INTERNATIONAL STANDARD

IEC 60728-12

First edition
2001-02

Cabled distribution systems for television and sound signals –

Part 12: Electromagnetic compatibility of systems

Systèmes de distribution par câbles destinés aux signaux de radiodiffusion sonore et de télévision –

Partie 12: Compatibilité électromagnétique des systèmes



Reference number
IEC 60728-12:2001(E)

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International Electrotechnical Commission 3, rue de Varembé Geneva, Switzerland
Telefax: +41 22 919 0300 e-mail: inmail@iec.ch IEC web site http://www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CABLED DISTRIBUTION SYSTEMS FOR TELEVISION AND SOUND SIGNALS –

Part 12: Electromagnetic compatibility of systems

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
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International Standard IEC 60728-12 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this standard is based on the following documents:

FDIS	Report on voting
100/191/FDIS	100/217/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A and B are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2003. At this date, the publication will be:

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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The following differences exist in some countries:

a) In Great Britain, based on the national Regulation MPT 1510: *Radiation Limits and Measurement Standard; Electromagnetic radiation from cabled distribution systems operating in the frequency range 30 MHz – 1 000 MHz*; May 1984 (revised 1989 and 1997) measurements of radiation from complete systems at the distribution frequencies in use and at other specified relevant frequencies are performed (Great Britain).

b) In Great Britain, based on the national Regulation MPT 1520: *Radiation Limits and Measurement Standard; Electromagnetic radiation from cabled distribution systems operating in the frequency range 300 kHz – 30 MHz*; July 1984 (revised 1989 and 1997), measurements of radiation from complete systems at the distribution frequencies in use and at other specified relevant frequencies are performed (Great Britain).

c) In Finland, based on the Radio Act and the Telecommunications Market Act, the Telecommunications Administration Centre can restrict or prohibit the use of certain channels in cable networks for the reason that radiation from the network causes excessive interference to co-frequency radiocommunications, even if the network fulfils the radiation limits as stated in this standard (Finland).

d) In Finland, based on the Telecommunications Market Act, the Telecommunications Administration Centre can restrict or prohibit the use of certain channels in cable networks for the reason that the signal quality in the network will be degraded because of interference caused by leakage to the network of co-frequency radiocommunication signals (Finland).

e) In Japan, based on the Regulation for Enforcement of the Cable Television Broadcast Law, radiated field strength (signal leakage) should not be more than 34 dB(μV/m) (≤50 μV/m) at a distance of 3 m in the frequency range of operating channels (Japan).

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INTRODUCTION

Standards of the IEC 60728 series deal with cable networks for television, sound signals and interactive services including equipment, systems and installations:

– for headend-reception, processing and distribution of sound and television signals and their associated data signals, and

– for processing, interfacing and transmitting all kinds of interactive services using all applicable transmission media.

They cover all kinds of networks, such as:

– CATV-networks,

– MATV- and SMATV-networks,

– individual receiving networks,

and all kinds of equipment installed in such networks.

The scope of these standards extends from antennas and special signal source inputs to headend or other interface points, to networks as a whole, up through network outlets, or terminal inputs, where no network outlet exists.

The standardisation of any user terminals (i.e. tuners, receivers, decoders, multimedia terminals etc.) as well as of any coaxial and optical cables and accessories is therefore excluded.

This part of IEC 60728 has been prepared to lay down the measuring methods and performance requirements and recommendations for electromagnetic compatibility of cabled distribution networks for television and sound signals.

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CABLED DISTRIBUTION NETWORKS FOR TELEVISION AND SOUND SIGNALS –

Part 12: Electromagnetic compatibility of systems

1 Scope

This part of IEC 60728 applies to the radiation characteristics and immunity to electromagnetic disturbance of cable networks for television signals, sound signals and interactive services and covers the frequency range 0,15 MHz to 3,0 GHz.

This standard specifies EMC performance requirements and lays down the methods of measurement.

Cable networks beyond the network outlets (e.g. receiver leads, in simplest terms) which begin at the network outlet and at the subscriber's terminal equipment shall comply with these recommendations provided that no other specific provisions apply.

