?
- Has the resilience of end user equipment to adverse power quality been improved?

Each of the above questions are examined and dealt with in the following sections.

B1- 5.1 Has the cost or performance of equipment used by the ESI within Europe been influenced by EMC Standards?

The simple answer to this seems to be no. The performance and costs of ESI equipment, plant and system provisions have not, in ERA's opinion, been altered due to any of the power quality related aspects raised by the EMC Directive. A much wider debate within Europe has been whether HV Switchgear and Controlgear must comply with EMC Regulations, including CE-marking and the issue of a declaration of conformity by the manufacturer. Ref. 1 provided clarification. The position papers of the Co-ordinating committee for Common Market Associations of Manufactures of Industrial Switchgear and Controlgear (CAPIEL) and the UK's BEAMA Transmission & Distribution Association (BTDA) were revised in the light of Ref. 2 in June and July of 1997. The position adopted is that high voltage switchgear and controlgear constitute components and are therefore outside the scope of the EMC Directive. The Health and Safety Executive in the UK are challenging this position, and the situation may change in the near future.

The equipment commonly used in Transmission and Distribution include switchgear, transformers, lines and cables. Such equipment is not expected to give rise to excessive emissions and therefore do not have an impact upon power quality. Thus standards relating to power quality have not had impact on their design and costs. All manufacturers have an obligation that their equipment should not cause an unacceptable risk to health and safety. This will include having adequate immunity to electromagnetic disturbances to avoid danger. Therefore individual components within switchgear must be built to a suitable standard. At this level there are IEC standards which address immunity to some of the high frequency power quality phenomena. Circuit protection relays tested in accordance with IEC255 are one such example. However, such standards have helped to continue the trend set by other national standards, that they may have replaced, of achieving good product quality. No noticeable discontinuities in design and costs have resulted.

This is not to say that the ESI has not invested so as to improve power quality. Large investments have been made in the UK, for example, since privatisation. However, the incentive has been to address power quality targets set by OFFER, rather than those dictated by EMC Standards. Investments have been focused mainly on reducing 'customer minutes lost', which is arguably supply reliability rather than power quality.

B1- 5.2 Have emissions from end user equipment been reduced?

The standards that relate to emissions limits are summarised in Table B1-3.

Standards in the IEC 61000-6 series are generic standards that are applicable to a wide range of products intended for use in a particular environment. Product standards would take precedence for conformity assessment, but the phenomena listed would be similar.

The standards dealing with low frequency harmonic currents have evolved with the objective of promoting power quality by limiting the harmonic currents imposed on the mains supply. Examination of the recent changes to the standards show that they should have a positive effect in improving or at least maintaining power quality. The most recent form of IEC 61000-3-2 incorporates a Class D designation, which is applicable to certain types of equipment with an input power less than 600 W e.g. TVs and personal computer power supplies. The maximum permissible harmonic currents remain the same as those originally set by IEC555-2 but the requirement defines the limit in terms of current per watt, thus further restricting the amplitude of emissions on low power equipment. Although the consumption of individual Class D equipment is small the cumulative effect on the quality of mains supply is considerable due to the high numbers in use.

The changes to harmonic emission standards have provoked much debate and this continues today. Some manufacturers have suggested (Ref. 3) that the manufacturing life-span of information technology equipment (ITE) products is so short that the test requirements imposed by the proposed changes to ITE emissions and immunity standards may prevent products being imported into Europe. Nevertheless, the ESI in Europe is convinced of the need to limit harmonic and inter-harmonic current emissions from ITE and other sources through the use of appropriate equipment standards. Some have suggested that if supply voltage total harmonic distortion is allowed to reach 8 % then the supply network could prove unworkable. For equipment rated at more than 16 amps per phase, or in systems where there are cumulative emissions from a number of non-linear loads, the IEC standards have only recently been drafted and have not yet developed as established standards. Variable speed drives and UPSs have possibly become the most common source of significant current harmonics in industrial and commercial systems. At present these high frequency harmonic sources continue to be manufactured and installed without harmonic reduction features. Thus in this area IEC standardisation has not had an impact. Harmonised standards are published in the OJ, but only recently.

