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Technical Report

**Fixed Radio Systems;
Generic wordings for standards on
DFRS (Digital Fixed Radio Systems) characteristics;
Part 1: General aspects and point-to-point
equipment parameters**

Reference

RTR/TM-04093

Keywords

DFRS, DRRS, FWA, point-to-point, radio

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Contents

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document is part 1 of a multi-part deliverable covering the generic wording for standards on DFRS (Digital Fixed Radio Systems), as identified below:

Part 1: "General aspects and point-to-point equipment parameters";

Part 2: "Point-to-multipoint equipment parameters".

It is designed to provide the generic wording for standards (ENs) produced by ETSI WG TM4, concerning Digital Fixed Radio Systems (DFRS), formerly known as Digital Radio Relay Systems (DRRS) and point-to-point specific equipment.

The present document was originally published by TM as an internal document (TCTR 006-01), but since it has been found useful to refer to the content in other TM documents (standards and reports) it has been re-published as a TR. This has been done solely to make the content publicly available and no changes to the text have been made other than editorial changes.

This revision introduces a number of up-dating information following technology and regulatory evolution and the coming into force of new R&TTE Directive introducing, under article 3.2, the concepts of "essential requirements".

1 Scope

The present document defines the major issues for the standardization of the general aspects of Digital Fixed Radio Systems (DFRS) formerly known as Digital Radio Relay Systems (DRRS) and for point-to-point specific equipment parameters, in order to maintain a generic format for the editorial and technical contents. It is also essential to maintain a common understanding of the reasons behind the way certain parameters are defined among the various DFRS standards, which deal with the same general topics and may differ from each other merely from the point of view of numerical requirements. The present document therefore also explains the reasoning behind why the parameters in DFRS standards are defined in the way they are.

The present document aims to cover every issue that may be required. Specific standards may differ from the guidelines contained within the present document only if the specific argument is not covered or there is good technical reason for not following them.

2 References

For the purposes of this Technical Report (TR) the following references apply:

[1] ETSI EN 301 126-1: "Fixed Radio Systems; Conformance testing; Part 1: Point-to-point equipment - Definitions, general requirements and test procedures".

[2] ETSI SR 001 262: "ETSI drafting rules".

A list of suggested reference documents for the production of DFRS ENs are given in appendix A.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions relevant to conformance test requirements and test typology given in EN 301 126-1 [1] apply.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

DRRS	Digital Radio Relay System
DFRS	Digital Fixed Radio System

4 Basis for reference

a) Appendix A of the present document forms a template to be used during the elaboration of DFRS standards (ETS/EN). Appendix B of the present document provides additional guidance on the use of the template document and the clause numbering in appendix B follows the numbering in appendix A so, for example:

- clause B.5.2 (appendix B) offers guidance on the elaboration of clause A.5.2 (appendix A);

- B.annex B (appendix B) offers guidance on the elaboration of A.annex B (appendix A).

Appendix A contains the issues to be considered when producing a Digital Fixed Radio Systems (DFRS) standard. These systems were formerly referred to as Digital Radio Relay Systems (DRRS). These include:

- generic text, for normative requirements, to be used, under that item, in every new standard regarding DFRS characteristics (general aspects and point-to-point equipments parameters), where only a numerical value in the item (where it is required) has to be changed or included;
- the meaning or phrasing of these standard texts shall not be altered unless a specific, different requirement is considered necessary. In this case a brief description of the background motivation for each change shall be documented in an informative annex;
- in some cases, a selection of different statements on the same issue, which may be applicable depending the type of system, are shown in *underlined italic character*s. In this case, the relevant phrase shall be applied;
- clarification, if necessary, of the test methods in order to have a common understanding of the requirements among the various certification laboratories;
- the contents of appendix A should be used to draw up ENs on DFRS equipment characteristics, unless the argument to be dealt with is not thereby covered;
- annex A (normative) to appendix A, gives the generic rules for test reports in case of wide band coverage systems and multirate/multiformat interfaces and modulation;
- annex B (normative) to appendix A, gives the Table form summarizing EN Requirements relevant to article 3.2 of the R&TTE Directive [52];
- annex C (informative) to appendix A gives additional information for some DFRS characteristics, which are usually not the subject of standardization, but are however referred to for additional information.

b) Appendix B contains a brief description of the general technical background of the issue itself to support the standard text and/or illustrations and to give guidance on the numerical requirements of each issue (when applicable). This information has been supplied for the guidance of the editorial groups and would not form part of any standard produced.

5 Drafting rules

SR 001 262 "ETSI drafting rules" [2] and the related interactive tool "EDR Navigator", which give guidance to the use of the ETSI templates and style sheets when working on the production of standards and other documents for ETSI. Both are available in the ETSI web-site (http://portal.etsi.org/).
It is recommended that the handbook is read in conjunction with the present document.

Appendix A:
Text for the standardized items

A.Foreword

The "Foreword" clause in an ETSI deliverable is always the second unnumbered clause.

The "Foreword" shall appear in each ETSI deliverable. It shall not contain requirements, figures or tables, except for the transposition table (see clause 9a).

It consists of a general part, provided by the ETSI Secretariat, giving information on:

- the designation and name of the Technical Body that prepared the ETSI deliverable; and
- information regarding the approval of the ETSI deliverable.

For multi-part deliverables, the first part shall include in its foreword an explanation of the intended structure of the series. In the "Foreword" of each part belonging to the series, a reference shall be made to the titles of all other parts, if they are known.

Optionally, a specific part that is provided by the Technical Body may give as many of the following as are appropriate:

- an indication of any other organization that has contributed to the preparation of the ETSI deliverable;
- a statement that the ETSI deliverable cancels and replaces other documents in whole or in part;
- a statement of significant technical changes from the previous version of the ETSI deliverable;
- the relationship of the ETSI deliverable to other ETSI deliverables or other documents.

A.Introduction

The "Introduction" is an optional preliminary element used, if required, to give specific information or commentary about the technical content of the ETSI deliverable, and about the reasons prompting its preparation. It shall not contain requirements.

The "Introduction" shall appear after the "Foreword" and not be numbered unless there is a need to create numbered subdivisions. In this case, it shall be numbered 0 with clauses being numbered 0.1, 0.2, etc. Any numbered figure, table or displayed formula shall be numbered normally beginning with 1.

A.1 Scope

No standard text is given since it will vary according to the type of equipment and its use.

However the following specific sentences on applicable antenna standards, conformance test procedures, different equipments spectrum efficiency classes (if any), safety aspects and to the "Generic wording" technical background shall be made as:

The present document deals with radio frequency (RF) and base-band equipment characteristics; antenna system requirements are covered in EN 30. ... *(quote the relevant antenna standard).*

The present document does not cover aspects related to test procedures and test conditions which are demanded to the scope of EN 301 126-1 [45].

As the maximum transmission rate in a given bandwidth depends on system spectral efficiency, different equipment classes are defined in TR 101 036-1 [49] *(quote in the EN only the relevant classes; e.g. 2, 4 and 5)*:

Class 1: equipment spectral efficiency based on typical 2-states modulation scheme (e.g. 2-FSK, 2-PSK or equivalent);

Class 2: equipment spectral efficiency based on typical 4-states modulation scheme (e.g. 4-FSK, 4 - QAM, or equivalent);

Class 3: equipment spectral efficiency based on typical 8-states modulation scheme (e.g. 8 PSK, or equivalent);

Class 4: equipment spectral efficiency based on typical 16 or 32-states modulation scheme (e.g. 16 or 32-QAM, or equivalent);

Class 5: equipment spectral efficiency based on typical 64 or 128-states modulation scheme (e.g. 64 or 128-QAM, or equivalent);

Class 6: equipment spectral efficiency based on typical 256 or 512-states modulation scheme (e.g. 256 or 512-QAM, or equivalent).

The above classes are indicative only and do not imply any constraint to the actual modulation format, provided that all the requirements in the present document are met.

In some cases, two additional different "grades" of equipment (e.g. grade A and B) are used when, for same class of spectral efficiency, different grade of some performances (e.g. BER vs RSL or adjacent interference) are allowed.

"Safety aspects are outside the mandate of ETSI and they will not be considered in the present document. However, for conformity assessment to the essential requirements of article 3.1(a) of EC R&TTE Directive [52], compliance to EN 60950 *(or any other applicable safety standard harmonized under the EC R&TTE Directive [*52*] or under the LVD Directive [*58*])* may be provided." Additional information on conformity of DFRS to essential requirements under R&TTE article 3.1(a) and 3.1(b) may be found in EG 201 752 [70].

Guidance on the definition of radio parameters relevant to the essential requirements under R&TTE article 3.2 for DFRS may be found in TR 101 506 [57].

Technical background for most of the parameters and requirements referred in the present document may be found in TR 101 036-1 [49].

A.2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

In the latter case, the time frame of application and new certification procedures for new releases of these normative references next to the date of the first public enquiry of the present document or to the first certification of the equipment shall be agreed between the supplier and the regulatory authority. These new certification procedures will cover in any case only the parameters subject to changes from the on going release during the previous certification.

[1] ITU-R Recommendation F.634: "Error performance objectives for real digital radio-relay links forming part of the high-grade portion of international digital connections at a bit rate below the primary rate within an integrated services digital network".

[2] ITU-R Recommendation F.695: "Availability objectives for real digital radio-relays links forming part of a high grade circuit within an integrated services digital network".

[3] ITU-R Recommendation F.696: "Error performance and availability objectives for hypothetical reference digital sections forming part or all of the medium-grade portion of an ISDN connection at a bit rate below the primary rate utilizing digital radio-relay systems".

[4] ITU-R Recommendation F.697: "Error performance and availability objectives for the local-grade portion at each end of an ISDN connection at a bit rate below the primary rate utilizing digital radio-relay systems".

[5] ITU-R Recommendation F.746: "Radio-frequency arrangements for fixed service systems".

[6] ITU-R Recommendation F.752: "Diversity techniques for radio-relays systems".

[7] ITU-R Recommendation F.1093-1: "Effects of multipath propagation on the design and operation of line-of-sight digital radio-relays systems".

[8] ITU-R Recommendation F.1101: "Characteristics of digital radio-relays systems below about 17 GHz".

[9] ITU-R Recommendation F.1102: "Characteristics of fixed wireless systems operating in frequency bands above about 17 GHz".

[10] ITU-R Recommendation F.1397: " Error performance objectives for real digital radio links used in the international portion of a 27 500 km hypothetical reference path at or above the primary rate".

[11] ITU-R Recommendation F.1491: "Error performance objectives for real digital radio links used in the national portion of a 27 500 km hypothetical reference path at or above the primary rate".

[12] ITU-R Recommendation F.750: " Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based network".

[13] ITU-R Recommendation F.751: "Transmission characteristics and performance requirements of radio-relay systems for SDH-based networks".

[14] ITU-R Recommendation F.1191: "Bandwidths and unwanted emissions of digital fixed service systems".

[15] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".

[16] ITU-T Recommendation G.821: "Error performance of an international digital connection forming part of an integrated services digital network".

[17] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[18] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".

[19] ETSI EN 301 489-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services".

[20] ETSI ETS 300 385: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for digital fixed radio links and ancillary equipment with data rates at around 2 Mbit/s and above".

[21] ETSI EN 300 385 (V.1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment ".

[22] ITU-T Recommendation V.11: "Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s".

[23] ITU-T Recommendation V.24: "List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)".

[24] ITU-T Recommendation V.28: "Electrical characteristics for unbalanced double-current interchange circuits".

[25] ETSI ETS 300 233: "Integrated Services Digital Network (ISDN); Access digital section for ISDN primary rate".

[26] ETSI EN 300 631: "Fixed Radio Systems; Point-to-point Antennas; Antennas for point-to-point fixed radio systems in the 1 GHz to 3 GHz band".

[27] ETSI ETS 300 833: "Transmission and Multiplexing (TM); Radio relay equipment; Antennas used in point-to-point radio-relay systems operating in the frequency band 3-60 GHz".

[28] ETSI EN 300 019 (all parts): "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[29] ETSI EN 300 019-1-3: " Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".

[30] ETSI ETS 300 019-1-4: " Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations

[31] ETSI ETS 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

[32] ETSI ETS 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".

[33] ETSI ETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Radio specific functional blocks for transmission of M x STM-N".

[34] ITU-T Recommendation G.784: "Synchronous digital hierarchy (SDH) management".

[35] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".

[36] ETSI EN 300 645: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) radio relay equipment; Information model for use on Q-interfaces".

[37] ITU-T Recommendation I.412 (1988): "ISDN user-network interfaces - Interface structures and access capabilities".

[38] ITU-T Recommendation G.704 (1998): " Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels".

[39] ITU-T Recommendation G.707 (1996): "Network node interface for the synchronous digital hierarchy (SDH)".

[40] IEC Publication 154-2: "Flanges for waveguides. Part 2: Relevant specifications for flanges for ordinary rectangular waveguides"".

[41] ITU-T Recommendation G.783 (1997): "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".

[42] ITU-T Recommendation G.957 (1999): "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".

[43] ITU-T Recommendation O.151 (1992): "Error performance measuring equipment operating at the primary rate and above".

[44] ETSI EN 301 390: "Fixed Radio Systems; Point-to-point and Point-to-Multipoint Systems; Spurious emissions and receiver immunity at equipment/antenna port of Digital Fixed Radio Systems".

[45] ETSI EN 301 126-1: "Fixed Radio Systems; Conformance testing; Part 1: Point-to-point equipment - Definitions, general requirements and test procedures".

[46] ITU-R Recommendation SM.329-7: "Spurious emissions".

[47] CEPT/ERC Recommendation 74-01 "Spurious Emissions".

[48] ETSI TR 101 035 "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS) ".

[49] ETSI TR 101 036-1: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Generic wordings for standards on DRRS characteristics; Part 1: General aspects and point-to-point equipment parameters".

[50] ITU-T Recommendation O.181: "Equipment to assess error performance on STM-N interfaces".

[51] ERC/DEC (97)/10 ERC Decision of 30 June 1997 on the mutual recognition of conformity assessment procedures including marking of radio equipment and radio terminal equipment.

[52] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (R&TTE Directive).

[53] ETSI EN 300 417: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment".

[54] ETSI EN 301 167: "Transmission and Multiplexing (TM); Management of Synchronous Digital Hierarchy (SDH) transmission equipment; Fault management and performance monitoring; Functional description".

[55] ITU-T Recommendation G.708: "Sub STM-0 network node interface for the synchronous digital hierarchy (SDH)".

[56] ITU-R Recommendation P.530: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".

[57] ETSI TR 101 506: "Fixed Radio Systems; Generic definitions, terminology and applicability of essential requirements under the article 3.2 of 99/05/EC Directive to Fixed Radio Systems".

[58] Council Directive 73/23/EEC of 19 February 1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (LV Directive).

[59] ETSI TR 101 845: "Fixed Radio Systems; Technical Information on RF Interfaces applied by Fixed Service Systems including Fixed Wireless Access (FWA) in the light of the R&TTE Directive (Article 4.2)".

[60] Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive).

[61] ETSI EN 301 751: "Fixed Radio Systems; Point-to-Point equipments and antennas; Generic harmonized standard for Point-to-Point digital fixed radio systems and antennas covering the essential requirements under article 3.2 of the 1999/5/EC Directive".

[62] ITU-R Recommendation SM.1045: "Frequency tolerance of transmitters".

[63] ETSI SR 001 470: "Guidance to the production of candidate Harmonized Standards for application under the R&TTE Directive (1999/5/EC); Pro-forma candidate Harmonized Standard".

[64] ITU-R Recommendation F. 557: "Availability objective for radio-relay systems over a hypothetical reference circuit and a hypothetical reference digital path".

[65] ITU-R Recommendation F.1492: "Availability objectives for real digital radio-relay links forming part of international portion constant bit rate digital path at or above the primary rate".

[66] ITU-R Recommendation SM.1541: "Unwanted emissions in the out-of-band domain".

[67] ITU-R Recommendation F.1493: "Availability objectives for real digital radio-relay links forming part of national portion constant bit rate digital path at or above the primary rate".

[68] ITU-T Recommendation G.828: "Error performance parameters and objectives for international, constant bit rate synchronous digital paths".

[69] ITU-T Recommendation G.829: "Error performance events for SDH Multiplex and regenerator sections".

[70] ETSI EG 201 752: " Fixed Radio Systems; Point-to-Point and Point-to-Multipoint Equipment and Antennas; Identification of European standards (EN), applicable to fixed radio systems, for the essential requirements under the article 3.1 of the 1999/5/EC Directive".

A.3 Definitions, symbols and abbreviations

A.3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Allocated radio frequency band: allocation (of a frequency band): entry in the Table of Frequency Allocations of a given frequency band for the purpose of its use by one or more terrestrial or space radiocommunication services or the radioastronomy service under specific conditions

NOTE: This term shall also be applied to the frequency band concerned (Radio Regulations, Geneva 1998 Article S1.16).

Automatic Transmit Power Control (ATPC): this function is implemented to offer a dynamic power control that delivers the maximum power only during deep fading activity; in this way for most of the time the interference is reduced and the transmitter operates in a higher linearity mode

NOTE 1: When this function is used, the transmit power is dynamically changed and follows the propagation condition. In principle, when ATPC is implemented, three different level of power may be identified within the ATPC range.

- maximum available power (delivered only in condition of deep fading);
- maximum nominal power (useable on permanent base when ATPC is disabled); it should be noted that this power is "nominal for the equipment" and has not to be confused with the "nominal level set link by link" by the frequency co-ordinator body, eventually achieved through passive RF attenuators or RTPC function;
- minimum power (delivered in unfaded condition);

MAXIMUM nominal and maximum available power levels may be coincident or, in case of multi-states modulations formats, the maximum available power may be used to overdrive the transmitter (loosing linearity but gaining fade margin when the fade conditions have already impaired the expected RBER). Performance prediction are usually made with the highest "available power".

NOTE 2: The ATPC range is defined as the power interval from the maximum available power level to the minimum power level.

Conformity assessment procedure: As described in the R&TTE Directive [52] annexes II, III, IV and V.

Environmental profile: range of environmental conditions under which equipment within the scope of the present document is required to comply with the provisions of the present document

NOTE: The environmental profile relevant for R&TTE declaration of conformity is the one declared by the manufacturer with the intended limits of usage of the equipment. Any environmental profile, eventually requested in ETSI standards (e.g. EN 300 019 series [28]), is to be considered for voluntary application only.

Essential phenomenon: radio frequency phenomenon related to the essential requirements under article 3.2 of the R&TTE Directive, that is capable of expression in terms of quantifiable technical parameters

Harmonized radio frequency band: commonly referred as a portion of the frequency spectrum that CEPT/ERC allocates to a specific service through a CEPT/ERC Decision (proper definition is currently under study by CEPT/ERC). It should be noted that, presently, radio frequency bands allocated to Fixed Service are not harmonized.

Recommended radio frequency channel arrangement: predefined centre frequencies raster for a number of radio frequency channels, covered by a CEPT/ERC Recommendation in a not harmonized frequency band (not used for the same purpose by all administrations) that is recommended to the member countries in the case they use the relevant frequency band for Fixed Service

Maximum available power: See Automatic Transmit Power Control (ATPC).

Maximum nominal power: See Automatic Transmit Power Control (ATPC).

National radio frequency channel arrangement: predefined centre frequencies raster for a number of radio frequency channels, covered by a national regulation in a not harmonized frequency band used in a country (it may all or in part overlap with other national or recommended radio frequency channel arrangements)

Operating frequency range: range(s) of radio frequency channels covered by the Equipment Under Test (EUT) without any change of HardWare (HW) units (from EN 300 385)

Radio Equipment (as defined in the R&TTE Directive): radio equipment means a product, or relevant component thereof, capable of communication by means of the emission and/or reception of radio waves utilizing the spectrum allocated to terrestrial/space radiocommunication

Radio frequency channel arrangement: predefined centre frequencies raster for a number of radio frequency channels, as defined by ITU-R Recommendation F.746 used by administrations for co-ordination in the same geographical area

Radio frequency channel: portion of a radio frequency band, where a radio frequency channel arrangement has been established, dedicated to one fixed radio link

Remote frequency control (RFC): many fixed digital radio systems offered this functionality as a qualifying aid to the deployment. When this function is used, the transmit centre frequency/channel can be set either by a local control unit connected to the system control unit or to a by a remote network management terminal. The frequency variation is static and usually made at the activation or re-commissioning of links in order to easily obtain the licensed frequency assigned by the co-ordinating body to the network operator for that link, to control network interference in the same geographical area.

Remote Transmit Power Control (RTPC): many fixed digital radio systems offered this functionality as a qualifying aid to the deployment. When this function is used, the transmit power can be set either by a local control unit connected to the system control unit or to a by a remote network management terminal. The power variation is static and usually made at the activation or re-commissioning of links in order to easily obtain the EIRP required by the frequency co-ordinating body for that link, to control co-channel and adjacent channel interference in the same geographical area. In principle, this function is equivalent to the requirement of power regulation capability (e.g. by fixed attenuators) commonly required in fixed systems.

A.3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	decibel
dBc	decibel relative to mean carrier power
dBi	decibel relative to isotropic radiator
dBm	decibel relative to 1 mW
Fc	cut-off frequency
GHz	GigaHertz
kbit/s	kilobits per second
kHz	kiloHertz
km	kilometre
Mbit/s	Megabits per second
MHz	MegaHertz
mW	milliWatt
ns	nanosecond
ppm	parts per million

A.3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ATPC	Automatic Transmit Power Control
BB	Base Band
BER	Bit Error Rate
BWe	Evaluation bandwidth
CEPT	Conférence des Administrations Européennes des Postes et Télécommunications
DFRS	Digital Fixed Radio Systems
IF	Intermediate Frequency
IPI	Inter Port Isolation
ITU-R	International Telecommunication Union-Radiocommunication sector (previously CCIR)
ITU-T	International Telecommunication Union-Standardization sector (previously CCITT)
LO	Local Oscillator
NFD	Net Filter Discrimination
PDH	Plesiochronous Digital Hierarchy
PRBS	Pseudo Random Binary Sequence
RES	Radio Equipment and Systems
RF	Radio Frequency
RFC	Remote Frequency Control
RFCOH	Radio Frame Complementary OverHead
RL	Return Loss
RSCOH	Radio Section Complementary OverHead

RTPC	Remote Transmit Power Control
Rx	Receiver
S/N	Signal to Noise ratio
SDH	Synchronous Digital Hierarchy
SOH	Section OverHead
TC	Technical Committee
TM	Transmission and Multiplexing
TMN	Telecommunications Management Network
TX	Transmitter
WG	Working Group
XPD	Cross-Polar Discrimination
XPIC	Cross-Polar Interference Canceller

A.4 General characteristics

A.4.1 Frequency bands and channel arrangements

A.4.1.1 Channel arrangement

The equipment shall operate on one or more of the channels as defined below:

The frequency range(s) is(are) *lower frequency* to *higher frequency* GHz. The channel arrangement shall be in accordance with *ITU-R; CEPT or other references [Reference to be made in clause A.2].*

The description of relevant channel plan, channel spacing, alternated/co-channel arrangement, basic rasters (if any), reference frequency etc. is given in informative annex C.

