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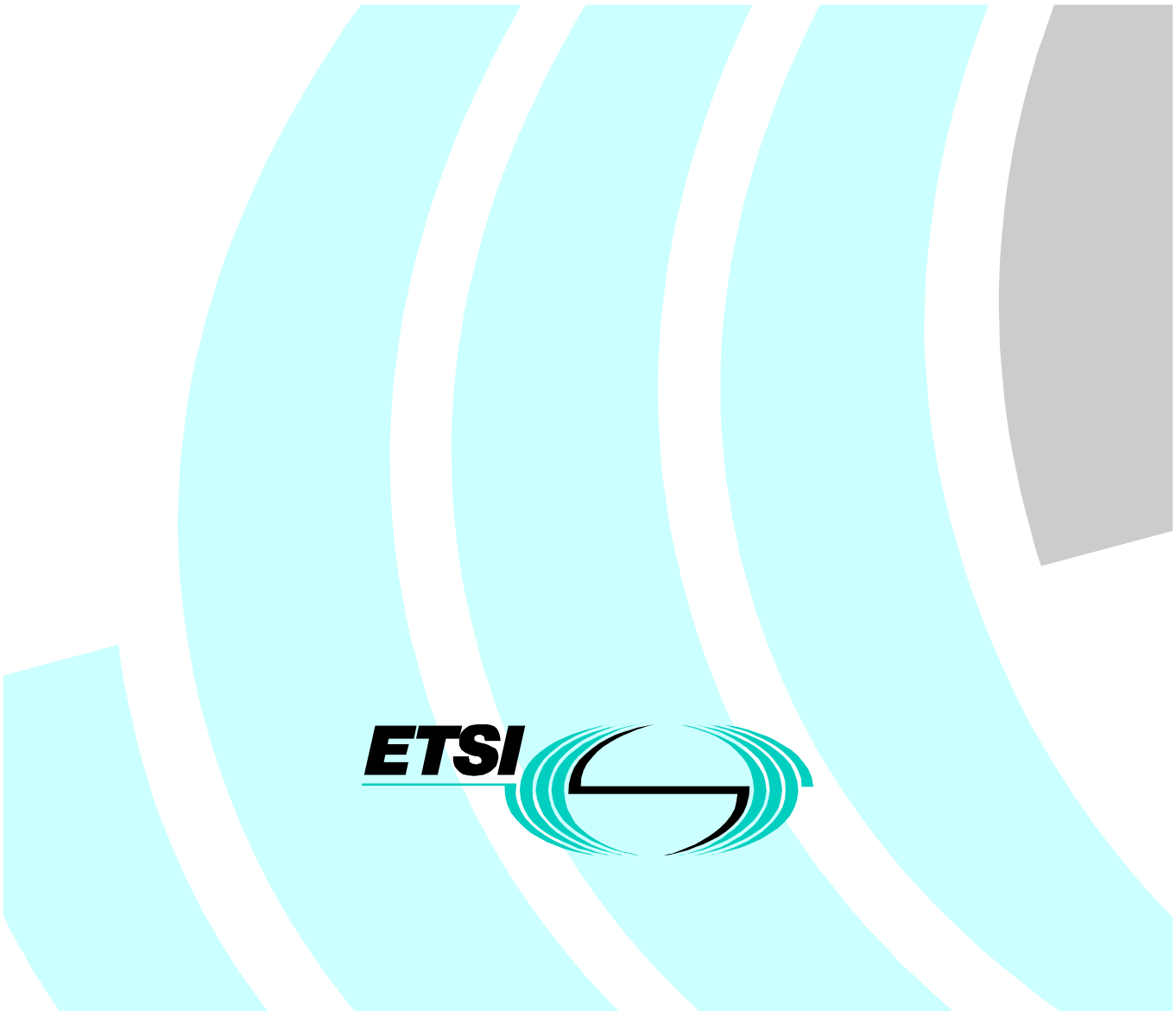
European Standard (Telecommunications series)

**Fixed Radio Systems;
Point-to-point equipment;
High capacity digital radio systems carrying
SDH signals (2 x STM-1) in frequency bands
with about 30 MHz channel spacing and using
Co-Channel Dual Polarized (CCDP) operation**



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Contents

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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 this document was: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Synchronous Digital Hierarchy (SDH); High capacity DRRS carrying SDH signals (2 × STM-1) in frequency bands with about 30 MHz channel spacing and using Co-Channel Dual Polarized (CCDP) operation".

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Date of adoption of this EN:	2 June 2000
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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 1xSTM 1 on each polarization that allows to transmit 2×STM 1 signals at the same frequency by using both polarizations in co-channel dual polarized (CCDP) mode of operation.

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 a 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 are 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.