To minimise the risk of interference to other radio services caused by possible radiation from a cable network and to limit the possible penetration of external signals which may interfere with the operation of a network, it is necessary not only to use equipment which satisfies the requirement of IEC 60728-2 regarding limits of radiation and of immunity to external fields, but, also, to ensure the integrity of all cable connections on each item of active or passive cable network equipment.

Cable networks employing coaxial cables can be a source of interference to a wide range of services that utilise the radio frequency spectrum. These include not only emergency services, safety of life, broadcasting, aeronautical and radio navigation services but also land mobile, amateur and cellular radio services.

As existing and planned radio services need to be protected, radiation limits specified for cabled networks should be complied with.

Additional protection for certain services may be required by national regulations.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60728. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60728 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(161), *International Electrotechnical Vocabulary (IEV) – Chapter 161: Electromagnetic compatibility*

IEC 60096, (all parts) *Radio frequency cables*

IEC 60728, (all parts) *Cabled distribution systems for television and sound signals*

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IEC 60728-1:1986, *Cabled distribution systems – Part 1: Systems primarily intended for sound and television signals operating between 30 MHz and 1 GHz* [1]

IEC 60728-2:—, *Cabled distribution systems for television and sound signals – Part 2: Electromagnetic compatibility of equipment* [2]

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this standard, the definitions contained in IEC 60050(161) and the following definitions apply.

NOTE The most important definitions of IEC 60050(161) are repeated hereafter with the IEV numbering given in brackets.

3.1.1
(electromagnetic) radiation
1) phenomenon by which energy in the form of electromagnetic waves emanates from a source into space;

2) energy transferred through space in the form of electromagnetic waves

NOTE By extension, the term "electromagnetic radiation" sometimes also covers induction phenomena.

[IEV 161-01-10]

3.1.2
immunity (to a disturbance)
ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance [IEV 161-01-20]

3.1.3
electromagnetic disturbance
any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[IEV 161-01-05]

3.1.4
screening effectiveness
ability of an equipment or system to attenuate the influence of electromagnetic fields from outside the equipment or system or to suppress the radiation of electromagnetic fields from inside the equipment or system

3.1.5
well-screened
a test set-up can be considered "well-screened" if its radiation level, when terminated with a matched load, is at least 20 dB below the expected radiation level of the equipment under test, the test set-up and the equipment being supplied with the same input signal level

[1] A new edition of this publication is under consideration.

[2] To be published

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3.1.6
electromagnetic interference (EMI)
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance [IEV 161-01-06]

3.1.7
operating frequency range
passband for the wanted signals for which the equipment has been designed

3.1.8
carrier-to-interference ratio
the minimum level difference measured at the output of an active equipment between the wanted signal and

– intermodulation products of the wanted signal and/or unwanted signals generated due to non-linearities;

– harmonics generated by an unwanted signal;

– unwanted signals that have penetrated into the operating frequency range;

– unwanted signals that have been converted to the frequency range to be protected (operating frequency range)

3.1.9
headend
equipment which is connected between receiving antennas or other signal sources and the remainder of the cable network, to process the signals to be distributed

NOTE The headend may, for example, comprise antenna amplifiers, frequency converters, combiners, separators and generators.

3.1.10
system outlet
a device for interconnecting a subscriber feeder and a receiver lead

3.1.11
inhouse network
a cable network normally laid out inside buildings to which splitters, subscriber taps or looped system outlets are connected

3.1.12
ignition noise
the unwanted emission of electromagnetic energy, predominantly impulsive in content, arising from the ignition system within a vehicle or device

3.1.13
building penetration loss
the ability of buildings, in which networks for distribution of television and sound are located, to attenuate the influence of electromagnetic fields from outside the buildings or to suppress the radiation of electromagnetic fields from inside the buildings

3.1.14
disturbance level
the level of an electromagnetic disturbance at a given location, which results from all contributing (interference) sources

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3.1.15
degradation (of performance)
an undesired departure in the operational performance of any device, equipment or system from its intended performance.

NOTE The term "degradation" can apply to temporary or permanent failure.

