ETSI TECHNICAL REPORT

ETR 151

February 1995

Source: ETSI TC-EE

Reference: DTR/EE-04005

ICS: 33.080

Key words: EMC, testing

Equipment Engineering (EE); Electro-Magnetic Compatibility (EMC) testing of telecommunication equipment above 1 GHz

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Foreword

This ETSI Technical Report (ETR) was produced by the Equipment Engineering (EE) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

Introduction

Until now, immunity threats involving telecommunication systems, identified to be above 1 GHz, are considered rare and are treated on a local case by case basis. However, there is concern that the new telecommunication services currently in use or under development may lead to a need for emission and immunity testing and compliance with determined requirements above 1 GHz. This ETR examines the need for any such additional testing, taking into account existing work in other agencies.

Future studies, depending on the outcome of this initial examination of the topic, could address the following:

a) the allowable emission levels;
b) the required immunity levels;
c) the application of available test methods;
d) the principles for the development of new test methods where there are currently no suitable ones available.

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1 Scope

This ETSI Technical Report (ETR) assesses the need for Electro-Magnetic Compatibility (EMC) emission and immunity testing of telecommunication equipments at frequencies above 1 GHz. It should be noted that the specification of frequency spectrum utilisation parameters of transmitters and receivers are excluded from this study as they are generally given in appropriate notified standards. This means that emissions from an intended radiator to an intended receiver have not been considered. Safety issues have also not been considered.

The EMC directive has no restrictions on the frequencies for which essential requirements should be complied with. However, in the current harmonised European EMC standards, except in the informative part of the CENELEC generic standard, there are no requirements for emission and immunity testing above 1 GHz.

Although Global System for Mobile Communication (GSM) and the Second generation Cordless Telephone (CT 2) operate below 1 GHz they are mentioned here as the first available examples of a new family of digital equipments with similar characteristics in the frequencies from 800 MHz to 3 GHz.

Examples of existing and future systems with their characteristics are listed in the tables attached to this ETR. The aim is not to provide an exhaustive list of all existing and forthcoming systems but to give a general idea of the situation.

This ETR addresses the following main topics:

a) potential sources of disturbance;
b) potential victims of the disturbance;
c) the environments in which the equipments are expected to operate, and as a consequence the necessary protection distances between the equipment for different services;
d) conclusions on the need for testing above 1 GHz based on the above.

2 References

This ETR incorporates by dated and undated reference, provisions from other publications. These references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETR only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 386-1: "Equipment Engineering (EE); Public telecommunication network equipment; Electro-Magnetic Compatibility (EMC) requirements; Part 1: Product family overview, compliance criteria and test levels".

[2] EN 50 081-1 (1992): "Electromagnetic Compatibility; Generic emission standard; Part 1: Residential, commercial and light industry".

[3] EN 50 082-1 (1992): "Electromagnetic Compatibility, Generic immunity standard; Part 1: Residential, commercial and light industry".

[4] ISO 7636 (1984): "Bells for bicycles and mopeds - Technical specification".

[5] IEC 945 (1994): "Marine navigational equipment - General requirements - Methods of testing and required test results".

[6] ETR 108 (1993): "European digital cellular telecommunications system (Phase 2); GSM Electro Magnetic Compatibility (EMC) considerations".

[7] draft IEC/SC77B WG7(38) (January 1994): "Immunity to RF emissions from digital radio telephones".

[8] CEPT SE 10(92)16: "Key Mobile Radio Parameters".

[9] Code of Federal Regulations 47 CFR Ch.1 (10/1/89 ed.) Sub-part A § 15.3; "Frequency Range of Radiated Measurements".

[10] CISPR/G/WG1(Secretariat) (November 1993): "Proposal for ITE Emission Limits above 1 GHz".

[11] Televerkets' Forskningsinstitutt Report TF R 40/92: "Interference from the TDMA structure in digital mobile communication to PSTN".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETR, the following definitions apply:

cellular: Mobile system designed to operate on the principle of communications cells with handover of subscribers between each.

mobile: Mobile transmitter/receiver equipment designated to be mounted in a vehicle, excluding handheld.

handheld: Mobile transmitter/receiver integrated into one equipment capable of being held in the hand.

base: Fixed radio transmitter/receiver equipment.