B1- 5.3 Has the resilience of end user equipment to adverse power quality been improved?

The standards that relate to the immunity of equipment are summarised in Table B1-4.

In the main the standards listed in Table B1-2, and other product specific standards, have helped to maintain a workable immunity from power supply disturbances on low voltage networks. Generic immunity standards require that the limit for each parameter must be selected with respect to a severity criterion, which defines the effect upon the equipment that is considered acceptable. One of three severity criteria may be selected:

Criterion A: Normal performance is maintained upon application of the disturbance.

Criterion B: Temporary degradation or loss of function or performance is acceptable provided it is self-recoverable.

Criterion C: Temporary degradation or loss of function or performance that requires operator intervention or system reset.

This concept of a severity criterion is potentially very powerful in achieving resilience to adverse power quality. In respect of fast voltage transients on the power supply or voltage dips lasting in the order of 10ms, then Criterion B would be normal, although most equipment users would prefer Criterion A.

However, in respect of voltage dips lasting in the order of 100ms, it is usually Criterion C that is applied. The duration of actual voltage dips is largely governed by the reaction times of protection equipment and tends to be of the order of 60ms to 200ms. Thus equipment built to the present IEC generic immunity standards, and thus also processes depending upon such equipment, will still be susceptible to typical system dips.

It is internationally accepted that ESI customers perceive voltage dips to be the most disrupting and costly of the power quality disorders. Therefore the application of IEC standards to end-use equipment has not yet significantly addressed dip immunity. Improvement in this aspect of immunity will only come when Criterion A or B is the norm. However, the existing standards potentially offer the knowledgeable user the opportunity to specify equipment with appropriate severity criteria, albeit at a premium price.

B1- 6 Conclusion

From the viewpoint of power quality, the IEC framework of standards helps to set actual power quality by limiting emissions. It also helps to enhance the end user's perception of power quality by specifying immunity. In this paper we have sought to assess the impact of IEC standards by restricting consideration only to power quality, reviewing applicable standards and drawing upon ERA's experience in EMC testing. The conclusions drawn are as follows:

a) The direct costs to the ESI of the enforcement of IEC or European standards or equivalent that relate to power quality have been minimal.

b) There have been, and continue to be, major power quality benefits to the ESI brought about by applying the appropriate IEC EMC standards or equivalent to end-user equipment. Most important are the limits on current emissions. There has been some improvement in immunity to voltage variations but insufficient to substantially improve matters.

c) The IEC standards have impacted mainly on equipment connected to the LV network (i.e. less than 1000 volts). In the UK and other European countries the limits on current emissions from commercial and industrial premises connected at medium and high voltages tend to be governed, at present, by national practices. In the UK, Engineering Recommendation G5/3 for harmonics is still applied and is due to be revised. However, the IEC standard on voltage flicker is rigorously enforced in the UK and coupled with the IEC test protocols provides a well-defined and workable control.

d) Voltage dip immunity in end user equipment continues to be a major power quality issue in Europe and is only gradually improving with the implementation of IEC standards. As a result, equipment malfunction due to transient voltage dips continues to lead to complaints about adverse power quality. In some regions of Europe it may even be perceived that power quality is reducing due to a lack of voltage dip immunity alone. The reality is more likely to be that such perception is influenced by an increase in the numbers of susceptible equipment, or changes in the application of equipment, despite the fact that dip immunity complies with present day EMC Standards. However, the IEC standards offer a framework for specification and testing that could eventually benefit both the ESI and end users. It is up to the user to take advantage of these standards.

e) The implementation of the EMC Directive was a defining event in Europe. It introduced mandatory EMC requirements that depended upon IEC standards or equivalents. A review of pass / fail success rates in ERA's EMC Test Department has shown that the adoption of EMC standards, since the implementation of the EMC Directive, has substantially improved the emission and immunity performance of terminating equipment.

