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European Standard (Telecommunications series)

**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**



Reference

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The former title of the present document was: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Synchronous Digital Hierarchy (SDH); High capacity DRRS carrying SDH signals (up to $2 \times$ STM-1) in frequency bands with about 30 MHz channel spacing and using Co-Channel Dual Polarized (CCDP) operation".

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1 Scope

The present document specifies the minimum performance parameters for a high capacity digital radio-relay system operating in frequency bands with about 30 MHz channel spacing in the 4 GHz, 6L GHz, 7 GHz, 8L GHz, 13 GHz and 15 GHz bands. The channel capacity is 1 x STM-1 on each polarization that allows to transmit up to 2 x STM-1 signals at the same frequency by using both polarizations in co-channel dual polarized (CCDP) mode of operation with cross-polar interference canceller techniques (XPIC).

The present document is also applicable to 1 x STM-1 systems operating only with co-polar arrangement of about 30 MHz for which the CCDP operation with XPIC is considered a non mandatory options; for those systems the clauses relevant to XPIC operation (i.e. co-channel "internal" interference) are not applicable. These systems are intended for local high capacity links (e.g. mobile infrastructure connections) where few channels may be used by different operators) and the crowded environment could require co-polar operation on adjacent channels.

It has to be noted that STM-1 systems can be grouped in order to offer an SDH interface higher than STM-1.

The area of application of these digital radio-relay systems is foreseen to be in regional and trunk networks forming part of an SDH-network including optical rings.

Systems considered in the present document shall be able to respect ITU-R and ITU-T performance objectives.

The systems considered shall operate in these networks having regard for existing hop length, which are considered to be normally up to about 30 km to 40 km for regional and about 60 km for trunk networks, respectively. Hop lengths greater than this latter length are used in special applications.

The systems considered in the present document are intended to operate in the same network with existing, Alternate Polarization (AP), SDH and PDH systems reported in EN 300 234 [14] and in CEPT Recommendation T/L 04-04 [7], respectively.

NOTE 1: Adjacent channel co-polar operation on the same route between digital systems designed according these older standards and digital systems defined by the present document, is not feasible.

The parameters specified fall into two categories:

- a) Parameters that are required to provide compatibility between channels connected to the same antenna via multichannel branching system, or channels on the same route connected to separate antennas.

NOTE 2: Due to the internal functionality of the XPIC, equipment operating on both polarization of the same channel is considered to form a single CCDP system.

- b) Parameters defining the transmission quality of the proposed system.

The standardization deals with baseband, IF and RF characteristics relevant to SDH. Antenna/feeder system requirements are also considered for information to the reader, however antenna characteristics are generally covered in EN 300 833 [17].

Baseband interfaces have to be considered for STM-1 signals in accordance with ITU-T Recommendation G.707 [36] and ITU-T Recommendation G.957 [42].

PDH interfaces according ITU-T Recommendation G.703 [35] for signals mapped into STM-1 signal according to ITU-T Recommendation G.707 [36] could be used.

The present document does not contain aspects related to test procedures and test conditions, however they are to be found in EN 301 126-1 [18].

Safety aspects are outside the mandate of ETSI and they will not be considered in the present document. However compliance to EN 60950 [1] will be required to comply with 1999/5/EC Directive (R&TTE) [8].

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.

- [1] EN 60950: "Safety of information technology equipment".
- [2] CEPT/ERC Recommendation 12-02: "Harmonised radio frequency channel arrangements for analogue and digital terrestrial fixed systems operating in the band 12.75 GHz to 13.25 GHz".
- [3] CEPT/ERC Recommendation 12-07: "Harmonised radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 15.23 GHz to 15.35 GHz".
- [4] CEPT/ERC Recommendation 12-08: "Harmonised radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz".
- [5] CEPT/ERC Recommendation 14-01: "Radio-frequency channel arrangements for high capacity analogue and digital radio-relay systems operating in the band 5925 MHz - 6425 MHz".
- [6] CEPT/ERC Recommendation 74-01: "Spurious emissions".
- [7] CEPT/ERC Recommendation T/L 04-04: "Harmonisation of 140 Mbit/s digital radio relay systems for operation below 10 GHz utilizing 64 QAM at about 30 MHz spacing".
- [8] 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.
- [9] ETSI TR 101 035: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS)".
- [10] ETSI ETS 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".
- [11] ETSI ETS 300 119 (all parts): "Equipment Engineering (EE); European telecommunication standard for equipment practice".
- [12] 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".
- [13] ETSI ETS 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".
- [14] ETSI EN 300 234: "Fixed Radio Systems; Point-to-point equipment; High capacity digital radio systems carrying 1 x STM-1 signals and operating in frequency bands with about 30 MHz channel spacing and alternated arrangements".
- [15] ETSI EN 300 385: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment".
- [16] ETSI ETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Radio specific functional blocks for transmission of M x STM-N".
- [17] ETSI EN 300 833: "Fixed Radio Systems; Point-to-point Antennas; Antennas for point-to-point fixed radio systems operating in the frequency band 3 GHz to 60 GHz".

- [18] ETSI EN 301 126-1: "Fixed Radio Systems; Conformance testing; Part 1: Point-to-point equipment - Definitions, general requirements and test procedures".
- [19] ITU-R Recommendation F.382-7: "Radio-frequency channel arrangements for radio-relay systems operating in the 2 and 4 GHz bands".
- [20] ITU-R Recommendation F.383-6: "Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band".
- [21] ITU-R Recommendation F.385-6: "Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band".
- [22] ITU-R Recommendation F.386-6: "Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the 8 GHz band".
- [23] ITU-R Recommendation F.497-6: "Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band".
- [24] ITU-R Recommendation F.557-4: "Availability objective for radio-relay systems over a hypothetical reference circuit and a hypothetical reference digital path".
- [25] ITU-R Recommendation F.635-5: "Radio-frequency channel arrangements based on a homogenous pattern for radio-relay systems operating in the 4 GHz band".
- [26] ITU-R Recommendation F.636-3: "Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band".
- [27] ITU-R Recommendation F.695: "Availability objectives for real digital radio-relay links forming part of a high-grade circuit within an integrated services digital network".
- [28] ITU-R Recommendation F.750-4: "Architectures and functional aspects of radio-relay systems for synchronous digital hierarchy (SDH)-based networks".
- [29] ITU-R Recommendation F.752-1: "Diversity techniques for radio-relay systems".
- [30] ITU-R Recommendation F.1092-1: "Error performance objectives for constant bit rate digital path at or above the primary rate carried by digital radio-relay systems which may form part of the international portion of a 27 500 km hypothetical reference path".
- [31] ITU-R Recommendation F.1093-1: "Effects of multipath propagation on the design and operation of line-of-sight digital radio-relays systems".
- [32] ITU-R Recommendation F.1101: "Characteristics of digital radio-relay systems below about 17 GHz".
- [33] ITU-R Recommendation F.1189-1: "Error performance objectives for constant bit rate digital paths at or above the primary rate carried by digital radio-relay systems which may form part or all of the national portion of a 27 500 km hypothetical reference path".
- [34] ITU-R Recommendation F.1191-1: "Bandwidths and unwanted emissions of digital fixed service systems".
- [35] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
- [36] ITU-T Recommendation G.707: "Network node interface for the synchronous digital hierarchy (SDH)".
- [37] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".
- [38] ITU-T Recommendation G.783: "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".
- [39] ITU-T Recommendation G.784: "Synchronous digital hierarchy (SDH) management".

- [40] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".
- [41] ITU-T Recommendation G.827: "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".
- [42] ITU-T Recommendation G.957: "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".
- [43] ITU-T Recommendation O.151: "Error performance measuring equipment operating at the primary rate and above".
- [44] ITU-T Recommendation O.181: "Equipment to assess error performance on STM-N interfaces".
- [45] ITU-R Recommendation SM.329-8: "Spurious emissions".
- [46] 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".
- [47] 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".
- [48] ITU-T Recommendation G.828: "Error performance parameters and objectives for international, constant bit rate synchronous digital paths".