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 ITU-T Recommendation G.707 [36] could be used.

Antenna/feeder system requirements are covered in ETS 300 833 [17].

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 CENELEC EN 60950 [1] will be required to comply with 99/5/EC Directive (R&TTE).

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, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] CENELEC EN 60950: "Safety of information technology equipment".

[2] CEPT/ERC Recommendation 12-02: "Harmonized 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: "Harmonized 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: "Harmonized radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3 600 MHz to 4 200 MHz".

[5] CEPT/ERC Recommendation 14-01: "Radio-frequency channel arrangements for high capacity analogue and digital radio-relay systems operating in the band 5 925 MHz - 6 425 MHz".

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

[7] CEPT/ERC Recommendation T/L 04-04: " Harmonization 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 (V1.1): "Transmission and multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS)".

[10] ETSI ETS 300 019, Parts 1-3 and 1-4: "Equipment engineering; Environmental conditions and environmental tests for telecommunications equipment".

[11] ETSI ETS 300 119 part 1-4: "Equipment engineering; 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: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); High capacity DRRS 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 ETS 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-relays links forming part of a high grade circuit within an integrated services digital network".

[28] ITU-R Recommendation F.750-3: "Architectures and functional aspects of radio-relay systems for SDH-based networks".

[29] ITU-R Recommendation F.752-1: "Diversity techniques for radio-relays 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-relays 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 emission of digital radio relay 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".

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
CW	Continous 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)
STM-4	Synchronous Transport Module Level 4 (622 Mbit/s)
TMN	Telecommunication Management Network
TX	Transmitter
XIF	cross polarization Improvement Factor due to XPIC operation
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].

6LGHz 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].

4.2 Modes of operation

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

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 3dB loss hybrid put at reference points C and/or C', narrow band RF filters concept or others implementation) additional losses ranging from 3 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

There shall be no requirement to operate transmitting equipment from one manufacturer with receiving equipment from another.

There shall be no requirement to operate, on the same radio frequency channel, systems from different manufacturer on vertical and horizontal polarization.

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] 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)

Equipment shall operate under the conditions specified in ETSI EN 300 385 [15].

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.

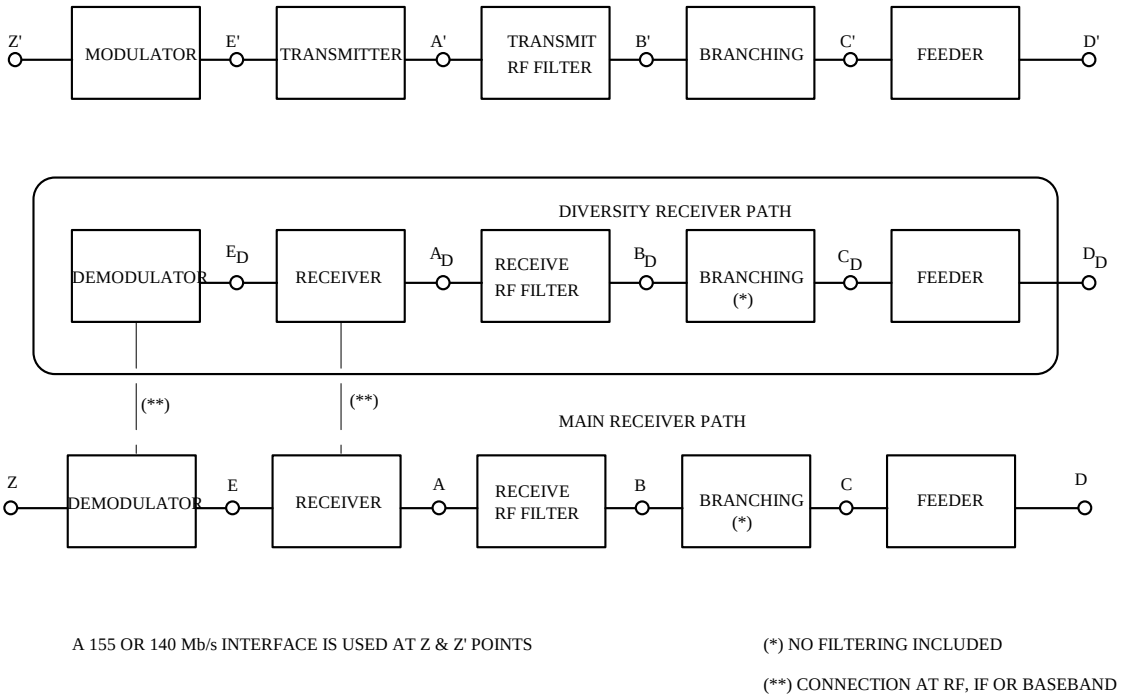

Figure 1: Block Diagram

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 system specified in the present document shall comply with ETS 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	>= + 21 dBm	<= + 26 dBm
Range B	>= + 26 dBm	<= + 31 dBm
Range C	>= + 31 dBm	<= + 34 dBm
Range D	>= + 34 dBm	<= + 38 dBm

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

For **outdoor** 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 re-use 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 allocation;

b) Control of interference into digital channels between systems of different manufacturers operating on the adjacent channel allocation on different polarization of the same antenna;

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 mask proposed in Figure 2 for all frequency bands considered is based on a level of compatibility required 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.