[IEV 161-01-19]

3.1.16
subscriber's feeder
a feeder connecting a subscriber tap to a network outlet or, where the latter is not used, directly to the subscriber equipment

NOTE A subscriber feeder may include filters and a balun transformer.

3.1.17
receiver lead
a lead which connects the network outlet to the subscriber equipment

3.1.18
external immunity
ability of a device, equipment or network to perform without degradation in the presence of electromagnetic disturbances entering other than via its normal input terminals or antenna [IEV 161-03-07, modified]

3.2 Abbreviations

AM	Amplitude Modulation
CATV	Community Antenna Television (network)
DSC	Distress, Safety and Calling
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPIRB	Emergency Position Indicating Radiobeacons
FM	Frequency Modulation
ILS	Instrument Landing System
ITU-R	International Telecommunication Union – Radiocommunication
MATV	Master Antenna Television (network)
RF	Radio Frequency
SMATV	Satellite Master Antenna Television (network)
TV	Television
VOR	VHF Omnidirectional Range
VSB	Vestigial Side Band

4 Methods of measurement

These methods of measurement describe the procedures for the testing of cable networks. The purpose of the measurements is to determine:

– the level of radiation generated by cable networks, and

– the immunity of cable networks to external field strengths (e.g. those radiated by other radiocommunication services and RF applications).

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The measurements cover the essential parameters and environmental conditions in order to assess cases of electromagnetic incompatibility between cable networks and other electrical or electronic equipment, networks, installations or other cabled networks with respect to the intended operation of such cable networks.

NOTE Methods of measurement for digital signals are under consideration.

4.1 Radiation from cable networks

The methods described hereafter are applicable to the measurement of radiation from cable networks (combination of cables, equipment and networks).

Testing of the cable networks for compliance with the relevant limits may be initially carried out with the terminal equipment connected. Where limits are exceeded, individual sections of the network (e.g. headend, satellite-receiving outdoor unit, distribution network, distribution installation beyond the network outlets and terminal equipment) may be tested in succession to determine beyond any doubt which section of the network does not comply with the limits.

The number of test frequencies shall be selected to give a realistic representation of the radiation pattern throughout the operating frequency range and to enable the maximum level of radiation to be recorded and the results interpreted accurately.

The field strength measurement procedure is used in order to achieve results which are sufficiently accurate and do not require excessive technical effort.

The substitution measurement technique is applied to carry out more accurate measurements of the radiated disturbance power level generated by any part of the network.

If discussions arise about the actual radiation from a cable network, the substitution method according to 4.1.2 shall apply.

The maximum permitted radiation level is given in Table 1.

The following problems can cause radiation of cable networks:

– poor or faulty screening of passive equipment (plugs, splitters, etc.);
– poor or faulty screening of active equipment (amplifiers, converters, etc.);
– poor or faulty screening of the distribution cables against induced voltages;
– excessive impedance in the ground connections of the input terminals of active and passive equipment;
– insufficient rejection of power supply-borne interference on mains-powered equipment;
– inadequate mounting of connectors and cables;
– damage to the screening of cables or connectors.

4.1.1 Field strength method

4.1.1.1 Equipment required

The equipment required for the measurement of the radiation from a network is listed below:

– a suitable spectrum analyzer (battery powered) with a digital recorder or a plotter;

  The spectrum analyzer should cover the frequencies distributed within the network with a resolution bandwidth (IF bandwidth) of 100 kHz and an appropriate slow sweep speed.

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– a calibrated antenna;

  It is strongly recommended that a very broadband antenna be used to reduce the number of measurements. It is also recommended that a directive antenna be used to be able to test each side of the street independently of the other one. A good choice would be, for example, a log-periodic antenna covering the frequency range from 80 MHz to 950 MHz.

– a calibrated low-noise amplifier covering the required frequency range;

– an antenna cable of known loss/frequency characteristic;

– a suitable vehicle to carry the above equipment, with the broadband antenna fixed on the top of the vehicle and oriented in order to get the maximum reception level perpendicular to the driving direction.