A.4.1.2 Channel spacing for systems operating on the same route

System bit rates and their relevant *co-polar (or alternated or interleaved)* channel spacing in the present document are reported in table A.1 (for the precise payload bit rates see clause A.5.1).

NOTE: According to system characteristics the equipment can be connected either to separate antennas or on separate polarization to the same antenna.

Table A.1: Digital systems channel spacings for various bit rates

	Payload Bit Rate [Mbit/s]⇒	**2**	**2 × 2**	**8**	**2 × 8**	**34**	**51**	**140 and 155**
Channel Spacing [MHz]	Class x equipments	3,5	7	14		56		
	Class y equipments	3,5	3,5	7	14	28	56	112
	…………	……	……	…..	…..	……	…..	……
	Class z equipments			3,5	7	14	14/28	56

NOTE 1: n x 2 Mbit/s and n × 34 bit rates may be used where appropriate.
n × 2 Mbit/s mapped into SDH VC12 or VC2, according ITU-T Recommendation G.708 [55], transport bit rates may be used where appropriate (e.g. three or four times VC12 into an 8 Mbit/s channel spacing).
NOTE 2: Other payloads equivalent in bit-rate are also considered.

A.4.2 Compatibility requirements between systems

One or more of the following statements will be applicable:

a) there shall be no requirement to operate transmitting equipment from one manufacturer with receiving equipment from another;

b) *there may be* a requirement to multiplex different manufacturers equipment on the same polarization of the same antenna;

c) *there may be* a requirement to multiplex different manufacturers equipment on different polarization of the same antenna. This is not applicable to systems with integral antenna;

d) depending on the application, it shall be possible to operate the system in vertical and/or horizontal polarization, if required by the channel arrangement;

e) there may be a requirement to connect radio equipments to a feeder/antenna assembly of a different manufacturer.

A.4.3 Performance and availability requirements

Equipment shall be designed in order to meet network performance and availability requirements foreseen by ITU-T Recommendations *G.821 [16], for capacities below the primary rate, or G.826 [17] and G.828 [68] for capacities at or above the primary rate*.

The events for SDH multiplex and regenerator sections should be measured according to ITUT Recommendation G.829 [69].

The performance and availability objectives for any overall radio connection operating at ***capacities below the primary rate****, in the high, medium or local grade portions of the network, have to be based on the criteria defined in ITUR Recommendations F.634 [1] and F.695 [2], for the high grade, F.696 [3],for the medium grade, F.697 [4] for the local grade and F.557 [64], for the overall reference digital path.*

The performance and availability objectives for any overall radio connections operating at ***capacities at or above the primary rate****, used in the international or national portion of the digital path, have to be based on the criteria defined in ITUR Recommendations F.1397 [10] and F.1492 [65], for international portion, F.1491 [11] F.1493 [67], for the national portion.*

The implication of the link design on the performance is recognized and the general design criteria reported in ITU-R Recommendations F.752 [6], F.1093 [7], F.1101 [8] and F.1102 [9] are to be applied according the foreseen propagation scenario reported in ITU-R Recommendation P.530 [56].

A.4.4 Environmental profile

The equipment shall be required to meet the environmental conditions set out in the multipart standard EN 300 019 [28] which defines weather protected and non-weather protected locations, classes and test severity.

The equipment shall comply with all the requirements of the present document at all times when operating within the boundary limits of the operational environmental profile of the equipment.

The environmental profile of the equipment shall be declared by the manufacturer.

The fulfilment of EN 300 019 [28] environmental profiles is voluntary and not essential from the point of view of R&TTE [52]; for this purpose any operational environmental profile, as declared by the manufacturer, shall be used.

Any test, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the R&TTE Directive [52] for radio equipment, shall be carried-out with the same principles and procedures, for reference and extreme conditions, reported in clause 4.4 of EN 301 126-1 [45]. The requirement for test at reference or extreme conditions is reported in the relevant clause of the present document according to the principles for similar requirements in EN 301 126-1 [45].

A.4.4.1 Equipment within weather protected locations (indoor locations)

Equipment intended for operation within temperature controlled locations or partially temperature controlled locations should meet the requirements of EN 300 019-1-3 [29] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of EN 300 019-1-3 [29] classes 3.3 (non-temperature controlled locations), 3.4 (sites with heat trap) and 3.5 (sheltered locations) may be applied.

A.4.4.2 Equipment for not-weather protected locations (outdoor locations)

Equipment intended for operation within not-weather protected locations should meet the requirements of ETS 300 019-1-4 [30], class 4.1 or 4.1E.

Class 4.1 applies to many European countries and class 4.1E applies to all European countries.

A.4.5 Power supply

The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in EN 300 132-1 [31] and EN 300 132-2 [32].

NOTE: Some applications may optionally require secondary voltages that are not covered by EN 300 132.

For DC systems, the positive pole of the voltage supply will be earthed at the source.

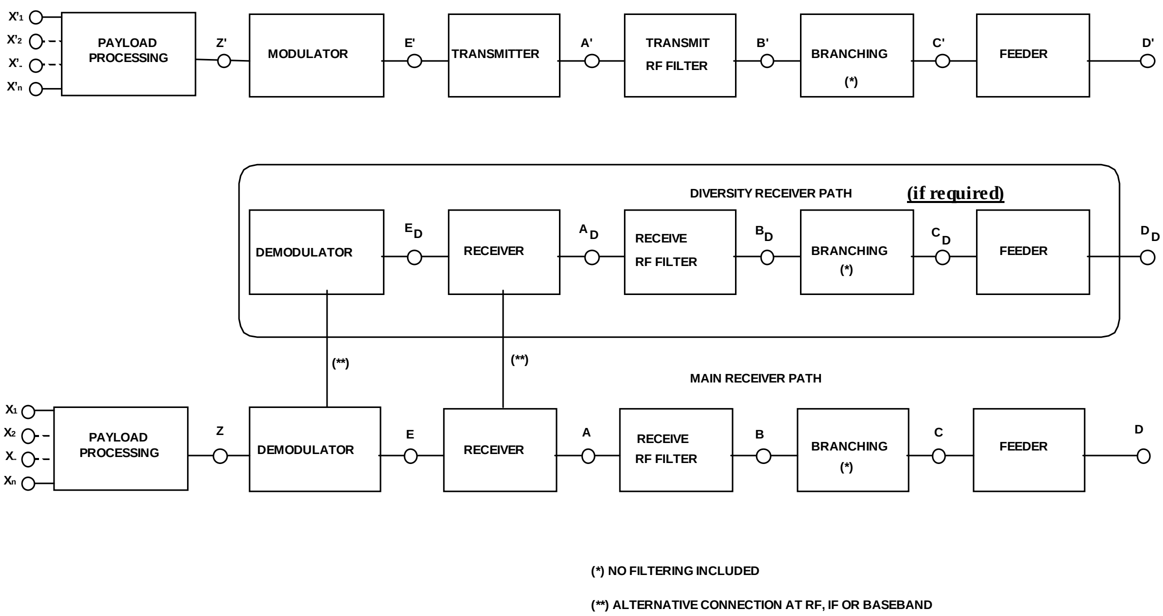
A.4.6 Electromagnetic compatibility

This requirement is considered essential under article 3.1 b) of R&TTE [52].

The system shall operate under the conditions specified in relevant parts of the multipart standard EN 301 489-1 [18] and EN 301 489-4 [19], which are harmonized under the R&TTE Directive [52].

Alternatively, also harmonized ETS 300 385 [20] or its subsequent revision EN 300 385 V.1.2.1. [21] are applicable until the date of their cessation of presumption of conformity reported in the EC official journal.

A.4.7 System block diagram



NOTE 1: For the purpose of defining the measurement points, the branching network does not include a hybrid.
NOTE 2: The points shown above are reference points only; points C and C', D and D' in general coincide.
NOTE 3: *(to be included only if applicable)*
Points B, C, B' and C' may coincide when simple duplexer is used.

Figure A.1: System block diagram

A.4.8 Telecommunications Management Network (TMN) interface

For SDH equipment the general requirements for TMN interface and functionality are given by:

- EN 300 417-1-1 [53], EN 300 417-2-1 [53], EN 300 417-3-1 [53], EN 300 417-4-1 [53], EN 300 417-5-1 [53], EN 300 417-6-1 [53], EN 301 167 [54], ETS 300 635 [33] and EN 300 645 [36].
- ITU-T Recommendations G.784 [34] and G.773 [35].
- ITU-R Recommendations F.750 [12] and F.751 [13].

NOTE: The standardization of TMN interface functionalities is under the responsibility of and under development in ETSI TC-TMN, and will be applicable to the radio relay systems considered in the present document.

A.4.9 Branching/feeder/antenna requirements

A.4.9.1 Antenna radiation patterns

This requirement is considered essential under article 3.2 of R&TTE [52].

See EN 300 833 [27].

A.4.9.2 Antenna Cross-Polar Discrimination (XPD)

This requirement, if applicable, is considered essential under article 3.2 of R&TTE [52].

See EN 300 833 [27].

A.4.9.3 Antenna Inter-Port Isolation (IPI)

See EN 300 833 [27].

A.4.9.4 Waveguide flanges (or other connectors)

When *flanges (or other connector types)* are required at reference point*(s) B, B', C, C'*, the following type shall be used according to IEC 154-2 [40]:

- *UBR/PBR/CBR-XXX (or other connectors type)*, for the complete frequency range *lower limit* to *upper limit GHz (if applicable)*.

NOTE: UBR/PBR/CBR YYY (or other connectors type) may be used for the lower part of the band lower limit to upper limit GHz. UBR/PBR/CBR ZZZ (or other connectors type) may be used for the higher part of the band lower limit to upper limit GHz.

A.4.9.5 Return loss

For systems which intend to apply compatibility requirements under clause A.4.2 b) or 4.2 c), the minimum return loss shall be *X dB* at point C and C' over the full RF band and measured back in the direction to the transmitter.

Equipment according to the present document may also have system configurations with integral antennas or very similar technical solutions, without long feeder connections; return loss is not considered essential. In this case and when the antenna is an integral part of the equipment there shall be no requirement.

For return loss requirement of feeder/antenna assembly, see annex A.

NOTE: On a national customer basis it may be required to multiplex equipment from different manufacturers on the same branching/antenna of one polarization.
This will result in additional national customer requirements for RL also at reference points B and B', which will be verified in an acceptance test.

A.4.9.6 Intermodulation products

When multi-channel branching system are concerned, in case the system is intended to comply with compatibility requirement in clause A.4.2(c), each intermodulation product, caused by different transmitters linked to the same branching system, shall be less than -XXX dBm referenced to reference point B with an output power per transmitter relevant to the one referred in clause A.5.3.1.

NOTE: The reference power shall be the maximum power stated by the manufacturer for the equipment. This clause is not intended for conformance test, but only, if required, for type test agreed between user and manufacturer. The measurement, if any, will be carried out with unmodulated signals of the same power of the average level of the digital signals.

A.5 Parameters for digital systems

Radio equipments subject to the present document, might be designed in order to cover wide radio-frequency band and/or a number of different bit-rate transmission capacity; this could be made by HW and/or SW presetting.

The equipment shall comply with all the requirements of the present document at any possible operating frequency and transmission bit-rate; however, for the purpose of conformity assessment to R&TTE [52], the test report shall be produced under the principle set in clause A1.

A.5.1 Transmission capacity

Payload bit rates(s) considered in the present document are: *2,048 Mbit/s, 2 × 2,048 Mbit/s, 8,448 Mbit/s, 2 × 8,448 Mbit/s, 34,386 Mbit/s, 51,840 Mbit/s (STM-0), 139,264 Mbit/s, Nx155,520 Mbit/s (NxSTM-1), STM-N or other capacities. System rates configured as n × 2 Mbit/s and n-times 2 Mbit/s mapped into SDH VC12/VC2 transport bit rates (sub-STM-0 rates sSTM-1n/sSTM-2n according ITU-T Recommendation G.708 [*55*]) may be used where appropriate.*

In the following these capacities will be simply referred as 2 Mbit/s, 2 × 2 Mbit/s, 8 Mbit/s, 2 × 8 Mbit/s, nxVC12 (sSTM-1n), nxVC2 (sSTM-2n), 34 Mbit/s, 51 Mbit/s (STM-0), 140 Mbit/s, and 155 Mbit/s (STM-1).

The above system capacity are reported as the most common digital data rates for classical PSTN transport networks; however systems used in access network may offer other internationally standardized data interface of equivalent bit-rate as required by the market growth.

A.5.2 Baseband parameters

All the following specified baseband parameters refer to point X and X' of figure A.1. Parameters for service channels and wayside traffic channels are outside the scope of the present document.

One or more of the following clauses will be applicable.

A.5.2.1 Plesiochronous interfaces

*Plesiochronous interfaces at 2 Mbit/s, 8 Mbit/s, 34 Mbit/s and 140 Mbit/s shall comply with ITU-T Recommendation G.703 [*15*]. Parameters for service channels and wayside traffic channels are outside the scope of the present document.*

A.5.2.2 ISDN interface (primary rate)

*The transmission of 2 Mbit/s signals using the structure and functions of ISDN primary multiplex signals is to be in accordance with ITU-T Recommendations G.703 [*15*], G.704 [*38*], I.412 [*37*] and ETS 300 233 [*25*].*

A.5.2.3 SDH baseband interface

*The SDH baseband interface shall be in accordance with ITU-T Recommendations G.703 [*15*], G.707 [*39*], G.783 [*41*], G.784 [*34*] and G.957 [*42*] and ITU-R Recommendation F.750 [*12*].*

Two STM-N physical interfaces are possible:

- STM-1 CMI electrical (ITU-T Recommendation G.703 [15]);
- STM-N optical (ITU-T Recommendation G.957 [42]).

*The use of reserved bytes contained in the Section OverHead (SOH), and their termination shall be in accordance with ITU-R Recommendation F.750 [*12*]. Further details on the possible use of the SOH bytes including additional RFCOH or RSCOH are given in TR 101 035 [*48*].*

A.5.2.4 Other data channel baseband interface

One of the following sentence may be applicable

- *The data interfaces should be in accordance to….(e.g. ITU-T Recommendations V.11 [*22*], V.24 [*23*] and V.28 [*24*]).*
- *The data interface offered by the equipment shall be declared by the supplier together with the relevant set of applicable international standards in agreement with the network operator.*

A.5.2.5 Analogue channel baseband interface

If applicable characteristic of analogue interfaces may be reported here.

A.5.3 Transmitter characteristics

The specified transmitter characteristics shall be met with the appropriate baseband signals applied at reference point Z' of figure A.1. For Plesiochronous Digital Hierarchy (PDH) interfaces this shall be a Pseudo-Random Binary Sequence (PRBS) according ITU-T Recommendation O.151 [43]. For SDH interface ITU-T Recommendation O.181 [50] test signal applies.

A.5.3.1 Transmitter power range

Transmitter maximum mean output power at reference point C' of the system block diagram (see figure A.1) shall not exceed *+XX dBm* (including tolerance and, if applicable, ATPC/RTPC influence).

For the purpose of system engineering *N classes* of nominal output power are defined (see intervals in table A.2).

NOTE: The technological evolution may result in equipment falling outside of the range(s) foreseen in this clause. In this case the equipments of different output power sub-ranges are not considered to require individual type approval, however their use is subject to individual national agreements.

Table A.2: Output power sub-ranges (including tolerance)

sub-range 1	> $x1_L$ dBm	<= $x1_H$ dBm
sub-range 2	> $x2_L$ dBm	<= $x2_H$ dBm
....	....	....
sub-range N	> xN_L dBm	> xN_H dBm

A capability for output power level adjustment may be required for regulatory purposes, in which case the range of adjustment, *either by fixed or automatic attenuators*, should be in increments of 5 dB or less.

A.5.3.2 Transmit power and frequency control

These requirements are considered essential under article 3.2 of R&TTE [52].

A.5.3.2.1 Transmit Power Control (ATPC and RTPC)

Automatic Transmit Power Control (ATPC) and Remote Transmit Power Control (RTPC) are commonly optional features.

From the point of view of hardware implementation, ATPC and RTPC functions are made by an electronic attenuator implemented along the transmitting chain (e.g. at IF or at RF level or at both level) and can be realized in a mixed configuration, e.g.:

- ATPC only is implemented;
- RTPC only is implemented;
- ATPC + RTPC are implemented with separate attenuator functions;
- ATPC + RTPC are implemented with a single attenuator complying both functions with different command functions (either HW or SW) and the ranges of both may be traded-off from a maximum available attenuation.

The presence of ATPC feature is sufficient for considering also some receiver and system parameters (see clauses A.6 and A.7) among essential requirements under R&TTE Directive [52] article 3.2.

A.5.3.2.1.1 Automatic Transmit Power Control (ATPC)

Equipment with ATPC will be subject to manufacturer declaration of ATPC ranges and related tolerances.

The correct operation of ATPC function according the supplier declaration shall be tested according the test method described in clause A.5.2.3 of EN 301 126-1 [45].

Testing shall be carried out with output power level corresponding to:

- ATPC set manually to a fixed value for system performance (see clauses A. A.5.5 and A.A.5.6);
- ATPC set at maximum available power for transmit performance (see clause A.A.5.3).

It shall be verified that the emitted RF spectrum is within the absolute RF spectrum mask evaluated for the maximum available output power of the equipment, including the attenuation introduced by RTPC, if any.

The equipment shall comply with the requirements of spectrum masks in clause A.A.5.3.5 with ATPC operating in the range between maximum nominal power and maximum available power including the attenuation introduced by RTPC function (if any). Where the use of ATPC is considered compulsory for regulatory purposes the transmitter output power must meet the spectrum mask limits throughout the ATPC range.

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the R&TTE Directive [52], shall be carried-out with:

- ATPC set at maximum available power for transmit performance (see clause A.A.5.3).
- ATPC set manually to a fixed value for system performance (see clauses A. A.5.5 and A.A.5.6);

The test shall be carried-out at reference climatic conditions.

[The following sentence may also be required, particularly in frequency bands where rain attenuation is dominant):]

Not to impair ES performance, it is preferable that the threshold of ATPC intervention is designed to be in a RSL region where the BBER of clause A.A.5.5.2 is still met (see annex A).

A.5.3.2.1.2 Remote Transmit Power Control (RTPC)

Equipment with RTPC will be subject to manufacturer declaration of RTPC ranges and related tolerances.

The equipment shall comply with the requirements of spectrum masks in clause A.A.5.3.5 along all RTPC range.

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the R&TTE Directive [52] shall be carried-out at three operating conditions (lowest, medium, and highest delivered power) of the RTPC power excursion and with ATPC (if any) set to maximum available power. The test shall be carried-out at reference and extreme climatic conditions.

Even if all the procedure provided by clause 5.2.6 of EN 301 126-1 [45] are followed, the actual tests, at the lower RTPC power levels, might fall outside the available sensitivity of test instruments, currently available on the market. In this event, the supplier shall produce an attachment to the test report containing:

- the calculated evidence that the noise floor of the actual test bed is higher than the mask requirement;
- the calculated evidence that the actual noise floor, generated by the transmitter according its noise figure and its implemented amplification/attenuation chain; is lower than the mask requirement.

A.5.3.2.2 Remote Frequency Control (RFC)

This functionality is commonly an optional feature.

Equipment with RFC will be subject to manufacturer declaration of RFC ranges and related change frequency procedure.

RFC setting procedure shall not produce emissions outside the previous and the final centre frequency spectrum masks required in clause A.A.5.3.5.

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the R&TTE Directive [52], shall be carried for RFC setting procedure for three frequencies (i.e. frequencies settings from lower to centre, centre to higher and back in the covered range). The test shall be carried-out at reference climatic conditions.

A.5.3.3 Transmitter output power tolerance

This requirement is considered essential under article 3.2 of R&TTE [52].

The nominal output power shall be declared by the supplier.

The tolerance of the nominal output power shall be within:

- for systems operating within non-weather protected locations classes 4.1 and 4.1E defined in ETS 300 019-1-4 [30] and within classes 3.3, 3.4 and 3.5 weather protected locations defined in EN 300 019-1-3 [29]:
    - nominal output power ±X dB;
- for systems operating within other classes of weather protected locations defined in EN 300 019 [28]:
    - nominal output power ±Y dB; (see note for Rapporteurs X≥Y).

The above limits are intended as ETSI voluntary requirements; from the point of view R&TTE declaration of conformity the power tolerance shall be:

- nominal output power ±X dB; (see note for Rapporteurs this X is numerically the same X as above)

within the environmental profile declared by the manufacturer for the intended limits of usage of the equipment.

A.5.3.4 Transmitter local oscillator frequency arrangements

Note for the Rapporteurs: This clause is optional, it was used in the past when specific arrangement was required. If required, one or more of the following statements may be applicable:

- *when separate transmit and receiver Local Oscillators (LO) are used, the LO frequencies for both transmitters and receivers should be arranged so that for channels in the lower half of each go or return sub-band the frequency is higher than the channel assigned frequency, and for channels in the upper half of each go or return sub-band the LO frequency is lower than the channel assigned frequency;*

- *whenever a single LO is used for both transmitter and receiver the LO frequency shall be arranged between or above or below the corresponding transmit and receive frequencies;*

- *there shall be no requirement on LO frequency arrangement.*

A.5.3.5 Radio Frequency (RF) spectrum mask

Note for the Rapporteurs: Figure A.2 is indicative of all masks problematic. One ore more figures should be used as appropriate; frequency/attenuation corner points should be clearly identified either in the figure itself or in a specific table. Possible compatibility requirements from clause A.4.2 might result in different spectrum masks. The spectrum masks limits are necessary for a number of intra-system and inter-system regulatory and performance requirements. Whenever required mask attenuations, beyond those reported in table B.1 of appendix B, are considered not relevant to essential requirements under article 3.2 of the R&TTE Directive [52]; this fact, shown with f) limit in FigureA. 2, shall be properly remarked in the text. The masks shall be generally extended up to ±250 % of the relevant channel separation (for any regulatory purpose); beyond this frequency, masks are expected to describe only internal requirement of the system.

This requirement is considered essential under article 3.2 of R&TTE [52].

Clause A.4.2 provides compatibility requirements. The compatibility requirements provide options for single-channel and multi-channel RF branching systems.

The spectrum masks are shown in figure A.2, both for the normal channels on the same branching networks (curves a, b) and for the inner side of innermost channels on the same branching networks (curves c, d).