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, values above 65 dB should be verified by adding a measured filter characteristic to the spectrum measured at reference point A'.

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.

RF emitted spectrum masks, for the various frequency bands are shown in Figures 2 and 3.

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 Discrimanation (NFD) of adequate value to fulfil the adjacent channel interference in subclause 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 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.

6.5 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 ± 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 [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

Maximum RF frequency tolerance shall not exceed ± 30 ppm for all frequency bands considered. This limit includes both long term and short term ageing effects.

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

6.7 Return loss at point C'

Minimum return loss shall be not less than 26 dB at point C' for indoor systems.

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).

No cross-polar interference shall be introduced before the receiver.

For receiver operation under XPI-conditions see subclause 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 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.

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 without branching network (i.e. 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 4 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.

The final requirements are under study.

7.6 Return loss at point C

Minimum return loss measured at point C shall be better than 26 dB for indoor systems.

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<=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.

8.3 Interference sensitivity

8.3.1 Co-channel "external" interference sensitivity

The following specifications applies to "external" interferers from similar systems but from a different route (nodal interferer).

For the frequency bands given under subclause 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 Annex B, Figure B.1. It is indicative.

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 subclause 4.1 the limits of the adjacent-channel interference sensitivity shall be as given in Table 6.

Typical behaviour is indicated in Annex B, Figure B.2. It is informative.

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 = $10E^{-4}$ 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 = $10E^{-6}$ 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 subclause 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 subclause 8.2 for the case without diversity.

10 Cross Polar Interference Sensitivity

This paragraph covers specific aspects of the performance of the system in presence of cross polarization interference (XPI) not covered in the previous ones.

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 subclause 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 Annex B, 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 Annex A, 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