4.1.1.2 Measurement procedure

The antenna shall be connected to the input of the spectrum analyzer via the low-noise amplifier, if necessary, with a well-screened and well-matched coaxial cable.

Before starting measurements, a calibration procedure (see 4.1.1.3) is required to obtain the limit line related to the limit field values (see 5.1). The measurement procedure can then start for the first street, following the centre line of the lane closest to the building where the distribution network is installed.

It is important to drive the vehicle slowly along the street, according to the spectrum analyzer operation, to get a clear overview on the screen of the spectrum analyzer.

A survey is first conducted in order to ascertain the frequencies and field strengths of local transmitters so that these may be eliminated from the measurement results.

If one or more carriers exceed the limit line, the vehicle stops and the operator checks the frequency(ies) of this (or those) carrier(s).

If one or more of the exceeding carriers is emanating from the network, then the operator shall record the spectrum analyzer pattern and note that place on the map of the town for a future repair. After repair, the field strength should be measured again.

Because of the antenna directivity, the vehicle has to be driven along each street twice to test both sides.

4.1.1.3 Calibration procedure

When a calibrated broadband antenna is used, the limit line shall be obtained for each frequency by calculation with the formula and using the antenna factor given by the antenna manufacturer:

$$U_L = E_L - (k_A + A_C)$$

where

U_L is the level corresponding to the permitted limit, in dB(µV);

E_L is the field strength limit for the considered frequency, in dB(µV/m);

k_A is the antenna factor, in dB;

A_C is the cable loss between antenna and spectrum analyzer, in dB.

If the field strength limit is a very low value, a low noise preamplifier shall be inserted between the antenna and the spectrum analyzer.

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In that case, the formula shall be:

$$U_L = E_L - (k_A + A_C) + G$$

where G is the gain of the low-noise amplifier, in dB.

4.1.2 Power method (substitution measurement method)

In order to obtain more accurate results on the equivalent radiated disturbance power generated by a network, or if the measurement accuracy achieved on the basis of previous measurement procedures is not sufficient, the substitution measurement method shall be applied.

4.1.2.1 Equipment required

The equipment required for the measurement of the radiation from a network is listed below:

– a selective measuring receiver covering the frequency range of interest and of sufficient sensitivity;
– broadband antennas for the frequency range from 30 MHz to 950 MHz and a log-periodic antenna for the frequency range from 950 MHz to 3 000 MHz;
– a signal generator covering the frequency range of interest and with a sufficient output power;
– a transmitting antenna with a front-to-back ratio of minimum 10 dB and a known gain;
– an attenuator to be connected to the terminals of the transmitting antenna;
– suitable measurement cables;
– suitable mounting equipment to enable the height and polarisation of the transmitting antenna to be adjusted (e.g., a telescopic mast).

4.1.2.2 Measurement procedure

First the maximum radiation of the network in the direction of interest shall be measured at a suitable distance with a broadband receiving antenna and a measuring receiver (spectrum analyzer) changing the height and polarisation of the antenna to obtain a maximum reading.

The maximum measured values and their related frequencies shall be noted (level a_1).

Then the cable distribution network (either the complete network or a section of it) is replaced by a transmitting antenna supplied by a calibrated signal generator. The antenna shall be a type with a front-to-back ratio of minimum 10 dB, to minimise the reflection effects from the building.

An attenuator connected to the base of the antenna is required in all cases in order to avoid any mismatch. The transmitting antenna shall be set up in front of the wall of the building in the area of the supposed maximum radiation source.

To minimise other unwanted reflections, the signal generator shall at first be set to a level P_{SG2}, so that a sufficient readable value can be noted on the measuring receiver (level a_1). The level of P_{SG2} shall be fixed.

Then the position (height and polarisation) of the transmitting antenna shall be varied in order to get the maximum reading on the measurement receiver (equal or greater than the level a_2).

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In this position the transmitting antenna shall be fixed. Now the RF level of the signal generator (P_{SG1}) shall be varied to obtain the same level a_1 on the measuring receiver.

