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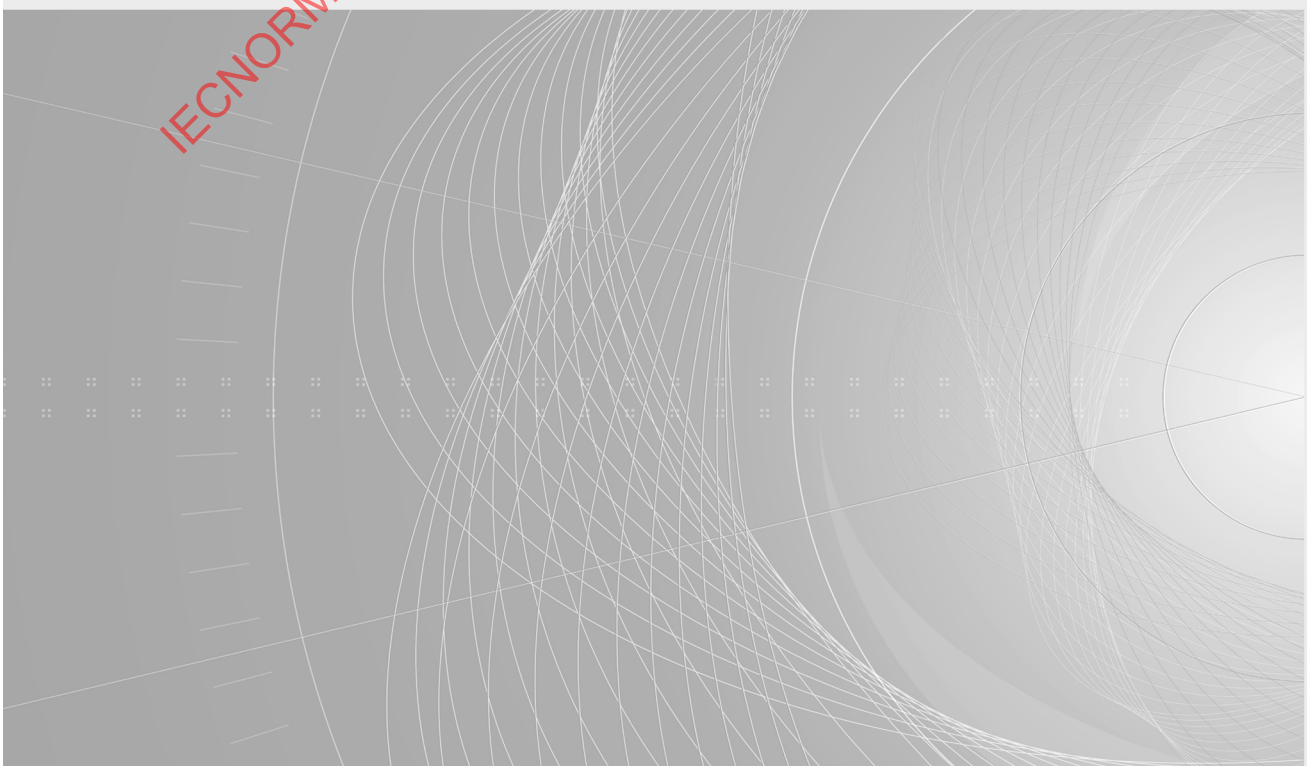
INTERNATIONAL STANDARD

Cable networks for television signals, sound signals and interactive services – Part 12: Electromagnetic compatibility of systems



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CONTENTS

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CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

Part 12: Electromagnetic compatibility of systems

FOREWORD

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International Standard IEC 60728-12 has been prepared by technical area 5: Cable networks for television signals, sound signals and interactive services, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This second edition cancels and replaces the first edition published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) IEC 60728-12 with its methods of measurement and EMC performance requirements is explicitly dedicated to "under operating conditions (in situ)" to ensure the ongoing EMC integrity of cable networks.
b) The first intermediate frequency range (1st IF range) for satellite signal transmission was extended to cover now frequencies from 950 MHz up to 3 500 MHz.

c) The method of measurement and the requirements for in-band immunity were extended taking into account the new EMC environment due to the allocation of broadband wireless services in the frequency band 694 MHz to 862 MHz. As a consequence, the limits of in-band immunity were specified for analogue and additionally for digital signals in this frequency range.

