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Australian/New Zealand Standard™

Electromagnetic compatibility (EMC)

Part 2.3: Environment—Description of the environment—Radiated and non-network-frequency-related conducted phenomena

[IEC title: Electromagnetic compatibility (EMC), Part 2: Environment,
Section 3: Description of the environment—Radiated and
non-network-frequency-related conducted phenomena]

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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

RECONFIRMATION

OF

AS/NZS 61000.2.3:1999

Electromagnetic compatibility (EMC)

Part 2.3: Environment—Description of the environment—Radiated and non-network-frequency-related conducted phenomena

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Australian/New Zealand Standard™

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TE/3, Electromagnetic Interference, as one of a series of Standards intended to facilitate control of electromagnetic interference and the compatibility of electrical and electronic equipment.

This Standard is identical with and has been reproduced from IEC 61000-2-3:1992, *Electromagnetic compatibility (EMC), Part 2: Environment, Section 3: Description of the environment—Radiated and non-network-frequency-related conducted phenomena*.

The objective of this Standard is to provide designers and manufacturers of electronic equipment with a description of the electromagnetic environment and a basis for equipment design within that environment.

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AUSTRALIAN/NEW ZEALAND STANDARD

Electromagnetic compatibility (EMC)

Part 2.3

Environment—Description of the environment—Radiated and non-network-frequency-related conducted phenomena

1 General

1.1 *Scope and object*

This Technical Report describes the electromagnetic environment. It is intended as a basis to achieve electromagnetic compatibility in system and equipment design, using test standards (techniques and limits), and mitigation methods (including installation practices), which satisfactorily take account of undesirable effects that otherwise might result from unintended electrical and electronic equipment interactions.

This report is primarily concerned with the characteristics and levels of electromagnetic fields and of non-network-frequency-related conducted emissions from unintentional sources of interference. Its application is part of the process of achieving electromagnetic compatibility of systems; this requires the immunity characteristics of equipment to be considered together with any normal or special equipment or cable installation practices that may be required. Trade-offs should be made between physical separation, filtering and shielding when considering equipment installation and design, in order to achieve emission and immunity characteristics which meet system requirements.

1.2 *Reference document*

IEC 1000-2-1: 1990, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 1: Description of the environment – Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems.*

2 General considerations

There are various approaches that can be used for describing the environment. Classification in terms of typical environmental locations such as urban, industrial, residential and commercial may have some meaning in that each of these tends to imply some general characteristics of the environment on which compatibility levels may be based. However, it must be recognized that equipment not normally associated with a particular class of environment may indeed affect any specific location.

For the above reason, the approach taken in this report is to state the electromagnetic levels expected from particular sources or classes of sources. The level expected at a particular location must then be determined with reference to the sources existing at that location.

At the same time it should be recognized that one cannot always identify all sources that may affect a particular environment. Such is the case, for example, with conducted disturbances in a power system generated at large distances, for example large distant nonlinear industrial loads or unpredictable exceptionally severe lightning strokes. It is meaningful to make a distinction between public supply and industrial or private networks.

The quality of service at the point of common connection due to remote users will depend upon the capacity of the network and the loads connected to it that an individual consumer knows little about. Voltage fluctuations can be caused by load switching as well as by system faults and lightning strokes. Within a consumer's system, residential or industrial, the low frequency effects of local loads can be predicted. In general, one would expect the remote sources to limit the quality of service delivered to a particular consumer location, and that any given system should perform properly in the absence of local sources. This is assuming that the quality of service is otherwise satisfactory. Local sources can be expected to have more significant effects in possible system and device degradation.

2.1 Coupling between emitting and susceptible devices

The major reason for considering electromagnetic compatibility is the existence of devices (equipment, systems) which show susceptibility to electromagnetic emission from other devices.