If applicable the following statement and note may apply too:

- *Curves a and c apply only to single RF channel systems (partially outdoor) systems.*

- *When up conversion is performed from a 70 MHz intermediate frequency, the limit of the residual LO emission at point C' will not be limited by the spectrum mask but shall meet the limits of spurious emissions, either the external (see paragraph A.5.3.7.1) or if applicable the internal requirement (see paragraph A.5.3.7.2) whichever is the more stringent.*

NOTE 1: Equipment for innermost channels are not considered to require individual type approval testing provided that the manufacturer supplies evidence of the design data of the adopted filters to match the requirement of the required TX spectrum mask and RX selectivity in clause A.A.5.4.6.

The 0 dB level shown on the spectrum masks relates to the spectral power density of the carrier centre frequency, disregarding residual of the carrier (eventually due to modulation imperfection).

Masks shall be measured with a modulating base-band signal given by a PRBS *signal given in ITU-T Recommendation O.151 [*43*]* in the case of PDH signal *or in ITU-T Recommendation O.181 [*50*] for STM-N signal.*

The masks do not include frequency tolerance.

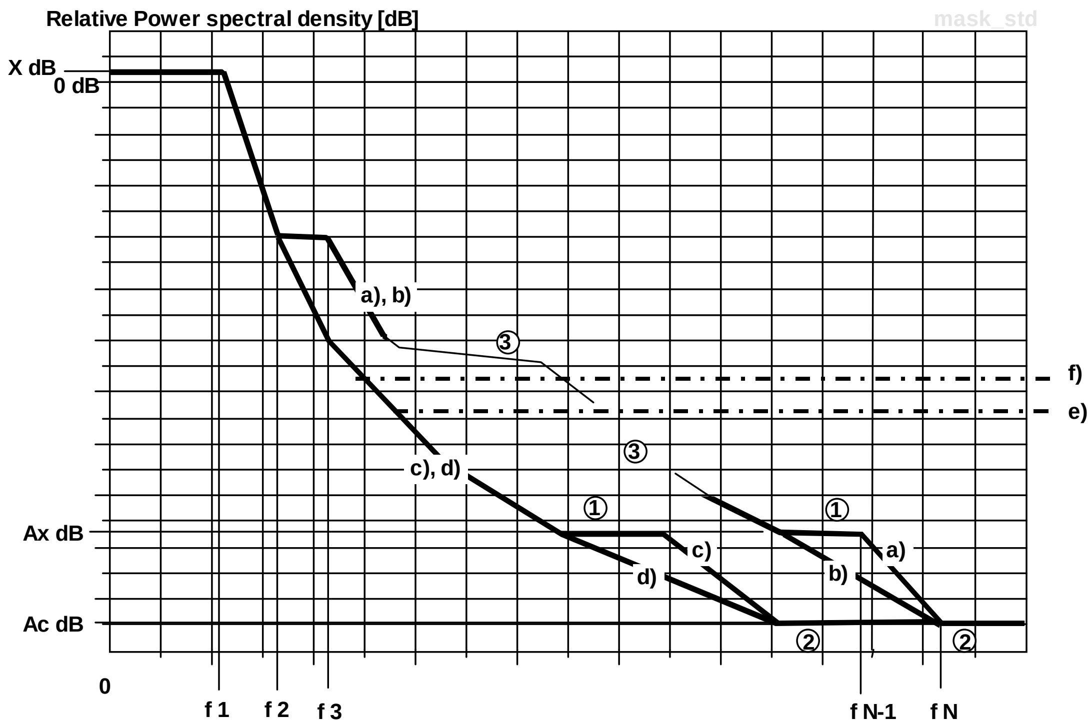
The masks given in figure A.2 fix lower limits of Ax dB and Ac dB for systems with compatibility requirements according to clause A.4.2 c) and b), respectively, in order to control local interference between transmitters and receivers on different or same polarization respectively.

NOTE 2: These values may be evaluated by adding a measured filter characteristic to the spectrum at A' of figure A.2. Due to limitations of some spectrum analysers, difficulties may be experienced when testing high capacity/wideband systems. In this event, the following options are to be considered: measurement using high performance spectrum analyser; use of notch filter; two step measurement technique. When difficulties are experienced, the plots of one test may be produced as evidence of conformance to the spectrum mask.

Table A.3 shows the recommended spectrum analyser settings.

Table A.3: Spectrum analyser settings for RF power spectrum measurement

Channel separation	MHz	### ...		0.003 <CS≤ 0.03	0.03 <CS≤ 0.3	0.3 <CS≤ 0.9	0.9 <CS≤ 12	12 <CS≤ 36	36<CS		≤...
Centre frequency		fo		fo	fo	fo	fo	fo	fo		fo
Sweep width	**MHz**	...		0,5	2	5	20	50	200		...
Scan time		auto		auto	auto	auto	auto	auto	auto		auto
IF bandwidth	**kHz**	...		1	3	10	30	100	300		...
Video bandwidth	**kHz**	...		0,03	0,1	0,1	0,3	0,3	0,3		...



Frequency from nominal centre frequency [MHz]

KEYS:

a)	Normal channel spectrum with nearest local receiver on cross polarization.
b)	Normal channel spectrum with nearest local receiver on co-polarization.
c)	Inner side of innermost channel with nearest local receiver on cross polarization.
d)	Inner side of innermost channel with nearest local receiver on co-polarization.
e)	Limit of direct measurement at reference point B' or C'.
f)	Limit for relevance to essential requirements under article 3.2 of the R&TTE Directive [52].
①	Frequency zone of nearest local receiver on cross polarization.
②	Frequency zone of nearest local receiver on co-polarization.
③	*Frequency zone where standard channels mask has to be defined according to link planning interference requirements.*

Figure A.2: Limits of spectral power density

If necessary for ENs dealing with multiple bit rates/channel spacing the following statement and table will apply.

Reference frequencies f 1 to f N are reported in table A.4 for the bit rate and channel spacing foreseen:

Table A.4: Spectrum mask frequency limits

Spectrum efficiency class	Bit Rate	Channel Spacing	f 1	f 2	f 3	....	....	f N-1	f N
	....	....	....	....	....	....	....	....	....
	....	....	....	....	....	....	....	....	....
	....	....	....	....	....	....	....	....	....

A.5.3.6 Discrete CW components exceeding the spectrum mask limit

These requirements are considered essential under article 3.2 of R&TTE [52].

A.5.3.6.1 Discrete CW components at the symbol rate

The power level (reference point B') of spectral lines at a distance from the channel centre frequency equal to the symbol rate shall be less than -x dBm *or x dB below the average power level of the carrier*.

A.5.3.6.2 Other discrete CW components exceeding the spectrum mask limit

Should CW components exceed the spectrum mask, an additional allowance is given.

Those lines shall not:

- exceed the mask by a factor more than {10 log (CSmin/IFbandwidth) - 10} dB (see note);
- be spaced each other in frequency by less than CSmin.

Where:

CSmin = "XX" MHz for "A" GHz band

CSmin = …………………

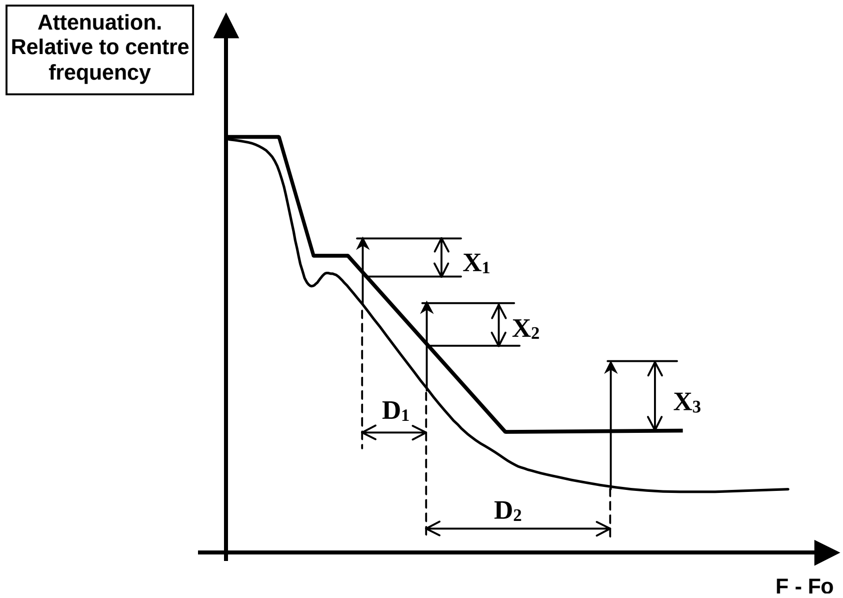
CSmin = ………….

CSmin = "YY' MHz for "N" GHz band

IF bandwidth is the recommended resolution bandwidth reported in table A.3.

NOTE: In case the calculation of the allowance factor will result in a negative value, no additional allowance is then permitted.

Figure A.3 shows a typical example of this requirement.



X_1 , X_2 , X_3 [dB] $\leq$ 10log(CSmin/BWe) -10

D_1 , D_2 $\geq$ CSmin

Figure A.3: CW lines exceeding the spectrum mask (typical example)

A.5.3.7 Spurious emissions

It is necessary to define spurious emissions from transmitters for two reasons:

a) to limit interference into other systems operating wholly externally to the system under consideration (external emissions), which limits are referred by CEPT/ERC Recommendation 74-01 [47] based on ITU-R Recommendations SM.329 [46], and ITU-R Recommendation F.1191 [14];

b) to limit local interference within the system where transmitters and receivers are directly connected via the filter and branching systems (internal emissions).

This leads to two sets of spurious emission limits at reference point *B'* (*for systems with multichannel branching operation) or C' (for all other cases).*

NOTE: "Internal" limits are required not to be more relaxed than the "external" ones.

A.5.3.7.1 Spurious emissions - external

This requirement is considered essential under article 3.2 of R&TTE [52].

According to CEPT/ERC Recommendation 74-01 [47] the external spurious emissions are defined as emissions at frequencies which are removed from the nominal carrier frequency more than ± 250 % of the relevant channel separation.

Outside the band of ±250 % of the relevant channel separation, the Fixed Service radio systems spurious emission limits, defined by CEPT/ERC Recommendation 74-01 [47], together with the frequency range to consider for conformance measurement, shall apply at reference point C' of figure A.1.

A.5.3.7.2 Spurious emissions - internal

The levels of the spurious emissions from the transmitter, referenced to reference point B' of figure A.1 are specified in table A.5.

The required level will be the total average level integrated over the bandwidth of the emission under consideration.

Table A.5: Internal levels for the transmitter spurious emissions

Spurious Emission Frequency Relative to Channel Assigned Frequency	Specification Limit	Controlling Factor for requirement application
The level of all spurious signals both discrete CW and noise-like evaluated as total signal level	≤ -XX dBm (-90 dBm is commonly used)	If spurious signal's frequency falls within receiver half band, for digital systems with compatibility requirements as in clause A.4.2 b)
	≤ -YY dBm (-70 dBm is commonly used)	If spurious signal's frequency falls within receiver half band, for digital systems with compatibility requirements as in clause A.4.2 c)
	…….	…………

Requirements for internal spurious emissions are not necessary for systems that are not intended to comply with any compatibility requirements under clause A.4.2

A.5.3.8 Radio frequency tolerance

This requirement is considered essential under article 3.2 of R&TTE [52].

Maximum radio frequency tolerance shall not exceed:

- ±X ppm. *or ± XX kHz, whichever is the more stringent,* for operation in environmental classes 3.1 and 3.2. (or equivalent weather-protected environment.
- ±Y ppm. *or ± YY kHz, whichever is the more stringent,* for operation in other environmental classes.

This limit includes both short-term factors (environmental effects) and long-term factors (ageing effects).

In the type test the manufacturer shall state the guaranteed short-term part and the expected ageing part.

A.5.4 Receiver characteristics

A.5.4.1 Input level range

The lower limit for the receiver input level shall be given by the threshold level for Bit Error Ratio (BER) = 10^{-x}. The upper limit for the receiver input level, where a BER of 10^{-x} is not exceeded shall be -XX dBm; *a BER of 10^{-y} may only be exceeded for levels greater than –YY dBm. These limits apply without interference and are referenced to point B.*

For equipment designed to operate only with ATPC as a fixed permanent feature, the above maximum input levels are reduced by an amount up to the ATPC range.

A.5.4.2 Rx Local Oscillator (LO) frequency arrangements

NOTE: The whole clause is optional and used in the past in very particular cases.

One or more of the following statements may be applicable:

- the receiver's LO frequencies shall be selected in order to avoid the possibility of local transmitters falling at the image frequency of the receivers;
- when separate transmit and receiver local oscillators are used, the LO frequencies for receivers should be the same of the corresponding transmitters;

- whenever a single LO is used for both transmitter and receiver the LO frequency shall be arranged between or above or below the corresponding transmit and receive frequencies;
- there shall be no requirement on LO frequency arrangement.

A.5.4.3 Spurious emissions

Spurious emissions from the receiver are emissions at any frequency, measured at point C.

It is necessary to define spurious emissions from receivers for two reasons:

a) to limit interference into other systems operating wholly externally to the system under consideration (external emissions), which limits are referred by CEPT/ERC Recommendation 74-01 [47];

b) to limit local interference within the Sub-STM-1 system where transmitters and receivers are directly connected via the filter and branching systems.

This leads to two sets of spurious emission limits where the specific limits given for 'internal' interference are required to be no greater than the "external" level limits.

A.5.4.3.1 Spurious emissions - external

This requirement is considered essential under article 3.2 of R&TTE [52].

At reference point C of figure A.1, the limit values of CEPT/ERC Recommendation 74-01 [47] shall apply.

A.5.4.3.2 Spurious emissions - internal

When equipments are foreseen to share the same antenna the following sentences may be applicable:

Spurious emissions limits, referenced to point B, are specified below in table A.6.

The required level will be the total average level integrated over the bandwidth of the emission under consideration.

Table A.6 Limits of Spurious Emissions-Internal

Specification Limit	Controlling factor
≤-XX dBm (commonly –110 dBm is used)	Spurious falling in the same receiver half-band For systems with compatibility requirements of clause A.4.2 b)
≤-YY dBm (commonly –90 dBm is used)	Spurious falling in the same receiver half-band For systems with compatibility requirements of clause A.4.2 c)

For systems without compatibility requirements of clause A.4.2 there is no requirement.

In addition, when compatibility with FDM systems on the same branching/antenna system is required and the digital equipment uses 70 MHz intermediate frequency, the LO residual emission, at reference point B, shall be:

≤-125 dBm For systems with compatibility requirements of clause A.4.2b in the 7 GHz band.

≤-110 dBm For systems with compatibility requirements of clause A.4.2b in all other band and with compatibility requirements of clause A.4.2c in all band.

A.5.4.4 Void

A.5.4.5 Receiver image rejection

If applicable, the receiver image(s) rejection shall be *≥XX dB*.

Also the following table may alternatively be applicable:

The receiver image(s) rejection shall be as listed in table A.7.

Table A.7: Receiver image rejection

Controlling factor	Image rejection
a) if image(s) frequency falls within receiver half band and branching on different polarizations is used as defined by the compatibility requirements in clause A.4.2 (c)	≥ 90 dB
b) in systems not intended to fulfil any compatibility requirements in clause A.4.2	Not Applicable
c) if image(s) frequency falls within receiver half band and branching on same polarization is used as defined in clause A.4.2 (b) or in the transmitter half band on different polarization as defined by the compatibility requirements in clause A.4.2 (c)	≥ 100 dB
d) if image(s) frequency falls within transmitter half band and branching on same polarization is used as defined by the compatibility requirements in clause A.4.2 (b)	≥ 120 dB

A.5.4.6 Innermost channel receiver selectivity

Note for the Rapporteurs: This clause is optional

For systems which are intended to comply with compatibility requirement under clause A.4.2b) and 4.2c), to guarantee innermost TX/RX channel compatibility, the inner side of the innermost receiver shall be within the mask given in figure A.4.

Since it is not considered feasible to make a practical measurement of this characteristic, the manufacturer shall supply the design data of the filters implemented on this receiver.

Picture as Required

Figure A.4: Overall minimum receiver selectivity of the inner side of innermost receiver

A.5.5 System performance without diversity

All parameters are referred to reference point C (for systems with simple duplexer) or B (for systems with multi-channel branching system) of the system block diagram of figure A.1. Losses in RF couplers used for protected systems are not taken into account in the limits specified below.

All measurements shall be carried out with the test signals defined in clause A.5.3.

A.5.5.1 BER as a function of receiver input signal level RSL

This requirement is considered essential under article 3.2 of R&TTE [52].

All parameters are referred to reference point *C (for systems with simple duplexer) or B (for systems with multi-channel branching system)*. Losses in RF couplers possibly used for protected systems are not taken into account in the limits specified below.

Equipment working at the relevant RSL thresholds, reported in the Tables of the relevant annex(es), shall produce a BER (*Bit or Block Error Rate)* equal or less than the corresponding values (e.g. 10^{-3}, 10^{-6} and 10^{-8} or 10^{-10}) also indicated in the same tables.

One of the following statement may also be applicable:

- *when innermost Tx/Rx channel local interference is present, the allowed threshold degradation on the values stated in table A.6 are X' dB at 10-x, Y' dB at 10-y and Z' dB at 10-z when an additional decoupling ≥ D dB is introduced simulating an achievable antenna IPI and feeder losses (or, if applicable, antenna circulator decoupling);*

NOTE: Equipment for innermost channel are not considered to require individual type approval testing provided that the manufacturer shall supply evidence of the design data of the adopted filters to match the requirement of clauses A. 5.3.5. and A.5.4.5.

- *the threshold values stated in table A.8 shall be met even when innermost Tx/Rx channel local interference is present, with an additional decoupling ≥ D dB is introduced simulating an achievable antenna IPI and feeder losses (or, if applicable, antenna circulator decoupling); nevertheless an actual thresholds degradation on actual BER performances may be present.*

Table A.8: BER performance thresholds

	RSL @ BER →	RSL @ 10^{-x}	RSL @ 10^{-y}	RSL @ 10^{-y}
Bit rate (Mbit/s) ↓	Channel spacing (MHz)↓			

A.5.5.2 Equipment Residual BER (RBER)

The equipment RBER level under simulated operating conditions without interference is measured with a signal level at reference point *B (or C)* which is 10 dB above the level which gives BER = 10^{-6} (as specified in clause A.5.5.1):

- *for systems of less than 196 kbit/s: BBER < under study;*
- *for systems less than 2 Mbit/s: BBER < under study;*
- *for systems less than 34 Mbit/s: BBER < under study;*
- *for systems of 34 Mbit/s and above: BBER < under study;*
- *all measurements are made at the payload bit rate defined in clause A.5.1.*

NOTE 1: Equipment which may supply different payload bit rates on the same aggregate transport rate are not required to perform individual BBER type approval for every possible payload port, the manufacturer will present one for type approval and make conformance declaration for the others.

Table A.9 gives the minimum recording time and the maximum numbers of errors that shall not be exceeded:

NOTE 2: When FEC is implemented, its activity may be recorded and RBER estimated, on a lower time base, by a law, stated by the manufacturer, which effectiveness may be verified, at suitable higher BER points, by the body which performs the test.

Table A.9: Allowed number of errors in a 24 hours background BER test

Bit rate	Channel spacing	Minimum recording time	Maximum errors number
....	....		....
....	....		....
....	....		....

A.5.5.3 Interference sensitivity

All receive signal levels and C/I measurements are referred to reference point B (for system with multi-channel branching system) or C (for systems with simple duplexer) of the RF block diagram (see figure A.1).

A.5.5.3.1 Co-channel "external" interference sensitivity

This requirement is considered essential under article 3.2 of R&TTE [52].

The limits of co-channel interference shall be as in table A.8 below, giving maximum C/I values for 1 dB and 3 dB degradation of the 10^{-6} BER limits specified in clause A.5.5.1.

This requirement applies also to systems with XPIC referring to "external" interferers from similar systems but from a different route (nodal interferer).

For frequency co-ordination purpose intermediate values may be found in the curve supplied in annex A.

Table A.10: Co-channel "external" interference sensitivity

co-channel "external" interference					C/I at BER @ 10^{-6} RSL degradation	
degradation ➔					1 dB	3 dB
Spectrum efficiency class ↓	Bit rate (Mbit/s) ↓	Channel spacing (MHz) ↓				
1						
2						
...						

A.5.5.3.2 Co-channel "internal" interference sensitivity

a) In flat fading conditions

The following specification applies to systems with XPIC only; the "internal interference" is considered that given by the twin system sharing the same XPIC system.

The limits of the co-channel "internal" interference sensitivity shall be as in table A.11.

Table A.11: Co-channel "internal" interference sensitivity

co-channel "internal" interference			C/I at BER @ 10^{-6} RSL degradation	
degradation ➔			1 dB	3 dB
Spectrum efficiency class ↓	Bit rate (Mbit/s) ↓	Channel spacing (MHz) ↓		
1				
2				
……				

b) In dispersive fading conditions

This requirement is for systems at in 18 GHz band and below.

To evaluate the performance during multipath propagation, dispersive cross-polarized main signals and non dispersive cross-polarization interferences are used in test bench in clause A.C.5.

Performance is evaluated by means of a signature degraded by the presence of Cross Polar Interference. In the above defined measurement conditions, the notch frequencies and depths are kept equal on both paths.

Limits for BER = 10^{-6} are reported in table A.12.

Table A.12: Degraded signature vs. XPI

Class/CS [MHz]	S/XPI [dB]	Signature Width [MHz]	Signature Depth [dB]
4/56	Tbd	Tbd	Tbd
5/28	Tbd	Tbd	Tbd
5/56	Tbd	Tbd	Tbd
6/40	Tbd	Tbd	Tbd

A.5.5.3.3 Adjacent channel interference

This requirement is considered essential under article 3.2 of R&TTE [52].

The limits of adjacent channel interference shall be as given in *table(s) 10.1 to 10.n* below for like modulated signals spaced of *1 to n channel spacing respectively*, giving maximum C/I values for 1 dB and 3 dB degradation of the 10^{-6} BER limits specified in clause A.5.5.1.

For frequency co-ordination purpose intermediate values may be found in the curve(s) supplied in the annex A.

Table A.13.1: 1st adjacent channel interference sensitivity

1st adjacent channel interference					C/I at BER @ 10^{-6} RSL degradation	
degradation ➔					1 dB	3 dB
Spectrum efficiency class ➔	Bit rate (Mbit/s) ➔	Channel spacing (MHz) ➔				
1						
2						
……						

Table A.13.n: nth adjacent channel interference sensitivity

nth adjacent channel interference					C/I at BER @ 10^{-6} RSL degradation	
degradation ➔					1 dB	3 dB
Spectrum efficiency class ➔	Bit rate (Mbit/s) ➔	Channel spacing (MHz) ➔				
1						
2						
……						

A.5.5.3.4 CW spurious interference

This requirement is considered essential under article 3.2 of R&TTE [52].