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

CT 2	Second generation Cordless Telephone
DAB	Digital Audio Broadcasting
dBi	Decibel with reference to the isotropic level
DCS	Digital Communication System (GSM at 1 800 MHz)
DECT	Digital European Cordless Telecommunication
DSRR	Digital Short Range Radio
EIRP	Effective Isotropic Radiated Power
FPLMTS	Future Public Land Mobile Telecommunication System
GSM	Global System for Mobile Communication
HIPERLAN	High Performance LAN
ISM	Industrial, Scientific and Medical
ITE	Information Technology Equipment
LAN	Local Area Network
PABX	Private Automatic Branch Exchange
PSTN	Public Switched Telecommunication Network
TDMA	Time Division Multiple Access
TFTS	Terrestrial Flight Telecommunication System
UMTS	Universal Mobile Telecommunication System (European name for FPLMTS)
VDU	Video Display Unit
VSAT	Very Small Aperture Terminal
WARC	World Administrative Radiocommunications Conference
WG	Working Group

4 Environment

This ETR addresses telecommunications equipment in the following environments:

a) telecommunication centres, see ETS 300 386-1 [1];

b) residential, commercial and light industrial, as defined in EN 50 081-1 [2] and EN 50 082-1 [3];

c) vehicular, as specified in ISO 7636 [4];

d) maritime, as specified in IEC 945 [5].

An increasing number of mobile equipments are designed to work in the frequency range close to and above 1 GHz. They can be used in many places, for example in an office close to Information Technology Equipment (ITE) as well as close to, or possibly in, telecommunication centres. The above environmental categories are well defined and do not recognise the use of mobile and new radio services.

Nevertheless, Electro-Magnetic Compatibility (EMC) compliance has to be ensured, therefore, a non-exhaustive list has been created which describes the requirements for equipments to coexist for such equipment which emits or can be susceptible to radiation above 1 GHz and in which environment they are expected to operate as shown in table 1.

In all these environments different services coexist and up to now only a few electromagnetic incompatibilities have been detected. In future, the number of mobile service types, as well as the use of each service itself, will increase, especially in the frequency range above 1 GHz. The use in all different environments is given. It is probable that more electromagnetic incompatibilities will appear.

As different services will need to coexist, new ways of defining environments may be necessary. Working distances of different equipment can help to solve EMC. Therefore, clause 8 has been included which provides a way of assessing the risk of electromagnetic incompatibility between telecommunications and other equipment.

5 Existing and future equipment

Attached at table 2 are the main details of the existing and future equipments that operate just below and above 1 GHz. These can be regarded as the main emission sources at those frequencies that pose a threat to telecommunication equipment. As can be seen there are a significant number and it can be argued that the main threat will come from the large numbers of mobile equipments that will proliferate over the next few years. The equipment listed has been used as a basis for the threat evaluation carried out in clause 6.

6 Immunity - protection of telecommunication services

As a consequence of the World Administrative Radiocommunications Conference (WARC) 1992, many new radio services have been planned at frequencies above 1 GHz. The effects on telecommunications equipment means that the immunity of such equipment to these phenomena has to be considered at frequencies above as well as below 1 GHz.

6.1 Immunity to radio transmissions

Some are already in operation near to 1 GHz (e.g. GSM, CT 2). Others will be established in a very close future (Terrestrial Flight Telecommunication System (TFTS), Digital Communication System 1800 (DCS 1800), Digital European Cordless Telecommunication (DECT), Radio LAN, Very Small Aperture Terminal (VSAT), Digital Audio Broadcasting (DAB), etc.). Further services planned, such as Future Public Land Mobile Telecommunication System (FPLMTS) and Universal Mobile Telecommunication System (UMTS), will operate at frequencies between 1,4 and 2,5 GHz. Table 3 gives related field strengths at various distances of some of these new services, assuming the transmitter uses an isotropic antenna unless a specific antenna gain is shown.

All these new radio services will be digitally modulated systems and will generate radio frequency electromagnetic fields which provides a threat to telecommunications equipment. A high powered mobile, such as GSM class 2 for example, can generate a field strength of 5,2 V/m at a distance of 3 m.

ETR 108 [6] considers threats from GSM to electronic equipment including electronic telephones and Video Display Units (VDUs), and gives further background to the situation. The conclusion states that there could be a compatibility problem between GSM transmitters and body worn audio apparatus, although only testing on old samples was carried out. The EMC Directive and consequent improvement in the design should keep this to a minimum. In particular, some of the more modern hearing aids are capable of up to 10 times the immunity protection of older designs (in V/m). Finally it concluded that domestic equipment was likely to be vulnerable to the 8 W mobile station.