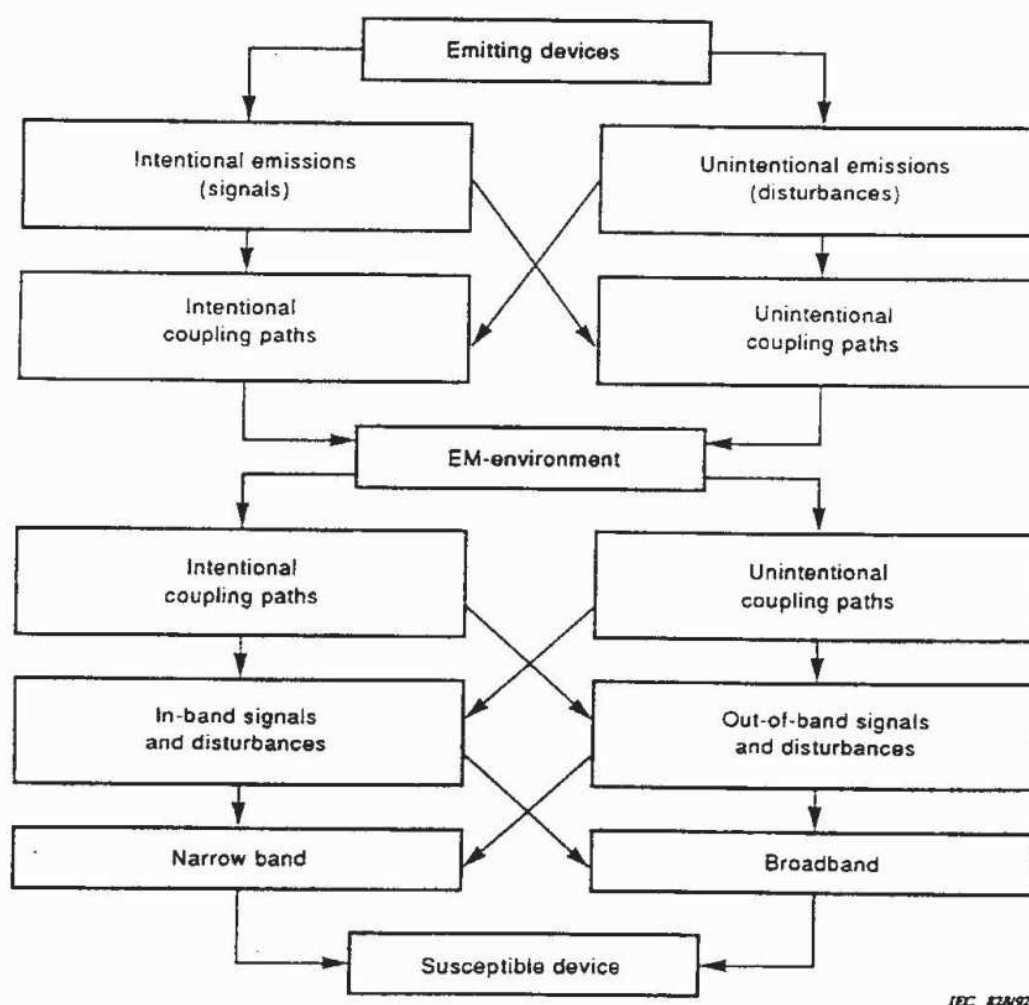


Figure 1 – Coupling paths between emitting and susceptible devices

Emitting devices may have intentional emissions, such as a radio-frequency broadcasting signal, or unintentional emissions, such as the magnetic field produced by the deflection coils of a video display unit. Through various coupling paths such emission may reach the site where a susceptible device is located as shown in figure 1, thereby establishing the electromagnetic environment for that device. The subdivisions shown in this figure are important for a description of the electromagnetic environment. Moreover, the technical possibilities available to prevent or solve an interference problem are related to these subdivisions, as are also the relevant EMC specifications.

The susceptible device may be exposed to the electromagnetic environment via intentional coupling paths, such as the aerial of a radio receiver, or via unintentional coupling paths such as the recording head of a video tape recorder, a signal cable or a mains cable. Both types of coupling paths, intentional and unintentional, may carry disturbances having frequency components in the frequency band designated for the desired signal of the susceptible device, and disturbances having components outside that band. The disturbances received may be considered narrow band or broadband. For example, the disturbance from a switched-mode power supply operating at 40 kHz is narrow band when measured with a CISPR receiver in the frequency range 10 kHz to 150 kHz since the receiver bandwidth is 200 Hz and the harmonic components are measured separately when tuning over the frequency range. However, the same disturbance is broadband for a video system with a 5 MHz bandwidth because of the harmonics of the 40 kHz signal. The terms broadband and narrow band are always determined by the bandwidth over which the disturbance is detected or measured. Hence, the same source can be both broadband and narrow band.

2.2 Units and decibels

The decibel (dB) was originally defined as the ratio r of two powers P_1 and P_2 dissipated in a resistance R expressed as a logarithmic unit as follows:

$$r(\text{dB}) = 10 \log_{10} \left(\frac{P_1}{P_2} \right) = 10 \log_{10} \left(\frac{V_1^2/R}{V_2^2/R} \right) = 20 \log_{10} \left(\frac{V_1}{V_2} \right)$$

where P_1 and P_2 are measured or determined under identical conditions. Hence, r can be expressed in terms of the associated voltages V_1 and V_2 as indicated in the above equation.

If V_2 is chosen to be a unit value, for example 1 μV , and V_1 is expressed in terms of that unit, then r gives the magnitude of V_1 expressed in "dB with respect to 1 μV ", normally abbreviated to r (dB(μV)). This latter approach is widely used in the field of EMC. Hence, if Y is a unit value then $X(\text{dB}(Y))$ is defined as:

$$X(\text{dB}(Y)) = 20 \log_{10} \left(\frac{X}{Y} \right)$$

Certain conventions exist for the choice of Y . Here are some examples:

a) In the case of conducted emissions, the voltage is expressed in dB(μ V), i.e. decibels above 1 μ V; and the current in dB(μ A), i.e. in decibels above 1 μ A. For example, 120 dB(μ V) corresponds to 10^6 μ V or to 1 V.

b) In the case of radiated emission, the electric field strength is expressed in dB(μ V/m) and the magnetic field strength in dB(μ A/m). For example, 34 dB(μ V/m) corresponds to 50 μ V/m. In statutory measurements and CISPR recommendations, the magnetic field strength H at frequencies below 30 MHz is usually expressed in dB(μ V/m), the unit of the electric field strength E , where dB(μ A/m) would be more appropriate. In such cases, the magnetic field H expressed in dB(μ A/m) and in dB(μ V/m) satisfies the relation:

$$H \text{ (dB}(\mu\text{A/m))} = H \text{ (dB}(\mu\text{V/m))} - 51,5 \text{ (dB}(\Omega))$$

where $51,5 \text{ dB}(\Omega) = 20 \log_{10} Z_0$ when $Z_0 = 377 \Omega$ and $Z_0 = E/H$.

The wave impedance $Z_0 = 377 \Omega$ applies only to the case of a plane electromagnetic wave. However, this is not relevant here as the measurement display is calibrated in such a way that the signal induced by the magnetic field H in the magnetic field antenna, is interpreted as a signal produced by an electric field of strength $E = Z_0 H$. See also 3.1.2.

In the case of large conducted disturbances, the use of nonlinear surge diverters precludes the application of dB units and analytical methods which are based on a linearity hypothesis.