f) The level of immunity for some power quality phenomena would be insufficient to adequately protect terminating equipment from the disturbances defined in EN 50160. In particular, the frequency of occurrence of voltage dips, and the 95% per week basis for assessing most parameters, means that actual power quality could result in considerable disruption in equipment performance and yet meet EN 50160.

g) The existing standards potentially offer the knowledgeable user the opportunity to specify equipment with appropriate severity criteria, albeit at a premium price.

h) The public electricity supply companies should strive to improve the characterisation of network performance so that terminating equipment standards can continue to evolve to meet actual conditions. The characterisation of supply voltage dips is particularly important. It is understood that OFFER may increase the pressure to report dip performance. PESs are known to be investing in power quality monitoring equipment. However, a common measurement protocol and open reporting is needed to provide users with workable information upon which investment decisions can be made.

B1- 7 References

1) Robert A. *Supply quality and reliability relevant standards and possible services for industrial consumers* IBC Conference on Improving Distribution Power Quality and Transmission Optimisation, Amsterdam, 14-16 January 1998, pp1-25

2) European Commission DGIII *Guidelines on the application of Council Directive 89/336/EEC of May 1989* European Commission, June 1997, 200pp. Available from the DTI

3) Horan B. *The effects of immunity requirements on ITE products* UK EMC Journal, April 1998. Available at http://www.emc-journal.co.uk/980408.html

4) European Committee for Electrotechnical Standardisation *Voltage characteristics of electricity supplied by public distribution systems* EN 50160, 1995

5) International Electrotechnical Committee: Electromagnetic Compatibility (EMC) IEC 61000 series

Table B1-1

Comparison between EN 50160 and IEC 61000-2-2 and also between environmental levels, specified by EN 50160, and end user equipment immunity specifications defined by European EMC regulations

	Compatibility Levels **IEC61000-2-2**	**IEC 61000-6-1 and IEC 61000-6-2** Generic Residential, Commercial, Light Industry/Industrial Immunity Standards	**Voltage characteristics of electric supplies (EN50160)**	
	LV	LV	LV	MV
Frequency	2%		1% for 95% of week -6%/+4% for 100%	1% for 95% of week -6%/+4% for 100%
Voltage Magnitude		± 10 % applied for 15 minutes (EN 50082-2)	±10% for 95% of week, 10min rms	±10% for 95% of week, 10min rms
Rapid voltage changes	3% 8% infreq Pst<1.0 Plt<0.8	(Covered by IEC 61000-3-3)	5% normal 10% infreq Plt <1 for 95% wk	4% normal 6% infreq Plt <1 for 95% wk
Temporary overvoltage			<1.5kV	170% (solidly or impedance earth) 200% (unearthed or resonant earth)
Transient overvoltage		± 1 kV (±2 kV EN 50082-2) 5/50 ns Tr/Th 5 kHz Repetition Frequency	Generally <6kV Occasionally higher	
Voltage unbalance	2%		2% for 95% of week , 10min rms 3% in some locations	2% for 95% of week , 10min rms 3% in some locations