For telecommunications systems, the sources of disturbances could be:

- external to the telecommunication centres, for example in case of telecommunication equipment in outdoor locations such as by the roadside, telephone boxes, repeaters and amplifiers on trunk cables, or concentrators and cable distribution boxes, but also minor telecommunication centres located in rural areas serving the local community;

- internal to the telecommunication centres if the radio transmitter equipment is located near transmission or switching equipment.

Moreover, considerations relating to the use of using radio equipment inside the telecommunication centre may arise one day, as the need of mobile communications spreads out all over developed countries.

The effects of radio transmissions are, in most cases, a transient phenomena (Time Division Multiple Access (TDMA) pulses, transient dialling, etc.) and the effect of such perturbation could be short, but sometimes can be enough to disturb, e.g., a power converter, to jam digital transmission systems or signalling links, to induce errors in hard disk data processing, or cause audio interference to audio electroacoustical devices in telecommunications centres.

The spread of these radio terminals will cause the greatest threat that has ever been taken into account up to now to ITE and also to general electronic devices.

Concerning the GSM system in Europe, it is considered that within a year handheld radio terminals with an Effective Isotropic Radiated Power (EIRP) of typically 2 W peak power will be widespread. Within a few more years, millions of units of radio equipment could be in use if the development of the GSM network follows the projected growth pattern. In addition, we do not know now what the consequences will be of the introduction, for public use, of DECT, Radio LANs, DCS 1800, VSATs or FPLMTS in the next 5 to 10 years.

These future mobile systems above 1 GHz are the next systems to be planned as a widespread terrestrial mobile radio network, but DECT could be highly generalised with the development of radio Private Automatic Branch Exchange (PABX) and Radio LANs which may be the standards for interconnecting computer systems in the year 2 000 and beyond.

Concerning DECT, for integral antenna terminal systems it is a fact that the power radiated should be 250 mW but for some cases special applications could require an antenna gain much higher than 0 dB, up to 12 dBi and for point-to-point applications 22 dBi.

Even with 250 mW, disturbances can occur at close distances, so equipment installed in an office environment should be adequately protected.

6.2 Work in other standardisation bodies

Within IEC TC 77 a document is in preparation on the immunity of electrical and electronic equipment to radiated electromagnetic energy generated by fixed and portable radio telephones operating in the frequency range 0,8 to 3 GHz (IEC/SC77B WG 7(38) [7]).

They recommend measurements to be performed from 800 to 960 MHz and 1,7 GHz to 2 GHz.

Within CENELEC TC 110 it has been requested that Working Group 2 (WG2) prepare a new ENV based on a test at 1,89 GHz with square wave modulation. The WG will collaborate with the IEC in this work.

7 Emission - Protection of telecommunication services

Radiation from electronic devices can easily disturb telecommunication equipment. Table 4 gives some examples for radio communication systems which use frequencies above 1 GHz, but includes GSM. The information used in this table is contained in CEPT SE 10(92)16 [8]. In the second column the minimum receiver sensitivity is given for each system. For cellular systems the received signal level can be substantially higher, especially near the base station. However, at the border of the service area of a base station and also for fixed links, when fading occurs, the received signal level exceeds the receiver sensitivity by only a few dBs.

In the third column the minimum required protection ratio is given. These values apply for co-channel interferers of the same system, i.e. using the same bandwidth and modulation scheme. The bandwidth is given in the fifth column.

The maximum interference level can be obtained by subtraction of the protection ratio from the receiver sensitivity. It gives the maximum field strength which can be tolerated at the antenna of the victim receiver.

The other columns give the EIRP that an interfering source can emit in order to generate the maximum allowed field strength for several distances between interferer and victim. Free-space propagation is assumed here.

7.1 Narrowband interference sources

Narrowband interference sources have a bandwidth that is smaller than the receiving bandwidth of the victim. Their energy content need to be measured with a measuring receiver with a bandwidth that is larger than the interference source bandwidth. For interferers of this kind the values of table 4 apply, the modulation of the interference source is not taken into account. However, with this method it is not possible to detect whether several narrowband interference sources are affecting one communications channel.