3 Abbreviations and symbols

3.1 Abbreviations

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

6L	Lower 6 (GHz frequency band)
AP	Alternate Polarization
ATPC	Automatic Transmit Power Control
BB	BaseBand
BER	Bit Error Rate
C/I	Carrier to Interference (ratio)
CCDP	Co-Channel Dual Polar
CMI	Code Mark Inversion
CSmin	minimum practical Channel Separation (for a given radio-frequency channel arrangement)
CW	Continuous Wave
DRRS	Digital Radio Relay System
FDM	Frequency Division Multiplexing
IF	Intermediate Frequency
LO	Local Oscillator
NFD	Net Filter Discrimination
ppm	parts per million
RF	Radio Frequency
RFCOH	Radio Frame Complementary OverHead
RX I/P	Receiver Input level
RX	Receiver
SDH	Synchronous Digital Hierarchy
SOH	Section OverHead
STM-1	Synchronous Transport Module Level 1 (155,52 Mbit/s)
TMN	Telecommunication Management Network
TX	Transmitter
XPD	Cross Polar Discrimination
XPI	Cross Polar Interference
XPIC	Cross Polar Interference Canceller

3.2 Symbols

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

dB	decibel
dBm	decibel relative to 1 mW
GHz	GigaHertz
km	kilometre
Mbit/s	Mega-bit per second
MHz	MegaHertz
ppm	parts per million
ns	nanosecond

4 General Characteristics

4.1 Frequency bands and channel arrangements

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

4 GHz	The channel plan shall be in accordance with CEPT/ERC Recommendation 12-08, annex A, part 2 [4] or ITU-R Recommendations F.382 [19] or F.635-5 [25].
6L GHz	The channel plan shall be in accordance with CEPT/ERC Recommendation 14-01 [5] or ITU-R Recommendation F.383 [20].
7 GHz	The channel plan shall be in accordance with ITU-R Recommendation F.385 [21].
8L GHz	The channel plan shall be in accordance with ITU-R Recommendation F.386 [22].
13 GHz	The channel plan shall be in accordance with CEPT/ERC Recommendation 12-02 [2] or ITU-R Recommendation F.497 [23].
15 GHz	The channel plan shall be in accordance with CEPT/ERC Recommendation 12-07 [3] or ITU-R Recommendation F.636 [26].

It is recognized that, particularly in bands 7 GHz and 8 GHz there might be a number of national channel arrangements that are not referenced in the above recommendations, however the provision of the present document are valid also for them, provided that the channel separation is contained between 28 MHz and 30 MHz.

4.2 Modes of operation

The mode of operation is co-channel dual polar (CCDP) for all frequency bands.

The actual exploiting of both polarization is considered optional; in particular, for the case of partially outdoor systems, the XPIC and frequency reuse may even not be applicable, while compatibility with other systems, that fully exploiting the CCDP frequency reuse, is maintained.

In defining system characteristics for CCDP systems the additional losses introduced by the branching networks should be taken into account. Depending on the implementation (split branching for even and odd channels followed by a 3 dB loss hybrid put at reference points C and/or C', narrow band RF filters concept or others implementation) additional losses ranging from 3 dB to 6 dB should be considered in evaluating the available net system gain.

When narrow-band RF filters are used losses affect directly receiver thresholds at reference point B. As a consequence this should be taken into account in specifying receiver threshold limits.

4.3 Compatibility requirements between systems

- a) There shall be no requirement to operate transmitting equipment from one manufacturer with receiving equipment from another.
- b) There shall be no requirement to operate, on the same radio frequency channel, systems from different manufacturer on vertical and horizontal polarization.
- c) There may be the requirement of operating systems from different suppliers under the same branching systems.

4.4 Performance and availability requirements

Equipment shall be designed in order to meet network performance and availability requirements foreseen by ITU-T Recommendations G.826 [40], G.828 [48] and G.827 [41] following the criteria defined in ITU-R Recommendations F.695 [27] and F.557 [24], F.1092 [30] or F.1189 [33] for international or national portion of the digital path.

The implication of the link design on the performance is recognized and the general design criteria reported in ITU-R Recommendations F.752 [29], F.1093 [31], F.1101 [32], F.1092 [30] and F.1189 [33] are to be applied.

4.5 Environmental Conditions

Both indoor and partially outdoor installations are considered.

The equipment shall be required to meet the environmental conditions set out in ETS 300 019 [10] which defines weather protected and non-weather protected locations, classes and test severity.

The manufacturer shall state which class the equipment is designed to withstand.

4.5.1 Equipment within weather protected locations (indoor locations)

Equipment intended for operation within temperature controlled locations or partially temperature controlled locations shall meet the requirements of ETS 300 019 [10] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [10] classes 3.3 (Non temperature controlled locations), 3.4 (Sites with heat trap) and 3.5 (Sheltered locations) may be applied.

4.5.2 Equipment for non-weather protected locations (outdoor locations)

Equipment intended for operation within non-weather protected locations shall meet the requirements of ETS 300 019 [10], class 4.1 or 4.1E.

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

4.6 Mechanical dimensions

For outdoor installation, the outdoor unit may be separable from the antenna.

For indoor installation the equipment shall conform to ETS 300 119 [11].

Other mechanical arrangement which can be made compatible with ETS 300 119 [11] may also be considered.

4.7 Power Supply

The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in ETS 300 132-1 [12] and ETS 300 132-2 [13].

4.8 Electro Magnetic Compatibility (EMC)

The equipment shall comply with EN 300 385 [15] or to relevant parts of the multipart standard EN 301 489-1 [46] and EN 301 489-4 [47].

4.9 TMN interfaces

TMN interface, if any, shall be in accordance with ITU-T Recommendation G.773 [37].

4.10 Block diagram

The reference points are shown in figure 1. These points are reference points only and not necessarily measurement points.

The receiver diversity path shown in the block diagram refers only to combining techniques.

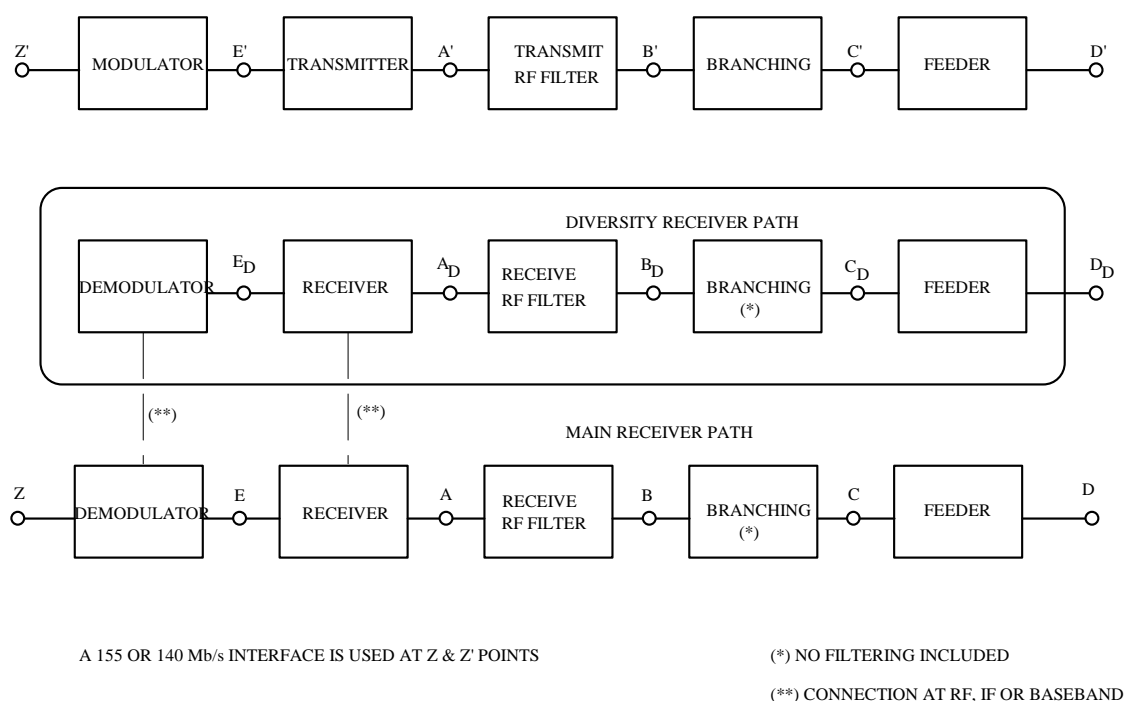


Figure 1: Block Diagram

4.11 Intermediate frequency

If for test and maintenance purposes IF frequencies are used, the chosen frequencies shall allow the use of standard test equipment.