Harmonic voltage	6% 5^{th} 5% 7^{th} 3.5% 11^{th} 3% 13^{th} THD <8%	(IEC 61000-3-2)	6% 5^{th} 5% 7^{th} 3.5% 11^{th} 3% 13^{th} THD <8% 95% week 10min rms	6% 5^{th} 5% 7^{th} 3.5% 11^{th} 3% 13^{th} THD <8% 95% week 10min rms
Inter-harmonics	0.2%		Under consideration	Under consideration
Mains signalling	0.11-0.5kHz: 3.5-6% 0.5-2kHz : 2-5% 3-20kHz : 2% 20-150kHz: 0.3%	(Covered by EN 50065-1)	1-0.5kHz : 9% 1-10kHz : 5% 99%, 3s mean	1-0.5kHz : 9% 1-10kHz : 5% 99%, 3s mean
DC components	Under consideration			
Voltage dips	Urban: 1 to 4 month Rural: much more	30 % Reduction for 10 ms No detrimental effects 60 % reduction for 100 ms Can be manually reset	<u>Majority</u> Duration < 1 s Depth < 60 % <u>Some Locations</u> 1000/Year < 15 % = 2 or 3 per day	<u>Majority</u> Duration < 1 s Depth < 60 % <u>Some Locations</u> 1000/Year < 15 % = 2 or 3 per day
Short interruptions		> 95 % Reduction for 5 s	<u>Majority</u> 20 - 500/year Duration 1 s; 100%	<u>Majority</u> 20 - 500/year Duration 1 s; 100%
Long interruptions			10 - 50 /year Duration > 180 s; 100%	10 - 50 /year Duration > 180 s; 100%

Table B1-2

Product and generic standards harmonised under the EMC Directive

Types of Product	**Standards which should be applied to make a Declaration of Conformity Under the EMC Directive 89/336/EEC**			
	Emissions			**Immunity**
	Harmonics	**Voltage fluctuations**	**Radio Interference**	**All aspects**
Household appliances and portable tools, e.g. vacuum cleaners, washing machines, heating and cooking appliances, dimmers etc	EN 60555-2/ IEC or EN 61000-3-2(1)	EN 60555-3/ IEC or EN 61000-3-3(1)	EN 55014* or CISPR 14	EN 55104*
Lighting eqpt, eg luminaires (with and without electronic components) but not lighting controls	EN 60555-2/ IEC or EN 61000-3-2(1)	IEC or EN 61000-3-3(3)	EN 55015 or CISPR 15	IEC or EN 61547
TV and video, domestic audio products	EN 60555-2/ IEC or EN 61000-3-2(1)	EN 60555-3/ IEC or EN 61000-3-3(1)	EN 55013 or CISPR 13	EN 55020 where applicable, else EN 50082-1

Information Technology (IT) equipment**	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	EN 55022 Class A or Class B	EN 50082-1 or EN 50082-2
Industrial, Scientific and Medical (ISM) equipment designed to generate rf energy**	IEC or EN 61000-3-2(3)	IEC or EN 61000-3-3(3)	EN 55011 or CISPR 11	EN 50082-1 or EN 50082-2
Residential and Light Industrial equipment**	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 50081-1	EN 50082-1
Industrial electronic power and control eqpt**	IEC or EN 61000-3-2(3)	IEC or EN 61000-3-3(3)	EN 50081-2	EN 50082-2
Industrial non-electronic equipment e.g. commutator motors**	IEC or EN 61000-3-2(3)	IEC or EN 61000-3-3(3)	EN 50081-2 In principle	EN 50082-2 In principle
Mains signalling equipment	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 50065-1	EN 50082-1
Cabled distribution systems for TV, sound, multimedia	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 50083-2	EN 50083-2
Home and building electronic systems (HBES)	IEC or EN 61000-3-2(4)	IEC or EN 61000-3-3(4)	EN 50090-2-2	EN 50090-2-2
Uninterruptible Power Systems (UPS)	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 50091-2	EN 50091-2
Alarm systems, alarm system components	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	EN 50081-1 or EN 50081-2	EN 50130-4
Taximeters, electronic	Not applicable	Not applicable	EN 50148	EN 50148
Arc welding equipment	IEC or EN 61000-3-2(4)	IEC or EN 61000-3-3(4)	EN 50199	EN 50199
Audio, video, AV and entertainment lighting control, professional	IEC or EN 61000-3-2(4)	IEC or EN 61000-3-3(4)	EN 55103-1	EN 55103-2
Fuses, low voltage	Not applicable	Not applicable	EN 60269-1	EN 60269-1
Fuses, high voltage	Not applicable	Not applicable	EN 60282-1	EN 60282-1
Switchgear and controlgear, low-voltage, assemblies	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	IEC or EN 60439-1	IEC or EN 60439-1
Watt-hour meters, ac	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	IEC or EN 60521	IEC or EN 60521
Medical Equipment	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 60601-1-2	EN 60601-1-2
Watt-hour meters, ac, static, for active energy (classes O.2S and O.5S)	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	IEC or EN 60687	IEC or EN 60687
Automatic electrical controls for household and similar	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	EN 60730 Parts 1, 2-5, 2-6, 2-7, 2-8, 2-9 & 2-11	EN 60730 Parts 1, 2-5, 2-6, 2-7, 2-8, 2-9 & 2-11
Telecontrol equipment and systems	IEC or EN 61000-3-2(4)	IEC or EN 61000-3-3(4)	EN 60870-2-1	EN 60870-2-1
Marine navigational equipment	Not applicable	Not applicable	IEC or EN 60945	IEC / EN 60945
Low voltage switchgear and controlgear	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	EN 60947 Parts 1, 2, 3, 4-1, 4-2, 5-1, 5-2, 6-1	EN 60947 Parts 1, 2, 3, 4-1, 4-2, 5-1. 5-2, 6-1
Residual Current Devices (RCCBs)	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 61008-1	EN 61008-1
Residual Current Devices (RCBOs)	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 61009-1	EN 61009-1