d) The substitution method of measurement (power method) was deleted.

e) EMC measurements below 30 MHz were deleted.

f) New Annex D “Measurements at other distances than the standard distance of 3 m”.

g) New Annex E “GPS based leakage detection system for cable networks”.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
100/2895/FDIS	100/2926/RVD

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

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The reader's attention is drawn to the fact that Annex A lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

A list of all parts in the IEC 60728 series, published under the general title *Cable networks for television signals, sound signals and interactive services,* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

Standards and deliverables of the IEC 60728 series deal with cable networks including equipment and associated methods of measurement for headend reception, processing and distribution of television and sound signals, and for processing, interfacing and transmitting all kinds of data signals for interactive services using all applicable transmission media. These signals are typically transmitted in networks by frequency-multiplexing techniques.

This includes, for instance:

- regional and local broadband cable networks,
- extended satellite and terrestrial television distribution systems,
- individual satellite and terrestrial television receiving systems,

and all kinds of equipment, systems and installations used in such cable networks, distribution and receiving systems.

The extent of this standardization work is from the antennas and/or special interfaces to the headend or other interface points to the network up to any terminal interface of the equipment on the customer's premises.

The standardization work will consider coexistence with users of the RF spectrum in wired and wireless transmission systems.

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

CABLE NETWORKS FOR TELEVISION SIGNALS, SOUND SIGNALS AND INTERACTIVE SERVICES –

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 3,5 GHz.

NOTE 1 Measurements below 30 MHz are not generally considered useful in the context of cable networks and are difficult to perform in practice.

This document specifies methods of measurement and EMC performance requirements under operating conditions (in situ) to ensure the ongoing EMC integrity of cable networks.

Cable networks beyond the system outlets (e.g. the receiver lead, in simplest terms) that begin at the system outlet and end at the input to the subscriber's terminal equipment are not covered by this document. Requirements for the electromagnetic compatibility of receiver leads are specified in IEC 60966-2-4, IEC 60966-2-5 and IEC 60966-2-6.

Cable networks and a wide range of radio services have to coexist. These include, for example, the emergency services, safety of life, broadcasting, aeronautical, radio navigation services and also land, mobile, amateur and cellular radio services. Frequency ranges of typical safety of life services are listed in Annex B. Additional protection for certain services may be required by national regulations. Annex A gives information on legal requirements in certain countries.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility* (available at: www.electropedia.org)

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

IEC 60728 (all parts), *Cable networks for television signals, sound signals and interactive services*

CISPR 16-1-1, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-4, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
building penetration loss
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

3.1.2
carrier-to-interference ratio
minimum level difference measured at the output of an active equipment or at any other interface within the network 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)

3.1.3
degradation
<of performance> undesired departure in the operational performance of any device, equipment or system from its intended performance

Note 1 to entry: The term "degradation" can apply to temporary or permanent failure.

[SOURCE: IEC 60050-161:1990, 161-01-19]

3.1.4
disturbance level
level of an electromagnetic disturbance at a given location, which results from all contributing (interference) sources

3.1.5
electromagnetic disturbance
any electromagnetic phenomenon which can degrade the performance of a device, equipment or system, or adversely affect living or inert matter

Note 1 to entry: An electromagnetic disturbance can be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[SOURCE: IEC 60050-161:1990, 161-01-05]

3.1.6
electromagnetic interference
EMI
degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

Note 1 to entry In French, the terms "perturbation électromagnétique" and "brouillage électromagnétique" designate respectively the cause and the effect, and should not be used indiscriminately.

Note 2 to entry In English, the terms "electromagnetic disturbance" and "electromagnetic interference" designate respectively the cause and the effect, but they are often used indiscriminately.

[SOURCE: IEC 60050-161:1990, 161-01-06]

3.1.7
electromagnetic radiation
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 1 to entry: By extension, the term "electromagnetic radiation" sometimes also covers induction phenomena.

[SOURCE: IEC 60050-161:1990, 161-01-10]

3.1.8
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 antennas

[SOURCE: IEC 60050-161:1990, 161-03-07]

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

Note 1 to entry: The headend can, for example, comprise antenna amplifiers, frequency converters, combiners, separators and generators.

3.1.10
ignition noise
unwanted emission of electromagnetic energy arising from the ignition system within a vehicle or device

Note 1 to entry: Ignition noise is predominantly impulsive in content.