For a receiver operating at the RSL specified in clause A.5.5.1. for 10^{-6} BER threshold, the introduction of a CW interferer at a level of *+XX dB*, with respect to the wanted signal and at any frequency up to the relevant upper and lower frequency limits derived from the table A.reported in appendix B (see clause B.5.5.3.4), but excluding frequencies either side of the wanted frequency by up to 250 % the relevant co-polar channel spacing, shall not result in a BER greater than 10^{-5}.

This test is designed to identify specific frequencies at which the receiver may have a spurious response; e.g. image frequency, harmonics of the receive filter, etc. The actual test range should be adjusted accordingly. The test is not intended to imply a relaxed specification at all out of band frequencies elsewhere specified in the present document.

A.5.5.3.5 Front-end non-linearity requirements (two-tone CW spurious interference)

For a receiver operating at the RSL specified in clause A.5.5.1 for 10^{-6} BER threshold, the introduction of two equal CW interferes each with a level of *+YY dB*, with respect to the wanted signal and located at the 2nd and 4th adjacent channel in the receive halfband, shall not result in a BER greater than 10^{-5}.

A.5.5.4 Distortion sensitivity

One of the following three statements will be applicable, depending on the frequency band and/or the system baud-rate and distortion sensitivity:

1) *For a delay of 6,3 ns and a BER of 10^{-3} the width of the signature shall not exceed ±XX MHz relative to the channel assigned frequency and the depth shall not be less than XX dB:*

   - *for a delay of 6,3 ns and a BER of 10^{-6} the width of the signature shall not exceed ±XX MHz relative to the channel assigned frequency and the depth shall not be less than XX dB;*

   - *these limits are valid for both minimum and non-minimum phase cases;*

   - *the limits specified for BER = 10^{-3} shall also be verified by the loss of synchronization and re-acquisition signatures.*

2) *Rainfall is the main propagation factor in the 18 GHz band limiting performance. Powerful equalizers to compensate propagation distortion are not considered necessary for 18 GHz equipment. The specifications for distortion sensitivity are given below in the form of signatures:*

   - *for two path propagation with a delay of 6,3 ns and a BER of 10^{-3} the width of the signature shall not exceed ±XX MHz relative to the assigned channel centre frequency, the depth shall not be less than X dB;*

   - *for two path propagation with a delay of 6,3 ns and a BER of 10^{-6} the width of the signature shall not exceed ±XX MHz relative to the assigned channel centre frequency, the depth shall not be less than X dB;*

   - *these limits are both valid for minimum and non-minimum phase cases. They shall also be verified by the loss-of-synchronization and re-acquisition signatures.*

3) *Outage from multipath phenomena is not considered relevant for the systems subject to the present document.*

A.5.6 System characteristics with diversity

Space, angle and frequency diversity techniques are applicable. In this clause, only combining techniques are considered.

A.5.6.1 Differential delay compensation

It should be possible to compensate for differential absolute delays due to antennas, feeders and cable connections on the two diversity paths. The limit is at least *XX* ns of differential absolute delay.

A.5.6.2 BER performance

When both receiver inputs (main and diversity, reference point B and BD) are fed with the same signal level at an arbitrary phase difference, input level limits for specified BER values of clause A.5.5.1 shall be lower than those given under clause A.A.5.5 for the case without diversity:

- more than 2,5 dB for IF or baseband combining systems;

- more than 1,5 dB for RF combining systems;

- no improvement for baseband switch systems.

A.5.6.3 Interference sensitivity

[Under study]

A.5.6.4 Distortion sensitivity

[Under study]

A.Annex A (normative): Wide radio-frequency band covering units and multirate equipment specification and tests

Note for Rapporteurs: This annex is necessary, in case of EN candidate for being harmonized under the R&TTE, in order to set the rules for the production of the test report for essential parameters necessary to fulfil the conformity assessment to article 3.2 essential requirements.

A.A.1 Wide radio-frequency band covering units

Even if radio frequency front-ends for FDRS are commonly designed for covering all or part(s) of the possible operating channels within a specific radio frequency channel arrangement, equipments can provide single radio frequency channel operation (e.g. when the RF duplexer filters is tuned to a specific channel) or offer a wider operating frequency range (e.g. wide-band RF duplexer and frequency agility by RFC function for easiness of deployment and spare parts handling by operators with large networks made by more than one assigned channels).

The equipment shall comply with all the requirements of the present document at any possible operating frequency.

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the R&TTE Directive [52], shall be carried-out in the following way:

1) in the case of equipments intended for single channel operation, the test report shall be produced for one radio frequency channel arbitrarily chosen by the supplier (see figure A.A.A.1);

2) in the case of equipments intended for covering an operating frequency range, the test report shall be produced for the lowest, intermediate and highest possible radio frequency channel within that operating frequency range (see figure A.A.A.2);

3) it is not required that all the tests, required for the test report, are done on the same sample of equipment and at the same time; provided that the test report includes all the tests required by the present document, each test may be made on different samples of the same equipment, at different channel frequencies or frequency ranges and in different times.

When applicable also the following additional provisions apply to the production of the test report:

- in the case of equipments covering a radio frequency channel arrangement with more than one operating frequency range, the test report shall be produced for one of the operating frequency ranges arbitrarily chosen by the supplier, using the above procedures for equipments intended for single channel operation or for covering an operating frequency range (see figure A.A.A.2);
- in the case of equipments designed to cover, with the same requirements under the same ETSI standard, a number of fully or partially overlapping recommended and/or national radio frequency channel arrangements, similarly established across contiguous radio frequency bands allocated to Fixed Service, the test report shall be produced for one radio frequency channel arrangements arbitrarily chosen by the supplier, using the above procedures for equipments intended for single channel operation or for covering an operating frequency range (see figures A.A.A.1 and A.A.A.2).

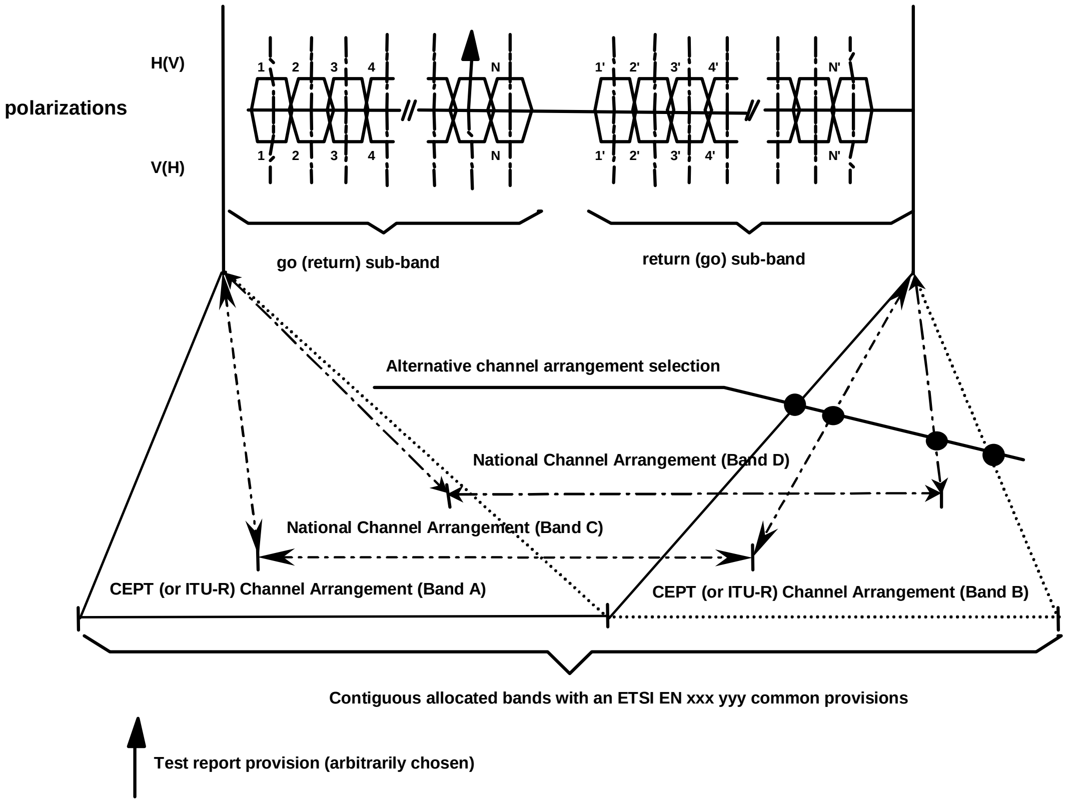


Figure A.A.1: Test report frequency requirement for equipments intended for single channel operation

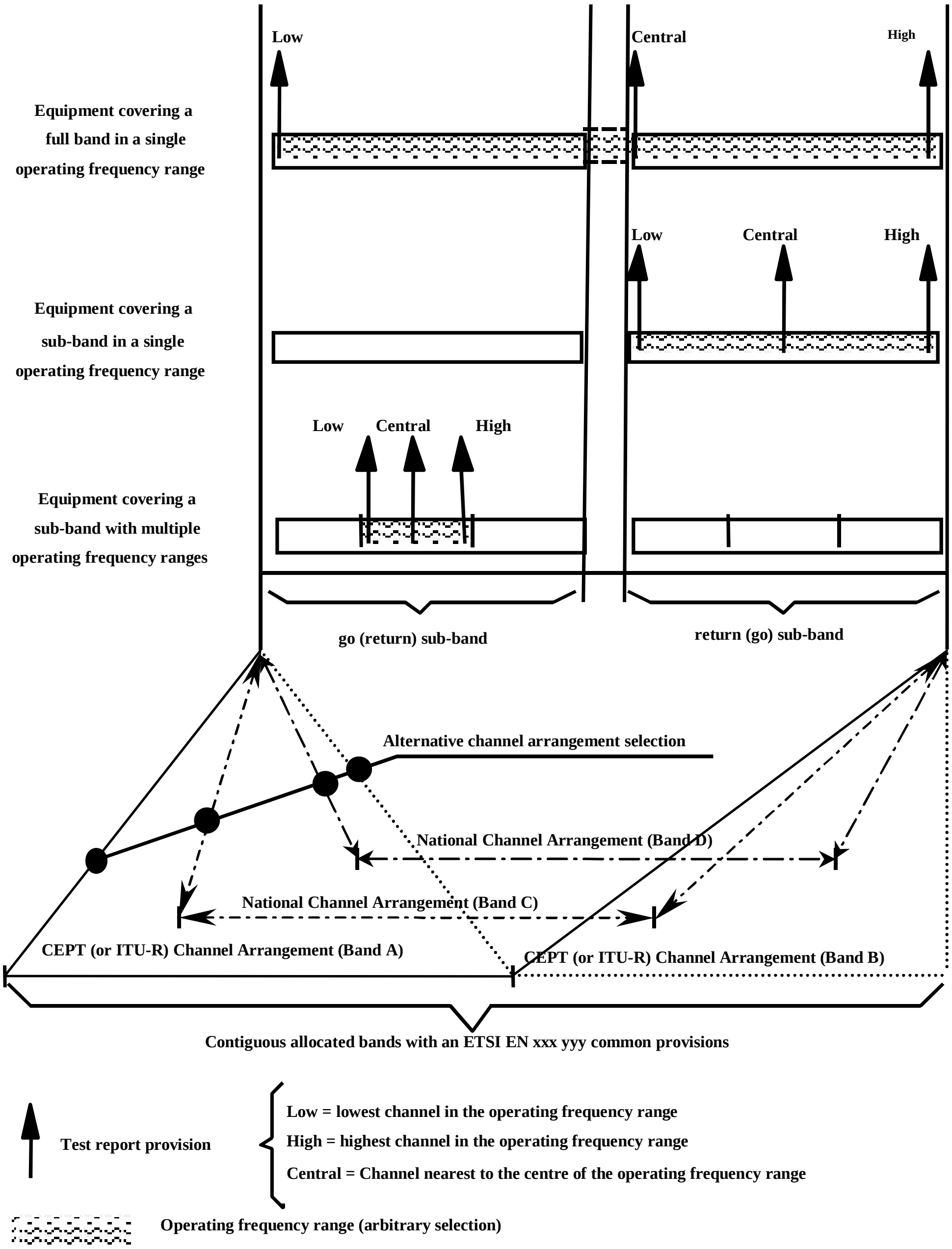


Figure A.A.2: Test report frequency requirements for equipments intended for covering an operating frequency range

A.A.2 Multirate/Multiformat equipment

FDRS equipments can cover a number of different payload-rate or different modulation format through software pre-settings.

In such cases the equipment shall comply with all the requirements of the present document at any possible payload operation.

The tests, carried out to generate the test report and/or declaration of conformity, required to fulfil any Conformity assessment procedure foreseen by the Directive 1999/5/EC [52], shall be carried-out for transmitting phenomena (see clause A.4.5) at any possible bit rate and modulation format operation, while receiving phenomena (see clause A.4.7) and control and monitoring functions (see clause A.4.8) shall be tested only at the lowest and the highest bit rate for any modulation format.

A.Annex B (normative): The EN Requirements Table (EN-RT)

The EN Requirements Table (EN-RT) serves a number of purposes, as follows:

- it provides a tabular summary of all the requirements;
- it shows the status of each EN-R, whether it is essential to implement in all circumstances (Mandatory), or whether the requirement is dependent on the supplier having chosen to support a particular optional service or functionality (Optional). In particular it enables the EN-Rs associated with a particular optional service or functionality to be grouped and identified;
- when completed in respect of a particular equipment it provides a means to undertake the static assessment of conformity with the EN.

Table A.B.1: EN Requirements Table (EN-RT)

EN Reference		**EN <xxx xxx>**				**Comment**
No.	**Reference Clause**	**EN-R (see note)**	**Status**			
1	<x.y.z>	<Limits for parameter 1>				
2	<etc.>	<etc.>				
3						
<etc>						
NOTE: <This><These> EN-R<s> <is><are> justified under Article <X> of the R&TTE Directive.						

Guidance note: *Select the one item under the relevant Article covered by the present document and amend the Note appropriately.*

Key to columns:

No Table entry number;

Reference Clause reference number of conformance requirement within the present document;

EN-R Title of conformance requirement within the present document;

Status Status of the entry as follows:

M Mandatory, shall be implemented under all circumstances;
O Optional, may be provided, but if provided shall be implemented in accordance with the requirements;
O.n this status is used for mutually exclusive or selectable options among a set. The integer "n" shall refer to a unique group of options within the EN-RT. A footnote to the EN-RT shall explicitly state what the requirement is for each numbered group. For example, "It is mandatory to support at least one of these options", or, "It is mandatory to support exactly one of these options".
Comments To be completed as required.

A.Annex C (informative):

A.C.1 Radio Frequency (RF) channel arrangement

The relevant radio frequency channel arrangement is provided by (*related ITU-R, CEPT or other body recommendation)*; however, for readers convenience, figure A.C.1 gives its general overview.

The centre gap is *actual value or other reference to the basic raster relationship (e.g. taken as a multiple of the basic raster of 3,5 MHz).*

The innermost channels are *actual value of the spacing if relevant for particular selectivity or other reference MHz* spaced.

The transmitter receiver duplex frequency separation is *value or any other motivated duplex frequency separation definition.*

Figure(s) as Required

Figure A.C.1: Radio frequency channel arrangement

A.C.2 Antenna and feeders requirements

A.C.2.1 Antenna Inter-Port Isolation (IPI)

Compatibility criteria *(reported in clause A.4.2 c) if applicable)* of innermost cross-polarized TX and RX equipment will be guaranteed with an IPI of *"X" dB plus twice a feeder loss of "Y" dB.*

A.C.2.2 Feeder/antenna assembly return loss

The minimum return loss of the feeder/antenna assembly, connected to indoor systems, should be considered not less than Y dB. The measurement shall be referred to reference point C/C' towards the antenna.

For partially outdoor systems with short connections to the antenna, the antenna return loss should be considered not less than X dB. The measurement shall be referred to reference point D/D" towards the antenna.

A.C.3 Automatic Transmit Power Control (ATPC)

Automatic Transmit Power Control (ATPC) may be useful in some circumstances, e.g.:

- to reduce interference between neighbouring systems or adjacent channels of the same system;
- to improve compatibility with analogue and digital systems at nodal stations;
- to improve residual BER or BBER performance;
- to reduce upfading problems;
- to reduce transmitter power consumption;
- to reduce digital to digital and digital to analogue distant interference between hops which re-use the same frequency;
- to increase system gain as a countermeasure against rainfall attenuation;

- in frequency bands where multipath is dominant propagation factor, to improve adjacent channel protection to differential fading conditions caused, by operation of adjacent channels on different antennas on parallel route (e.g. operated by different operators).

ATPC as an optional feature is aimed at driving the Tx power amplifier output level from a proper minimum which facilitates the radio network planning requirements and which is used under normal propagation conditions up to a maximum value which fulfils all the specifications defined in the present document.

ATPC may also be used to increase the output power above the nominal level up to the maximum level specified by the manufacturer, with the agreement of administrations and operators, during fading conditions. This can be useful because in frequency ranges above 13 GHz the main limiting factors are given by non selective fading events.

For planning considerations in a nodal environment a system equipped with ATPC can be considered to operate with its minimum transmitter power.

In some systems ATPC may be employed as a fixed feature in order to reach a higher nominal system gain; when ATPC is a fixed feature the ATPC range is defined as the power interval from the maximum (including tolerances) output power level to the lowest transmitter output power level (at reference point B') with ATPC; when it is optional two ranges may be defined, a "down-range" from the nominal level to the minimum (including tolerances) and an "up-range" from the nominal level to the maximum (including tolerances). Therefore, in such systems, when ATPC is disabled, the nominal output power for stable operation is lower than the maximum in dynamic operation with ATPC enabled.

To avoid reduction in the practical ATPC range, the minimum power level should not be less than 5 dBm.

The use of the ATPC may increase the percentage of time in which the system operates at low receiver signal level; it may be preferable that the threshold of ATPC intervention is designed to be in a RSL region where the BBER is still met, so that, even if the system would remain at constant RSL for an higher percentage of time, an increase of Errored Blocks (EB) or Background Block Error Ratio (BBER) objectives is avoided with respect to a system without ATPC function.

A.C.4 Co-channel and adjacent channel Interference

The reference performances for co-channel and adjacent channel *spaced by one or more channel spacing* C/I are shown in figures A.C.2, A.C.2.1*, A.C.2.2 ......A.C.2.n*

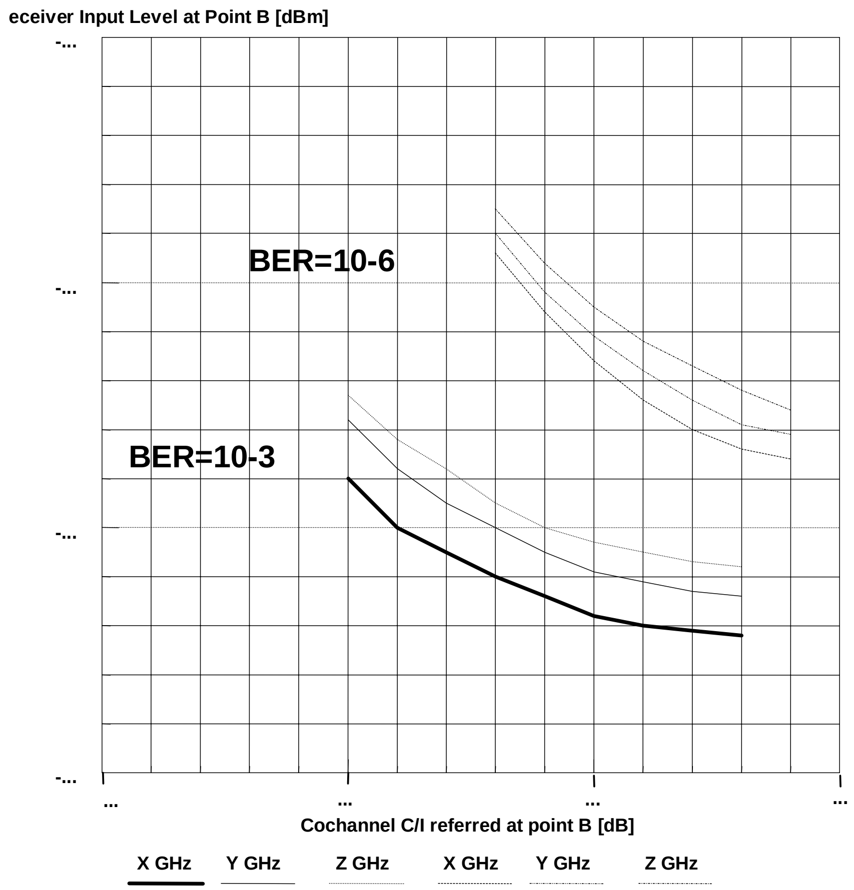


Figure A.C.2: Co-channel interference threshold degradation

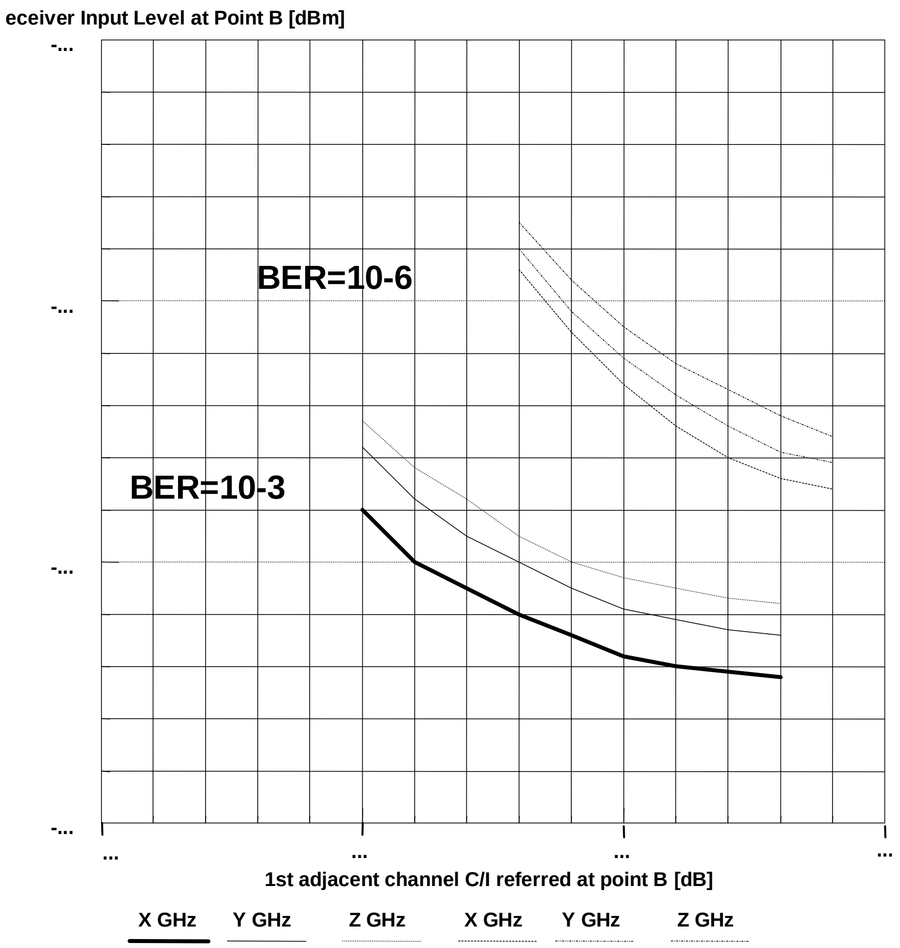


Figure A.C.2.1: 1st adjacent channel interference threshold degradation

Figure as required

Figure A.C.2.2: 2nd adjacent channel interference threshold degradation

....