4.12 Branching/feeder/antenna requirements

Antennas required for the systems specified in the present document shall comply with EN 300 833 [17].

5 Baseband characteristics

5.1 Plesiochronous digital hierarchy

The PDH interface at 140 Mbit/s, in compliance with ITU-T Recommendation G.703 [35] may be used.

These baseband signals shall be carried "open port", i.e. in a transparent manner independent of their content and they shall be mapped into a SDH frame in accordance with ITU-T Recommendation G.707 [36].

5.2 Synchronous Digital Hierarchy

The SDH baseband interface shall be in accordance with ITU-T Recommendations G.703 [35], G.707 [36], G.783 [38], G.784 [39], G.957 [42] and with ETS 300 635 [16].

Two STM-N interfaces are possible:

- STM-1 CMI electrical (ITU-T Recommendation G.703 [35]);
- STM-N optical (ITU-T Recommendation G.957 [42]).

The use of reserved bytes contained in the SOH, and their termination shall be in accordance with ITU-R Recommendation F.750 [28]. Further details on the possible use of the SOH bytes including additional RFCOH are given in ETSI TM4 document TR 101 035 [9].

6 Transmitter Characteristics

6.1 Output power

The value of output power (nominal and tolerance) referred to point B' for four different output power ranges shall be as shown in the table 1 not including the ATPC.

Table 1

Range A	$\geq +21$ dBm	$\leq +26$ dBm
Range B	$\geq +26$ dBm	$\leq +31$ dBm
Range C	$\geq +31$ dBm	$\leq +34$ dBm
Range D	$\geq +34$ dBm	$\leq +38$ dBm

For **indoors** installation, the tolerance value around the nominal value is ± 1 dB.

For **outdoors** installation, the tolerance value around the nominal value is ± 2 dB.

NOTE: Equipments of different output power ranges are not considered to require individual type approval. However this is subject to individual national agreement.

6.2 Automatic Transmit Power control (ATPC)

ATPC can be useful in many circumstances, especially:

- to improve analogue/digital compatibility in the case of antennas with poor Cross Polar Discrimination (XPD) performance or in the case of high nominal output power for the DRRS,
- to reduce digital to digital distant interference between hops which reuse the same frequency,
- to improve compatibility with both digital and analogue systems at nodal stations,
- to reduce the effects of up-fading propagation conditions on the system.

ATPC is an optional feature which is aimed at driving the TX Power Amplifier output level from a proper minimum in case of normal propagation up to a maximum value, which is defined by the relative class of output power and the complete fulfilment of all the specifications defined in the present document.

The ATPC range is the power interval from the nominal output power level to the lowest power amplifier output level (at point B') with ATPC. The minimum ATPC output power level shall be specified, to facilitate analogue to digital compatibility. The value is under study. Use of ATPC with CCDP systems requires further investigation to ensure that co-channel and adjacent channel C/I ratios and Residual BER performance characteristics remain acceptable under all conditions of the ATPC range.

6.3 RF spectrum masks

The three main factors considered in recommending a mask are as follows:

- a) Control of interference into analogue channels operating on the adjacent channel;
- b) Control of interference into digital channels between systems of different suppliers operating on the adjacent channel assignment;
- c) Different transmitter characteristics.

It is believed that any system conforming to a CCDP standard would also be compatible with analogue or digital channels on the adjacent channel allocation.

The spectrum masks proposed in figures 2, 3 and 4, for all frequency bands considered, are based on a level of required compatibility which is identical to that considered in CEPT Recommendation T/L 04-04 [7] and EN 300 234 [14] channels of systems defined in the present document, adjacent to systems according to the above referenced specifications, shall be used only cross polarized and without frequency-reuse.

Spectrum masks in figures 2 and 3 are applicable to multi-channel systems (typically in fully indoor trunk applications) where all channels in both polarization are exploited under the same branching/antenna system and systems from different suppliers may be required to operate under the same branching system according to clause 4.3 c).

Due to limitations of some spectrum analysers, difficulties may be experienced when testing high capacity/wideband systems. The spectrum masks marked (a) in figures 2 and 3 shall be verified directly by measurement (referenced to point B'); since it is not possible to measure attenuation values up to 105 dB directly, for measuring values above 65 dB the following options are to be considered:

- a) measurement using high performance spectrum analyser;
- b) use of notch filters and two step measurement technique;
- c) by adding a measured filter characteristic to the spectrum measured at reference point A'.
Where difficulties are experienced, the plots of one test conducted at ambient and environmental extremes may be produced as evidence to conformance to the spectrum mask.

The spectrum mask shown in figure 4 is applicable when there is no requirement to operate different supplier equipments under the same branching systems according clause 4.3 c).

Masks shall be measured with a modulating baseband signal given by ITU-T Recommendation O.151 [43] in the case of 140 Mbit/s signal or by ITU-T Recommendation O.181 [44] in the case of STM-N test signal.

The masks are referenced to an output power equal to the nominal value.

As far as innermost channels are concerned, the shown masks are relevant only to cross-polar connected channels, typical for operation with two antennas. For single antenna operation, the required de coupling of the even and odd channels, the summing hybrid and circulators and relevant spectrum masks are under study.

NOTE: Due to the more stringent requirements than that of systems operating with adjacent cross-polarized channels, the given masks are absolute maximum limits. Actual systems shall provide a Net Filter Discrimination (NFD) of adequate value to fulfil the adjacent channel interference in clause 8.3.2 and that could be derived from direct computation or measurement on the actual emitted spectrum and receiver RF, IF and BB selectivity.

The Spectrum Analyser settings for application to the RF spectrum masks defined by figures 2 and 3 are:

Table 2

IF Bandwidth	100 kHz
Total Sweep Width	100 MHz
Total Scan Time	auto
Video Filter Bandwidth	0,3 kHz

6.4 Discrete CW components exceeding the spectrum mask limit

6.4.1 Spectral lines at the symbol rate

The power level of spectral lines at a distance from the channel centre frequency equal to the symbol rate shall be less than -37 dBm.

6.4.2 Additional CW components

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

Those lines shall not:

- exceed the mask by a factor more than $\{10 \log (CS_{min}/IF_{bandwidth}) - 10\}$ dB (see note);
- be spaced each other in frequency by less than CS_{min} .

Where:

CS_{min} = 10 MHz for 4 GHz band;

CS_{min} = 14,825 MHz for 6L GHz band;

CS_{min} = 7 MHz for 7 and 8 GHz band;

CS_{min} = 1,75 MHz for 13 and 15 GHz band.

IF bandwidth is the recommended resolution bandwidth reported in table 2.

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

Figure 5 shows a typical example of this requirement.

6.5 Spurious emissions

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

- a) To limit interference into systems operating wholly externally to the system under consideration (external emissions) which limits are referred by CEPT/ERC Recommendation 74-01 [6] based on ITU-R Recommendations SM.329-8 [45] and F.1191 [34];
- b) to limit local interference within the system where transmitters and receivers are directly connected via the filter and branching systems (internal emission).

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 at point B' for indoor systems and C' for outdoor systems, where a common TX/RX duplexer is used.

6.5.1 Spurious emissions-External

According to CEPT/ERC Recommendation 74-01 [6] the external spurious emissions are defined as emissions at frequencies which are removed from the nominal carrier frequency more than $\pm 250\%$ of the relevant channel separation.

Outside the band of $\pm 250\%$ of the relevant channel separation, the Fixed Service radio systems spurious emission limits, defined by CEPT/ERC Recommendation 74-01 [6] together with the frequency range to consider for conformance measurement, shall apply.

6.5.2 Spurious emissions-Internal

The levels of the spurious emissions from the transmitter, referenced to point B' are specified below.