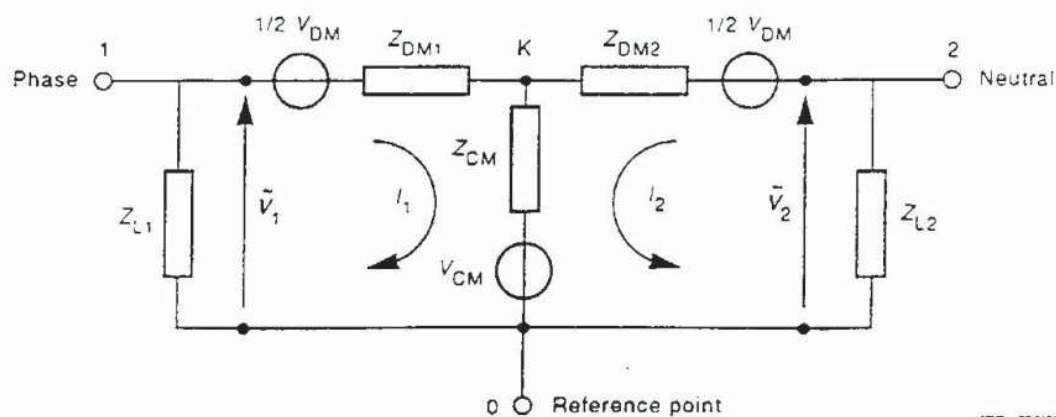
3 Source, coupling and susceptor models, and their limitations

When electrical and electronic devices and coupling paths are examined in detail, they can be found to be extremely complex. In order to deal with them in a practical way, simplification is necessary. This is done through the method of developing models. Disturbance sources emit by mechanisms of conduction, induction and radiation. Coupling paths may occur through conduction, induction or radiation, and most usually by combinations of these phenomena.

3.1 Source models

3.1.1 Conducted emissions

For conducted emission, the source can often be considered as a two-port or three-terminal device. Figure 2 shows noise sources in differential mode (V_{DM}) and in common mode (V_{CM}). Connection points 1 and 2 can be identified as, for example, the neutral and the phase of a mains connection, or as the connection points of a desired signal of a control line. Connection point 0 represents the reference of the source, formed for example by the protective earth, the steel reinforcement in a building, or a metal chassis. In many cases it may be necessary to consider the source as an N -port network, as in the case where a multi-wire flat cable is involved.



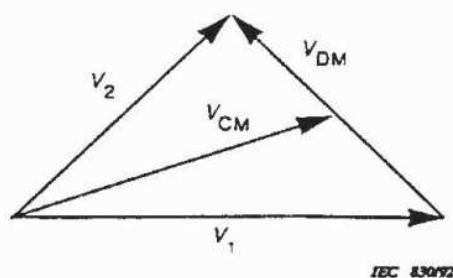
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Figure 2 – Source model for conducted emission
(Source loaded by Z_{L1} and Z_{L2})

The voltages V_{DM} and V_{CM} are complex voltages having desired as well as disturbance components. However, the desired voltage from the source, whether this is a power line or a signal line, is predominantly represented in the V_{DM} component. The disturbance voltage components of V_{DM} and V_{CM} may be of equal importance.

The relatively simple lumped representation in figure 2 is valid when the connection points 1, 2 and 0 are at such short distances from each other that, at all frequencies to be considered, no wavelength or field-induction effects play a noticeable role. The common-mode source amplitude and impedance are represented by V_{CM} and Z_{CM} respectively. The differential-mode source amplitude and impedance are represented by two sources of amplitude $\frac{1}{2}V_{DM}$ and by the impedances Z_{DM1} and Z_{DM2} . It should be noted that, in general, Z_{DM1} is not equal to Z_{DM2} . Equal values occur only by chance or when special measures have been taken in the construction of the system involved. If the source is unloaded ($Z_{L1} = Z_{L2} = Z_{L12} = \infty$), the nodal point K is in the "electrical middle", however this is not normally the case when the source is loaded because of $Z_{L1} \neq Z_{L2} \neq Z_{L12}$. As a result, the common-mode current I_{CM} may be determined by both V_{CM} and V_{DM} . The current I_{CM} is equal to the half vector-sum of I_1 and I_2 , like V_{CM} in figure 3 is half the vector-sum of V_1 and V_2 .

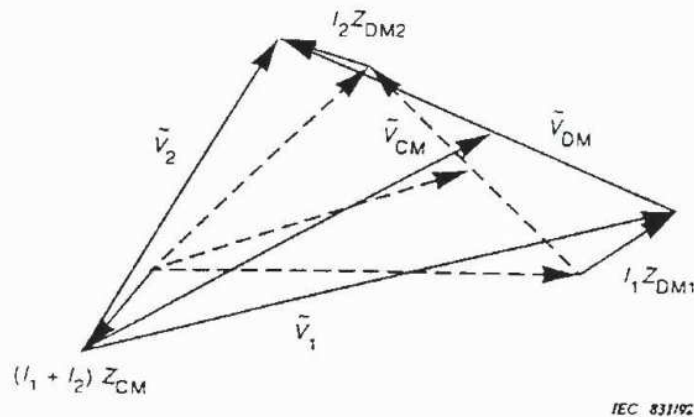
An example of the relation between the open-circuit voltages V_{DM} , V_{CM} , V_1 and V_2 is given in figure 3.



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Figure 3 – Relation between V_{CM} , V_{DM} , V_1 and V_2 for the unloaded situation

In figure 4 relations are given between the voltages $\tilde{V}_{CM}$, $\tilde{V}_{DM}$, $\tilde{V}_1$ and $\tilde{V}_2$, for the loaded situation.



IEC 831/92

Figure 4 – Relations between the voltages $\tilde{V}_{CM}$, $\tilde{V}_{DM}$, $\tilde{V}_1$ and $\tilde{V}_2$, for the loaded situation

Low-level conducted disturbance voltages are typically measured using an artificial network having a well-defined load impedance. For example, the CISPR V-terminal network has $Z_{L12} = \infty$ and $Z_{L1} = Z_{L2}$ with $Z_{L1} = 150 \Omega$, or $50 \Omega // 50 \mu H$ or $50 \Omega // 5 \mu H$. These values are considered to relate to the (average) absolute value of the impedance presented by the real mains, which depends, among other things, on the mains current for which the network has been designed. It is important to note that the artificial mains networks mentioned here are not valid for all applications, for example the case of the propagation of transients.

It must therefore be recognized that measurements of emission from sources are of a limited nature. For example, to determine compliance with a conducted emission limit, the measurement is made with a specified terminating impedance. No direct measurement of the source impedance is made. Thus, when a given source is placed in a circuit which presents an impedance to it which is different from the measurement impedance, the actual emission will differ from that measured. Such variations must be anticipated by system EMC engineers when designing compatible systems.