....

Figure as required

Figure A.C.2.n: Nth adjacent channel interference threshold degradation

A.C.5 Measurement test set for XPI characteristics

We define in figure A.C.3 a measurement set-up that allows to simulate wanted signals affected by flat and/or dispersive fading conditions in presence of XPI (Cross Polar Interference) which level and phase can also be varied.

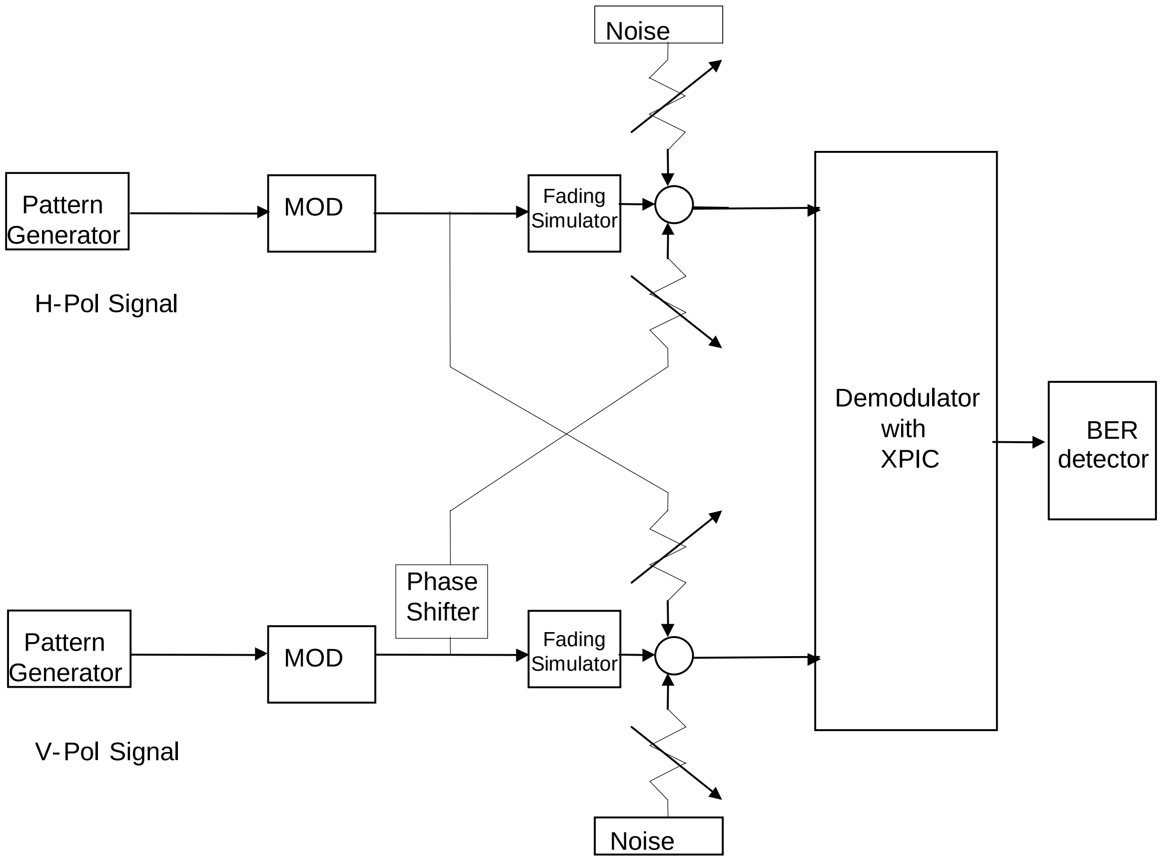


Figure A.C.3: IF Measurement test set

As an alternative a full RF test set-up may be used as reported in figure A.C.4.

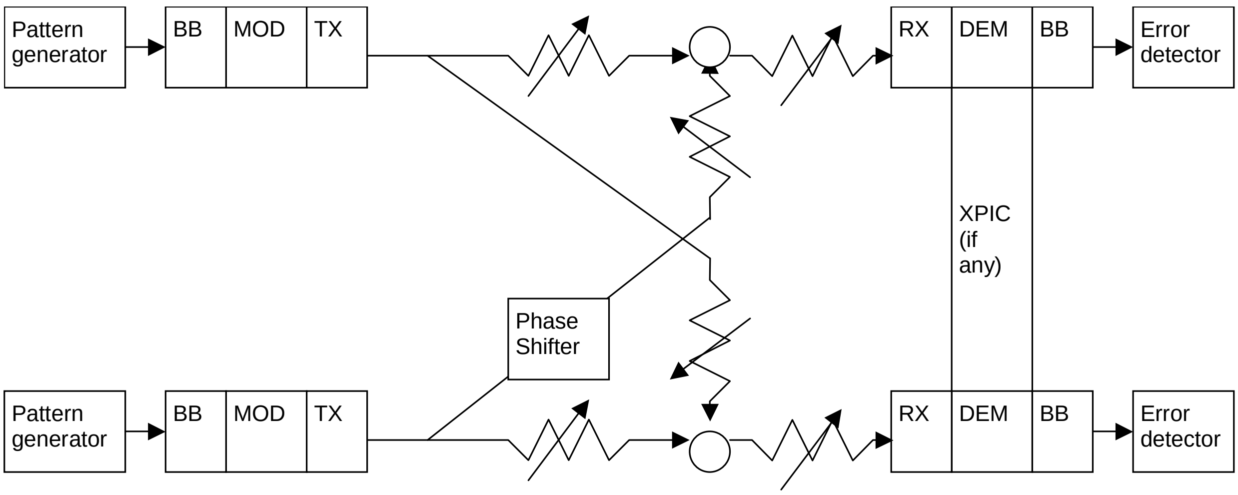


Figure A.C.4: RF Measurement test set

A.Annex D (informative): Bibliography

- ETSI EN 300 339: "Radio Equipment and Systems (RES); General Electro-Magnetic Compatibility (EMC) for radio equipment".
- ETSI EN 301 127: "Fixed Radio Systems; Point-to-point equipment; High capacity digital radio systems carrying SDH signals (up to 2 x STM-1) in frequency bands with about 30 MHz channel spacing and using co-polar arrangements or Co-Channel Dual Polarized (CCDP) operation".

Appendix B: Background for the standardized items and for the normative and informative annexes

B.1 Scope

This clause contains a brief description of the equipment type, its use within the network, specific requirements and any other information useful to identify the commercial and technical environment in which it will be used. This clause will be used by ETSI as a database and document sales reference, so it should be short, concise, and aimed at those who may be unfamiliar with DFRS or radio systems in general.

In the scope should be placed all the reference to those side standardization area which are relevant to the system operation, while not specifically related to the equipment parameters reported in the standard itself.

These arguments may be summarized as:

- Antennas parameters: antenna parameters are considered essential for a correct and efficient spectrum management. WG TM4 decided not to include antenna parameters in each equipment standard but to produce a set of specific standards covering all the relevant parameters for P-P and P-MP antennas in every relevant frequency band. Reference to the required antenna standard is therefore required.

- Conformance testing procedures: even if not mandatory, testing procedures are extremely helpful for mutual recognition of type tests under the procedures set by ERC Decision (97)/10 [51] and in future for a common base for presumption of conformity and market survey under the scope of the R&TTE Directive [52]. WG TM4 decided not to include conformance testing procedures in each equipment standard but to produce a set of specific standards covering the testing procedures and characterization of parameters from the regulatory point of view for P-P and P-MP equipment and antennas. Reference to the required standard is therefore required.

- Spectrum efficiency classes: standards for fixed radio systems are usually structured as multiple system types (for different capacity and spectrum efficiency in the various options of channel separation provided by CEPT channel arrangements). Therefore the proposed 5 classes are used to identified the spectrum efficiency options for regulatory purpose only. This should not be considered compulsory for the actual modulation format used. The class number should be maintained constant even if some are not foreseen for the standard under development.

- Safety aspects, being safety aspects not included in the ETSI term of reference, safety requirement for equipment shall be explicitly excluded by any EN; however safety is required for compliance to the presumption of conformity to harmonized standards under the scope of EC RE&TTE Directive [52]. Therefore reference to the applicable CENELEC standard(s) is to be made.

- Generic Wording technical background: WG TM4 produced and maintain this TR 101 036 [49] in order to give the users of ETSI standards on Fixed Radio Systems the technical background of most parameters reported in WG TM4 standards. Reference to this TR is therefore considered necessary for solving doubts on the correct interpretation of the standard requirements.

- Reference to parameters essential for presumption of conformity to R&TTE Directive [52] based on the background of TR 101 506 [57].

B.2 References

These are references made to other Standards and Recommendations, either from ETSI or from other bodies (e.g. ITU-T or ITU-R) that contain normative information and/or parameters that are referenced in the text of the standard.

NOTE: "Normative" references are not applicable to the deliverable types Technical Report (TR) or ETSI Guide (EG).

Remember, it is particularly important to include an issue date of these references because of the possible negative impact on the equipment characteristics, cost, availability and certification of changes made in later versions. If it is required that the latest version of a normative reference is used, then the issue date should not be included.

B.3 Definitions, symbols and abbreviations

The purpose of this clause is to give the full meaning of the definitions, abbreviations and symbols used in the EN.

B.4 General characteristics

B.4.1 Frequency bands and channel arrangements

A figure of the relevant channel plan, if any, to be reported in informative annex C, is suitable for reference in understanding the related problems.

B.4.1.1 Channel arrangement

This clause gives the frequency range(s) for the equipment subject to the EN, together with references to the relevant CEPT and/or ITU-R Recommendations or other applicable documents; the description of the main features of the channel plan(s) is ERC (or ITU-R) responsibility that may change it without the standard is affected, therefore it is not appropriate that detailed reference is given in the main body of ENs. For reader convenience only, a specific informative annex may be produced.

For radio frequency channel arrangements definition and background see ITU-R Recommendation F.746 [5].

B.4.1.2 Channel spacing for systems operating on the same route

This clause may only be relevant for ENs where the use of multiple bit rates and equipment classes on different channel spacing is required. If only one bit rate/channel spacing is provided this may be given in the title of EN, but it is preferable if it is stated somewhere in the text as well.

The co-polar (or alternated or interleaved) channel spacings in this clause coincides with that used for first adjacent channel interference performance.

The actual connection to the antenna port(s) may be different; for example even if systems are specified for co-polar adjacent channel operation, it may be convenient to connect two adjacent channels to different polarization of the same antenna.

All the possible system types summarized in this clause, should be identified with a specific numeric code (see note) to be reported in a specific normative annex; these codes would be required by licensing administration to uniquely and easily refer to the system proposed for license.

NOTE: This subject is still under study by TM4.

B.4.2 Compatibility requirements between systems

At the date of publication of this TR, no P-P EN produced by WG TM4 has ever foreseen "air-interface compatibility" among transmitters and receivers from different manufacturer. However this will not prevent that in future EN it may be foreseen. It should be noted that article 4.2 of the R&TTE [52] requires operators to publish the interface technical characteristics at their NTP (network termination points) in order to stimulate competition on terminal equipment; this event may in future impact P-MP equipment but this is unlike for P-P. Additional information on application of article 4.2 to fixed radio systems are reported in TR 101 845 [59].

Moreover, this clause covers the fact that, on a market/national/customer basis it may be required to multiplex equipments from different manufacturer on the same branching/antenna of one polarization.
This will result in additional market/national/customer requirement for branching mechanical arrangement, which may be verified in a customer acceptance test.

This requirement, if present, will imply other requirements for related parameters, namely transmit spectrum masks (see clause B.5.3.5), internal TX and RX spurious emissions (see clauses B.5.3.7.2 and B.5.4.3.2) and antenna Inter-Port Isolation (IPI) (see clause B.4.9.3); which, together have to guarantee the required compatibility (i.e. no degradation or an allowed amount of thresholds degradation which value will be stated in the clause B.5.5.1 where flat fade threshold behaviour is stated).

B.4.3 Performance and availability requirements

These aspects are not directly related to equipment performance to be specified in an EN because they are strongly related to the hops length and/or dispersive behaviour and cannot be matter of any conformance test; nevertheless the equipment shall incorporate suitable features in order to be capable of meeting the requirements on standard hops and connections.

Consequently, this clause shall state in which grade (local, medium or high) of network performance, or in which portion (national or international) of the network, the equipment under the present document is to be used.

Performance and availability are regulated by ITU-T Recommendation G.821 [16] or G.826 [17] and G.828 [68] for measurements based on error counts or block count, respectively.

G.826 [17] is applicable to both SDH and PDH systems, while G.828 [68] is to be applied to "new" (i.e. designed after its adoption by ITU-T) SDH systems only.

G.821 [16] is applicable only to systems below the primary rate (i.e. < 1.5/2 Mbit/s) while G.826 [17] is applicable only for systems at or above the primary rate.

ITU-T Recommendations G.826 [17] and G.828 [68] are the most recently delivered recommendations and should be used at "path" level for all systems operating at or above the primary rate; in particular, G. 828 [68] should be used for SDH "paths" only.

The events for SDH multiplex and regenerator sections have to be measured according to ITUT Recommendation G.829 [69], which differs from G.828 [68] in the block sizes for the multiplex section (24 times 8 000 block/s for STM-1 instead of the 8 000 block/s used in G.826 [17] and G.828 [68] for paths).

ITU-T Recommendations cover the performance aspects of the hypothetical reference circuit, while radio connections within the network should conform to ITU-R Recommendations which transform ITU-T general requirements into specific requirements.

For ITU-T Recommendation G.821 [16] based networks, hypothetical and real radio reference paths or for applications in of local grade, medium grade and high grade portions, operating at capacities below the primary rate (i.e. < 1,5/ 2 Mbit/s), ITU-R Recommendation F.697 [4], for local grade circuits, ITU-R Recommendation F.696 [3], for medium grade circuits; for high grade circuits, ITU-R Recommendations F.634 [1], should be used for error performance limits, while the limits for unavailability can be set by using ITU-R Recommendation F.557 [64] and ITU-R Recommendation F. 695 [2].

For applications based on ITU-T Recommendation G.826 [17] and G.828 [68], operating at capacities at or above the primary rate, ITU-R Recommendation F. 1491 [11] and ITU-R Recommendation F. 1493 [67] should be used in the national portion, ITU-R Recommendation F. 1397 [10] and ITU-R Recommendation F. 1492 [65] should be adopted in the international portion.

B.4.4 Environmental profile and conditions

This clause refers to the requirement dictated by the practical use of the equipment when introduced in the actual network locations.

From the R&TTE [52] point of view, the environmental profile is not an essential requirement, however the manufacturer shall state the assumed profile under which the essential requirements are fulfilled and ensure that the equipment documentation clearly shows those limits for avoid the usage under different conditions that may endanger the equipment conformity.

The term "environmental" refers to every kind of climatic, chemical, mechanical, biological and other stresses, which the equipment is required to withstand, and that are generally given in EN 300 019 [28].

In general only environmental conditions during operation are a matter for EN but, whenever applicable, transport and storage environments may also be quoted from the same EN 300 019 [28].

Although radio-relay engineers would refer to the radio equipment location as "indoor" or "outdoor", EN 300 019 [28] terminology uses "weather protected" and "not weather protected" respectively. Under these two general headings, various sub-classes are depicted for better matching the different types of situations in which electronic equipment may be located.

The "E" in class 4.1E stands for extreme, so the temperature range is wider than and includes the range of normal class 4.1. Therefore equipment rated for 4.1E can be used anywhere in Europe, equipment rated for class 4.1 is only suitable for the more temperate regions with no significantly extreme weather conditions.

It is possible to test equipment cabinets to EN 300 019 [28], and this shall be kept in mind when deciding the parameters under which a piece of equipment is to be tested. For instance, it may be possible to use a piece of equipment rated for class 3.1 outdoors if protected by a previously approved class 4.1E cabinet.

Environments other than those referred by EN 300 019 [28] may be added to the standard text, provided that acceptable reasons are given.

B.4.5 Power supply

ETSI WG EE2 is responsible for characteristics at primary AC (mains) and secondary DC (battery) inputs. ETS 300 132-1 [31] and ETS 300 132-2 [32] should be used for reference.

These ETSs are relevant for conventional telecommunication centres. However the new scenario of private operators and customer premises, will possibly require different kinds of power supply interfaces, that is presently under study by WG EE2.

B.4.6 ElectroMagnetic Compatibility (EMC)

This is relevant to essential requirements under article 3.1b of R&TTE [52].

There are many different approaches and European bodies which deal with this subject. In 1992 WG RES9 was given the responsibility within ETSI for EMC of fixed radio systems and also reached agreement with WG EE4, which is responsible for other transmission equipment, regarding the boundary where the ETSs produced by the two bodies are applicable (i.e. if the multiplexer is an integral part of the radio equipment it will also fall under RES9). This is reflected in a joint EE4/RES9 meeting report (2nd February 1993). However in 1997 all EMC activities of RES9 and EE4 have been unified in the newly established WG ERM/EMC under the also new TC-ERM.

The EMC requirement for Point to Point Fixed Radio Systems of 2 Mbit/s and above were covered by ETS 300 385 [20] issued by WG RES9 where two classes of equipment type are considered (class A for commercial grade and class B for equipments which are supposed to meet standard ITU-T/ITU-R performance also in a polluted RF environment).

Following specific request from TM4, WG ERM/EMC has produced a revision of this standard; this version is EN 300 385 [21] and cover all Fixed Radio Systems, including P-P, P-MP and analogue systems of any system rate. This version merged the two classes of equipments A and B previously defined for differentiating the expected network performance into a single one with all the immunity criteria left to supplier declaration.

In principle emissions and immunity phenomena at antenna port are also required for conformity to EMC European Directive, however in producing EN 300 385 [21] it was agreed that Spurious emissions and CW spurious interference rejection would remain in each product standard, therefore these requirements shall be included in TM4 equipment standards (see clauses B.3.7.1, B.5.4.3.1 and B.5.5.3.4).

When R&TTE Directive [52] was implemented spurious emissions has been formally included into article 3.2 requirements and all equipment standards (previously published under the EMC Directive [60]). A new multi-part EN has been produced by WG ERM/EMC and the parts relevant to Fixed links are EN 301 489 part 1 [18] and part 4 [19]. These ENs set the same application and requirements of the EN 300 385 [21] and have been published in the EC OJ together the previous ETS 300 385 [20] and EN 300 385 [21]. The two latter will cease to be base for presumption of conformity by the date reported in the EC OJ (≈mid 2002).

It should be noted that, for fixed links, cabinet radiation requirement was exceptionally maintained in EN 301 489-4 [19], while for other radio services it has been included in equipment standards (possibly being indistinguishable from spurious emissions in equipment mostly with integral antennas).

The upper-bound frequency where EMC is defined within ETSI is up to now fixed to 1 GHz and this is also reflected in the ERM/EMC standards, nevertheless TM4 has expressed the opinion that in the present fixed/mobile environment this limit has to be raised to 2 GHz.

B.4.7 System block diagram

The reported block diagram is for typical point-to-point transceiver systems using diversity techniques, other specific block diagrams may also be applicable.

B.4.8 TMN interface

This argument is currently under responsibility, study and definition by ETSI WGs TM2 and TM3; TM4 contribution shall, in general, be addressed to the above WGs, giving proper resourcing, by means of specific joint activity, to support the development of specific radio information models. Nevertheless, other specific TM4 ETSs for PDH or analogue systems, if any result from a specific activity, might be applicable.

B.4.9 Branching/feeder/antenna requirements

A set of antenna standards has been produced or is under production by TM4; therefore equipment standards should no longer contain antenna parameters.

The scope of ENs (see clause 1) should contain the appropriate reference to the applicable antenna standard.

B.4.9.1 Antenna radiation patterns

This is relevant to essential requirements under article 3.2 of R&TTE [52].

The antenna radiation pattern is related to the network environment, so that it is, in general, a matter for National planning standards; however, when the antenna is an integral part of the equipment, reference to the antenna performance or, when available, to the relevant antenna EN, for certification purposes, shall be included in the equipment EN.

For dual polarized antennas, co-polar and cross-polar patterns shall be included for each polarization.

TM4 has developed EN 300 631 [26] and EN 300 833 [27] which deal with antenna characteristics; as a consequence these may be considered normative reference for radio equipment EN.

B.4.9.2 Antenna Cross-Polar Discrimination (XPD)

This is relevant to essential requirements under article 3.2 of R&TTE [52].

This factor is optional and may be useful for frequency co-ordination purpose or may be necessary for a minimum system performance (e.g. for co-channel use of multi-state high capacity systems or when, in alternated arrangements, adjacent channel NFD value is not enough to bear propagation induced de-polarization).

Under the above conditions a minimum requirement for XPD discrimination in unfaded conditions or, when available, reference to the relevant antenna EN has to be stated.

B.4.9.3 Antenna Inter-Port Isolation (IPI)

When equipment of different manufacturers and/or already existing analogue or digital equipment are required to be connected to different polarizations of the same antenna, a reference value of IPI *(plus, if applicable, an additional feeder loss which integrate the H/V local discrimination)* shall be stated.

With this value *compatibility (e.g. the required maximum threshold degradation stated in clause B.5.5.1 is achieved)* between innermost cross-polarized local TX and RX equipment is considered.

B.4.9.4 Waveguide flanges (or other connectors)

Standardization of flanges (or other connectors) is required at B-B' reference points when equipment from different suppliers is intended to be used on the same polarization of the same antenna, or at C-C' reference points unless integral antennas are required (see compatibility requirement in clause A.4.2).

B.4.9.5 Feeder/antenna return loss

Return Loss (RL) at reference point C/C' is of particular importance when long feeders are used to connect branching and antenna systems.

Mismatch at both end of the feeder may create echo distortion that, on first conservative assumption may be considered as a co-channel interference with C/I ≈ RL@(C/C') + RL@(D/D'); thus the value of RL may depend on the radio system type.

NOTE: This is if feeder transmission time delay is much higher than the symbol time interval of the system and neglecting the benefit of feeder attenuation.

When the feeder is not present or it is of negligible length, RL impact may be reduced to the produced transmission loss due to power reflection and a value of 20 dB may be in any case enough.