Watt-hour meter, ac, static, for active energy (classes 1 and 2)	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	IEC or EN 61036	IEC / EN 61036
Electronic ripple control receivers for tariff and load control	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	IEC or EN 61037	IEC / EN 61037
Time switches for tariff and load control	EN 60555-2/EN 61000-3-2(2)	EN 60555-3/EN 61000-3-3(2)	EN 61038	IEC / EN 61038
Programmable controllers	EN 60555-2/ IEC or EN 61000-3-2(2)	EN 60555-3/ IEC or EN 61000-3-3(2)	EN 50081-1 or EN 50081-2	IEC or EN 61131-2
Residual Current Devices (RCDs)	EN 60555-2/EN 61000-3-3(2)	EN 60555-2/EN 61000-3-3(2)	IEC or EN 61543	IEC / EN 61543
Power drive systems, adjustable speed	IEC or EN 61000-3-2(4)	IEC or EN 61000-3-3(4)	IEC / EN 61800-3	EN 61800-3

Types of Product	**Other standards, drafts or Directives**	**Types of Product**	**Other standards, drafts or Directives**
Lifts, escalators and passenger conveyors	prEN 12015 (E), prEN 12016 (I)	Electronic switches for household and similar	IEC or EN 60669-2-1 (E,I)
Cardiac pacemakers, implantable	EN 50061 (I)	Switchgear and controlgear, high-voltage	EN 60694 (E,I)
Mains signalling in low-voltage systems	prEN 50065-2-1, -2, -3 (I)	LV ancillary equipment - terminal blocks for copper conductors	EN 60947-7-1 (E,I)
Cabled distribution systems, installations	prEN 50083-8 (E,I)	Electromechanical contactors for household and similar purposes	IEC or EN 61095 (E,I)
Railways, all aspects	ENV 50121 (E,I)	Electrical equipment for measurement, control and laboratory use	IEC or EN 61326-1 (E,I)
Heating appliances, non-electric, household etc	prEN 50165 (I)	Machine tools (electronic control of manufacturing machinery robots)	TR 11062 (E/HF, I)
Installations, in-situ emissions	prEN 50217 (E)	Spark ignition engines eg mowers, chainsaws	CISPR 12 (E)
Hearing aids	prEN 50220 (I)	Measuring relays and protection eqpt	IEC 225-22-1 to -4 (E,I)
Rechargeable cells or batteries	prEN 50226 (E,I)	Small power electronics (stabilised power supplies)	IEC 478-3, -4
Control circuit devices and switching elements, proximity sensors, dc interface for sensors, and switching amplifiers (NAMUR)	prEN 50227	Power capacitors	IEC 931-1
Power transformers	prEN 50236 (E,I)	Electrical installations of ships	Draft IEC 92-504 (E/LF), draft IEC 533 (E/HF)
Resistance welding equipment	prEN 50240 (E,I)	Automotive whole vehicle, components***	Directive 95/54/EC (E,I)
Measuring relays and protection equipment	prEN 50263 (E,I)	Vehicle security systems***	Directive 95/56/EC (E,I)
Gas and breath analysers, detectors	prEN 50270 (E,I)	2/3-wheel vehicles***	Directive 97/24/EC (E,I)
Radio receivers on vehicles	prEN 55025 (I)	Telecommunications	See ITE above + various specific ETSs under development
Machinery, electrical equipment, safety	EN 60204-1 (E,I)	Radiocommunications transmitting equipment	EC Type-Examination by Notified Body necessary, various ETSs and drafts available
Relays, electrical all or nothing	prEN 60255 (E,I)		
Radio receivers, digital satellite radio	EN 60315-7 (I)		
Medical electrical equipment - magnetic resonance equipment	EN 60601-2-33 (E,I)		
Industrial process measurement and control equipment	prEN 60654-5 (E,I)		