3.1.11
immunity
<to a disturbance> ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance

[SOURCE: IEC 60050-161:1990, 161-01-20]

3.1.12
internal immunity
ability of a device, equipment or system to perform without degradation in the presence of electromagnetic disturbances appearing at its normal input terminals or antennas

[SOURCE: IEC 60050-161:1990, 161-03-06]

3.1.13
operating frequency range
passband for the wanted signals for which the equipment has been designed

3.1.14
receiver lead
lead that connects the system outlet to the subscriber's equipment

3.1.15
screening effectiveness
ability of equipment or a 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

3.1.16
spur network
cable network normally laid out inside buildings to which splitters, subscriber's taps or looped system outlets are connected

3.1.17
subscriber's feeder
feeder connecting a subscriber's tap to a system outlet or, where the latter is not used, directly to the subscriber's equipment

Note 1 to entry: A subscriber's feeder can include filters and balun transformer.

3.1.18
system outlet
device for interconnecting a subscriber's feeder and a receiver lead

3.2 Abbreviated terms

AM	Amplitude Modulation
DSC	Distress, Safety and Calling
DVB	Digital Video Broadcasting
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EPIRB	Emergency Position Indicating Radiobeacons
FM	Frequency Modulation
GPS	Global Positioning System
HFC	Hybrid Fibre Coax
IEV	International Electrotechnical Vocabulary
ILS	Instrument Landing System
LAS	Leakage Analysis Software
MIL	Military (use)
NAV	(Aeronautical) Navigation (Radio)
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SAT-IF	Satellite Intermediate Frequency
TV	Television
VOR	VHF Omnidirectional Range

VSB Vestigial Side Band

4 Methods of measurement

4.1 Basic principles

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).

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.

During the test, the cable network shall operate within its normal operating conditions, e.g. with regard to the signal level and signal quality at the system outlets.

NOTE Methods of measurement for radiated digitally modulated signals are under consideration. For digital egress measurements, where the level of emission is such that the signal is indeterminate from the general and other background noise, an analogue substitution method is employed by using an analogue video carrier where possible.

4.2 Radiation from cable networks

4.2.1 General

The methods described in 4.2 are applicable to the measurement of radiation from cable networks (combination of cables and equipment). The termination point of the cable network to be measured is the system outlet.

When testing cable networks, the terminal equipment may initially be connected. Testing of the cable networks against the relevant limits requires the terminal equipment to be disconnected. Where limits are exceeded, individual sections of the network (e.g. headend, satellite receiving outdoor unit, cable network, distribution installation) may be tested in succession to determine which section of the network does not operate within 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 maximum permitted radiation level is given in Table 1.

4.2.2 Field strength method

4.2.2.1 Used antenna

The field strength method uses a suitable electromagnetic field antenna in the frequency range 30 MHz to 3,5 GHz which is conventionally calibrated in terms of "equivalent electric component" of the electromagnetic field.

4.2.2.2 Equipment required to measure the electric field in the frequency range 30 MHz to 3,5 GHz

For the measurement of the radiation from a network, a calibrated measurement system comprising a radio disturbance measuring receiver with broadband dipole or a log-periodic antenna with tripod to measure the electric field component, as specified in CISPR 16-1-1 and CISPR 16-1-4, is required.

NOTE Measuring results received by the use of the described calibrated measuring system do not need a further correction due to near field condition while measuring.

This document defines radiation levels in terms of field strength at a 3 m distance from a radiating object. The standard distance is 3 m outside a building. In special cases (e.g. block of flats), a different measurement distance can be chosen as described in Annex D taking into account Formula (D.1).

In the frequency range 30 MHz to 1 000 MHz, a measurement bandwidth of 120 kHz and the quasi-peak detector shall be selected. In the frequency range 1 000 MHz to 3 500 MHz, a measurement bandwidth of 1 MHz and the peak detector shall be selected. The measurement bandwidths and the relevant detector types are defined in CISPR 16-1-1.

4.2.2.3 Measuring procedure to measure the electric field in the frequency range 30 MHz to 3,5 GHz

It will be necessary to ensure that the cable network is operating with its normal signal levels.

To reduce the measurement time, the frequency range is normally scanned using the peak detector. The maximum disturbance field strength values identified should then be re-measured using the quasi-peak detector.