3.1.2 Radiated emissions

Radiated emission levels are usually stated in terms of electric (E) and magnetic field (H) levels, expressed in $\text{dB}(\mu\text{V/m})$ and $\text{dB}(\mu\text{A/m})$. Particular sources differ in the relative magnitudes of each of these components and their variations with distance.

In the so-called far-field region of a source the distance between the source and the point of observation of the field is much larger than $\lambda / (2\pi)$, where λ is the wavelength of the field, and larger than the dimensions of the source. At such distances, and in the absence of nearby reflecting objects, the E and H fields are perpendicular to each other and perpendicular to the direction of propagation of the wave. In addition, there is a fixed relation between the magnitudes of E and H , which makes statements of electric field strength and magnetic field strength equivalent. In the far field and free space $E/H = 377 \Omega$ and the field levels fall off inversely with distance from the source.

In the near-field region of the source, the distance between the source and the point of observation is either much smaller than $\lambda/(2\pi)$ or smaller than the dimension of the source or both. The relation between the E and H fields now depends on the wavelength of the disturbances, the actual position in the near-field region and the type of source.

A simple model used for radiation is the dipole which may be of electric or magnetic types, (see figure 5). This model exhibits an inverse cubed variation of the field strength of its dominant component (electric field for an electric dipole, magnetic field for a magnetic dipole) at nearfield distances. For such sources a statement of the "dipole strength" would enable calculation of the field components (both electric and magnetic) at any distance. However, it is more usual to measure the dominant component at a fixed distance, without making reference to the source strength.

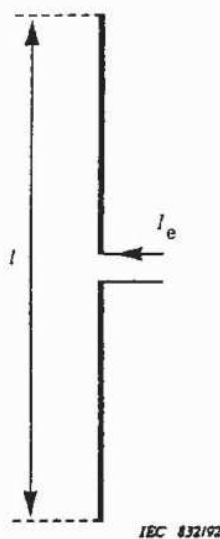


Figure 5a – Electric dipole
strength = $l \cdot I_e$

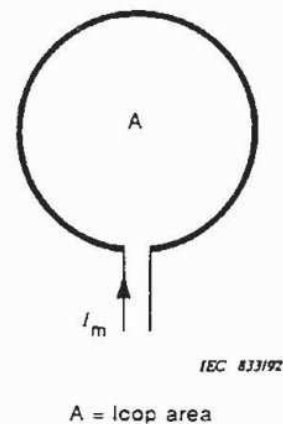


Figure 5b – Magnetic dipole
strength = $A \cdot I_m$

Figure 5 – Electric and magnetic dipole elements

In case of radio transmitters, the gain of the antenna in the intended coupling path and the net power P_t transferred to the antenna are usually known. As the antenna gain is always directional with respect to the antenna, the gain normally referred to is that associated with the direction of maximum radiation.

The effective or equivalent radiated power, ERP , of an antenna is defined as:

$$ERP = G_r P_t$$

where G_r is the antenna gain relative to the maximum directivity G_h of a half wave dipole.

The electric field strength produced by an antenna at a distance r in the far field of the antenna is expressed as:

$$E = \sqrt{\frac{ZG_h \cdot ERP}{4\pi r^2}} = 7 \frac{\sqrt{ERP}}{r}$$

where $G_h = 1,64$ and Z , the wave impedance of the medium, equals 377Ω in free space.

It follows that:

$$\sqrt{\frac{ZG_h}{4\pi}} = 7 \Omega^{1/2}$$

The term "effective or equivalent isotropically radiated power, $EIRP$ ", is also used for the antenna. The relation between ERP and $EIRP$ is given by:

$$EIRP = G_h ERP.$$

3.2 Coupling models

The phenomena involved in transferring electromagnetic energy from a source to a susceptor are, in general, very complex. Exact calculation of the energy transferred in particular cases may therefore be difficult. However, in many cases the important coupling may be described in terms of comparatively simple models. These models are divided into three main classes: common-impedance coupling, coupling by induction (near-field) and radiative (far-field) coupling.

3.2.1 Common-impedance coupling

This type of coupling is also referred to as conductive coupling. It occurs when currents or a portion of the currents associated with a source and susceptor share a common path. Typically the common path may be represented by a resistance, an inductance or a capacitance or by a combination of any of these. Two of many examples that can be cited are the sharing by the source and receptor of 1) a common power mains, and 2) a common ground current return path.

Resistive coupling

The resistive part of the common impedance R_c is determined by the conductor material and by the skin effect as a result of which the resistive part becomes frequency dependent. For a straight round conductor of diameter d one has:

$$\begin{aligned} R_c / R_{dc} &\approx d / 4 \delta & \text{when } \delta \ll d \\ \text{and } R_c / R_{dc} &\approx 1 & \text{if } \delta \gg d \end{aligned}$$

where R_{dc} is the d.c. resistance of the conductor and δ the skin depth given by:

$$\delta = \sqrt{\frac{2}{\omega \mu \sigma}}$$

where ω is the angular frequency of the signal, μ the permeability and σ the conductivity of the conductor material.