It has to be noted that branching systems realized with simple duplexer, due to the absence of wide band RF termination may not give the required RL on a full-band coverage but only on smaller bands across the relevant channel(s) frequency of the transmitter(s) and receiver(s) of the equipment under test.

B.4.9.6 Intermodulation products

When considering the inclusion of a multi-channel branching system, the transmitter power passing through slight non-linearities in the branching and antenna circulators, feeders and antenna may generate 3rd or higher order intermodulation products. These intermodulation products may fall at local receiver frequencies and cause threshold degradation (see background of clause B.5.3.5).

The level of the intermodulation product which may cause degradation depends on:

- the frequency on which the intermodulation products actually fall (worst case is co-channel and outside a benefit of a "pseudo NFD" may be taken into account);
- it should be noted that "nth order intermodulation products have a bandwidth "n" times wider than the generating signals;

- the threshold of the receiver and its sensitivity to co-channel interference which may be taken from clauses B.5.5.1 and B.5.5.3 (e.g. 1 dB threshold degradation is obtained with a level of an in band intermodulation product of IM ≈ $\text{Threshold}\big|_{BER=10^{-3}} - C/I\big|_{1dB@BER=10^{-3}}$).

Due to the high complexity of a test bay and difficulties in measurement itself, unless a full exploited multi-channel system is built up, this feature is not intended to be matter for conformance test but system design shall be carried out in order to meet this requirement avoiding in-field interference problems.

B.5 Parameters for digital systems

B.5.1 Transmission capacity

Bit rates at payload input port(s) shall be stated, in general these are standard ITU-T foreseen bit rates of PDH or SDH; other bit rates are also possible for special applications.

B.5.2 Baseband parameters

Reference to the international Standards for electrical, optical and, if applicable, physical characteristics are to be made.

B.5.3 Transmitter characteristics

B.5.3.1 Transmitter power range

The maximum allowed limit and the tolerance on the nominal value of this parameter are relevant to essential requirements under article 3.2 of R&TTE [52].

The transmitter nominal power level is, in general, subject to standardization in order to provide proper network design on both, links and nodes points of frequency co-ordination arising from the introduction of different equipment from different suppliers.

For this purpose regulatory administrations may choose to apply a limitation in the allowed range of transmitted power in order to limit harmful interference.

In any case the maximum allowed EIRP radiation (including any ATPC overdrive power) shall be within the radio regulation limits or any specific limits set by ITU-R for sharing conditions in certain frequency bands.

The ATPC range should not be taken into account unless for systems which use it on permanent base (ATPC cannot be disabled).

B.5.3.2 Transmit power and frequency control

B.5.3.2.1 Automatic Transmit Power Control (ATPC)

This function has some implication relevant to essential requirements under article 3.2 of R&TTE [52]. The presence of this functionality is enough for considering some receiver parameters also relevant to essential requirements under article 3.2 of R&TTE [52].

GENERAL

ATPC is a feature that is used for one or more of the following purposes:

- to reduce interference in crowded nodal stations;

- to minimize non linear distortion due to saturation in TX/RX circuits during normal propagation, keeping BBER as lower as possible in multi-state DFRS;

- to increase the available system gain increasing the output power over the nominal level which may guarantee suitable non linear distortion. This may be done during deep fadings, so that the additional non linear distortion become negligible with respect to the already thermally impaired S/N;

- in frequency bands where multipath is dominant propagation factor, to improve adjacent channel protection to differential fading conditions caused, by operation of adjacent channels on different antennas on parallel route (e.g. operated by different operators).

When ATPC is used nodal interference environment may be evaluated with the minimum transmitted power, in fact even if output power increases, the receive level, which actually produce nodal interference at the far end location, never increases over the level during normal propagation.

ATPC may be offered or used on an optional basis or, in some systems, it may be fixed feature (ATPC cannot be disabled).

The use of the ATPC may increase the percentage of time in which the system operates at low receiver signal level; the threshold of ATPC intervention should be designed to be in a RSL region where the BBER is still met, so that, even if the system would remain at constant RSL for an higher percentage of time, an increase of ES is avoided with respect to a system without ATPC function.

ATPC intervention threshold

The ATPC is used to reduce the interference reducing the transmitted power.

In conventional ATPC systems, the activation threshold is based on the receiver level only, and until the received signal level is higher than the ATPC activation threshold, the transmitted power is kept at the lower value.

While propagation events further increase the attenuation, the ATPC attenuation decreases, so a greater power is transmitted until the higher transmitted power is reached. The relationship between attenuation due propagation (Flat Fade) and BER can be evaluated from the typical example is given in figure A.2.

As it can be seen, for an attenuation in a given range of value the ATPC intervention produces a constant receive level and therefore a constant BER value. So if this value is greater than the RBER, the number of EB may be higher than a system without ATPC. The value depends on the percentage of time for which the attenuation is in the range from A_1 to A_2. Hence the contribution to the total Background Block Error (BBE) due to ATPC intervention is given by:

$$BBE = BER_{ATPC} \times N_{BL} \times T_{ATPC} = BER_{ATPC} \times N_{BL} \times (T_{A1} - T_{A2})$$

where BER_{ATPC} represents the constant BER value during the range of ATPC intervention, T_{ATPC} the percentage of time for which attenuation in the interval [A1-A2] and T_{A1}, T_{A2} represent the percentage of time of attenuation A1 or A2 is exceeded and N_{BL} represents the number of block per second.

If the threshold of ATPC intervention is not well set, the ATPC produces some events similar to a reduced flat margin, so the system may not be complied with the RBER requirements. If the ATPC threshold intervention is set in such a way that BER_{ATPC} < RBER no extra BBE are due to ATPC.

This item is particularly important in the high frequency bands, where ATPC is connected to rain attenuation and the percentage of time for which attenuation is in that range may be significant.

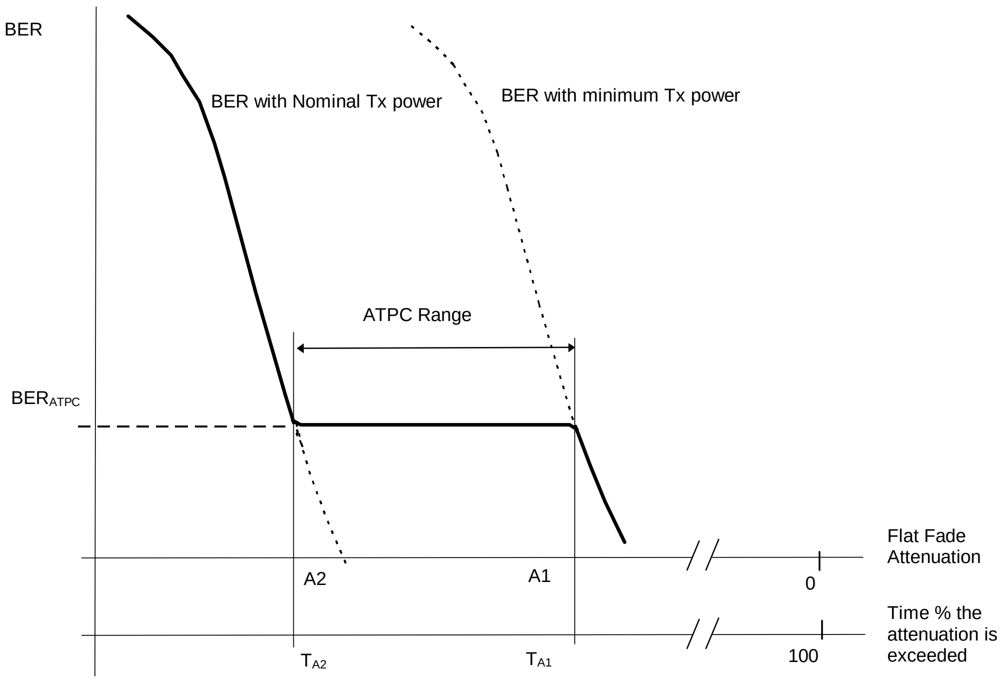


Figure B.1: BER vs Fading attenuation for a system with ATPC

B.5.3.2.2 Remote Transmit Power Control (RTPC)

This function has some implication relevant to essential requirements under article 3.2 of R&TTE [52].

This function may be useful for radio system used in micro-cells connection for frequency management purpose when new adjacent cells are exploited. Transmit power may be adjusted continuously or in steps by a SW control from a local terminal or a remote supervisory centre.

The spectrum mask is assumed to remain unchanged, however for wide band, low power systems, in particular in higher frequency bands at low RTPC level, the spectrum measurement sensitivity may become a limiting factor unless more complex test procedure is used; the argument is demanded to the conformance testing standards EN 301 026-1 [45].

B.5.3.2.3 Remote Frequency Control (RFC)

This function has some implication relevant to essential requirements under article 3.2 of R&TTE [52].

This function may be useful for radio system used in micro-cells connection for frequency management purpose when new adjacent cells are exploited. Transmit and receive frequency be set within a range of channels frequencies by a SW control from a local terminal or a remote supervisory centre.

B.5.3.3 Transmitter output power tolerance

This parameter is relevant to essential requirements under article 3.2 of R&TTE [52].

The power stated in clause B.5.3.1 is the nominal output power for the purposes of this test (e.g. that used for system gain evaluation). Within the environmental profile of operation the output power may vary and, if not controlled, interference or lack in system gain may arise.

Range of thermal stability depends on the implementation or not of Automatic Gain Control (AGC) of the power amplifier and on the relevant frequency band in which the equipment operates.

When different tolerance are requested according different environmental profiles (e.g. indoor or outdoor applications) the less stringent tolerance is the one relevant as essential parameter for article 3.2 of R&TTE [52].

B.5.3.4 Tx local oscillator frequency arrangements

Unless direct RF modulation is performed, a RF local oscillator is required to transfer the modulated IF signal to the required frequency band.

Up conversion may be performed selecting either the upper or the lower side-band of a mixer (spaced by ±IF frequency from the LO).

The selection of the side band has no impact on the system performance, apart from:

- LO frequency leakage may fall on one of the receiver connected to the same antenna;
- LO frequency leakage when outside the ± 250% of channel separation, is included into the external spurious emissions.

In the first case a higher selectivity is required not to impair the threshold of the interfered receiver (see background of clause B.5.3.5).

In the second case CEPT/ERC Recommendation 74-01 [47] has fixed the limit of -50 dBm or -30 dBm (for frequency below or above 21,2 GHz).

It is traditional in order to avoid, as much as possible, both the problems above the selection of LOs according the first statement reported in the following "standard text".

Nowadays new techniques, mainly that of a single LO for both TX and RX mixers, may require different implementation depending choices.

B.5.3.5 RF spectrum mask

This parameter is relevant to essential requirements under article 3.2 of R&TTE [52].

a1) General considerations

Output spectrum generated by DFRS may be described (see figures B.2, B.4 and B.6) as constituted by five main elements:

- signal main lobe (noise-like spectral density);
- secondary(ies) modulation lobe(s) and/or 3rd order intermodulation of the transmitter (noise-like spectral density adjacent to the main lobe);
- background noise due to the noise figure of the transmitter or to residual flickering noise of the digital to analogue modulator circuits (wide band noise-like spectral density);
- spectral lines due to the modulation process (discrete CW components related to the symbol frequency and its harmonics);
- other emissions (e.g. discrete CW leakage of LO or noise-like spectral density at image frequency if applicable).

This spectrum is then filtered by a RF filter.

Emission limits has to be a spectrum mask for the noise-like spectral density part and an absolute power level (or an attenuation relative to the carrier average power) for the discrete CW components.

According that ITU-R Recommendation F.1191 [14] and CEPT/ERC Recommendation 74-01 [47] defines the frequency boundary for limitation of out-of-band emissions as ±250 % of the relevant channel spacing, the spectrum mask shall be defined for regulatory purpose, from carrier centre frequency up to this boundary; however for "internal system compatibility" (i.e. when equipment of different manufacturer are required to share the same branching or antenna) the spectrum may be defined also beyond such boundary.

Output spectrum limitation at B' (or C') reference point is required:

1) for conformity to essential parameters under article 3.2 of R&TTE [52];
2) for frequency co-ordination among different equipments of different suppliers;

3) for their connection to the same antenna;

4) for their use on parallel route and/or for nodal concurrent hops;

5) for regulatory purpose and advanced sharing studies.

For conformity assessment to essential parameters under article 3.2 of R&TTE [52], the harmonized EN 301 751 [61] stated that mask floor attenuations higher than limits shown in table B.1, are not relevant.

Table B.1: Maximum spectrum masks attenuation relevant to the essential requirements under article 3.2 of R&TTE [52]

Operating frequency band	Maximum attenuation
F < 10 GHz	60 dB
10 GHz ≤ F < 17 GHz	55 dB
17 GHz ≤ F < 30 GHz	50 dB
F ≥ 30 GHz	45 dB

ITU-R SG1 "Spectrum Management" has established the TG1/5 in order to answer the mandate of WRC 95 and WRC 97 for studies on limits for digital modulations. Under this activity CEPT has proposed the introduction, on a drat recommendation, of "safety-net limits" generated as envelopes of all presently standardized CEPT and ETSI fixed radio systems.
The proposed masks should not endanger any future development, however, being they endorsed by ITU-R, would fix an absolute limits that could not be exceeded by ETSI standards.

These mask, merged with FCC specific, presently appears in ITU-R Recommendation SM.1541 [66].
These masks have been subdivided by mixing the following macro-typologies of applications which define the general shaping requirement of the spectrum mask:

- Digital systems of all modulation formats excluding FDMA P-MP systems.

- FDMA (Frequency division multiple access) systems which are characterized by a multi-carrier transmission methodology with sharper decay of the spectrum outside the assigned channel, but with flat 3rd order intermodulation products.

Rapporteurs and TM4 Members should be aware of not exceeding those ITU-R masks when developing new EN.

a2) Spectrum and frequency co-ordination (digital and analogue)

For frequency co-ordination purpose some factors are necessary:

- a spectrum mask which gives the attenuation of the noise-like spectral density relative to the actual centre frequency spectral density;

- a formula, related to the modulation format, which gives the relationship between the reference centre frequency spectral density and the total average power of the carrier. This may be necessary in order to evaluate, when required (e.g. for compatibility with analogue signals), the absolute value noise-like power of the digital signal integrated within a required bandwidth (e.g. 4 kHz) at a certain offset frequency removed from carrier centre frequency. For phase and angle modulation formats the well known relationship applies:

$$(P - Po)[dB] = 10\log\frac{Fs}{BWe}$$

where:

P is the total average power of the carrier [dBm];

Po is the average power level [dBm] falling into the BWe (Evaluation Bandwidth);

Fs is the symbol frequency of the modulated signal.

For frequency modulated signals the evaluation of the reference level require solution of very complex integrals.

For the simplest cases of 2 and 4 FSK modulation formats simpler expressions may be derived which give for the ratio spectral density at centre frequency to carrier mean power normalized in a band equal to bit-rate:

$$\frac{S_0[Fb]}{P} = \left(\frac{2}{\pi h}\right)^2 \qquad \text{for 2 levels FSK; and}$$

$$\frac{S_0[Fb]}{P} = \frac{2}{(3\pi h)^2}\left[10-\cos(3\pi h)-9\cos(\pi h)+\frac{1}{2}\left(\frac{10-\cos(6\pi h)-6\cos(4\pi h)-3\cos(2\pi h)}{2-\cos(3\pi h)-\cos(\pi h)}\right)\right] \text{ for 4 levels FSK,}$$

where:

- S_0[Fb] = spectral density at centre frequency normalized in a band equal to the bit-rate;
- h = 2 (Δf / Fs) = modulation index;
- Δf = peak frequency deviation;
- Fb = bit rate.

Other special cases of frequency modulations of interest are Minimum Shift Key (MSK) and Tamed Frequency Modulation (TFM) which needs far more complex simulations; these two cases are considered defined or of practical application only for h = 0,5.

In figure B.1 the computed values of So[Fb] are reported; these are theoretical values and slight difference in practical applications is possible.

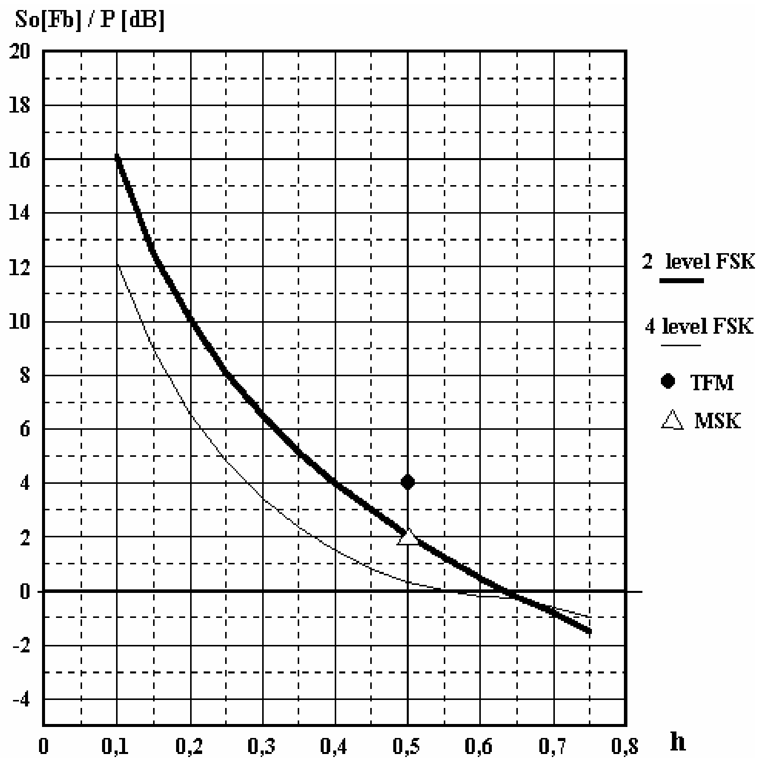


Figure B.2: Normalized spectral density to carrier mean power ratio (at centre frequency in a band equal to the bit-rate)

For practical spectrum analyser evaluation the actual measured value of the ratio is obtained from the value taken by figure B.1 as:

$$(P - P_0)\cdot[dB] = S_0[Fb]/P - 10\log(Fb/BWe)$$

An absolute limit or a relative attenuation with respect to the carrier average power for other discrete spurious emissions.

Other details on spectrum emission may be found in ITU-R Recommendations F.1101 [8] and F.1102 [9].

a3) Spectrum and NFD in digital to digital interference relationship

Moreover the spectrum mask constitutes the main factor which controls the Net Filter Discrimination (NFD) as defined by ITU-R Recommendation F.746 [5], which is useful to evaluate interference into receivers aligned on frequencies different from that of the interfering transmitter, figure B.2 shows typical scenario of a generalized noise-like spectrum emission.
Spectrum mask is strictly related to the digital to digital adjacent (by one or more channel spacing) channel interference which will be required in the following clause B.5.5.3 and their values shall have congruence to each other.

A particular case of interference which has to be controlled by the transmitted spectrum mask is the local transmitter to receiver interference between the innermost channels of the frequency plan which may be connected to the same antenna, either on same or on cross polarization; when it is the case, not to burden every transceiver with complex and costly filters, special spectrum mask (and special receiver selectivity) may be required for these innermost channel only. In the most critical case of very narrow YS, the NFD may be strongly dependent from the receiver selectivity too, due to the required high rejection to the main lobe of the interfering transmitter; in this case a mask for the selectivity of innermost receiver may also be required (see clause B.5.4.5).

With reference to figure B.3 it can be shown that, in general, interference to the first adjacent channels is related to the shape of the spectrum mask in its decaying part of the main signal lobe, but also to the interfered receiver filters; for this case the NFD has to be calculated through integration methods (see figure B.3 zones ①).

In other cases (e.g. adjacent channels by more than one channel spacing or relatively wide spaced innermost Tx/Rx interference) which receiver frequencies fall into the background noise part of the emitted spectrum (as shown in figure B.3 zones ② to ⑤), NFD may be easily evaluated as:

$$NFD(f)[dB] \cong S(f)[dB] + X[dB] + 10\log\frac{\text{Fs of interfering signal}}{\text{Fs of interfering signal}}$$

where S(f) is the relative attenuation of the spectrum mask at frequency removed from carrier centre frequency by f [MHz] and X[dB] is the allowed overshoot of the spectrum mask defined in figure B.2.

This NFD values may be used to evaluate the interference sensitivity on adjacent channels interference (reference to clause B.5.5.3) from the co-channel behaviour of the interfered receiver with the following relationships:

$$\frac{C}{I}\bigg|\text{nth}\cdot\text{adjacent}\cdot\text{ch} = \frac{C}{I}\bigg|\text{cochannel} + \text{NFD}\Lambda\ \Lambda\ \Lambda\ \Lambda\ \Lambda\ \left[\text{for same BER degradation}\right]$$

a4) Local receiver thresholds degradation

NFD may be used to evaluate the level of local interference (I_L) into receivers connected to the same branching or antenna (or even to different antennas of concurrent routes to the same nodal station) with the following relationship:

$$I_L[dBm]\big|(\text{on local Rx}) = P_{Tx}[dBm]\big|(\text{of local Tx}) - \text{NFD}[dB] - \text{D}[dB]$$

were D[dB] is the additional decoupling (if any) due to antenna circulator (co-polar interference) or IPI of the antenna (cross-polar interference) or antenna angular decoupling (nodal interference).
With I_L value the thresholds degradation may be evaluated by comparison with the total noise integrated on BW_n (receiver equivalent noise bandwidth):

$$\text{Thresholddegrad}[dB]\big|(\text{onlocalRx}) = 10\log\rangle 10^{-114+10\log BW[Mhz]} + 10^{I_L}\langle - \rangle - 114 + 10\log BW_n[Mhz]\langle$$

and, if applicable, reported to clause B.5.5.2.

NOTE: It has to be noted that being I_L a constant interference level, as a first assumption, it may be added to the receiver noise and threaten as a fixed noise figure degradation giving a fixed amount of dB degradation whichever were the RSL.