In the case of a broadband dipole, the measurement distance d is equal to the distance between the BALUN and the telecommunications network and in the case of a log-periodic antenna equal to the distance between the telecommunications network and the reference point of the antenna.

At the specified measuring point, the direction, height and polarization (horizontal and vertical) of the measuring antenna shall be varied in order to measure the maximum disturbance field strength.

NOTE 1 The actual variation of antenna parameters, particularly the antenna height, depends on the frequency to be measured. Where the size of the calibrated measuring antenna is not practical, the use of a calibrated loop antenna is useful.

The measurement result shall be observed for up to approximately 15 s. The relevant result is the maximum sustained value. Individual peaks shall be ignored.

If the measurement system used delivers only measurement results as RF-voltage levels, the disturbance field strength level is determined by converting the RF-voltage level using Formula (1):

$$E_{\text{dist}} = u_{\text{l}} + a_{\text{c}} + k_{\text{a}} \quad (1)$$

where

E_{dist} is the calculated disturbance field strength level in dB(µV/m);

u_{l} is the measured voltage level in dB(µV) at the antenna input of the measuring receiver (50 Ω);

a_{c} is the attenuation of the measuring cable in dB;

k_a is the antenna factor due to the specification of the manufacturer or the calibration of the measuring antenna in dB.

NOTE 2 Independently of the actual measurement distance used in any case for the calculation of the disturbance field strength level, the antenna factor (free space, due to the specification of the manufacturer or the calibrations) will be taken into account.

4.2.3 Subcarrier measurement procedure

4.2.3.1 General

The analogue subcarrier procedure is used when a direct measurement of radiation using broadband digital signals is not possible (e.g. when searching leaks or determination of summation of radiated field strength). This is due to a sensitivity decrease at the measurement receiver input resulting from a decrease in the signal-to-noise ratio in case of broadband disturbers. The necessary increase of the measuring dynamics can be achieved by narrow-band subcarriers.

4.2.3.2 Emission level and adjustments

For the evaluation of radiated disturbances of broadband digital signals using the subcarrier method first, the respective power levels shall be determined. First, the level of the wanted broadband digital signal at the feeding point for the subcarrier shall be established using the appropriate bandwidth (see Table 1). It is recommended to use the appropriate detector for each relevant frequency range (i.e. quasi-peak detector below 1 GHz, peak detector above 1 GHz).

Subsequently, it is to be examined whether a subcarrier is already present or other narrow-band reference signals can be used as subcarriers. Otherwise, an unmodulated sinusoidal subcarrier, if possible fed into the gap between the digital signals, is used. This subcarrier is applied so that the level of this signal, measured with a measuring bandwidth of 200 Hz, corresponds to the measured value of the digital signal measured before.

If necessary, the subcarrier can be fed with an increased level compared to the wanted level of the digital signal. It is important to appropriately take the system restrictions into account. With the determination of the disturbance field strength of the subcarrier outlined in 4.2.3.3, the received measured value shall be corrected accordingly.

In any case, the application of subcarriers shall be co-ordinated with the respective local network operator.

4.2.3.3 Determination of disturbing field strength

When the levels of subcarriers and broadband digital signals have been adjusted according to 4.2.3.2, the results of the subcarrier measurements at the relevant measuring points provide the dominant electrical field strength either directly or indirectly as conducted voltage at the antenna input of the measurement receiver.

If the subcarrier is fed into the relevant cable network with a higher level compared to the digital wanted signal, this level difference shall be subtracted from the received measured values accordingly. The result gives the disturbance field strength levels at the measuring point, together with the wanted signal transmission. The general approach to determine the field strengths as described in 4.2.2.1 and 4.2.2.3 remains untouched and is applied accordingly.

4.2.4 GPS based leakage detection system

To get a first and quick survey upon possible leakages of cable networks, GPS based leakage detection systems could be used. There are systems from different vendors available which all work in a similar manner. Annex E gives a short introduction to the principle function of such detection systems.

4.3 Immunity of cable networks

4.3.1 General

The carrier-to-interference ratio at any system outlet shall be measured by means of a suitable measuring receiver or spectrum analyser. The results shall meet the limits given in 5.3.

4.3.2 Measurement procedure for interference caused by high-power local outdoor transmitter

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

Initially, the wanted signal level in the disturbed channel shall be measured at each outlet. After that, the cable network shall be disconnected from the interchange point or the antennas as well as at the system outlets. The open interfaces shall be terminated with 75 Ω terminating loads.