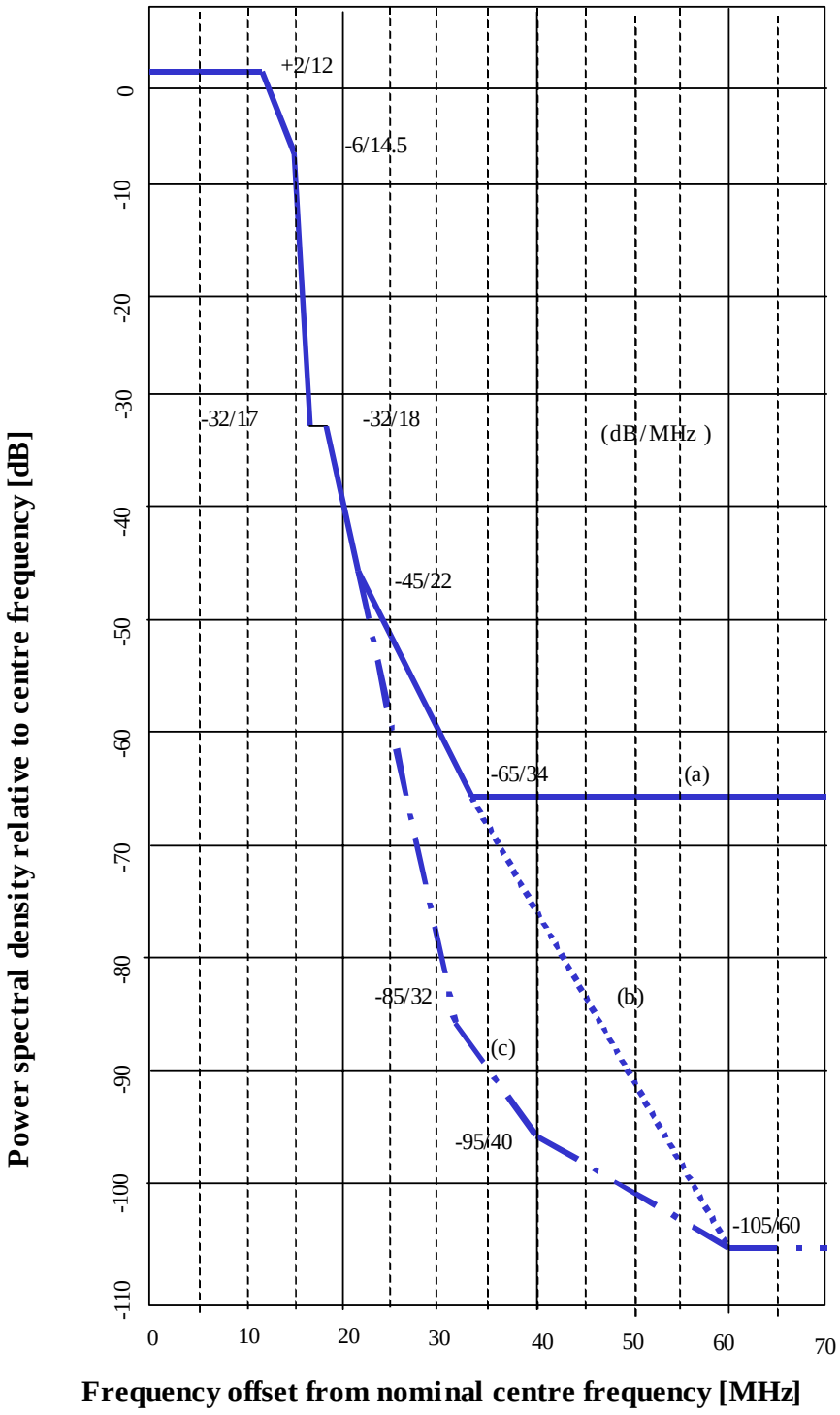

Figure 2: Spectrum mask for normal channels (b) for frequency bands with 29, 29,65 and 30 MHz channel separation, the limit for their direct measurement (a) and for the inner edges of innermost channels for 6L GHz band (c)