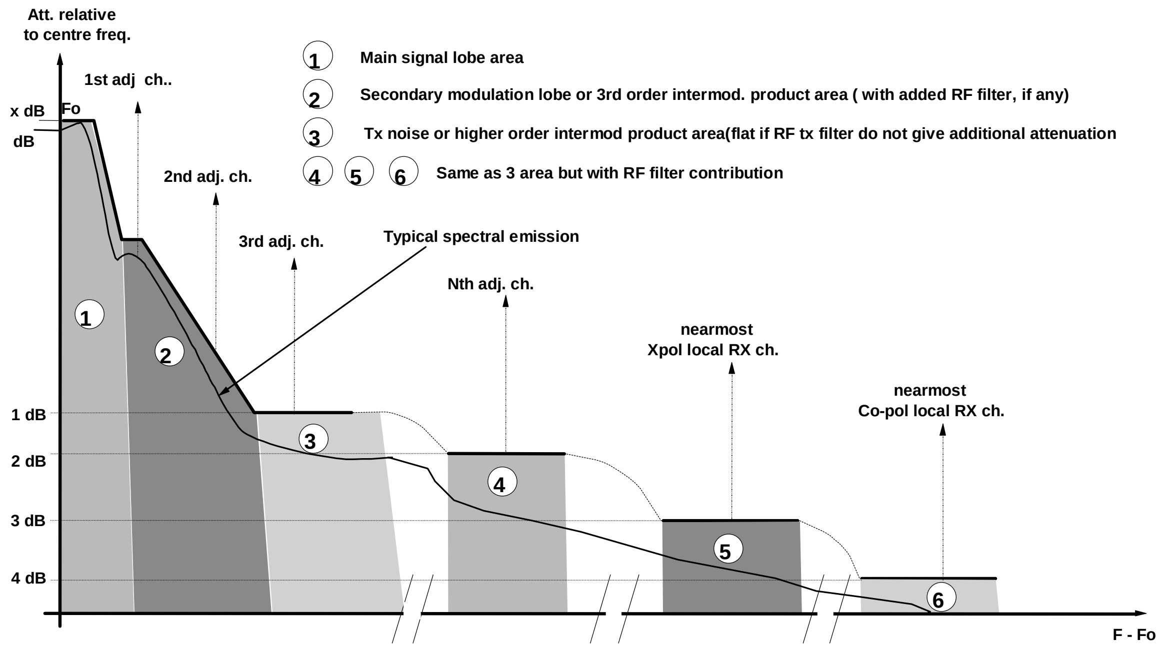


Figure B.3: Emitted spectrum areas (noise-like typical scenario)

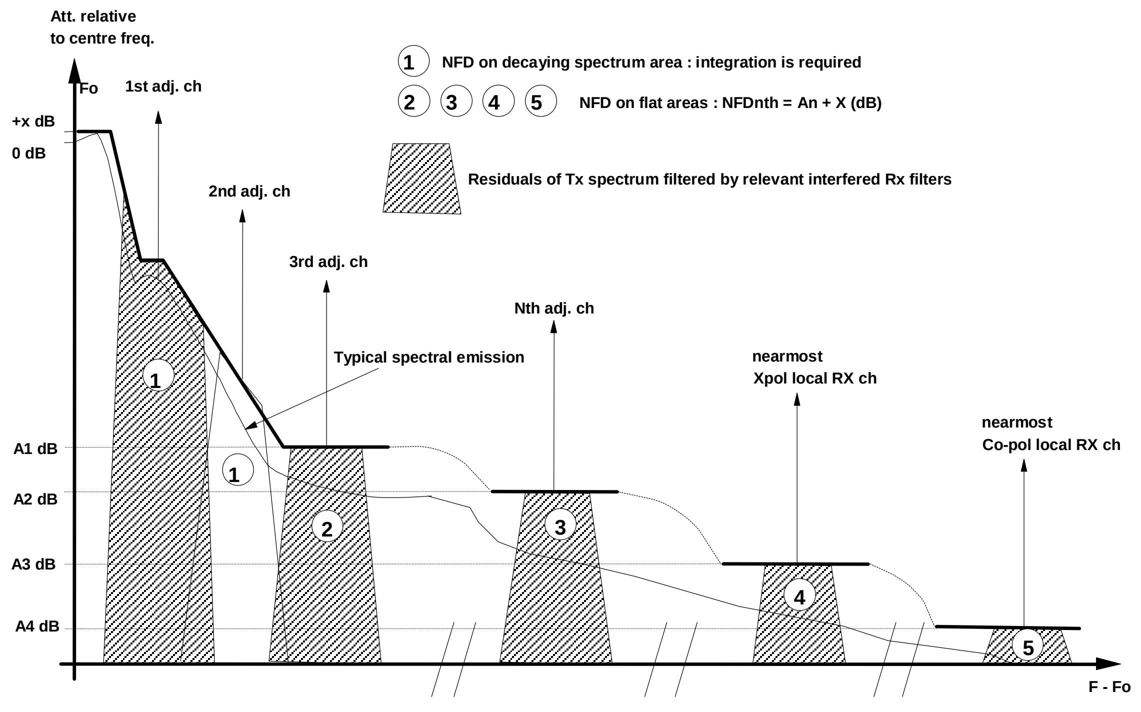


Figure B.4: NFD relationship with spectrum mask

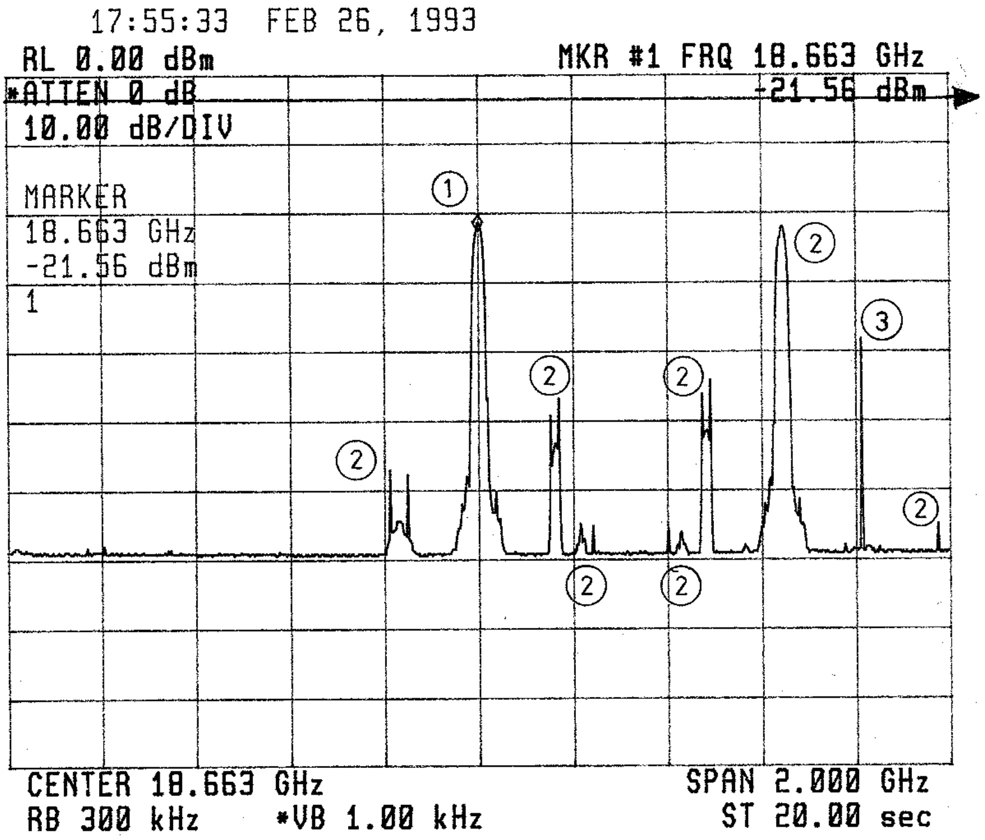
a5) Practical measurement impact

Practical measurements of spectrum density mask give the following difficulties that have to be taken into account in the mask definition for DFRS ETSs/ENs:

- being the spectral density of a noise-like type, there is a lower bound measurement limit due to the noise floor of the spectrum analyser (which cannot be improved by IF bandwidth but only by a better instrument), this noise floor worsens as the frequency increases.
  In particular wide band signals with low power output, typical of higher frequency bands systems, may experience power densities in the lower portion of the spectrum mask, which may fall beyond common spectrum analyser capability. In this event, in agreement with the regulatory administrations participating to WG TM4 activity, the following options have been considered: measurement using high performance spectrum analyser; use of notch filter; two step measurement technique. When difficulties are experienced, the plots of one test carried out in a precedent time, may be produced and accepted as evidence of conformance to the spectrum mask.

- the measurement sensitivity may not be increased by increasing the input level into the spectrum analyser, because of the possibility of 3rd order intermodulation distortion from the instrument itself, which may exceed the level of the spectrum under test;

- if wide band measurement were required (spectrum masks defined very far from centre frequency) the presence of conversion harmonics of the spectrum analyser may fake the measurement, requiring lengthy manual identification of the false components; a pre-selector option may override this limitation, but further reduces the available sensitivity of ~ 10 dB (see figures B.4 and B.5).



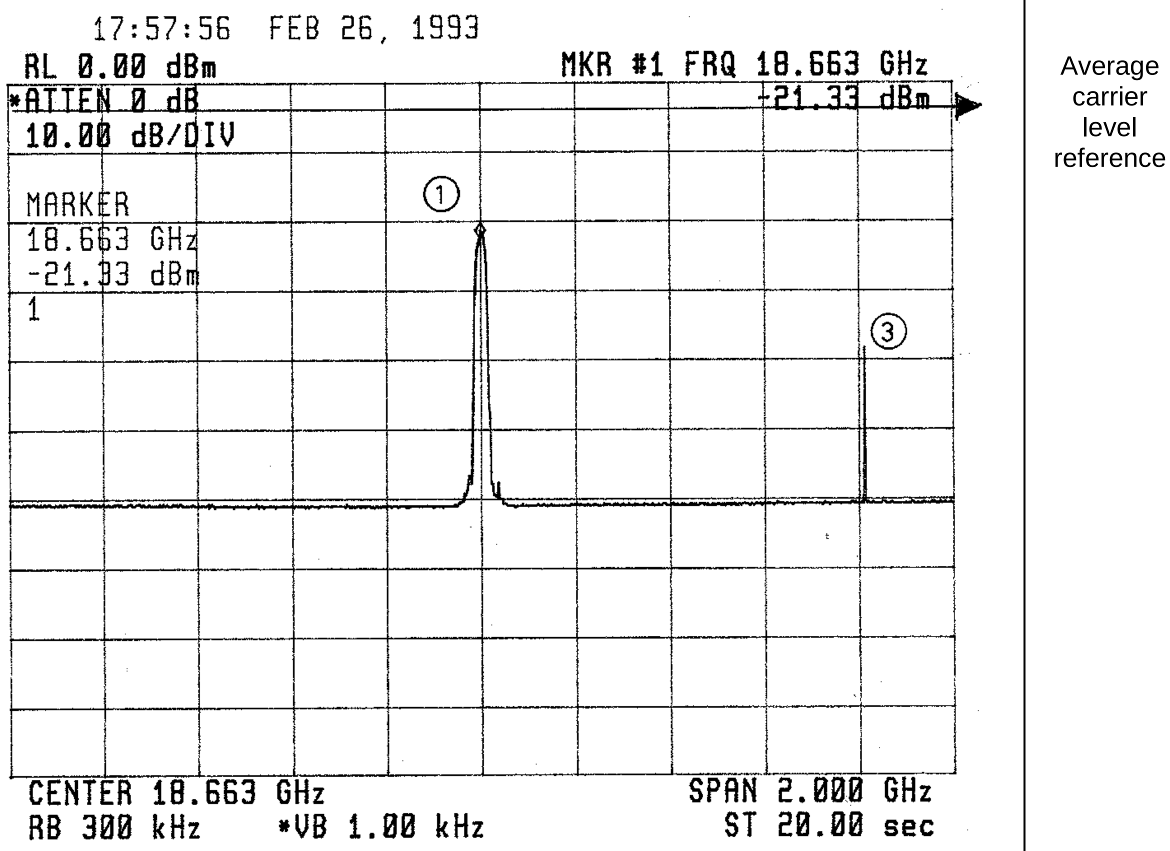
Average carrier level reference

① Main signal spectrum.

② False emissions (spectrum analyser conversions)

③ Real spurious emission (L.O. leakage)

Figure B.5: Example of wide band spectrum measurement (reference point A') by an analyser without pre-selector



① Main signal spectrum.

③ Real spurious emission (L.O. leakage).

Figure B.6: Same wide band spectrum measurement of the example in figure B.4 but by an analyser with pre-selector

On the consequence when high spectrum reduction is required for "internal compatibility" the spectrum mask shall indicate the measurement limits for "external compatibility" (i.e. for regulatory purposes) and the exceeding part shall be measured through alternative measurement if possible (e.g. measurement at reference point A' and adding Tx filter attenuation to estimate the spectrum value at reference point B' or C') or it may be subject of manufacturer declaration.

Also the symbol frequency (F_s) of the signal under test has an impact on the maximum relative sensitivity that can be measured, this is actually shown in figure B.6, where the measurement results on different F_s with different BWe are reported.

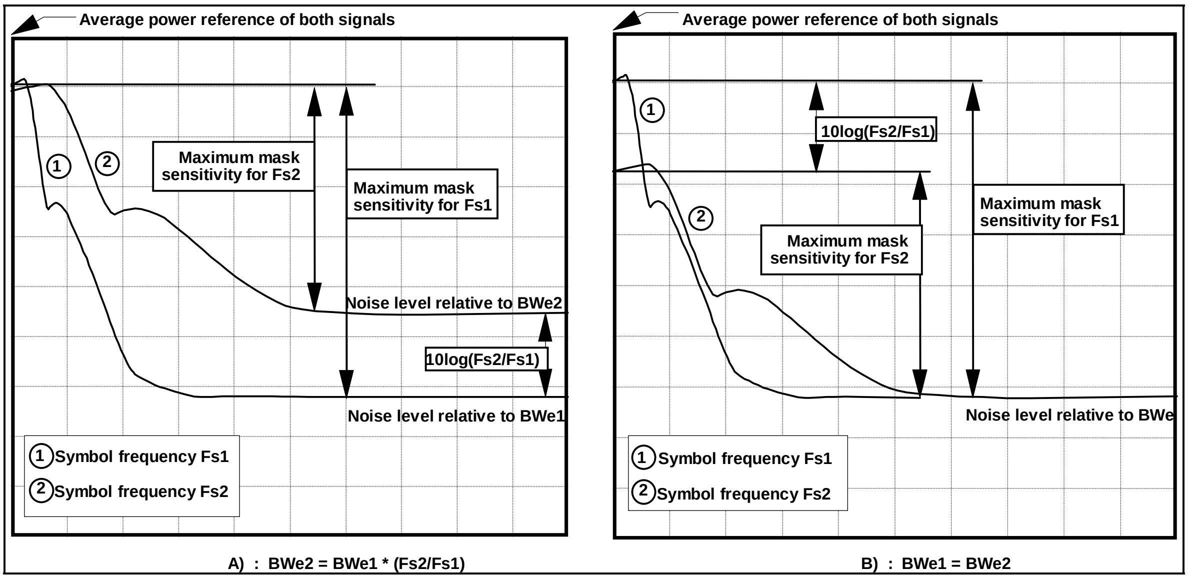


Figure B.7: Example of spectrum measurement results with different F_S and BWe

To avoid slight uncertainty due to selection of different BWe/Video filter/sweep time selection, two of these parameters (i.e. BWe and Video filter should be referred in the EN, leaving the third element (sweep time) to be automatically selected by the spectrum analyser in order to maintain calibrated results.

The BWe and Video filters have been usually standardized by WG TM4 and the practical used values as function of the channel separation reported in table A.3, have been also proposed to ITU-R TG1/5 for a "generic limits for out-of-band emissions" (see previous background in a1) therefore these values is expected to be used in any future standard.

a6) Discrete CW components and BWe impact

Evaluation bandwidth (BWe) and discrete components of unwanted emission give additional difficulties to be carefully analysed; from the point of view of the noise-like spectral components BWe is not influent for relative attenuation measurement in spectrum mask evaluation, provided that it were smaller than Fs.

On the contrary discrete components have a fixed power level which is independent from BWe, so that the relative level compared to noise-like spectral densities will change according to the ratio between different selected BWe (example in figure B.7).

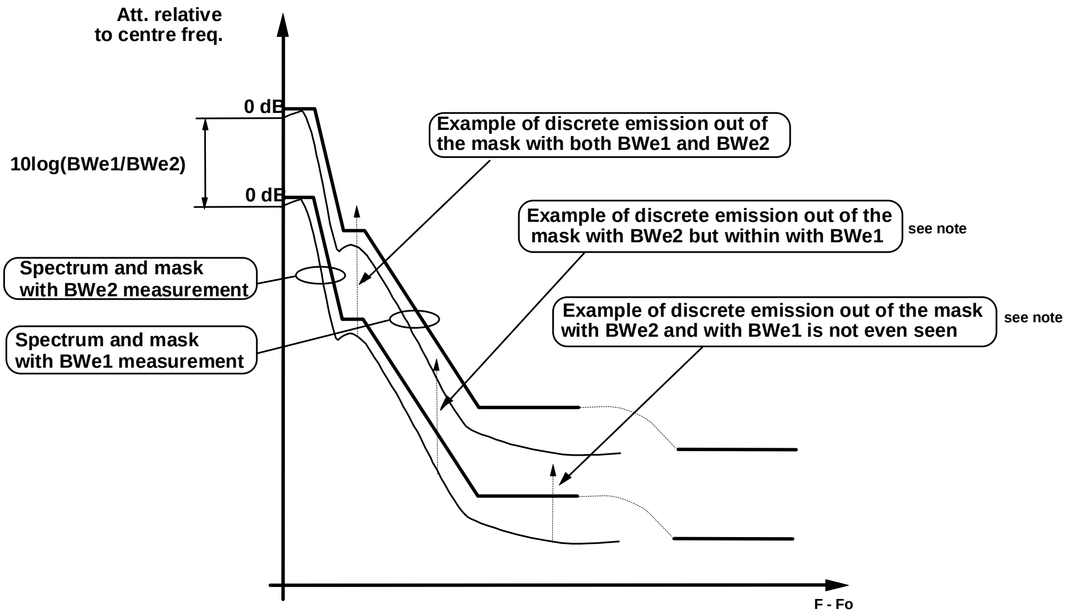


Figure B.8: Impact of BWe in spectrum mask measurement

From this considerations discrete components of unwanted emission (or some of them well identified) may have an absolute level limits or an attenuation relative to carrier mean power, see clause B.5.3.6 (spectral line at symbol rate) and clause B.5.3.7 (spurious emission), due also to the fact that Out-of-band emission limits are set as relative attenuation while CEPT/ERC limits of Spurious emissions require an absolute level.

Another approach for discrete components may be to limit them within the spectrum mask, but this means that systems with different Fs rate may result in having different level allowance on emission which, on the contrary, are rate independent. (Unless BWe were carefully chosen to follow the same ratio of F_s: BWe1/BWe2 = F_s1/F_s2, and this would require a spectrum analyser with continuously selectable resolution BWe).

a7) RF frequency tolerance and spectrum mask

In principle two approaches may be possible:

- Include the RF frequency tolerance into the spectrum mask; this means that an allowance has to be taken into account in drawing the mask itself. This approach may be useful for EN dealing with high frequency systems with a wide variety of bit rates and possible far different hardware realization, which may trade off frequency tolerance with spectrum width (frequency deviation for FSK modulation or roll-off factor for angle modulation). In this case the 0 MHz reference for the spectrum mask will be the "nominal" channel centre frequency. During discussion for conformance testing measurements (see EN 301 126-1 [45]) agreement was reached of not supporting this possibility any longer; new ETSs will not use this option.

- Not include frequency tolerance into the spectrum mask; this means that the mask may be tailored on the emitted spectrum itself. This approach may be more suitable for EN dealing with high capacity systems where frequency tolerance effect on adjacent channel compatibility is small and modulation format is in practice fixed by the network application itself. However modern small capacity DFRS make often use of synthesizers that give sufficiently low frequency instability which still may be neglected in a generic interference evaluation. In this case clause B.5.3.8 shall apply and the 0 MHz reference for the spectrum mask will be the "actual" transmitted centre frequency.

WG TM4 has decided, for coherence among all the produced ENs that the second approach will be used for any new or revised EN.

B.5.3.6 Discrete CW components exceeding the spectrum mask limit

These parameters are relevant to essential requirements under article 3.2 of R&TTE [52].

The emission includes in this range only the fundamental and out of band emissions.

Digital modulated carriers basically produce a spectral power density distribution which shape depends from the modulation parameters itself and are well defined by an attenuation mask expressed in dB relative to centre frequency. However other spectral lines emissions are unavoidably generated by actual systems.

According to the reference BWe required for spectrum measurement, these CW components may exceed the mask; however their actual power content may be negligible when compared to the actual spectrum power when integrated over the adjacent channels band.

For these spectral lines a limit in dBc is far more appropriate. Therefore limits for discrete spectral lines might not be considered within the spectral density masks but a specific limit, when appropriate, may be given.

B.5.3.6.1 Discrete CW components at the symbol rate

These discrete, out of band emissions, components are one example of what has been already discussed in the previous clause B.5.3.5; they are close to the main signal lobe and are due to unavoidable imperfections and non-linearity of practical implementation of radio transmitters and modulators. Their limits should be compatible with the foreseen NFD on the adjacent channel.

When compatibility with some older analogue systems on adjacent channels on the same route, more stringent limits are required in case they fall in the analogue base-band frequencies.

B.5.3.6.2 Other discrete CW components exceeding the spectrum mask limit

Inside the ± 250% of channel separation where Out-of-band are defined, due to various circuits imperfections (e.g. mixing sub-harmonics or carrier synthesizers phase locked loops and other clocks components).

Therefore, when digital to analogue compatibility is not required (and nowadays this may be considered always true), some CW components may be allowed to exceed the spectrum mask, provided that their total power relative to the spectrum power, integrated in the smaller possible victim receiver band (CSmin depending on the frequency band mixed capacity usage) within the mask frequency span, is small (e.g. 10 dB lower).

If we would allow CW lines to exceed the present mask by a factor:

{10log(CSmin/BWe) - 10} [dB] (if result is negative value 0dB allowance is assumed)

where CSmin is the minimum foreseen channel separation for the band in subject and BWe is the reference bandwidth of the spectrum mask.

and, in case of more than one line exceeding:

they are separated in frequency by more than CSmin

We would ensure that:

- Such even relaxed lines will not impair the NFD on all narrow or wide channels whichever they are mixed together.
- The NFD modification based on the "ideal" mask with BWe=CSmin (introduced in previous section as the "ideal" solution) would be formally exceeded by less than 0,5 dB and only on the unlikely worst case of a system that have spectral density exactly tangent to the mask itself.

We could also note that:

- Generally speaking, the allowance on the mask would range:

  from ≈ 10 dB (for the lower CS)

  to 0 dB (for the wider CS).

TM4 will define CSmin on the base not only of each single EN, but taking into account all ENs in the same frequency band and/or CEPT recommended channel arrangements.

B.5.3.7 Spurious emissions

Two different sets and limits for spurious emission may be included, one for "external" reasons in order to limit the emissions that through the antenna radiation pattern may fall into other nearby systems, the other for "internal" reasons in order to limit emissions that may fall into receivers connected to the same branching/antenna system of the transmitter.

B.5.3.7.1 Spurious emissions external

The external emissions concept and definition have been firstly reported in ITU-R Recommendation F.1191 [14].