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

Table 3

Spurious Emission Type	Specification Limit	Controlling Factor
Discrete (CW) spurious emissions within the same transmitter half band	< -60 dBm	Within transmitters half band, digital interference to analogue systems on the same route
All spurious emissions within the receiver half band	< -90 dBm	Within receivers other half band, digital into digital interference on the same local multichannel branching/antenna system
All spurious emissions within the receiver half band	< -70 dBm	Within receivers other half band, digital into digital interference for digital systems without branching network (i.e. single transceivers with duplexer)

6.6 Radio frequency tolerance

For all frequency bands considered, maximum radio frequency tolerance shall not exceed:

- ± 30 ppm for operation in environmental classes 3.1 and 3.2.
- ± 50 ppm or ± 400 kHz, whichever is the more stringent, for operation in other environmental classes.

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

6.7 Return loss at point C'

For systems which intend to apply to the compatibility requirements under clause 4.3 the minimum return loss shall be 26 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 an essential requirement. When the antenna is an integral part of the equipment there shall be no requirement.

For feeder/antenna return loss requirement see annex A.

7 Receiver Characteristics

In specifying receiver characteristics, it is intended that the receiver under test shall operate as a part of the complete receiving system comprising all components, including the Cross Polar Interference Canceller (XPIC), if applicable.

The requirements under this clause require that the receiver is not subject to any interference.

For receiver operation under XPI-conditions see clauses 9 and 10.

7.1 Rx local oscillator frequency arrangements

There shall be no requirement on LO frequency arrangement.

7.2 Receiver image rejection

The receiver image(s) rejection shall be:

- > 120 dB: If the image frequency(ies) falls within the transmitter half band.
- > 90 dB: In all other cases.

7.3 Spurious emissions

7.3.1 Spurious emissions-External

At reference point C, the limit values of CEPT/ERC Recommendation 74-01 [6] shall apply.

7.3.2 Spurious emissions-Internal

Spurious emissions which fall in the receiver half band shall be:

- < -125 dBm: when the systems provided by the present document are required to operate, according to clause 4.3 c), under the same branching systems with analogue systems;

NOTE 1: The required level (referenced to point B) will be the average level integrated over any 4 kHz of the FDM channels bandwidth.

- < -110 dBm: for all other cases where, according clause 4.3 c), digital systems of different suppliers are required to share the same branching system.

NOTE 2: The required level (referenced to point B) will be the total average level integrated over the bandwidth of emission under consideration.

For digital systems which are not required to share branching system among different suppliers (e.g. single transceivers with duplexer) there will be no requirement.

7.4 Input level range

The lower limit for the receiver input level shall be given by the threshold level for BER 10^{-3} . The upper limit for the receiver input level, where a BER 10^{-3} may not be exceeded shall be -17 dBm, a BER 10^{-10} may be exceeded for levels greater than -21 dBm. For equipment which is able to operate only with ATPC on a permanent basis, the maximum input level for BER $< 10^{-10}$ may be relaxed to -30 dBm.

These limits shall apply without interference and are referenced to point B.

7.5 Overall Receiver selectivity

In order to control transmit/receive interference between the innermost channels of the band, it is necessary to define an additional spectrum mask for the inner edge of the receiver operating in this part of the band.

Figure 6 propose mask for the overall relative receiver sensitivity for the inner edges of the innermost 6L GHz and for frequency bands with 28 MHz channel spacing and 56 MHz centre gap respectively. The receiver selectivity may be evaluated by calculating the effect of the receiver filter response on the received signal.

In figure 6 the mask (a) is for systems that offers compatibility requirements according clause 4.3 c), where different supplier equipments may share the same branching system; the mask (b) is for systems that do not offer compatibility requirements according clause 4.3 c), but different supplier equipments may still share the same site on different antennas.

7.6 Return loss at point C

For systems which intend to apply to the compatibility requirements under clause 4.3 the minimum return loss shall be 26 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 an essential requirement. When the antenna is an integral part of the equipment there shall be no requirement.

For feeder/antenna return loss requirement see annex A.

8 System Characteristics Without Diversity

8.1 Equipment background BER

Equipment background BER is measured under simulated conditions over an artificial hop with a signal level at point B which is between 15 dB and 40 dB above the lower level which gives BER = 10^{-3} . In a measurement period of 24 hours the number of bit errors shall be less than 10 (BER $\leq 10^{-12}$).

8.2 BER as a function of receive input level (dBm)

The reference point for the definition of the BER curve as a function of receiver input level is point B.

In table 4 the BER value given may be exceeded at signal levels lower than those specified. (For this specification these levels can therefore be considered as the minimum acceptable performance standard or, the maximum receiver threshold levels.)

Table 4

Frequency	< 10 GHz	13 GHz	14/15 GHz
BER			
10 ⁻³	-71 dBm	-70 dBm	-69,5 dBm
10 ⁻⁶	-67 dBm	-66 dBm	-65,5 dBm
10 ⁻¹⁰	-63 dBm	-62 dBm	-61,5 dBm

These limits are required when the connection to the same antenna port of even and odd channels, spaced about 30 MHz on the same polarization, is made with a 3 dB hybrid coupler placed at reference point C. When alternatively, for the above purpose, narrow-band branching filters solution is used, these limits may be 1,5 dB higher.

For outdoors and partially outdoors systems that are not subject to the compatibility requirements as stated in clause 4.2 there is a 2 dB relaxation on the above BER performance thresholds.

The above foreseen relaxations are not intended to be additive, in cases where both could be applicable, the supplier shall declare which one he adopts.

8.3 Interference sensitivity

8.3.1 Co-channel "external" interference sensitivity

The following specifications apply to "external" interference from similar systems but from a different route (nodal interference).

For the frequency bands given under clause 4.1. the limits of the co-channel interference sensitivity for the system shall be as given in table 5.

Typical behaviour is indicated in figure B.1.

Table 5: Degradation versus S/I in co-channel "external" interference

Reference BER	10 ⁻⁶	10 ⁻⁶
RSL Degradation	1 dB	3 dB
S/I (dB)	35	32

8.3.2 Adjacent channel interference sensitivity

For the frequency bands given under clause 4.1 the limits of the adjacent-channel interference sensitivity shall be as given in table 6.

Typical behaviour is indicated in figure B.2.

Table 6: Degradation versus S/I in Adjacent channel "external" interference

Reference BER	10 ⁻⁶	10 ⁻⁶
RSL Degradation	1 dB	3 dB
S/I (dB)	-5	-8

NOTE: To cope with differential fading effects in systems operating on adjacent channels on the same route but using different antennas, S/I values tighter by up to about 10 dB may be required, depending on hop length, fading occurrence factor and ATPC range. The relationship of these parameters on hop performance prediction is under study.

8.4 Distortion sensitivity

For a delay of 6,3 ns and a BER of 10⁻⁴ the width of the signature shall not exceed ±16 MHz relative the channel assigned frequency and the depth shall not be less than 17 dB.

For a delay of 6,3 ns and a BER of 10⁻⁶ the width of the signature shall not exceed ±19 MHz relative the channel assigned frequency and the depth shall not be less than 13 dB.

These limits are valid for both minimum and non-minimum phase cases.

The limits specified shall also be verified by the loss-of-synchronization and re-acquisition signatures.

The sensitivity to dynamic fading can be represented with the following parameters:

- for a notch speed up to 100 MHz/s and a BER = 10⁻⁴ the notch depth shall not be less than 16 dB (sweeping in ± half channel spacing);
- for a notch speed up to 100 MHz/s and a BER = 10⁻⁶ the notch depth shall not be less than 12 dB (sweeping in ± half channel spacing).

9 System Characteristics with diversity

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

9.1 Differential Delay Compensation

It shall 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 75 ns of differential absolute delay.

9.2 BER Performance

When both receiver inputs (main and diversity, point B and BD) are fed with the same signal level at an arbitrary phase difference, input level limits for specified BER values shall be:

- 2,5 dB below for IF or baseband combining systems,
- those given under clause 8.2 for the case without diversity.

10 Cross Polar Interference Sensitivity

This clause covers specific aspects of the performance of the system in presence of cross polarization interference (XPI) coming from the twin system on opposite polarization, not covered in the previous clause 8, that are mitigated by the XPIC operation.

These characteristics are applicable only to systems offering frequency reuse option.

10.1 Co-channel "internal" interference sensitivity in flat fading conditions

The following specifications apply to "internal" interference from the cross polarized channel of the same system.