Reactive coupling

The reactive part of common-impedance coupling can be produced by a common inductance. The common inductive reactance X_L can then be written as:

$$X_L = \omega L_L$$

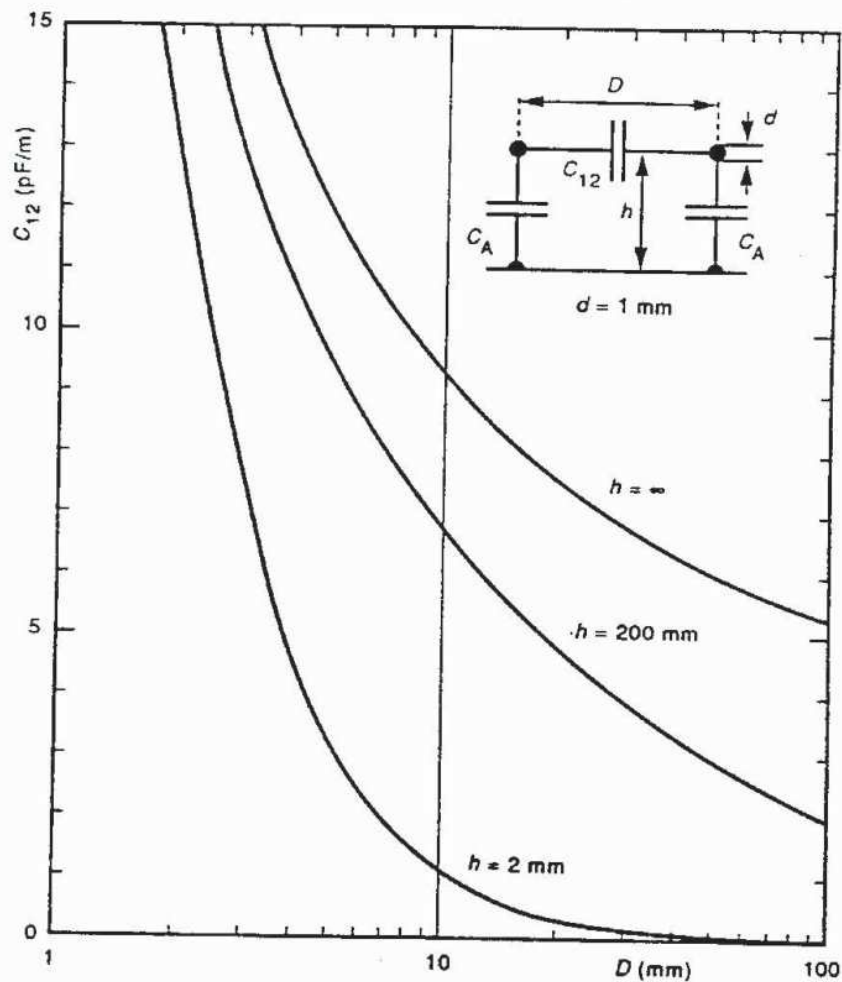
where L_L is the inductance of the conductor. The value of L_L depends on the shape of the current loop and its surroundings. However, as a rule of thumb, one can say that $L_L \approx 1 \mu\text{H/m}$ (or 1 nH/mm). In many electromagnetic interference problems $X_L \gg R_c$. For transient events, this is always the case, in spite of the emphasis given to massive earthing conductors.

3.2.2 Coupling by induction

Coupling by induction occurs when voltages or currents are induced in the circuits of the susceptor by local electric or magnetic fields or combinations of these emanating from the source. Examples are control circuits located in the vicinity of a large power transformer, arc furnace or welder and closely spaced (and parallel) transmission circuits such as a power line and a telecommunications line.

a) *Electric field coupling*

Electric field or capacitive coupling occurs when electric fields from one circuit impinge on another. For the low-frequency approximation it is appropriate to describe this type of coupling with a coupling capacitance. The magnitude of the capacitance depends primarily on the actual situation, i.e. on the shape of the circuits and on the surroundings of the circuits. An example is given in figure 6, where the coupling capacitance C_{12} per unit length is given between the wires (of diameter d) of two parallel loops at a distance D , using the ground plane as a common return, for three values of the loop height.



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Figure 6 – Capacitance per unit length as a function of conductor separation

Figure 6 clearly shows the influence of the surroundings on C_{12} . It also shows that C_{12} varies rapidly with D but that for $D/d > 10$ the coupling capacitance does not vary much with D . Note that for sufficiently high values of h the equation for the coupling capacitance reduces to:

$$C_{12}(h \rightarrow \infty) = \frac{\pi\epsilon}{\ln\left(\frac{2D}{d}\right)} \quad \text{F/m}$$

which is the equation for the capacitance between the wires in the absence of a ground plane.

The above example applies equally to two cables running parallel to a metallic plane, i.e. a shield or conduit, which forms the reference for the common-mode voltages on the cables.

In cases where the feedback from the receptor circuit to the emitter circuit is negligible and the circuits are small compared with the wavelength under consideration, the disturbance caused by capacitive coupling can be represented in the receptor circuit by a current source. The current source can be approximated by

$$I_c = j\omega C_{12} V$$

where V is the driving voltage at the emitter side of C_{12} .

b) Magnetic field coupling

Magnetic field or inductive coupling occurs when magnetic fields from one circuit impinge on another. An appropriate quantity to describe this type of coupling is the mutual inductance. Its value depends greatly on the actual situation, for example on the shape of the circuits and on the surroundings of the circuits, as in the case of the coupling capacitance.

In cases where the feedback of the receptor circuit to the emitter circuit is negligible and the circuits are small compared with the wavelength under consideration, the disturbance caused by the magnetic coupling can be represented in the receptor circuit by a voltage source. The voltage source can be approximated by:

$$V_1 = j\omega M_{12} I$$

where M_{12} is the mutual inductance between the two circuits involved and I the driving current in the emitter circuit. This can also be written as $j\omega B_1 A_2$ where A_2 is the area of the receptor loop and B_1 the flux density produced by the emitter loop in the receptor loop. In the last relation it is assumed that B_1 is a constant over the area A_2 .

A very useful model is one that accounts for the magnetic field in the vicinity of a parallel wire transmission line. Its magnitude as a function of parallel wire spacing and the distance from the wires is shown in figure 7. If the distance is large compared with the separation, the field strength falls off as $1/r^2$. If the distance is small compared with the spacing, the field is calculated as for a single wire (the closest wire).

Magnetic sources such as transformers, relays, etc. will produce field strengths attenuated as the third power of the distance.