ITU-R TG1/3 and subsequently TG 1/5 of SG-1 (Spectrum Management), with CEPT active participation, has continuously revised since 1996 ITU-R Recommendation SM.329 [46] introducing the definition of spurious emission frequency range recommended reference bandwidth and the recommended spurious emission levels for all services, which are in line, for Fixed service, to ITU-R SG-9 Recommendation F.1191 [14].

The following reference bandwidths (see note 1) are recommended by ITU-R Recommendation SM.329 [46] and CEPT/ERC Recommendation 74-01 [47]:

- 1 kHz between 9 kHz and 150 kHz.
- 10 kHz between 150 kHz and 30 MHz.

- 100 kHz between 30 MHz and 1 GHz.
- 1 MHz above 1 GHz.

NOTE 1: A reference bandwidth is a bandwidth in which spurious emissions level is specified;, actual measurements may be carried out with different bandwidth but the results should be normalized into the reference bandwidth with the rules specified by CEPT/ERC Recommendation 74-01 [47].

CEPT supported the Category B limits in SM.329 [46] and further specified the transition area near the boundary between Out-of-band and Spurious emissions in the CEPT/ERC Recommendation on "Spurious Emissions" produced by PT SE-21.

In particular the Category B limits have been defined as:

- 9 kHz to 21,2 GHz ≤ -50 dBm (≤ -40 dBm for P-MP terminal stations)
- 21,2 GHz to 300 GHz (see note 2) ≤ -30 dBm

NOTE 2: In CEPT/ERC Recommendation 74-01 [47] and in a further draft revision of ITU-R Recommendation SM.329 [46], as guidance for practical purposes, the following measurement parameters are normally recommended:

Fundamental frequency range	Spurious frequency range	
	lower frequency	**upper frequency (see note)**
9 kHz to 100 MHz	9 kHz	1 GHz
100 MHz to 300 MHz	9 kHz	10th harmonic
300 MHz to 600 MHz	30 MHz	3 GHz
600 MHz to 5.2 GHz	30 MHz	5th harmonic
5.2 GHz to 13 GHz	30 MHz	26 GHz
13 GHz to 150 GHz	30 MHz	2nd harmonic
150 GHz to 300 GHz	30 MHz	300 GHz
NOTE: The test should include the entire harmonic band and not be truncated at the precise upper frequency limit stated.		

ETSI WG TM4, has also published EN 301 390 [44] to define the limits for Fixed Radio Systems from ETSI point of view; this activity endorsed the CEPT/ERC limits for all P-P systems and for P-MP with fundamental emission below 21,2 GHz, while for P-MP systems with fundamental emissions above 21,2 GHz a tighter limit above 21,2 GHz has been required. This has been shown necessary through careful consideration of cumulative disturbance in a P-MP multi-operator environment. This is also reflected in the fact that EN 301 390 [44] is used in P-MP harmonized standards for setting the essential requirement according article 3.2 of R&TTE Directive [52].

Therefore EN 301 390 [44] should be referred as unique reference for "external spurious emission" of all Fixed Radio systems.

B.5.3.7.2 Spurious emissions internal

For "internal" spurious limit the following consideration may be applicable:

- the level of interference falling in the band of a generic receiver has to be compared with the BER 10^{-3} threshold referred in clause B.5.5.1;
- the allowed C/I (e.g. threshold degradation < 1 dB) may be found in clause B.5.5.3.1 for co-channel interference ≤ 1 dB;
- the maximum allowable level (e.g. threshold degradation < 1 dB) of spurious emission falling in receiver sub-band may be derived by the following relationship:
    - spurious emission level ≤ RSL @10^{-3} threshold - C/I co-channel @ 1dB degradation + D[dB] where D is the Tx/Rx decoupling already defined in the background of clause B.5.3.5;
- being, in general, the receiver bandwidth comparable with the spectrum width of the "internal" emissions, the required level will be the total average level of the emission under consideration.

When the equipment output include a section of plain waveguide, which acts as a high-pass filter, the lower frequency limit of measurement may be increased to a frequency lower than the cut-off frequency (fc) where the waveguide sufficient attenuation to guarantee that the CEPT limits are surely met (80 dB attenuation is considered enough when considering the limits of maximum output power, of spurious emission and them reasonable intrinsic relative attenuation).

The attenuation introduced at frequency "f" by a below cut-off waveguide is given by:

$$A[dB/cm] = \frac{2\pi \times 8{,}69 \times f_c[GHz]}{30} \times \sqrt{1-\left(\frac{f}{f_c}\right)^2}$$

Figure B.9 shows the waveguide length necessary for 80 dB attenuation at frequencies lower than f/f_c 0,7.

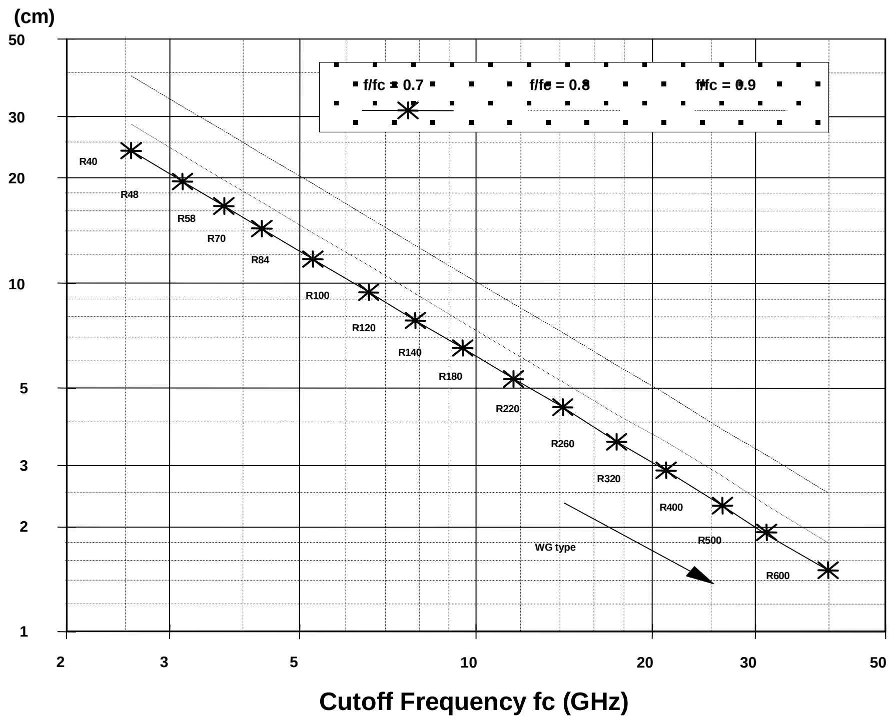


Figure B.9: Cut-off waveguide length for >80 dB attenuation

B.5.3.8 Radio frequency tolerance

If spectrum masks do not include an allowance for frequency tolerance (see clause B.5.3.5) a value shall be stated in order to control interference environment, since this limit includes both short-term factors (environmental effects) and long-term ageing effects, the EN should define a way to guarantee that the type test also covers the effects of ageing.

This can be achieved provided that the actual short-term value is lower than the standardized limit, the manufacturer will state the expected ageing and, if applicable, the maintenance procedure of realignment in order to guarantee that the total frequency instability will remain within the limits.

New ENs will not include frequency tolerance into the spectrum mask (see also clause B.5.3.5 a1)).

It should be noted that ITU-R Recommendation SM.1045 [62] reported limits for frequency tolerances of all systems; the ETSI limits should be maintained tighter than those limits.

B.5.4 Receiver characteristics

B.5.4.1 Input level range

DFRS may experience BER both during deep fading (which may increase the noise floor above the threshold) and up-fading phenomena (which may generate 3rd order intermodulation distortion due to saturation in the receiver RF/IF chain).

In order to evaluate the flat fade margin available on the standardized system, the maximum nominal input level has to be defined taken into account a suitable margin to cope with up-fading induced performance degradation; this means that it is necessary to define not only the usual BER thresholds but also the minimum up-faded RSL versus BER.

B.5.4.2 Rx local oscillator frequency arrangements

Unless direct RF demodulation is performed, a RF local oscillator is required to transfer the RF modulated signal to the required IF.

Down conversion may be performed selecting either the upper or the lower side-band of a mixer (spaced by ± IF frequency from the LO).

The selection of the side band has no impact on the system performance, a part from the additional consideration that the receivers LO frequencies allocation, which, usually, are the same of the corresponding transmitters LOs, may give the problem of a local transmitter allocated nearby the image frequency; this results in additional selectivity constrains (see clause B.5.4.5).

Nowadays new techniques, mainly that of a single LO for both TX and RX mixers) may require implementation dependent choices.

B.5.4.3 Spurious emissions

The same background as clause B.5.3.7 is applicable.

B.5.4.4 Receiver IF

Often DFRS, unless direct RF demodulation is implemented, use one or more IF in order to achieve suitable selectivity.

On the other hand the presence of an IF may facilitate some measurement (e.g. S/N versus BER) during maintenance, training and type approval by the user; for this purpose it may be useful that the IF frequency is chosen where standard instruments may be available (i.e. 35, 70 or 140 MHz). When more than one IF is used (multiple conversion receivers) one may be required to fall upon the standardized ones.
However new highly integrated digital systems (e.g. for the lower bit rates and when high complexity digital adaptive equalizers make amplitude and group delay distortions unessential for the performance of the system) may not supply IF external access and/or monitoring points. Moreover modern link analyser offer wide band operation.

Therefore WG TM4 decided that this section is no longer of importance and may be deleted from the "Generic Wording". Very specific need should be treated as special case.

B.5.4.5 Receiver image rejection

For some systems, typically with a multi-channel branching system, particular problems may arise. For instance, a local transmitter near the image(s) frequency(ies) of some receivers. Suitable image(s) rejection values are necessary in order to avoid impairment of the receiver performance due to interference at this(these) frequency(ies).

The required receiver RF attenuation (e.g. for less than 1 dB threshold degradation of this(these) receivers) may be taken as:

$$A@(Tx\ fo) \geq P_{out}(Tx) - RSL@10^{-3}\ \text{threshold} - C/I\ \text{cochannel}@1dB\ \text{degradation} - D - NFD@(|(|Frx - Ftx|) - Fi|)$$

where D is the Tx/Rx decoupling already defined in the background of clause B.5.3.5 and Fi is the IF image frequency.

NOTE: The definition of a receiver image rejection is not applicable to receivers with direct demodulation.

B.5.4.6 Innermost channel receiver selectivity

This optional clause may be necessary when very high selectivity on innermost channels is required due to the very narrow YS provided by the radio frequency channel arrangement (see also clause B.5.3.5).

A mask of the total RF, IF and BB attenuation to ensure the necessary rejection to the interfering transmitter signal being the transmitter spectrum mask is itself not enough to guarantee a suitable NFD.

The measurement of this requirement may not be performed by any practical measurement methods, nevertheless it may be checked on the design data that should be supplied during conformance testing.

B.5.5 System performance without diversity

B.5.5.1 BER as a function of receiver input signal level RSL

RSL versus suitable BER thresholds (typically three at high, medium and low BER) should be stated.

The reference point may be C for simple systems with a duplexer or B for systems with multi-channel branching system.

BER may mean either bit error rate or block error rate.

When different system grade are foreseen each one will have its own required values.

When specific local "internal" interference may be present (e.g. innermost Tx/Rx local interference of frequency channel arrangements with particular troublesome YS value), the allowed thresholds degradation, if any, or a "no degradation" condition, shall be stated together with the minimum additional decoupling D dB (e.g. to simulate antenna circulator, antenna IPI or feeder losses) necessary to guarantee the degradation itself.

B.5.5.2 Equipment Background BER (BBER)

The BBER is standardized in order to match the ES % (or the EB %) performance required by ITU-R transmission performance.

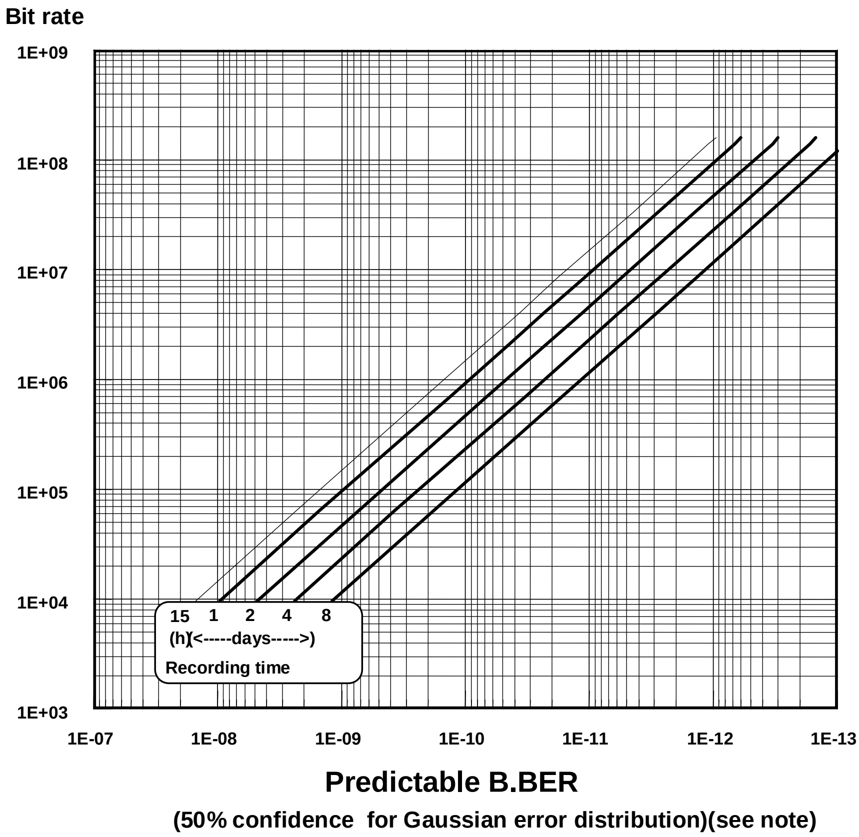
ITU-R Recommendation F.634 [1] reports a provisional method for in-field evaluation of BBER.

The standardized value may vary with the transmission bit rate and a suitable method for type test evaluation may be also suggested (e.g. number of errors or errored blocks within a suitable time period).

As a matter of fact the average time needed to measure BBER with 50 % confidence on a statistical "Gaussian" base is:

$$t[h] = \frac{k}{\mathrm{BBER} \times \mathrm{Bit} - \mathrm{rate} \times 3\,600}$$

where k is a factor for due confidence of the measurement.



Confidence: 50 % of BERmeas. ≤ BBER
46 % of BBER ≤ BERmeas. ≤ 2 x BBER
3 % of 2 x BBER ≤ BERmeas. ≤ 3 x BBER
≤1 % of BERmeas. ≥ 3 x BBER

NOTE: For non-Gaussian (burst) error distribution, about same confidence may be obtained by multiplying these figures for the average coding/mapping/FEC errors-per-burst induced on the measuring port.

Figure B.10: result for 50 % confidence on a gaussian error distribution base

This time, when codes/scramblers/FECs may produce non-gaussian errors distribution, should be even more increased by a factor typically equal to the average error number in error bursts induced on the measuring port (because, in this case, the burst distribution only is Gaussian).

These measuring times have an impact on the type approval/conformance tests, which, for the lowest bit-rates, may not be practically performed if the required BBER is too low.

The following solutions may be used:

- fix the required BBER on the base of a reasonable test time;
- when FEC is implemented, its activity may be recorded and BBER estimated by a law, stated by the manufacturer, which effectiveness may be verified, at suitable higher BER points, by the body which performs the test.

B.5.5.3 Interference sensitivity

The determination of interference sensitivity is necessary for frequency co-ordination when the standardized equipment is used in field.

B.5.5.3.1 Co-channel "external" interference sensitivity and

B.5.5.3.2 Co-channel "internal" interference sensitivity

"External" co-channel interference is the basic performance which depends from the modulation format only (the use of error correction techniques may also have slight influence) while the "internal" one strongly depends on the XPIC design.

If the radio system works on a co-channel band reuse frequency plan and makes use of XPIC (cross Polar Interference Canceller) in order to reduce the interference from its twin cross-polarized system, two different types of co-channel behaviour may be defined: one from any "external" completely un-correlated source (which does not benefit of XPIC improvement), and another "internal" to the system from the twin system (on which XPIC is active).

XPIC may be used to combat de-polarization effects caused by multipath propagation and/or rain attenuation. The XPIC behaviour is proposed to be described by three characteristic values:

1) the asymptotic (or residual) XPD which is the limiting value of C/I achieved at the output of the XPIC for large values of C/I at the receiver inputs;

2) the XPD improvement factor XIF in case of flat cross-talk and co-channel fading (rain model);

3) the XPD improvement factor XIF in case of dispersive co-channel fading and dispersive cross-talk (multipath model).

B.5.5.3.3 Adjacent channel interference

Adjacent (at one or more channel spacing) channel interference performance shall be congruent with the spectrum mask of the interfering signal (see background to clause B.5.3.5) and, vice versa, specific requirements on adjacent (at one or more channel spacing) channel interference performance shall be reflected in the interfering transmitter spectrum mask.

The limits are given in a table form for 1 dB and 3 dB threshold degradation versus like modulated C/I ratio in order to give clear point of measurement for conformance-testing; for frequency co-ordination purposes intermediate values shall be recorded in an informative annex.

B.5.5.3.4 CW spurious interference

CW interference sensitivity may also be required in order to verify a minimum rejection, on a very wide band basis, of the possible frequency(ies) which may be sensitive for the equipment under test (e.g. harmonics, sub-harmonics, shifter and IF related frequencies).

EN 301 390 [44] gives the generic limits for the upper and lower limits (see note) of the required measurement; they are reported in the following table.

NOTE: When waveguide is used between reference points A and C of figure 1, which length is higher than twice the free space wavelength of cut-off frequency (Fc), the lower limit of measurement will be increased to 0,7 Fc and, when the length is higher than four times the same wavelength, to 0,9 Fc.

Fundamental receiver frequency range	CW Spurious response frequency range	
	lower frequency	upper frequency (see note)
9 kHz - 100 MHz	9 kHz	1 GHz
100 MHz - 300 MHz	9 kHz	10th harmonic
300 MHz - 600 MHz	30 MHz	3 GHz
300 MHz - 5.2 GHz	30 MHz	5th harmonic
5.2 GHz - 13 GHz	30 MHz	26 GHz
13 GHz - 150 GHz	30 MHz	2nd harmonic
150 GHz - 300 GHz	30 MHz	300 GHz
NOTE: The test should include the entire harmonic band and not be truncated at the precise upper frequency limit stated.		

B.5.5.3.5 Front-end non-linearity requirements (two-tone CW spurious interference)

The introduction of frequency and rate agile radio relay system opens up the risk for non-linear effects in the receivers. In order to assure that such effects need not to be considered at the frequency planning of radio network, a two-tone requirement is needed. The intention of this requirement is to represent worst case conditions, with respect the interference levels and frequencies.

B.5.5.4 Distortion sensitivity

The concept of "signature" of a radio receiver has been introduced by Bell Research Labs in the late 1970s.

It is not the only one that may be used to characterize multipath propagation, however it is the most practical for a laboratory simulated hop measurement.

The delay of the two rays is usually as 6,3 ns, due to the fact that the original Bell Research Labs experimental hop Atlanta-Palmetto, where the theory was produced, shows practical distortions well approximated by a two rays model with that delay. On different hops, this delay is expected to be different in a range of few ns. However, for uniformity of results, the 6,3 ns delay has been widely used as reference for equipment characterization.

In principle, the measurements should be made applying a two rays fade simulator at RF level; however, as a consequence of the intrinsic RF to IF down conversion linearity, the measurement is usually made by IF fade simulator, provided that suitable IF section points be provided on the equipment; a lot of standard IF instruments are now available on market.

B.5.6 System characteristics with diversity

Diversity techniques are to be used for performances and/or availability requirement.

This clause is therefore optional.

B.5.6.1 Differential delay compensation

When space diversity is used the antenna spacing follows the well known empirical formula $D > 2\,000\ \lambda_0$ which lead to a path delay difference between the two signals of the order from few to some tenths of meters corresponding to a differential time delay.

This difference shall be re-equalized before the RF, IF or BB combiner to avoid producing a multipath-like distortion on the combined signal.

A minimum delay recovery capability, which is higher for the lower frequency bands, has to be foreseen.

B.5.6.2 BER performance

When combining in phase two equal coherent signals a gain of 6 dB is obtained, while adding the two incoherent receiver noises the total only increases by 3 dB.

As a consequence a theoretical gain of 3 dB on the S/N ratio and RSL is obtained with respect to a single reception; nevertheless, in practical applications, slight difference may arise (e.g. when digital control of discrete phase steps is applied).

When the selection of signals coming from different antennas is made through a baseband switch, no improvement is expected.

B.Annex A (normative): Wide radio-frequency band covering units and multirate equipment specification and tests

R&TTE Directive [52] requires, for presumption of conformity, that a test report is stored by the supplier for market surveillance; it should be also presented to a Notified Body in case no harmonized standards are available.

Modern equipment, are designed to cover a wide range of channel frequencies and bands, and/or a number of different payload-rate and/or a number of different modulation formats, through hardware/software pre-settings. The number of different combinations of these different operation formats may become enormous.

It is therefore necessary to set common, fair and unique rules in order to limit the number and cost of those tests, while maintaining suitable technical confidence that the essential requirements under R&TTE [52] article 3.2 will be fulfilled in any conditions.

Considering that one type test of a single equipment will not in any case ensure the conformity of all the system produced (this is in any case legally guaranteed only by the declaration of conformity), the proposed methodology is considered technically sound to verify the basic design of a system and not exceedingly burdening in comparison to the common procedures usually followed by most manufacturer for internal qualification of their products.

B.Annex B (normative): The EN Requirements Table (EN-RT)

This annex is foreseen for harmonized ENs and summarizes the parts relevant to the essential requirements under R&TTE article 3.2; moreover, it gives evidence of the relationship of various optional functionalities (if any) with the essential R&TTE requirements.

The frame of this annex is reported from ETSI special report for harmonized standards SR 001 470 [63] "Guidance to the production of candidate Harmonized Standards for application under the R&TTE Directive (1999/5/EC) - Pro-forma candidate Harmonized Standard".

B.Annex C (informative):

B.C.1 Radio Frequency (RF) channel arrangement

The annex is considered self-explanatory.

B.C.2 Antenna requirements

The annex is considered self-explanatory.

B.C.3 Automatic Transmit Power Control (ATPC)

The annex is considered self-explanatory.

B.C.4 Co-channel and adjacent channel Interference

Clauses B.5.5.3.1 and B.5.5.3.3 required, for conformance test purpose, only points at 1 dB and 3 dB degradation point, however field problematics require a wider range of values.

The requirements of clauses B.5.5.3.1 and B.5.5.3.3 should be given in a graphical format to aid frequency co-ordination problematics.

History

Document history		
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