For the frequency bands given under clause 4.1, the limits of the co-channel interference sensitivity for the system shall be as given in table 7.

Typical behaviour is indicated in figure B.3. It is indicative only.

Table 7: Degradation versus S/I in co-channel "internal" interference

Reference BER	10^{-6}	10^{-6}
RSL Degradation	1 dB	3 dB
S/I (dB)	16	13

Referring to the measurement test bench in annex A, clause A.2 note that measurement has to be made adding the same values of noise and interference to both paths, and varying the phase shifter of the interfering path we have to find the worst condition for this characteristic (see clause A.2).

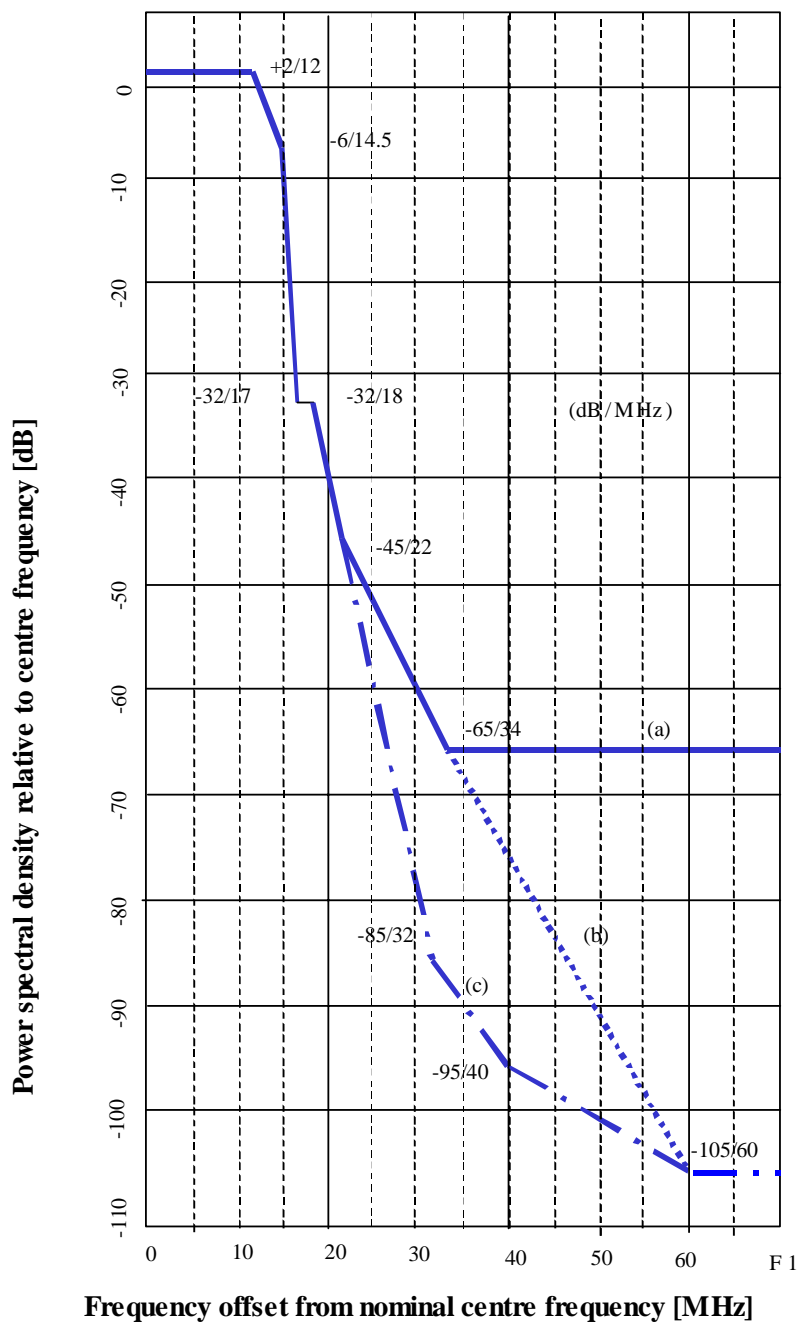
10.2 Co-channel "internal" interference sensitivity in dispersive fading conditions

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.2.

In the above defined measurement conditions, keeping the notches frequency and depth equal on both paths, the BER = 10^{-6} signature limits, with a significant value of XPI, shall be given in table 8.

Table 8: Signature Limits

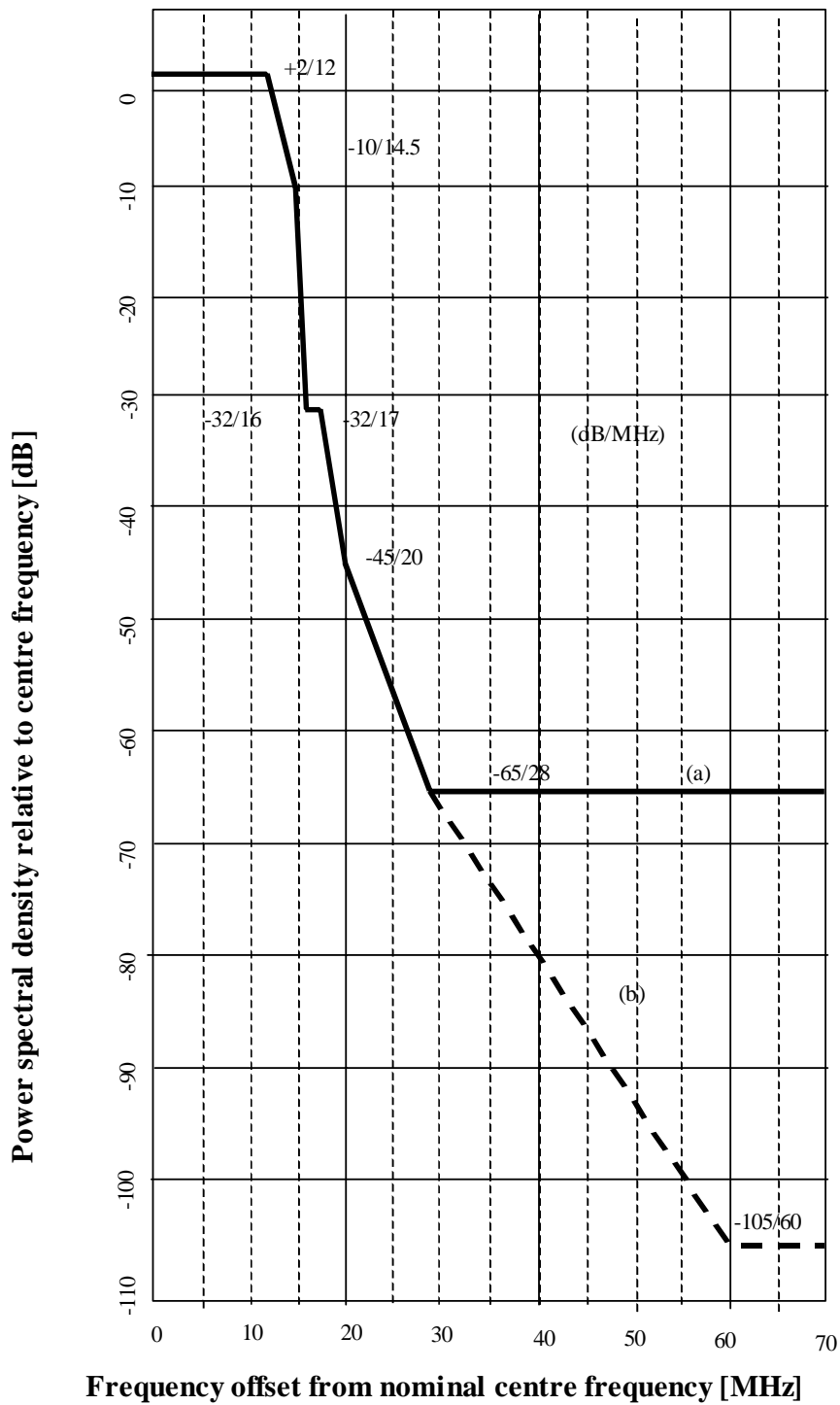
XPI (dB)	Signature Width	Signature Depth
15	± 23 MHz	10 dB