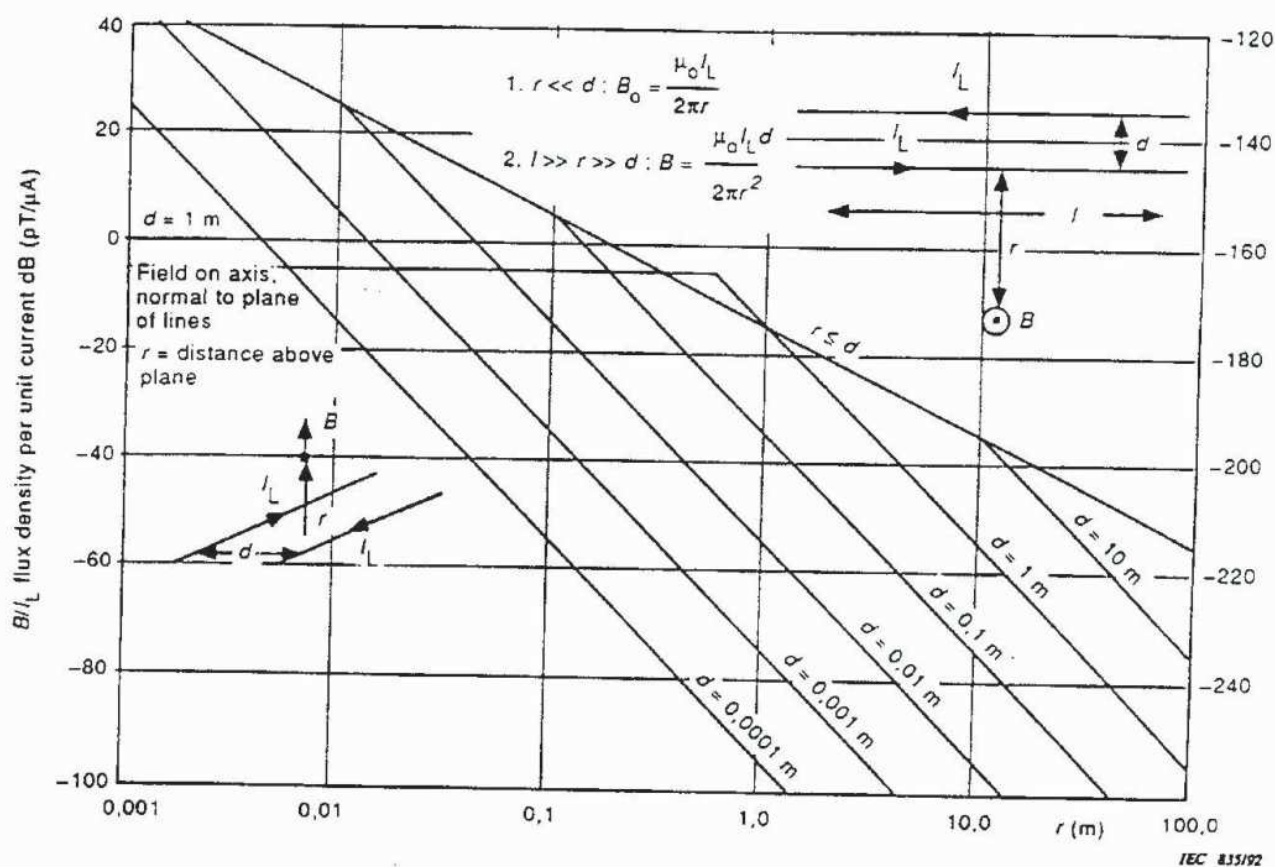


Figure 7 – Flux density from parallel conductors

c) Mixed coupling

In many cases the coupling mechanisms discussed in the preceding subclauses occur simultaneously. Which of the three mechanisms will dominate depends on the actual situation. Only in a limited number of cases it is possible to indicate whether capacitive coupling will dominate over magnetic coupling, or vice versa. An example is the case of coupling between two parallel wires. Assuming the receptor circuit to be terminated by its characteristic impedance on both ends, magnetic coupling dominates if the emitter circuit is terminated with an impedance lower than the characteristic impedance and capacitive coupling dominates if that impedance is higher.

3.2.3 Radiative coupling

Radiative coupling may be the primary means of coupling when the source and the susceptor are relatively far apart i.e. in the far-field situation. The coupling mechanism by electromagnetic radiation and the voltages induced in the susceptor circuits can be calculated from either the electric or the magnetic field component of the field as these have a fixed relationship. Generally there is no feedback from the susceptor to the source. An example of radiative coupling is a sensitive receiver or control element affected by the field produced by a relatively distant radar transmitter or high-frequency industrial heating equipment.

3.3 *Susceptible device models*

Disturbing energy is coupled to a susceptor in the same way as it is coupled from an emitter, i.e. by either conduction or radiation. The models are simplified so as to provide statements on the levels of disturbing voltage or current on connected power, signal or control lines, and levels of homogeneous electric or magnetic fields, assuming the most disturbing polarization, in which a given device or equipment can be immersed. Of course the levels may be dependent on the waveform and frequency of the disturbance, its repetition rate (if periodic or almost periodic) and the characteristics of internal circuits. Many mechanisms of generation of interference within a device have been discussed in the literature, but it is beyond the scope of this report to review them here.

It is important, however, to note that the preferred parameters used in describing the environment depend upon the characteristics of the equipment under consideration.

4 **Emission levels and the environment**

In view of the models identified above, it is necessary to recognize the characteristics of typical sources and the associated coupling mechanisms.

4.1 *Conduction environment*

For power mains both the disturbing voltage appearing on the mains and the capability of the source to deliver large surge currents is important. Both line to line and line to earth voltages should be known. The attenuation in a building may be negligible or appreciable depending on the characteristics of the lines and the installation.

For signal lines, the disturbances appearing at the terminals of an equipment to which they are connected depend on the influences of the electromagnetic fields, including primarily electric or primarily magnetic fields in the environment traversed by the lines, as well as on differential and common-mode currents impressed directly on the lines by other connected equipment.