7.2 Broadband interference sources

Broadband interference sources have a bandwidth that is larger than the receiving bandwidth of the victim. They can be measured with a relatively narrowband measuring receiver. However, in that case a correction factor needs to be subtracted from the maximum interference values in table 4 to compensate for the difference between the bandwidth of the measuring receiver and the bandwidth of the communication channel. A measuring bandwidth of 120 kHz is used as an illustration in obtaining the correction factors shown in table 5.

This means that in the case of a GSM receiver a broadband interference source at 10 m is allowed to emit 31 - 2 = 29 dBpW or at a distance of 1 km is allowed to emit 103 - 25 = 78 dBpW from a 15 GHz fixed link receiver. However, in these two examples the actual bandwidth of the interference source can be completely different.

7.3 Work in other standardisation bodies

As far as emissions are concerned, the WG has become aware of other work being conducted within CISPR/G and rather than develop separate proposals it is considered more appropriate to track the international work being carried out and contribute to that as necessary. IEC/SC77B WG7(38) [7] gives these details and recommends that, as a matter of urgency, limits are required in the frequency range 1 GHz to 2,7 GHz and from 10,7 GHz to 12,75 GHz. The need for testing above 1 GHz is determined on the basis of results obtained from testing below 1 GHz.

It is worthwhile noting that the FCC have specified testing up to 40 GHz based on the highest clock speed contained within the equipment, this is contained in reference [9].

8 Source/victim operating distances

Table 6 shows typical minimum distances between sources and victims of electromagnetic disturbances as they can occur during normal operation. A given source of electromagnetic energy can find a potential victim (destination of disturbance) at a distance normally not closer than shown in table 6. "Normally" means that shorter distances are possible but do not represent normal use.

These values originate from an assessment which tries to take into account the particularities of the listed applications (e.g. operational environment, operational conditions, portability, special device features).

The knowledge about the distance between source and victim is important for the estimation of the attenuation of the disturbance.

The combination of tables 3 and 6 provides the ability to assess the risk of electromagnetic incompatibility by verification of the disturbing potential and the operating distance of the source and victim against the mentioned disturbances. For example in table 3, choosing GSM handheld (peak power 2 W) at a distance of 1 m results in a field strength of 7,7 V/m. From table 6, choosing the Radio LAN as victim shows a typical minimum source/victim distance of 1 m against the GSM Handheld equipment. Therefore, the Radio LAN needs to withstand a field strength of 7,7 V/m at that distance.

Where only little experience about the characteristics of use exists (modern and future applications such as GSM), the knowledge about similar older products (analogue mobile telephone network) were used for prediction.

9 Field strength at victims

Table 7 provides a summary of the situation as calculated from tables 3 and 6. The field strength at victims against various sources are given for the various typical minimum source/victim distances.

When comparing the field strength as stated in ETS 300 386-1 [1] (3 V/m) it can be seen that apart from the 1,3 GHz radar, only the High Performance LAN (HIPERLAN) and handheld GSM and DCS equipments exceed that limit.

The levels from the radar represents the field strength from the main beam and, in practice, far more reduced levels would be experienced due to the scanning effect. Of the other equipments, only DECT handsets approach the limit given in ETS 300 386-1 [1].

NOTE: All calculations are based on free field emissions, i.e. no reflections have been catered for. In addition the source equipment frequency considered are out of the receiving band so far as the victim equipment is concerned.

Table 7 is, therefore, useful to assess the immunity required of PTT equipment in a normal working environment.

10 Case histories and laboratory evaluation

There seems to be considerable difficulty in obtaining fully documented and verified case histories. The reasons for this may be that manufacturers do not want adverse publicity for their products, operators are unwilling to admit to providing a lower than satisfactory level of service or simply that there are few instances of interference. The only obvious EMC problems have been between very sensitive receivers and strong transmitters, for example, radars have disturbed link receivers at 450 MHz. In general terms the solution has been to re-locate the receiving antenna.

Recently there has also been concern about the vulnerability of hearing aids to certain emissions. This is causing a great deal of concern and it does appear that there are only limited possibilities to make these devices immune to such emissions.

NOTE: However, these devices do not comply with any immunity standards.

In relation to laboratory evaluations, a report by Televerkets Forskningsinstitutt [11] examines the risk of audible interference in analogue Public Switched Telecommunication Network (PSTN) telephone handsets by GSM and DECT systems using TDMA. The report found that significant interference was found, although that from DECT was less due to the lower radiated power and the higher frequency used.