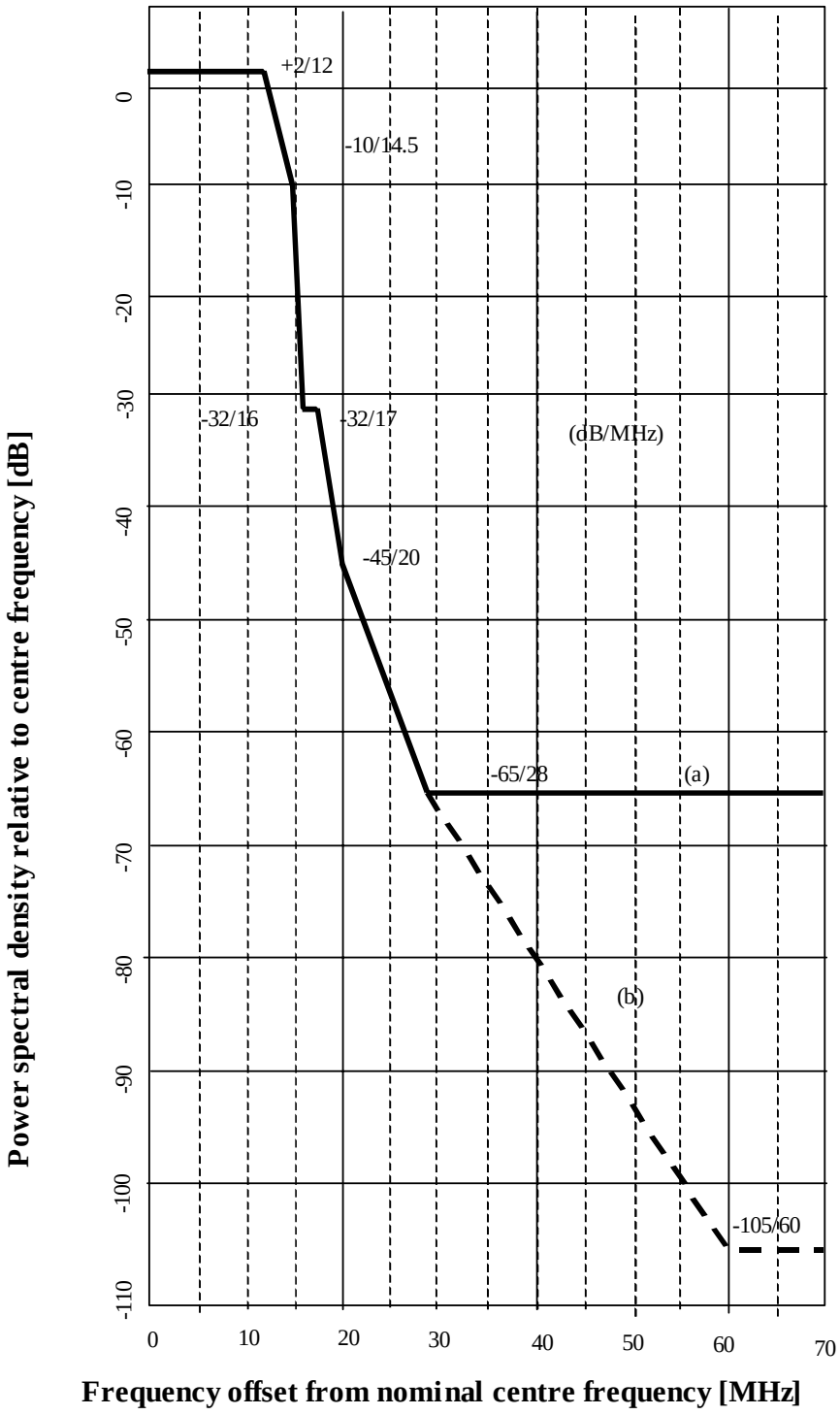

Figure 3: Spectrum mask for normal channels (b) for frequency bands with 28 MHz channel separation and the limit for their direct measurement (a) (valid also for the innermost channels with 56 MHz centre gap)

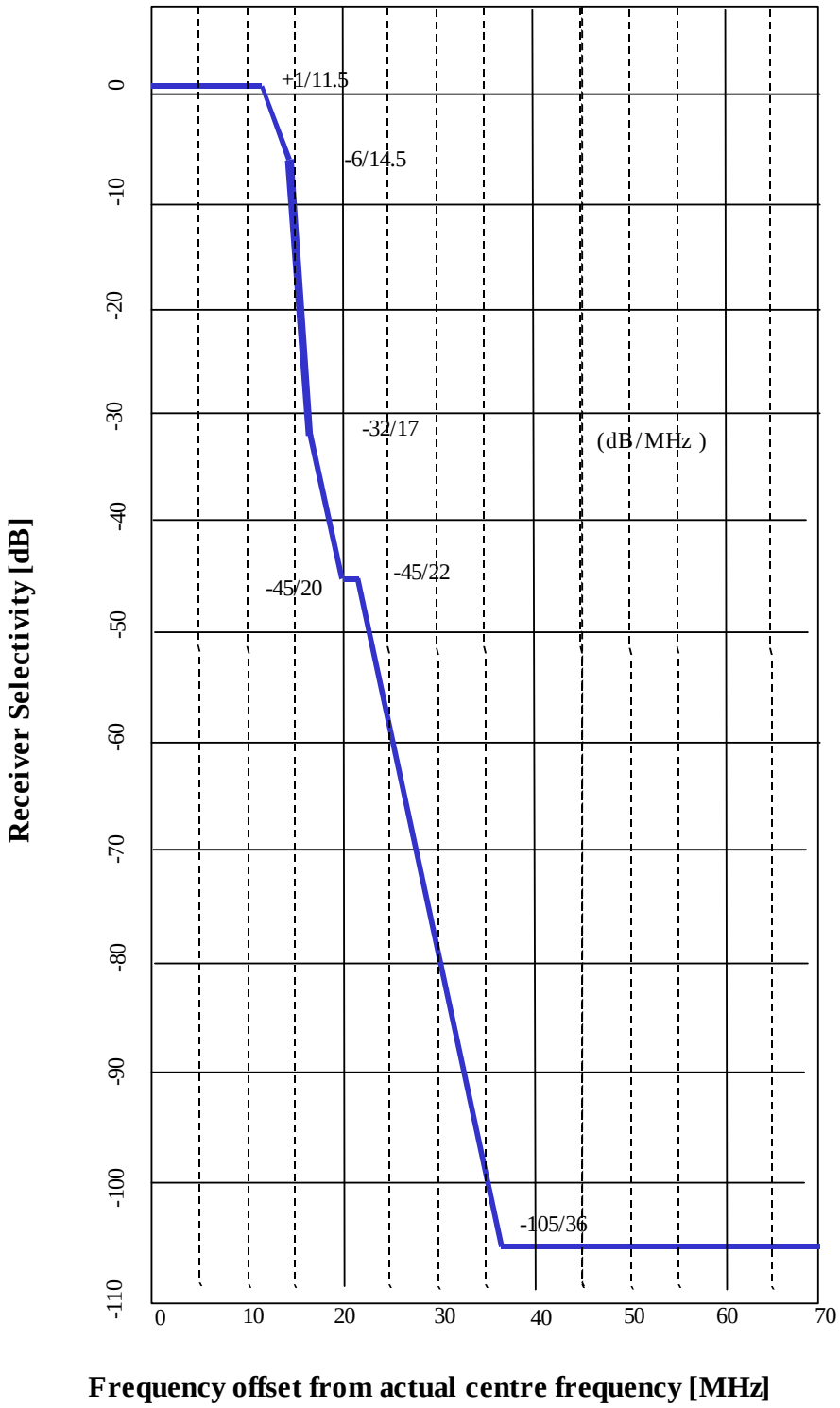

Figure 4: Limits for the receiver selectivity for the inner edges of the innermost channels in the 6L GHz band

Annex A (normative): Requirements and Measurement test set

A.1 Branching, Feeder and Antenna Requirements

The parameters and values specified in subclause 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>= 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

Not less than 24 dB at the feeder flange (points C and C') with antenna connected.