4.2 *Induction field environment*

The important induction fields are those which emanate from single devices such as transformers, solenoids and similar magnetic devices and those from the power mains, especially where there is significant separation between the power conductors. The former creates magnetic fields that vary in strength inversely with the cube of the distance. Fields from the latter vary inversely with the distance at distances less than the conductor separation and inversely with the square of the distance for distances greater than the separation, when the propagation is exclusively differential mode. With fields originating in common-mode currents, the field strength varies inversely with distance.

4.3 *Radiation field environment*

Radiated field strengths are traditionally stated in terms of the electric or magnetic field strength at a specified distance, for example 3 m, 10 m, or 30 m. If that distance is in the far field region of a source, the field strength can then be estimated at any larger distance in a reflection free environment. In such situations the *ERP* and the *EIRP* (see 3.1) may be used as a convenient statement of environmental level.

4.4 *Statistical considerations*

All sources of interference and the couplings between source and susceptor can be specified quantitatively in terms of specific parameters. In describing a given environment, one must recognize that these parameters are subject to statistical variation either from source to source of a given type or with time for a given source. For example, mains impedances may vary as devices connected to the mains are energized and field distributions may depend critically on positions of objects or personnel in the vicinity of the source or susceptor. Thus, the accuracy of a predicted environmental condition may depend upon the care with which such factors are accounted for.

As noted above, disturbance levels may vary with distance from the source. As susceptible devices can be located at distances on a somewhat random basis, very significant variations in field strengths may be experienced from one location to another.

4.5 *Implications for limits*

In view of the discussion in the previous paragraph, specification of limits must take into account the statistical uncertainties expected in levels of voltage, current, or field strength to be protected against. A choice exists between requiring devices with high immunity or low emission levels in order to provide protection in all possible configurations, or placing restrictions on the location of susceptible devices and thereby enable relaxation of limits. Which philosophy is adopted will ultimately depend upon economic and criticality factors to be determined between manufacturer and user in each case.

It should be understood that the environmental levels at a given location predicted following procedures outlined here are dependent upon installation practices used in that location.

Equipment may be installed in a special way which will protect it from the degradation of performance that would otherwise be experienced.

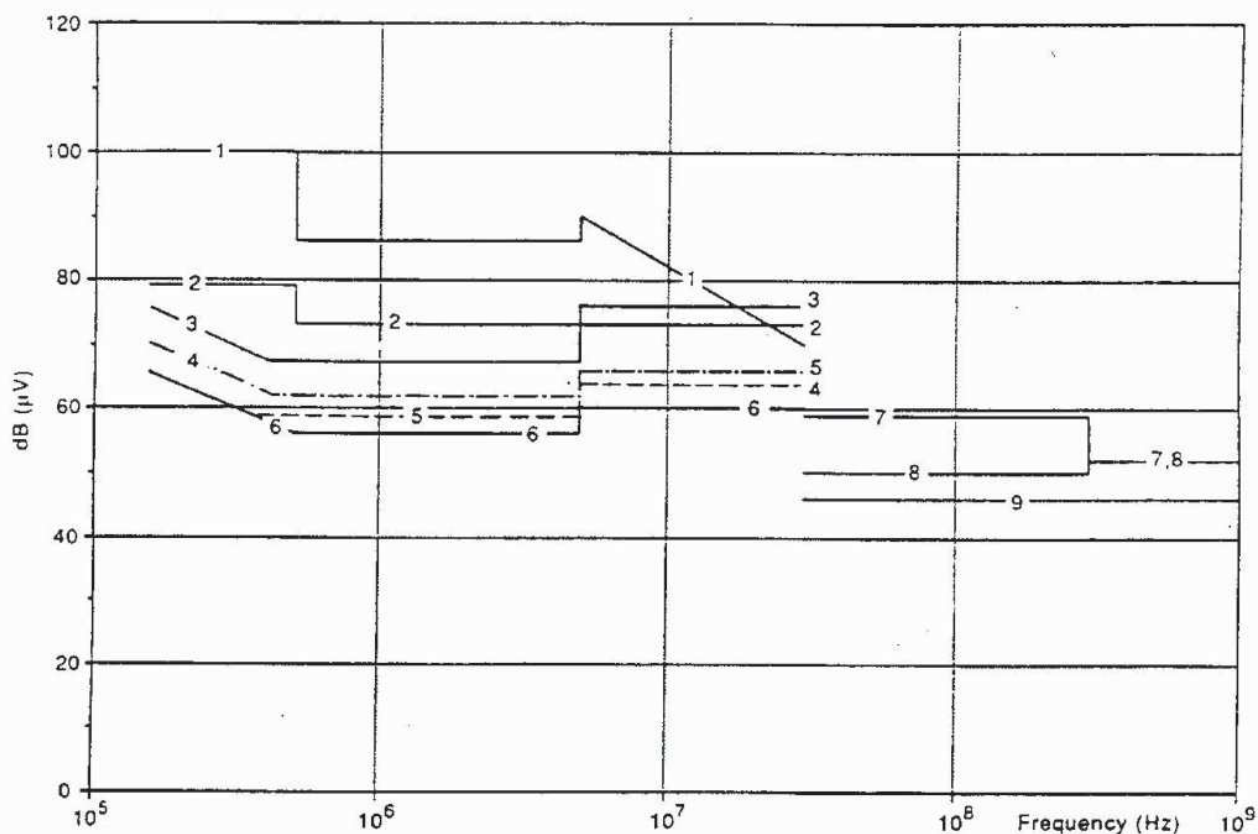
4.6 *Environment implied by invoking of standard limits*

Standard limits on emission have been developed by national and international regulatory authorities, and by voluntary standardization organizations. To the extent that such limits are applied, they serve to control environmental levels. Two examples which may be mentioned are the environment inside a commercial aircraft and the general environment where radio receivers may be located.

4.6.1 Conducted environment

As an example figure 8 gives a summary of low-level conducted emission levels recommended by CISPR in the frequency range from 150 kHz to 1 GHz. These levels are expressed in terms of dB (μ V) measured across an artificial network which below 30 MHz simulates the impedance of the power line and above 30 MHz that of the antenna.