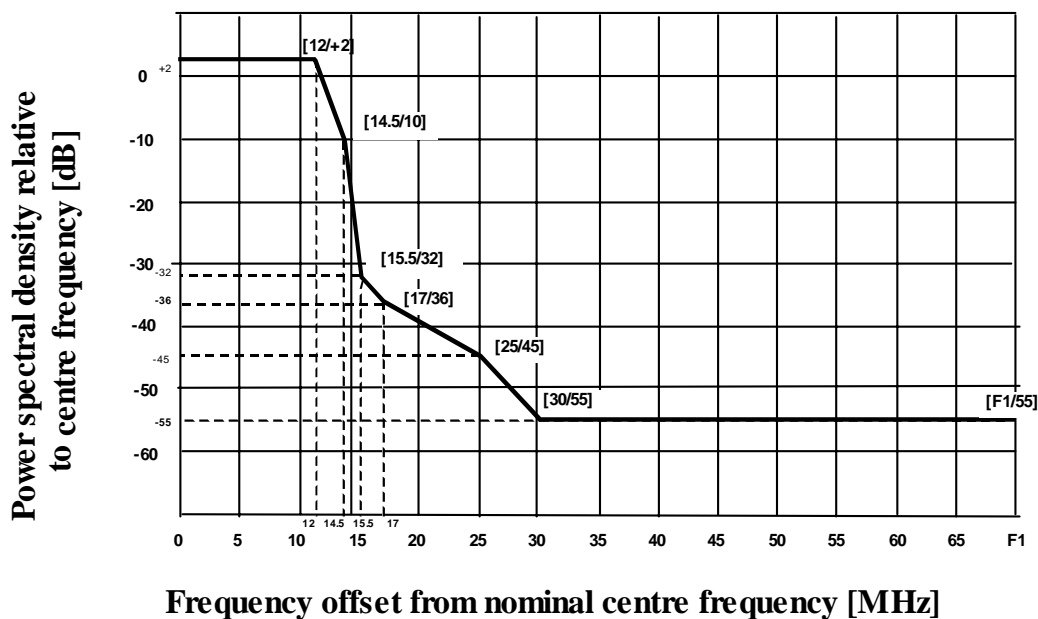
F1 = 72,5 MHz (for channel separation 29 MHz)
 74,125 MHz (for channel separation 29,65 MHz)
 75 MHz (for channel separation 30 MHz)

Figure 2: Spectrum mask for frequency bands with 29, 29,65 and 30 MHz channel separation (for equipments with compatibility requirements according to clause 4.3 c):

- (a) limit for direct measurement**
- (b) normal channels**
- (c) inner edges of innermost channels for L6 GHz band**

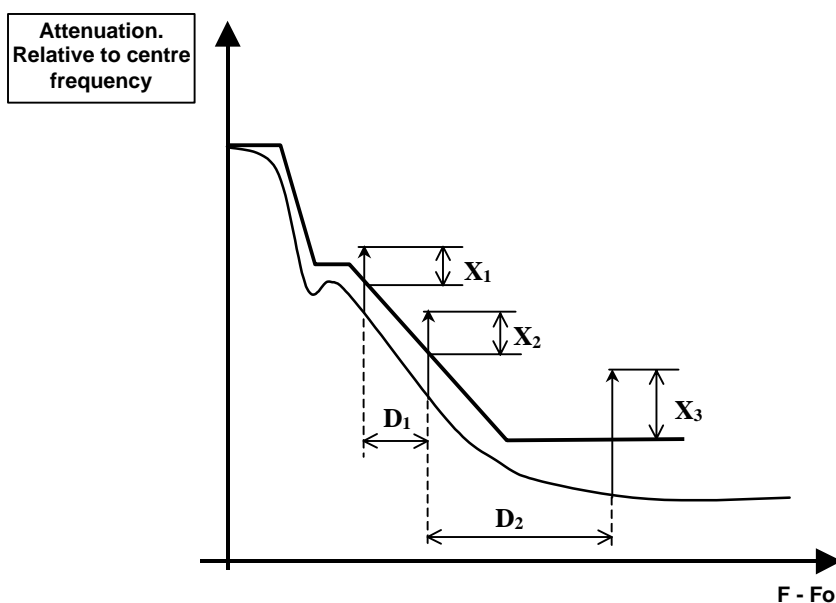


**Figure 3: Spectrum mask for frequency bands with 28 MHz channel separation:
 (for equipments with compatibility requirements according to clause 4.3 c))
 (a) limit for direct measurement
 (b) normal channels (valid also for the innermost channels with 56 MHz centre gap)**



F1 = 72,5 MHz (for channel separation 29 MHz)
 74,125 MHz (for channel separation 29,65 MHz)
 75 MHz (for channel separation 30 MHz)

**Figure 4: Limits of spectral power density
 (for systems with no compatibility requirements according clause 4.3 c)**



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

$$D_1, D_2 \geq \text{CSmin}$$

Figure 5: CW lines exceeding the spectrum mask (typical example)

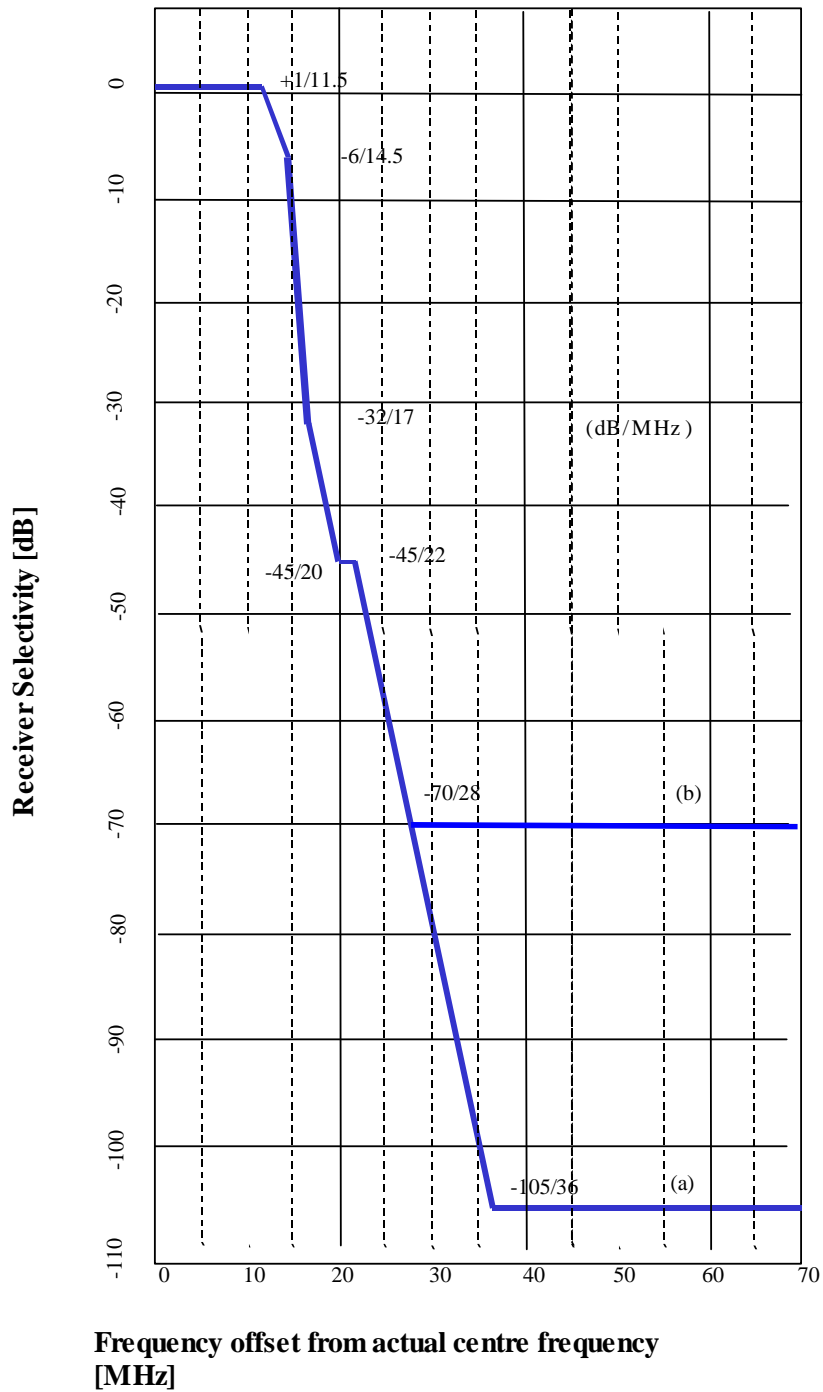


Figure 6: Limits for the receiver selectivity for the inner edges of the innermost channels in the 6L GHz band

- (a) Systems with compatibility requirement according to clause 4.3 c
- (b) Systems without compatibility requirements according to clause 4.3 c

Annex A (normative): Requirements and Measurement test set

A.1 Branching, Feeder and Antenna Requirements

The parameters and values specified in clause 10.2 are essential prerequisites for the system specification given in the present document.