The disturbance level of the ingress signal is then measured at each outlet by means of a measuring receiver in the peak mode, taking into account the bandwidth of the wanted signal. Ensure that the measuring receiver is well-matched to the network under test and that the relevant return loss is taken into consideration.

The difference between the wanted signal level and the level of the interfering signal level shall meet the RF carrier-to-interference ratio specified in Table 4.

If the carrier-to-interference ratio is equal to or greater than the stated 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 system outlet (receiver leads, receiver, other subscriber's 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 normal operating condition of the network shall subsequently be restored.

If all these provisions do not lead to a better carrier-to-interference ratio, it shall be assumed that the interfering signals intrude into the cable network. Then, 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 4 shall be met is indicated in Table 3.

If the interfering field strength is equal to or lower than this value, the network does not meet the requirements.

If the measured interfering field strength exceeds this value, then this problem should be referred to the national regulatory authorities.

5 Performance requirements

5.1 General conditions

The relevant conditions in the sense of good engineering practice applicable to cable networks to meet the values specified in 5.2 and 5.3 are as follows:

- professional planning;
- compliance with the requirements of the IEC 60728 series and IEC 60096 series;

- use of suitable equipment, components (plugs, connectors, etc.) and coaxial cables which are in accordance with the IEC 60728 series and IEC 60096 series, or use of such equipment which 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. Therefore, only suitable connections for plugs and clamps shall be used. The installation instructions of the manufacturer of the equipment and components shall be considered.

5.2 Radiation from cable networks and other sources

5.2.1 General

Cable networks are operated in a general EMC environment that may be influenced by a large number of equipment and systems, the EMC behaviour of which is described in different product standards (e.g. CISPR 32). Therefore, it might be difficult or even impossible to distinguish between the different sources of disturbances.

The maximum permitted radiation levels, given in Table 1, shall apply according to the method of measurement specified in 4.2.

5.2.2 Measurement of the total radiation

For the measurement of the radiation (caused by a cable network and/or all other possible disturbance sources), the total radiation level is measured with a receiver having a quasi-peak detector and/or a peak detector and measuring bandwidths as stated in Table 1 (according to CISPR 16-1-1 and CISPR 16-1-4).

Table 1 – Limits of total radiation

Frequency range MHz	Field strength limit at 3 m distance dB(µV/m)	Measuring bandwidth kHz	Measuring detector
30 to 950	40	120	Quasi-peak
950 to 2500	50	1000	Peak
2500 to 3500	64	1000	Peak

5.2.3 Measurement of narrowband radiation

If during the measurement of the total radiation according to 4.2.2 a significant contribution of single carrier disturbance is present, the measurements shall be repeated and the radiation limits according to Table 2 shall apply.

Table 2 – Narrowband radiation limits

Frequency range MHz	Field strength limit at 3 m distance dB(µV/m)	Measuring bandwidth kHz	Measuring detector
30 to 950	27	120	Quasi-peak
950 to 2500	50	1000	Peak
2500 to 3500	64	1000	Peak

For single carrier measurements, other receivers can also be used.

5.3 Immunity of cable networks

Table 3 details the maximum expected field strength levels immediately outside the building. These levels should be used to determine a defined RF carrier-to-interference ratio (performance criterion as specified in Table 4) to be obtained in the wanted channel at any point in the cable network. Immunity requirements for equipment are specified in IEC 60728-2. These requirements however cannot be directly applied to cable networks consisting of several connected equipment and components.

Table 3 – Maximum expected field strength

Frequency range MHz			Field strength dB(µV/m)
0,15	to	3500	106
694	to	862	120 [a]
[a] In cases where digitally modulated wanted signals are applied.			

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

The performance criteria for the cable networks refer to AM-VSB-TV or QAM-DVB signals in the frequency range 30 MHz to 1000 MHz and to FM-TV signals in the frequency range 950 MHz to 3500 MHz.

Where other signals (e.g. digitally modulated signals) are distributed, the lower permissible carrier-to-interference ratios of these signals shall lead to a higher immunity of the cable network.

The method of measurement shall be chosen as specified in 4.3.2.