It is noted that levels vary from about 200 μ V to about 16 mV depending upon the frequency and the device generating the emission. The levels are those measured by a CISPR receiver which contains a quasi-peak weighing circuit designed to give a first-order correlation between the measured quantity and the interference effect on radio reception produced by various waveforms. Since many disturbance sources are indeed subject to limits such as these, it is considered that the levels presented here are representative of what one might expect to find on the mains leads. However, as mentioned previously not all devices are controlled and one must be particularly alert to the possibility of an uncontrolled device being connected in such a way as to affect a particular environment. In some countries limits have been adopted below 150 kHz.



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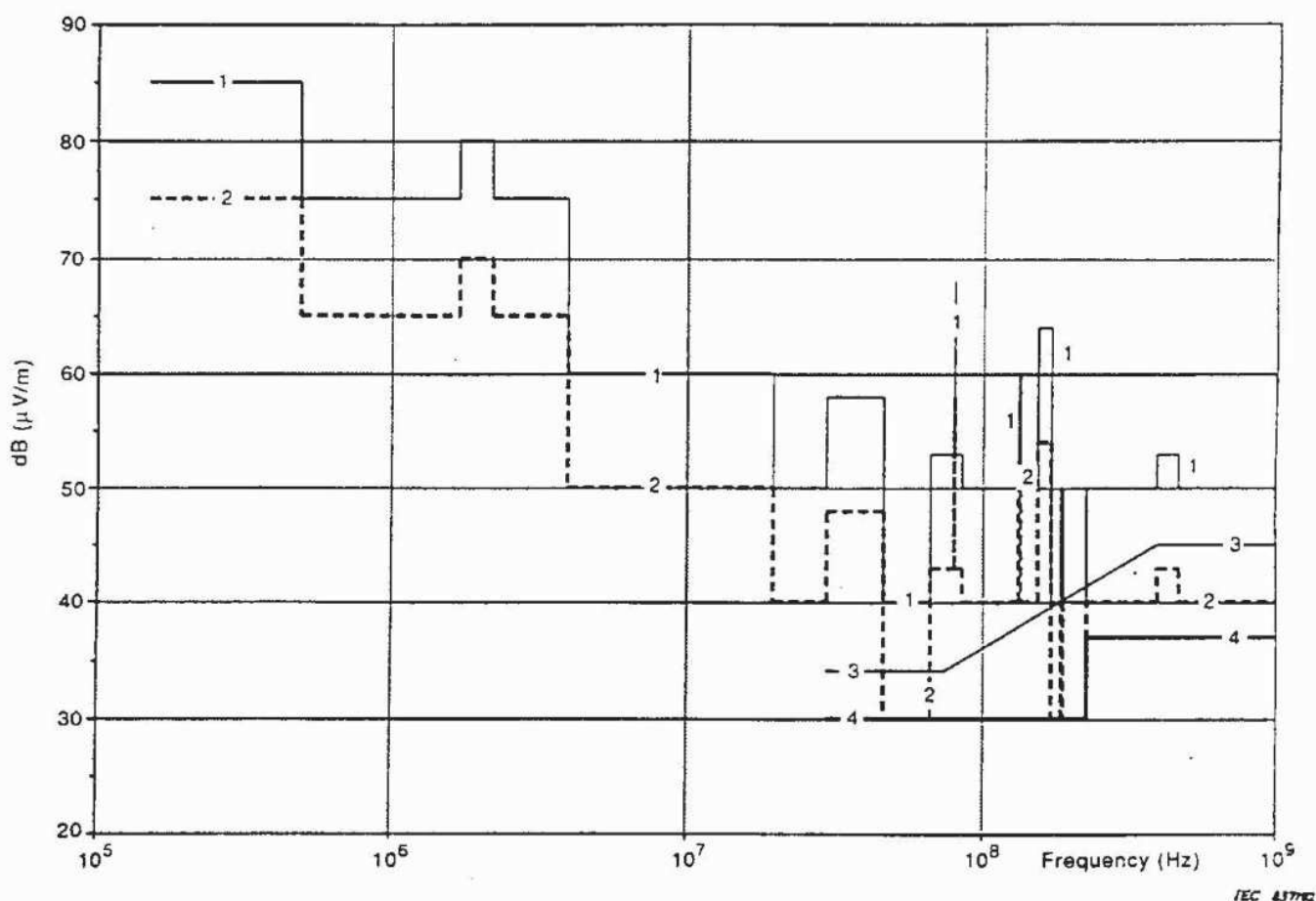
- 1) Group 2 ISM equipment, class A, quasi-peak
- 2) Group 1 ISM equipment, class A, quasi-peak, and ITE, class A, quasi-peak
- 3) Portable tools (1 000 W to 2 000 W)
- 4) Portable tools (700 W to 1 000 W)
- 5) Portable tools (<700 W)
- 6) Class B ISM equipment, quasi-peak, and ITE, class B, quasi-peak
- 7) Frequency modulation car radios
- 8) Frequency modulation sound receivers
- 9) Television receivers and video recorders

Figure 8 – CISPR limits for conducted emission

The use of a quasi-peak detector is relevant only to interference problems involving the reception of broadcast signals. In more general EMC problems the use of the quasi-peak detector might give misleading information. Similarly, the artificial mains impedance used in the standardized CISPR measurement method may not be valid for other applications.

4.6.2 Radiated environment

Figure 9 shows a summary of CISPR limit levels. Note that these levels are given in terms of electric field strengths at specified distances, so that descriptions of consequent radiated levels at a particular location can be validated only to the extent that the position and the nature of each source can be identified.



- 1) Group 2 ISM equipment, class A, 30 m measurement distance
- 2) Group 2 ISM equipment, class A, measuring distance 30 m from exterior wall outside the building in which the equipment is situated
- 3) Vehicles, motor boats, and spark-ignited engine-driven devices, 10 m measurement distance
- 4) Group 1 ISM equipment, 30 m measurement distance

Figure 9 – CISPR limits (field strength) for radiated emission