* = Will shortly be replaced by EN 55014-1 and EN 55014-2
** = Use specific product standard where available
*** = Outside the scope of 89/336/EEC

(1) = The product falls within the scope of EN 60555-2 or -3, therefore EN 61000-3-2 or -3 are suitable for the standards route to conformity under the EMC Directive since they were listed in the OJ in September 1995. The old standards, EN 60555-2 or -3, are withdrawn at the date of withdrawal of conflicting standards (dow). The dow was recently agreed to be 1 January 2001 for both harmonics and flicker. These dates and clauses have been a matter of debate and could still be subject to change.

(2) = Domestic products in this category fall within the scope of EN 60555-2 or -3, therefore see (1) above. Non-domestic products did not fall within the scope of EN 60555-2 or -3, but are usually within the scope of EN 61000-3-2 and -3. For products which were not in the scope of EN 60555-2 and/or -3 but are now covered by EN 61000-3-2 and/or -3, the dow is also 1 January 2001. What this means is currently a matter of debate and is subject to change.

(3) = Products in this category are not usually domestic, therefore EN 60555-2 or -3 would not have applied but EN 61000-3-2 and EN 61000-3-3 will probably apply. See (2) above regarding non-domestic products.

(4) = as referenced in normative text E = emissions, HF = high frequency, LF = low frequency, I = immunity

Note: Table B1-2 correct as at October 1997

Table B1-3
Emission Standards

Environment	Standard	Power quality phenomena
Residential	IEC 61000-3-2. Formerly IEC555-2 first published in 1982.	Current harmonics
	IEC 61000-6-3	RF emissions, conducted and radiated
	IEC 61000-3-3	Voltage fluctuations and flicker
Light Industrial	IEC 61000-3-2	Current harmonics
	IEC 61000-3-4 (draft)	Harmonic. Emission for equip. having >16A/phase
	IEC 61000-6-4	RF emissions, conducted and radiated
	IEC 61000-3-3	Voltage fluctuations and flicker
Industrial	IEC 61000-3-2	Current harmonics emitted by individual equipment
	IEC 61000-3-6	Assessment of emission limits for distorting loads in MV and HV systems (comprising all of an installation's equipment)
	IEC 61000-3-7	Assessment of Emission limits for fluctuating loads in MV and HV systems
	IEC 61000-6-4	RF emissions, conducted and radiated
	IEC 61000-3-5 (Technical report)	Voltage fluctuations and flicker

Table B1-4
Immunity Standards

Environment	Standard	Power quality phenomena
Residential, commercial and light industrial	IEC 61000-6-1	Voltage dips
	IEC 61000-4-11	Voltage dips and short-duration interruptions