Table 4 – Required carrier-to-interference ratio

Applicable frequency range MHz			Carrier-to-interference ratio dB
5	to	30	currently undefined
30	to	1000	≥ 57 (AM) ≥ 35 (64/256 QAM)
950	to	3500	≥ 33 (FM) ≥ 13 (QPSK)

Annex A
(informative)

Information on legal requirements in some countries

A.1 Legislation in Germany

In Germany, according to Article 6(3) of the Act on Electromagnetic Compatibility of Equipment of 26 February 2008, the Federal Government is allowed to take special measures to protect radio receiving and transmitting stations operated in defined frequency ranges for safety purposes and public telecommunications networks from the effects of electromagnetic emissions. According to this Article 6(3), suitable and necessary measures have to be taken in "Order on the protection of public telecommunications networks and radio receiving and transmitting stations operated in defined frequency ranges for safety purposes (Sicherheitsfunk-Schutzverordnung – SchuTSEV) of 13 May 2009" to protect safety-related radio receiving and transmitting stations operating in defined frequency ranges from electromagnetic emissions, including precautionary measures.

A.2 Requirements in Germany

The Order sets out requirements to be met by line-bound telecommunications equipment and networks in defined frequency ranges (Table A.1 and Table A.2).

Table A.1 – Protection of particular frequency ranges according to § 3 of the Order

Frequency range MHz			Application to be protected
2,850	to	3,155	Aeronautical communications
3,400	to	3,500	Aeronautical communications
3,800	to	3,950	Aeronautical communications
4,650	to	4,850	Aeronautical communications
5,450	to	5,730	Aeronautical communications
6,525	to	6,765	Aeronautical communications
8,815	to	9,040	Aeronautical communications
10,005	to	10,100	Aeronautical communications
11,175	to	11,400	Aeronautical communications
13,200	to	13,360	Aeronautical communications
15,010	to	15,100	Aeronautical communications
17,900	to	18,030	Aeronautical communications
21,924	to	22,000	Aeronautical communications
23,200	to	23,350	Aeronautical communications
30,350	to	30,750	MIL
34,350	to	35,810	Authorities and organizations with security tasks
38,450	to	39,850	Authorities and organizations with security tasks
43,300	to	45,250	MIL
46,000	to	47,000	MIL
74,205	to	77,485	Authorities and organizations with security tasks, aeronautical navigation
84,005	to	87,265	Authorities and organizations with security tasks
108,000	to	137,000	Aeronautical communications, aeronautical navigation
138,000	to	144,000	Aeronautical communications
165,200	to	165,700	Authorities and organizations with security tasks
167,550	to	169,390	Authorities and organizations with security tasks
169,800	to	170,300	Authorities and organizations with security tasks
172,150	to	173,990	Authorities and organizations with security tasks
240,250	to	270,25	Aeronautical communications
275,250	to	285,25	Aeronautical communications
290,250	to	301,25	Aeronautical communications
306,250	to	318,25	Aeronautical communications
328,250	to	345,25	Aeronautical navigation, aeronautical communications
355,250	to	399,90	Authorities and organizations with security tasks, aeronautical communications
443,593 75	to	444,968 75	Authorities and organizations with security tasks
448,593 75	to	449,968 75	Authorities and organizations with security tasks

Table A.2 – Field strength limit values at a 3 m distance from line-bound telecommunications facilities and networks

Frequency			Field strength limit value (peak) at 3 m distance dB(μV/m)	Measurement bandwidth
9	to	150 kHz	$40 - 20 \times \log_{10}(f)$, f in MHz	200 Hz
> 150	to	1 000 kHz	$40 - 20 \times \log_{10}(f)$, f in MHz	9 kHz
> 1	to	30 MHz	$40 - 8{,}8 \times \log_{10}(f)$, f in MHz	9 kHz
> 30	to	108 MHz	27 [a]	120 kHz
> 108	to	144 MHz	18 [b] (27) [a]	120 kHz
> 144	to	230 MHz	27 [a]	120 kHz
> 230	to	400 MHz	18 [b] (27) [a]	120 kHz
> 400	to	1 000 MHz	27 [a]	120 kHz
> 1	to	3 GHz	40 [c]	1 MHz

[a] The limit corresponds to an equivalent radiation power of 20 dB (pW).

[b] The limit of 18 dB(μV/m) is valid for all broadband digital line-bound broadcast signals. For all other signals the limit value is 27 dB(μV/m).