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	14

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.

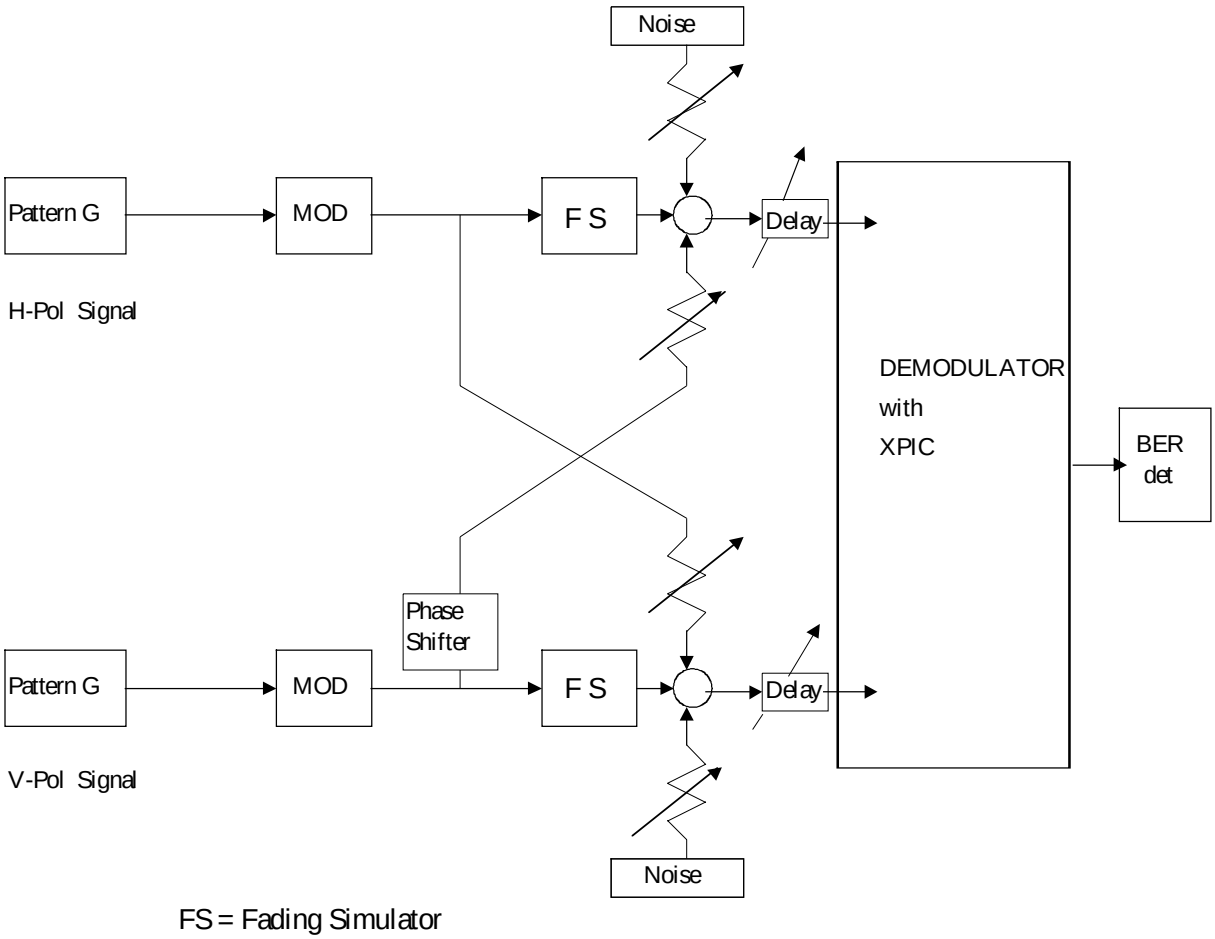

Figure A.1: Measurement test set

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.