11 Conclusion

This ETR has been prepared to evaluate the need to extend testing above 1 GHz for equipment used within the public telecommunications network.

Digital radio communication services are already operating above 1 GHz. Others, such as transmission and switching equipment, will be enhanced with increased clock frequencies and their harmonics will also be detected above 1 GHz.

The greatest problems that could be encountered in the near future could be to achieve electromagnetic compatibility between new digital mobile radio communication services and electronic and telecommunications equipment.

So far as emissions are concerned, since the Working Group was formed CISPR/G have started to study proposals for limits for emissions above 1 GHz as detailed in CISPR/G/WG1 [10], and it is considered appropriate to track and assess the impact of these proposals as they develop. However, the WG would confirm that emission testing above 1 GHz appears necessary. The principle adopted of assessing the requirement to test by conditional testing below 1 GHz together with an examination of the equipments characteristics would seem a reasonable way to progress.

Concerning immunity, the problems identified appear to be concerned with DCS, DECT and GSM handsets and HIPERLAN equipment. It is therefore recommended that spot frequency immunity testing, with appropriate representative modulation, be carried out at the following nominal frequencies 900 MHz, 1 300 MHz, 1 750 MHz and 1 890 MHz. The testing level should be carried out at 3 V/m, this complies with the limits as in CEPT/SE 10(92)16 [8]. Although the HIPERLAN has been identified as a problem area it is not considered that it is at a sufficiently advanced stage of development to warrant consideration for testing at this time. The WG consider that testing at the above spot frequencies would provide confidence that the equipment will be sufficiently immune, we would consider that testing throughout the frequency bands, as proposed by TC 77 in CISPR/G/WG1 [10] is unnecessary.

This should be an acceptable step towards the compliance of telecommunications equipment to the growing threat presented by the growth of new radio communication services and would also protect the RF spectrum in a frequency range where many new widespread radio services are about to appear.

Table 1: Possible location and use of existing telecommunications equipment

Equipment	Telecommunication centre	Residential, commercial and light industrial	Vehicular	Maritime
PSTN normal priority	yes	yes	-	-
GSM 1800 mobile	possible use	yes	yes	yes
DCS mobile	possible use	yes	no	no
GSM 1800 handset	possible restricted use	yes	yes	yes
DCS handset	possible restricted use	yes	no	no
DECT transceiver	possible use	yes	-	yes
Radio LAN	-	yes	-	-
ITE + telephone + fax	yes	yes	-	yes
PBX	yes	yes	-	-
Fixed links cabinets	yes	-	-	-
Industrial, Scientific and Medical (ISM) microwave	yes	yes	-	-
Radar 1,3 GHz	-	airports	near airports	in harbours
Radar 10 GHz	-	-	-	yes

Table 2: Main existing or future terrestrial emission sources (above 1 GHz)

System	Output power	Max. EIRP	Frequency	Frequency	Channelling	Modulation	Mobile-base	Calculated field strength	Comments
	peak		**Mob → Base**	**Base → Mob**		**Scheme**	**Access type**	**at 3 m**	
	W	**W**	**MHz**	**MHz**	**kHz**			**V/m**	
L band radars			One way						
Transmitters	2 000 000	210 6		1 220 - 1 370	Pulse modulated		not applicable at 3 m		
		30 dBi max			example parameters	T = 2 μs			
		O dBi earth level				Fr = 300 Hz			
	(CCIR/8-1/Temp. document 55)		Allocated bands	the system is under definition process					
FPLMTS	Base	10	1 885 - 2 010		To be defined	To be defined	To be defined	5,8	
Future Public Land	Mobile	1	2 010 - 2 025					1,8	
Mobile Telecom	Personal outdoor	0,02	2 110 - 2 185					0,3	
System (WARC 92)	Personal indoor	0,003	2 185 - 2 200					0,1	
MICROWAVE OVENS		3,0		2 400 - 2 500				3,2	
Radio LANs	CEPT TR 10-01	0,1	2 400 - 2 500	2 400 - 2 500				0,6	
HIPERLANs	CEPT Rec TR 22-06	1,0	5 150 - 5 300	5 150 - 5 300				1,8	
	CEPT Rec TR 22-06	0,1	17 100 - 17 300					0,6	