A.1.1 Antenna Radiation Pattern Envelopes

There are differing frequency management methods, differing traffic requirements and densities across ETSI countries therefore the selection of a particular standard will be the responsibility of the administration in conjunction with the user and other relevant parties.

Further study is required on this subject.

A.1.2 Cross-polar discrimination (XPD)

The value of XPD specified shall be the same as in the AP arrangements in the same frequency bands, that is $XPD \geq 28$ dB, allowing the use of the same antennas.

It should be noted that some critical hops could require greater values of XPD.

Further study is required on this subject.

A.1.3 Intermodulation products

Each intermodulation product caused by different transmitters linked to the same antenna shall be less than -110 dBm referenced to point C with an output power relevant to the Classes A to D (table 1) per transmitter.

A.1.4 Interport isolation

Not less than 40 dB.

A.1.5 Return loss

For systems which intend to comply with compatibility requirements under clause 4.3, the minimum return loss should be 24 dB at point C and C' over the full RF band and measured towards the antenna. In the same condition, for systems which are not intended to comply with any compatibility requirement under clause 4.3 and [do not] use "long" feeder connection, the minimum return loss should be 20 dB.

A.1.6 Antenna/Equipment/Feeder Flanges

When wave guides are required IEC PDR type flanges (rectangular) shall be used as below:

Frequency Band [GHz]	4	L6	7	8	13	14	15
PDR Flange Type	40	70	70/84	84	120	140	140

A.2 Measurement test set for XPI characteristics

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 is defined in figure A.1.

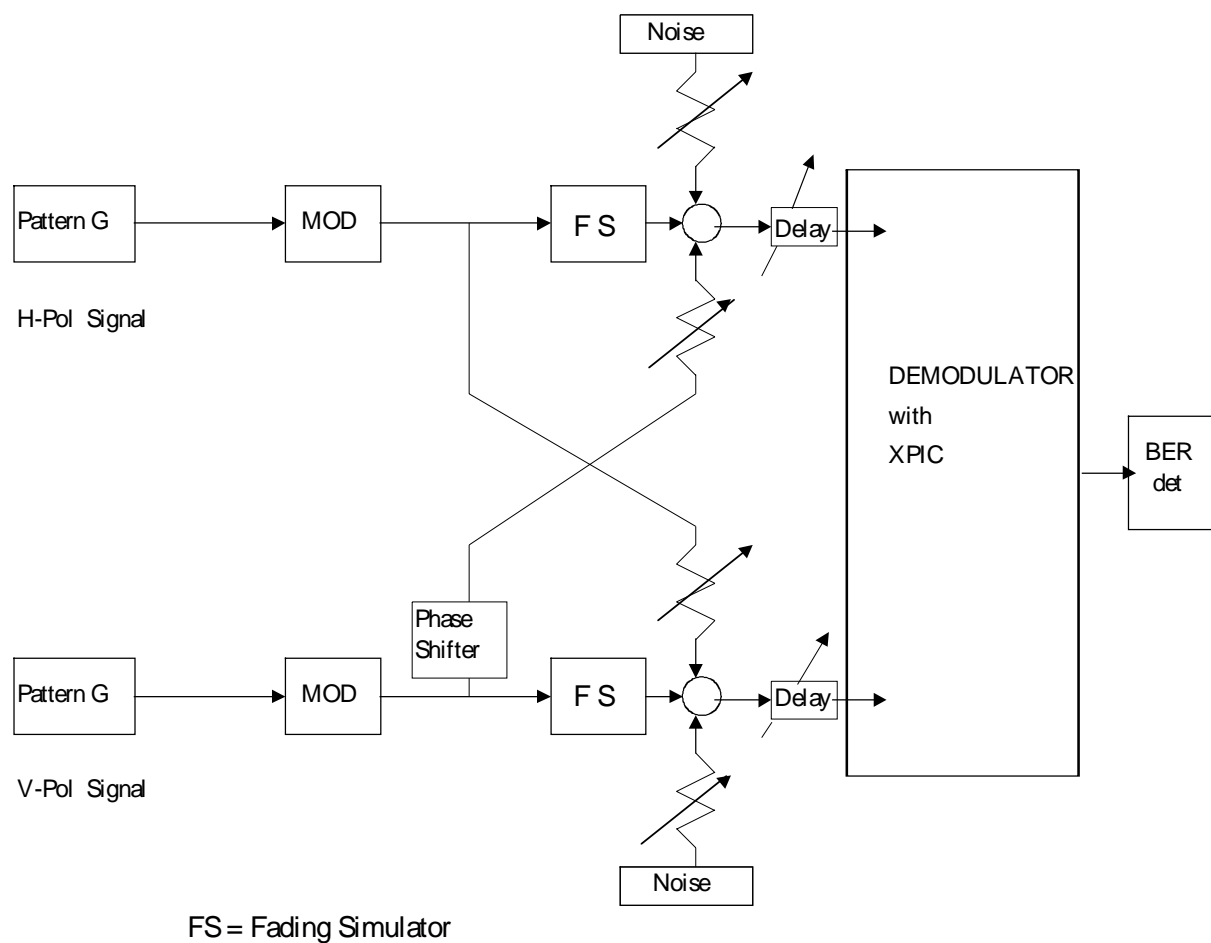


Figure A.1: Measurement test set

Annex B (informative): Typical behaviours of interference sensitivity

Typical behaviours of interference sensitivity are reported in the following figures as indicative characteristics.

- Figure B.1: co-channel digital external interference sensitivity mask.
- Figure B.2: adjacent-channel digital interference sensitivity mask.
- Figure B.3: co-channel internal digital interference sensitivity limits in cross-polar application.