The resulting disturbance power shall be calculated by following formula:

$$P = P_{SG1} - A_C - A_T + G_A$$

where

P is the radiated power of the network related to a half-wave dipole, in dB(pW);

P_{SG1} is the available output power of the signal generator, in dB(pW);

A_C is the cable attenuation, in dB;

A_T is the attenuator loss, in dB;

G_A is the gain of the transmitting antenna related to a half-wave dipole, in dB.

The maximum disturbance power shall meet the requirements given in 5.1.

By the above-mentioned measurement method, the ground reflections are eliminated with sufficient accuracy.

4.2 Immunity of cable networks

Interference can enter cable network equipment by the following means:

– poor or faulty screening of passive equipment (plugs, splitters, etc.);
– poor or faulty screening of active equipment (amplifiers, converters, etc.);
– poor or faulty screening of the distribution cables against induced voltages;
– poor or faulty screening of the distribution cables against induced currents;
– excessive impedance in the ground connections of the input terminals of active and passive equipment;
– insufficient rejection of power supply-borne interference on mains powered equipment;
– inadequate mounting of connectors and cables;
– damage of the screening of cables or connectors.

The carrier-to-interference ratio caused by an external field at any subscriber outlet shall be measured by means of a suitable measuring receiver or spectrum analyzer. The results shall comply with the limits given in 5.2.

4.2.1 Measurement procedure using a disturbing high-power local transmitter

In the case of disturbance, the carrier-to-interference ratio shall be measured at the outlets subject to disturbance.

First, the wanted signal level in the disturbed channel shall be measured. Next, the cable network shall be disconnected from the interchange point or the antennas. The disconnected inputs shall be terminated with 75 Ω terminating loads.

The disturbance level of the ingress unwanted signal is then measured by means of a measuring receiver in the peak mode, taking into account the bandwidth of the signal. Care shall be taken to ensure that the measuring receiver is well-matched to the network under test and that the relevant return loss is taken into consideration.

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The difference between the wanted signal level and the level of the interfering unwanted signal shall comply with the RF carrier-to-interference ratio specified in Table 3.

If the carrier-to-interference ratio is equal to or greater than the nominal value, the network meets the requirements. If the carrier-to-interference ratio is less than the required ratio, further studies are necessary. All distribution installations beyond the network outlet (receiver leads, receiver, other subscriber installations) shall be disconnected from the network under test for the purposes of these studies. In the majority of cases disturbance is caused by these items. The measurement of the disturbance level shall be repeated. After the measurement, the operating condition of the network shall subsequently be restored.

If all these provisions do not lead to a better carrier-to-interference ratio, it must be assumed that the interfering signals are intruding into the cable network. In this case the interfering field strength outside the building shall be measured in the vicinity of the assumed point of penetration.

The maximum field strength shall be determined by changing the site of the antenna. The field strength limit at which the carrier-to-interference ratios according to Table 3 shall be met is indicated in Table 2.

If the interfering field strength is equal to or lower than this value, the network does not meet the requirements and measures shall be taken by the network operator to improve the immunity of the network.

If the measured interfering field strength exceeds this value, the cable network requirements do not correspond to the requirements of other radio services (high power local transmitter). A solution to this problem shall then be achieved by the national regulatory authorities and the radio services operators. See also Note 2 of Table 2.

5 Performance requirements

The relevant conditions applicable to cable networks required to meet the values specified in 5.1 and 5.2 are as follows:

– professional planning;
– compliance with the requirements of the IEC 60728 and IEC 60096 series;
– use of suitable equipment, components (plugs, connectors etc.) and coaxial cables fulfilling these standards, or use of such equipment as can be deemed suitable on the basis of the details of the technical data sheets;
– correct installation of all parts of network equipment including the provision of appropriate connections between cables, plugs and equipment. Thus, only suitable connections for plugs and clamps shall be used. The installation instructions of the manufacturer of the equipment and components shall be considered.

5.1 Radiation from cable networks

The maximum permitted radiation levels, given in Table 1, apply according to the method of measurement specified in 4.1, unless other values for each service to be protected are given in national radio regulations.