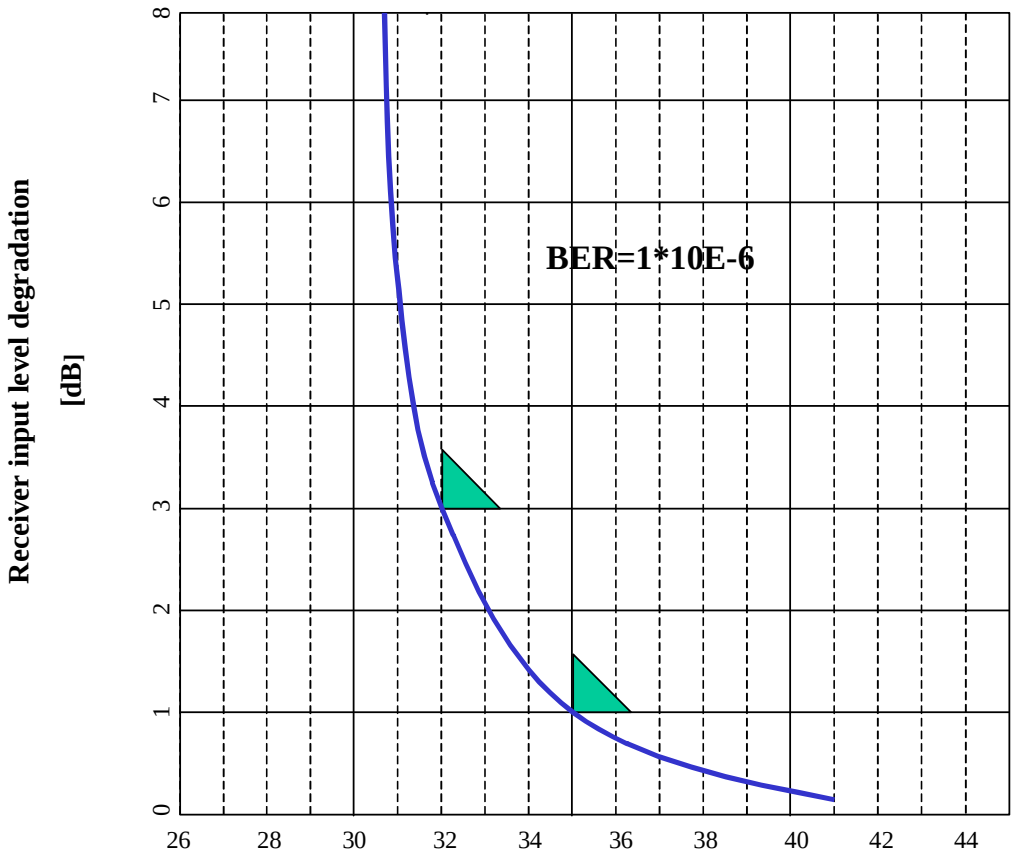

Figure B.1: Co-channel digital "external" interference sensitivity mask

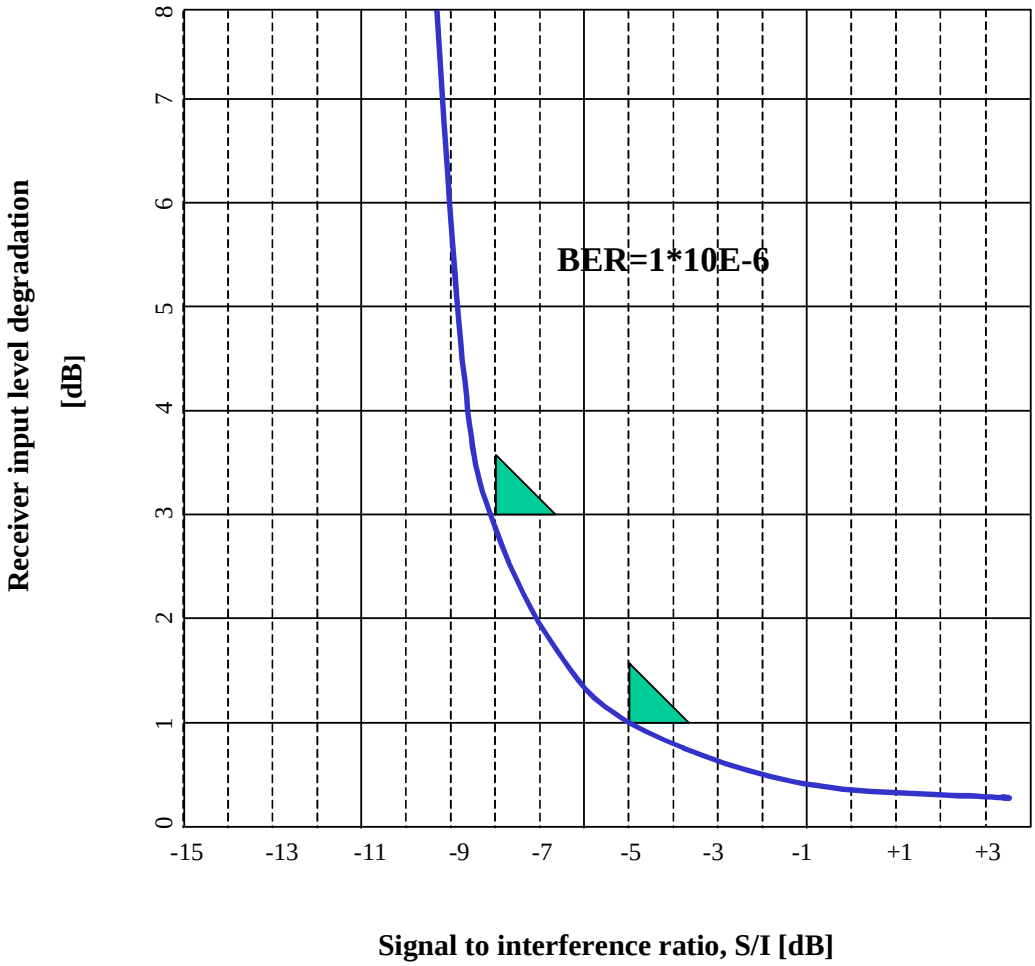

Figure B.2: Adjacent-channel digital interference sensitivity mask

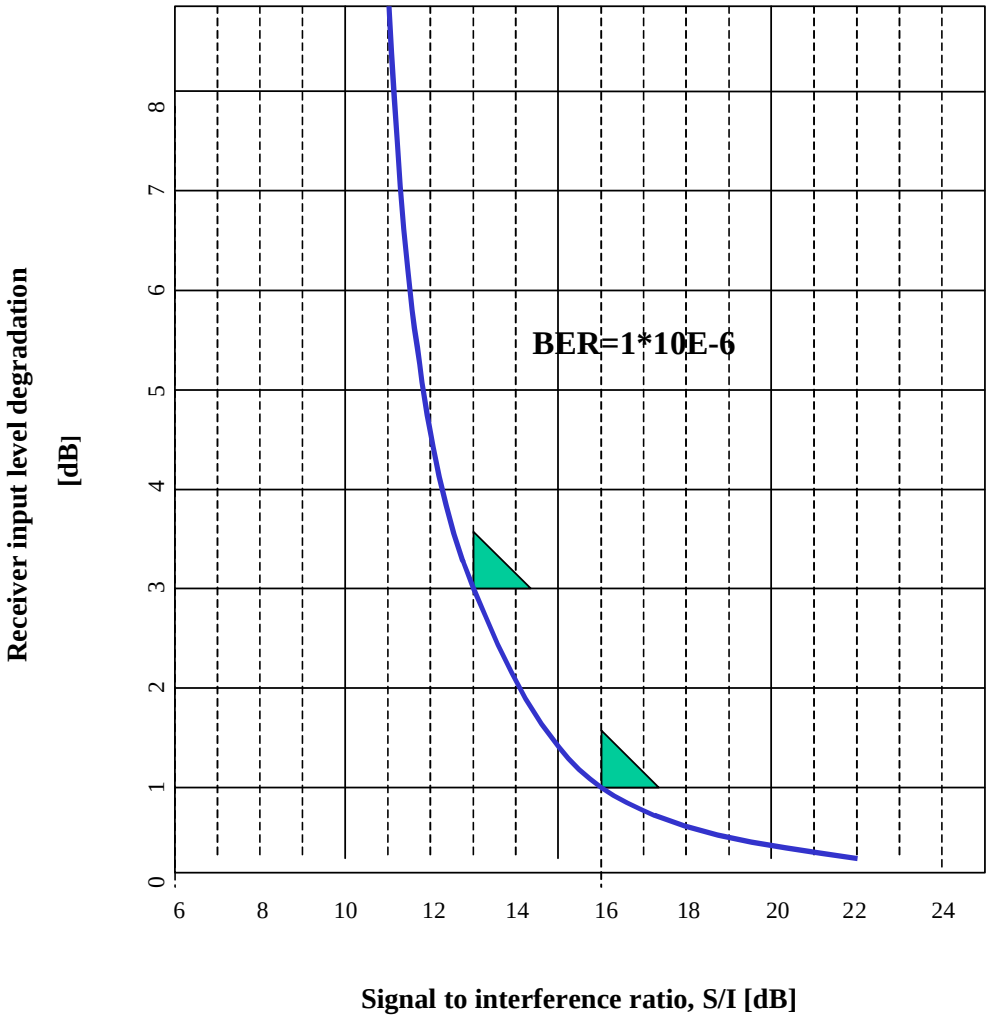

Figure B.3: Co-channel "internal" digital interference sensitivity limits in cross-polar application (referred to point B')

History

Document history			
V1.1.1	September 1999	Public Enquiry	PE 9959: 1999-09-15 to 2000-01-14
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