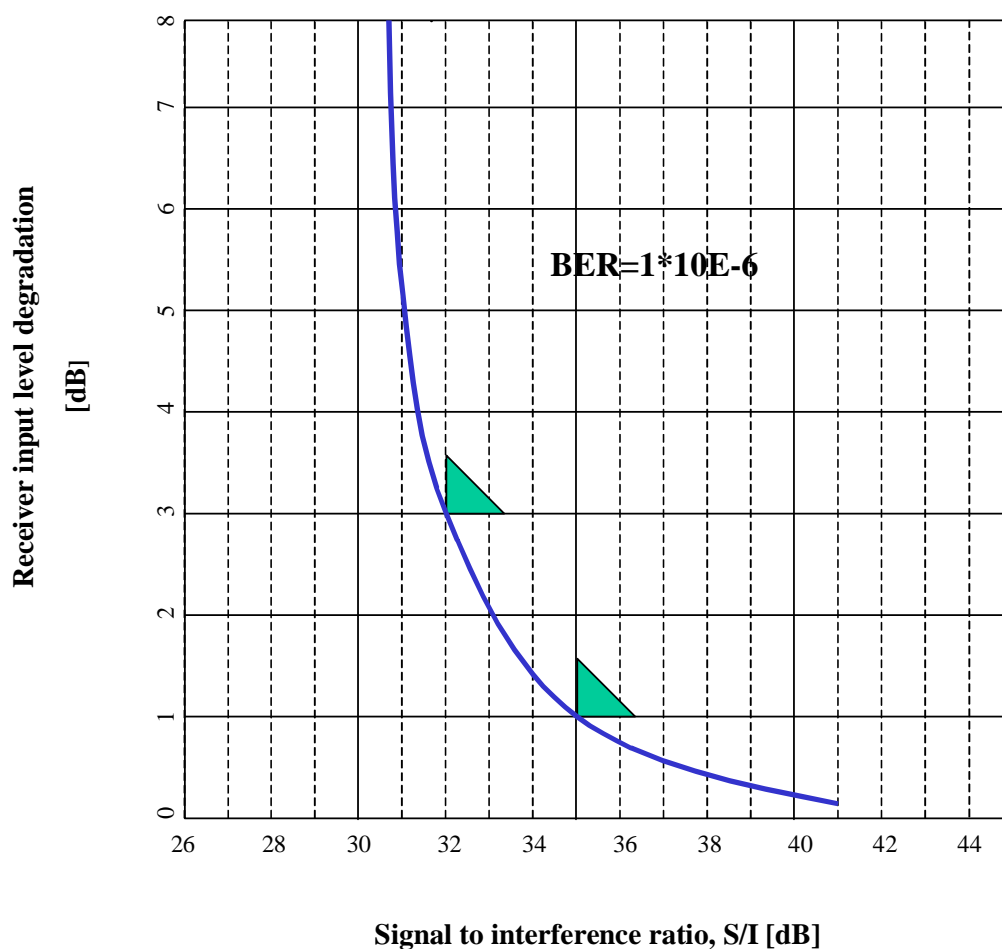


Figure B.1: Co-channel digital "external" interference sensitivity mask

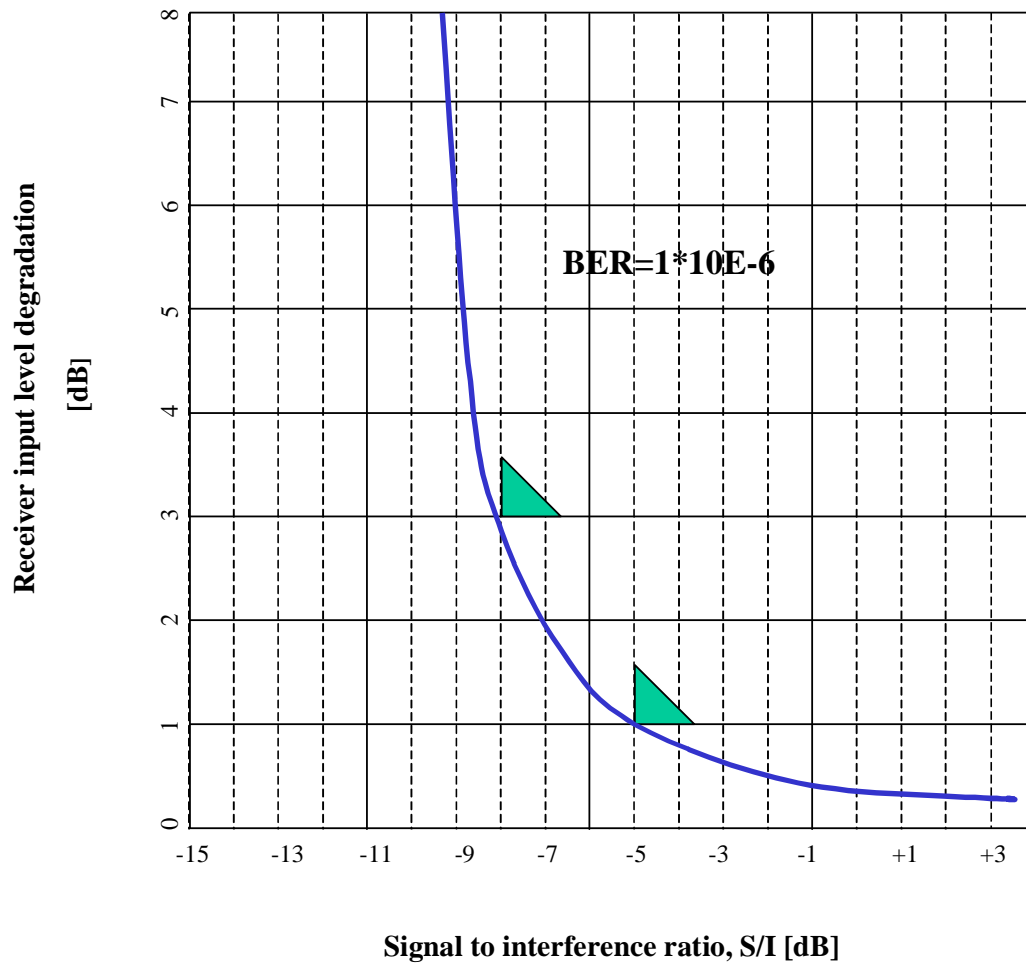


Figure B.2: Adjacent-channel digital interference sensitivity mask

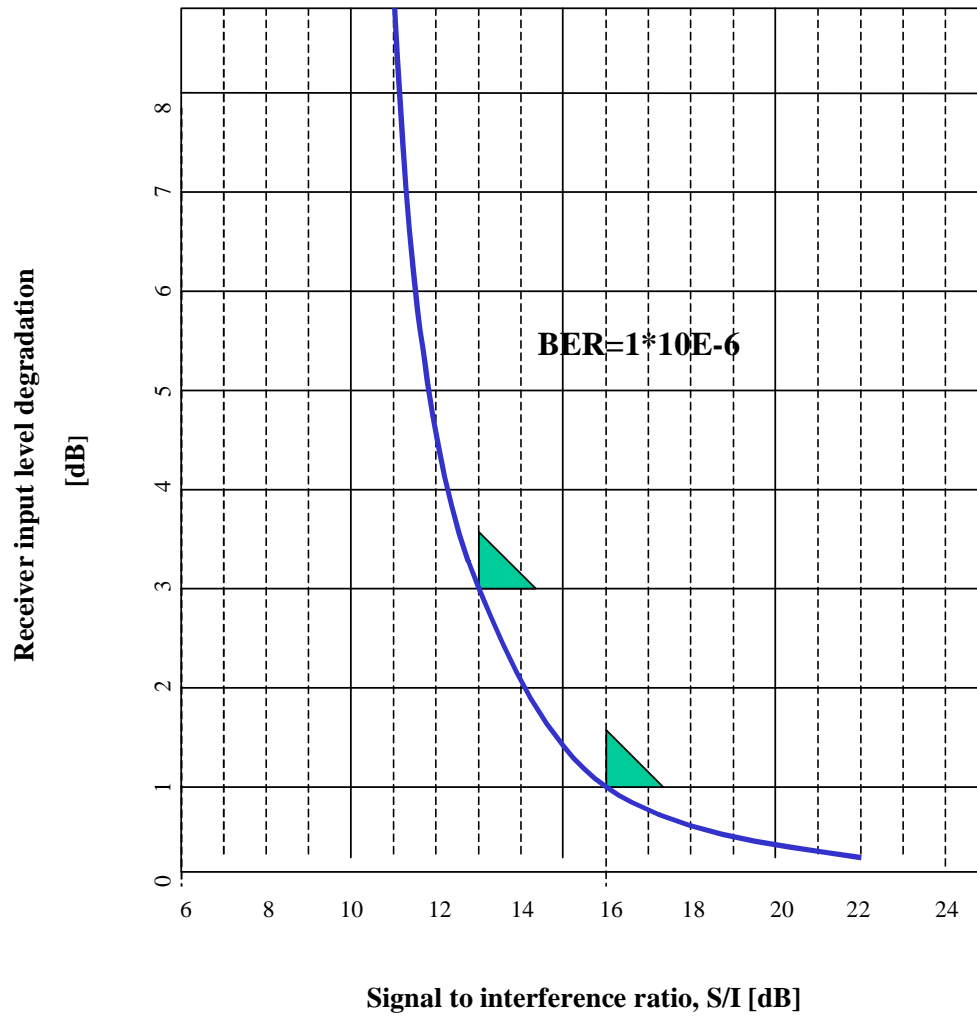


Figure B.3: Co-channel "internal" digital interference sensitivity limits in cross-polar application (referred to point B')

Annex C (informative): Bibliography

- 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".

History

Document history		
V1.1.1	September 2000	Publication
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