(continued)

Table 2 (continued): Main existing or future terrestrial emission sources (above 1 GHz)

System	Output power	Max. EIRP	Frequency	Frequency	Channelling	Modulation	Mobile-base	Calculated field strength	Comments
	peak		Mob → Base	Base → Mob		Scheme	Access type	at 3 m	
	W	W	MHz	MHz	kHz			V/m	
TFTS	En route stations	79,0		1 670 - 1 675	30,0	FDMA		16,2	
	Intermediate/airport	8,0						5,2	
CT 2	0,01	0,01	864,10 - 868,10	864,10 - 868,10	100	2GFSK	Time Duplex	0,2	
GSM						GMSK	TDMA		
Mobile Class 1	20,0	20,0	890 - 915		200		Fr = 217 Hz	8,2	low probability to appear on the market
Mobile Class 2	8,0	8,0	890-915		200		T = 577µs	5,2	Porta-mobile
Mobile Class 3	5,0	5,0	890 - 915		200			4,1	
Mobile Class 4	2,0	2,0	890 - 915		200			2,6	handset
Mobile Class 5	0,8	0,8	890 - 915		200			1,6	handset
Base station				935 - 960	200				
min	10	10		935 - 960	200			5,8	
max	50	320		935 - 960	200			32,7	

(continued)

Table 2 (concluded): Main existing or future terrestrial emission sources (above 1 GHz)

System	Output power	Max. EIRP	Frequency	Frequency	Channelling	Modulation	Mobile-base	Calculated field strength	Comments
	peak		Mob → Base	Base → Mob		Scheme	Access type	at 3 m	
	W	W	MHz	MHz	kHz			V/m	
DCS 1800						GMSK	TDMA		
Mobile Class 1	1	1	1 710 - 1 785		200			1,8	
Mobile Class 2	0,25	0,25	1 710 - 1 785		200			0,9	
Base station									
min	5			1 805 - 1 880	200			4,1	
max	20			1 805 - 1 880	200			8,2	
DECT			1 880 - 1 990	1 880 - 1 990	1 728	GFSK	TDMA/DUPLEX		
							Time Duplex		
Integral antenna equipment		0,25						0,9	
Non integral antenna equipment	0,25	4						3,7	
Point to Point application	0,25	40						11,5	Very specific cases
Digital Short Range Radio (DSRR)			888 - 890	933 - 935	25	GMSK	TDMA		
Non integral antenna equipment	4						Duplex/Simplex	3,7	minimum

Table 3: Calculated field strengths for different services

All field strengths in V/m.

	Distance from equipment	**1 m**	**3 m**	**10 m**	**30 m**	**500 m**	**1 000 m**	
Equipment	**Peak power (W)**							**Antenna gain (dB)**
GSM (handheld)	2	7,7	2,6	0,9				0
GSM class 2 (Mobile)	8	15,5	5,2	1,7				0
GSM	20			2,4	0,8	< 0,1		0
DECT	0,25	2,7	0,9	0,3				0
DECT	0,25	5,5	1,8	0,6				+ 6
DCS 1800	1	5,5	1,8	0,6				0
DCS 1800	0,25	2,7	0,9	0,3				
Radio LAN	0,1	1,7	0,6	0,2				
HIPERLAN	1	5,5	1,8	0,6				
HIPERLAN	0,1	1,7	0,6	0,2				
ISM	1	5,5	1,8	0,6				
Radar (1,3 GHz)	$2,10^6$					15,4	7,7	0
Radar (10 GHz)	$4,10^6$ $4,10^3$				365	21,9	11,0	+ 30 dB

Table 4: Derivation of maximum EIRP from a narrowband interference source

Victim	**Receiver sensitivity dBµV/m**	**Protec-tion ratio (dB)**	**Maximum allowed interference level (dBµV/m)**	**Channel band-width kHz**	**Maximum interference power (dBpW)**						
					1 m	**3 m**	**10 m**	**30 m**	**100 m**	**300 m**	**1 km**
GSM	35	9	26	200	11	21	31	41			
DECT	60	10	50	1 728	35	45	55	65			
DCS 1800	42	9	33	200	18	28	38	48			
Fixed link 4 GHz		25		35 000					88	91	91
Fixed link 6,7 GHz		25		35 000					95	92	92
Fixed link 11 GHz		25		35 000					101	98	98
Fixed link 13 GHz		25		35 000					103	100	100
Fixed link 15 GHz		25		35 000					106	103	103

Formula used to calculate maximum interference power:

$$P(dBpW) = E(dBmV/m) + 20 \log d - 10 \log 30;$$

where: E = maximum allowed interference level;
d = distance between source and victim.