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Table 1 – Radiation limits

Frequency range	Maximum level	
	Radiated disturbance power	Radiated field strength
MHz	dB(pW)	dB(μV/m)
5 to 30	under consideration	under consideration
30 to 1 000	20	27
1 000 to 2 500	43	50
2 500 to 3 000	57	64

NOTE 1 If the radiated field strength is assumed to be the result of a point source of radiation at a distance of 3 m, the two methods are equivalent.

NOTE 2 Additional protection may be required for safety of life services operating within the above frequency ranges. Frequency ranges of typical safety of life services are given in Annex A.

5.2 Immunity of cable networks

The external immunity limit (Table 2) specifies the reference field strength level immediately outside the building at which a defined RF carrier-to-interference ratio (performance criterion as specified in Table 3) shall be obtained in the wanted channel at any point in the cable network.

Table 2 – Immunity limits

Frequency range	Field strength
MHz	dB(μV/m)
0,15 to 900	106
950 to 3 000	106

NOTE 1 The interdependence between the maximum allowable field strength and the minimum carrier-to-interference ratio according to IEC 60728-1 is given in Annex B.

NOTE 2 If an external field strength higher than that specified in Table 2 occurs and this field strength disturbs the corresponding channel in the cable network, special measures have to be taken (e.g. increasing signal level at the system outlet, improving the screening effectiveness of the network or changing/not using the affected cable channel, etc.).

The performance criteria for the cable networks refer to AM VSB TV signals in the frequency range 30 MHz to 950 MHz and to FM TV signals in the frequency range 950 MHz to 3 000 MHz.

Where other signals (e.g. digitally modulated signals) are distributed, the lower permissible carrier-to-interference ratios of these signals may not be applied in order to reduce the immunity of the cable network.

The method of measurement shall be chosen as specified in 4.2.1.

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Table 3 – Carrier-to-interference ratio to the reference field strength (immunity level)

Frequency range MHz	Carrier-to-interference ratio dB
5 to 30	under consideration
30 to 950	≥57 (AM)
950 to 3 000	≥33 (FM)

NOTE These requirements may be relaxed only for those channels on which the distributed television or FM radio signals are at their original broadcast frequencies, i.e. the wanted and unwanted carriers are synchronous. In this case, the required immunity is governed by the subjective acceptability of echoes on the signals distributed on these channels.

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Annex A
(informative)

Frequency ranges of typical safety of life services

Frequency range MHz			Service
74,800	to	75,200	Aeronautical radio navigation; ILS marker beacons
108,000	to	117,975	VOR and ILS localiser aeronautical radio navigation;
121,450	to	121,550	Emergency Position Indicating Radio Beacons (EPIRBs)
156,525			DSC distress, safety, and calling
156,7625	to	156,8375	International marine distress, safety and calling
242,950	to	243,050	EPIRBs
328,600	to	335,400	ILS
406,000	to	406,100	EPIRBs

In some areas additional protection is also required for radio astronomy bands and other radio services.

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Annex B
(informative)

Interdependence between the maximum allowable field strength and the minimum carrier-to-interference ratio

The external immunity limit of 106 dB(µV/m) for field strength can be calculated taking into account the minimum signal level at the system outlet and the minimum carrier-to-interference ratio, both according to IEC 60728-1, and assuming a building penetration loss and a coupling factor from field strength to a λ/2 dipole, both corresponding to the frequency 166 MHz, as follows:

Maximum field strength outside the building		106 dB(µV/m)
Minus building penetration loss	–8 dB	
Maximum field strength inside the building		98 dB(µV/m)
Minus coupling factor	–11 dB(1/m)	
Minus screening effectiveness for passive equipment (IEC 60728-2, Class A)	–85 dB	
Maximum distortion level on cable network		2 dB(µV)
Plus minimum carrier-to-interference ratio (IEC 60728-1)	+57 dB	
Plus tolerance margin	+1 dB	
Minimum signal level on cable network / at system outlet (IEC 60728-1)		60 dB(µV)

This calculation shows that the minimum signal level at the system outlet of 60 dB(µV) according to IEC 60728-1 corresponds with a maximum allowable field strength outside the building of 106 dB(µV/m).

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