[c] This limit corresponds to an equivalent radiation power of 33 dB (pW).

A.3 Reference for legislation in Germany

Order on the protection of public telecommunications networks and radio receiving and transmitting stations operated in defined frequency ranges for safety purposes (Sicherheitsfunk-Schutzverordnung – SchuTSEV) of 9 May 2009 with respect to German Act on Electromagnetic Compatibility of Equipment, Article 6(3).

Annex B
(informative)

Frequency ranges of typical safety of life services

See Table B.1.

Table B.1 – Frequency ranges of typical safety of life services

Frequency range MHz			Service
74,800	to	75,200	Aeronautical radionavigation; ILS marker beacons
108,000	to	117,975	VOR and ILS localizer aeronautical radionavigation
121,450	to	121,550	Emergency position indicating radiobeacons (EPIRBs)
156,525			Distress, safety, and calling (DSC)
156,762 5	to	156,837 5	International marine distress, safety, and calling
242,950	to	243,050	EPIRBs
406,000	to	406,100	EPIRBs

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

Annex C
(informative)

Interdependence between the maximum allowable field strength and the minimum signal level at system outlet

For the purposes of this document, immunity of the cable network is expressed as a minimum carrier-to-interference ratio that is expected to be achieved for a specified wanted signal in the presence of an external (unwanted) field strength. Both parameters are interrelated and can be derived from each other if it is assumed that the cable network acts as a $\lambda/2$ dipole. In the worst case, the following parameters apply:

- minimum signal level of the wanted signal at the system outlet of the cable network as specified in IEC 60728-1;
- minimum carrier-to-interference ratio for the wanted signal as specified in IEC 60728-1;
- screening effectiveness of the used equipment as specified in IEC 60728-2;
- coupling factor which represents the transformation of the external electromagnetic field into a disturbing signal. It varies with frequency over a wide range and is calculated as

$$A_f = -20\lg\left[\frac{300/f}{2\pi}\right] \text{ with } f \text{ in MHz} \qquad \text{(C.1)}$$

NOTE When measured in arbitrary points in the cable network, signal level and carrier-to-interference ratio can deviate from the above-mentioned parameters.

By taking into account normatively defined (a) or physically determined (b) parameters, a formula can be formed:

Minimum signal level at system outlet (a) ..... [dB(µV)]

Minus carrier-to-interference ratio (a) ..... [dB]

Plus screening effectiveness (a) ..... [dB]

Plus coupling factor at relevant frequency (b) ..... [dB/m]

Results in maximum external field strength ..... [dB(µV/m)]

Depending on the actual situation of the network under test, additional parameters may be relevant.

- Tolerance margin:

  An adjustment of the minimum signal level to account for systematic uncertainties in the system design.

- Allowance for combination of equipment:

  An adjustment in the resulting allowable field strength to account for deviating characteristics of cable networks consisting of several equipment and components compared to the requirements for equipment as specified in IEC 60728-2.

- Building penetration loss:

  Depending on the reference point where the external field strength is going to be measured and the location where the interference is entering the cable network, the building penetration loss may need to be accounted for by introducing an additional attenuation for the external field strength.

For illustration, an example calculation takes into account a cable network inside a building using analogue signals at a frequency of 166 MHz. The equipment complies with Class A and the field strength is going to be measured outside the building.

Minimum signal level (IEC 60728-1)..... 60 dB(µV)
Minus tolerance margin..... 1 dB
Minus carrier-to-interference ratio (IEC 60728-1) .....57 dB
Plus screening effectiveness (IEC 60728-2).....85 dB
Plus coupling factor at relevant frequency.....11 dB/m
Plus building penetration loss ..... 8 dB
Results in maximum external field strength ..... 106 dB(µV/m)

In another example calculation, a cable network inside a building uses digital signals at a frequency of 850 MHz. The equipment complies with Class A according to IEC 60728-2 and the field strength is going to be measured inside the building.

Minimum signal level (IEC 60728-1)..... 54 dB(µV)
Minus tolerance margin..... 2 dB
Minus carrier-to-interference ratio (IEC 60728-1) .....32 dB
Plus screening effectiveness (IEC 60728-2).....75 dB
Plus coupling factor at relevant frequency.....25 dB/m
Plus building penetration loss ..... 0 dB
Results in maximum external field strength ..... 120 dB(µV/m)