Table 5: Example of correction factors for measuring bandwidth

Victim	Channel bandwidth kHz (B channel)	Measuring bandwidth kHz (B measured)	Correction factor dB
GSM	200	120	2
DECT	1 728	120	9
DCS 1800	200	120	2
Fixed links	35 000	120	25
Correction factor = 10 log (B channel/B measured).			

Table 6: Typical minimum source/victim distances

All distances in metres.

Source:	**Mobile**		**GSM/DCS Handheld**		**DECT**	**Radio LAN**	**PSTN (ITE)**	**Radar (note 3)**	**ISM microwave**	**Fixed links**	**PBX**
Victim:	GSM	DCS	GSM	DCS				1,3 GHz			
GSM 1800 Mobile	N/A	N/A	-	10	10	10	10	1 000	10	10	10
GSM Handheld	N/A	10	3	3	10	1	3	1 000	3	3	3
DCS Handheld	10	10	3		3	1	3		3		
DECT	10	10	3	3	N/A	1	1	500	3	3	1
Radio LAN (note 2)	10		1		1	N/A	1	500	N/A	3	3
ITE (note 1)	10		3		1	1	N/A	1 000	3 (note 6)		
PBX	10		3		1	3	(note 7)	1 000	10		N/A
FIXED LINKS	10		3		3	3	(note 7)	500	500		30
PSTN	10 (note 4)		10		1	1	N/A	1 000	10	10	3

NOTE 1: ITE includes equipment connected to telecommunications networks (including LANs).
NOTE 2: Radio LAN includes HIPERLAN.
NOTE 3: 1,3 GHz radar is used on airports, 10 GHz radar on ships.
NOTE 4: Use of handheld equipment inside building restricted, otherwise 3 m.
NOTE 5: The 2,4 GHz Radio LAN uses the same frequency band as ISM, so this is a spectrum management matter.
NOTE 6: For a telephone this can be 1 m.
NOTE 7: No mutual effect.

Table 7: Field strengths at victims

All field strengths in V/m unless otherwise stated.

Victim: / Source:	f(MHz)	GSM Mobile	GSM Handheld	DCS 1800 (Handheld)	Radio LAN	ITE	PABX	Fixed Links	PSTN	DECT
GSM mobile 8 W	890 - 915	N/A	(note 1)	1,7	1,7	1,7	1,7	1,7	1,7	1,7
GSM handheld 2 W	890 - 915	(note 1)	N/A	2,6	7,7	2,6	2,6	2,6	0,9	2,6
DCS 1800 1 W	1 710 - 1 785	0,6	1,8	N/A	5,5	1,8	1,8	1,8	0,6	1,8
DCS 1800 0,25 W	1 710 - 1 785	0,3	0,9	N/A	2,7	0,9	0,9	0,9	0,3	0,9
DECT (0 dB antenna gain)	1 880 - 1 900	0,3	0,9	0,9	2,7	2,7	2,7	0,9	2,7	N/A
DECT (6 dB antenna gain)	1 880 - 1 900	0,6	1,8	1,8	5,5	5,5	5,5	1,7	5,5	N/A
HIPERLAN (1 W)	5 150 - 5 300	0,6	5,5	5,5	N/A	5,5	1,8	1,8	5,5	5,5
Radio LAN	2 400 - 2 500	0,2	1,7	1,7	N/A	1,7	0,6	0,6	1,7	1,7
Radar 1,3 GHz	1,300	7,7	7,7	7,7	15,4	7,7	7,7	15,4	7,7	15,4
ISM (microwave)	2 400 - 2 500	0,6	1,8	1,8	N/A	1,8	0,6	< 1 mV/m	0,6	1,8

NOTE 1: Intended radiator/receiver field strength - not considered.
NOTE 2: PSTN and PABX equipments not considered as sources.

History

Document history	
February 1995	First Edition
February 1996	Converted into Adobe Acrobat Portable Document Format (PDF)

ISBN 2-7437-0085-8
Dépôt légal : Février 1995