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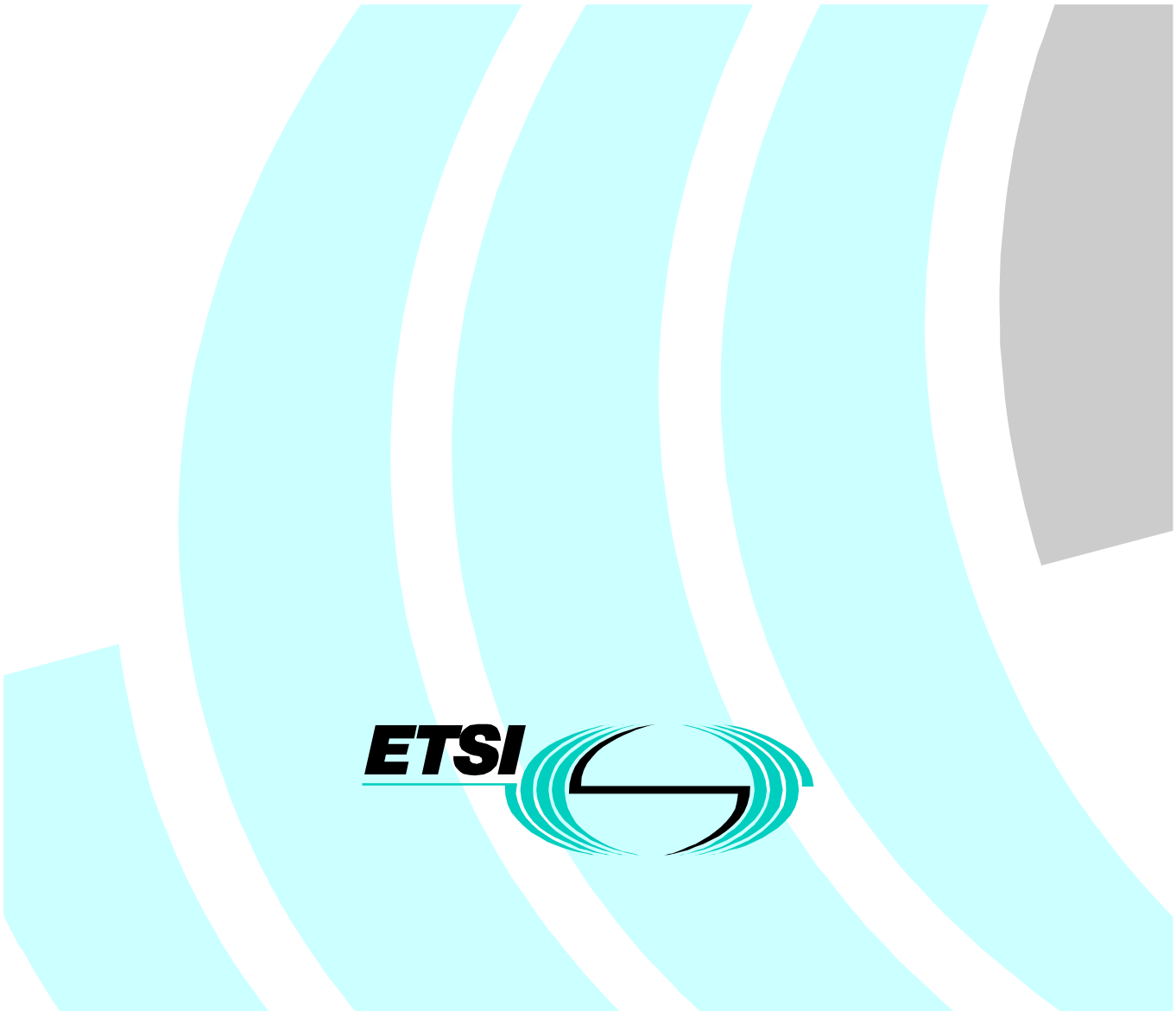
*European Standard (Telecommunications series)*

**Fixed Radio Systems;**
**Point-to-point equipment;**
**High capacity fixed radio systems carrying SDH signals (2 x STM-1) in frequency bands with 40 MHz channel spacing and using Co-channel Dual Polarized (CCDP) operation**



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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); High Capacity Digital Radio Relay Systems Carrying SDH Signals (2 x STM-1) Using Co-Channel Dual Polarized (CCDP) Operation in Frequency Bands with 40 MHz Channel Separation".

| **National transposition dates** | |
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| Date of adoption of this EN: | 16 February 2001 |
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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 40 MHz channel spacing in the 4 GHz, 5 GHz, U6 GHz and 11 GHz bands, by using both polarizations in the co-channel dual polarized (CCDP) mode of operation. The channel capacity shall be 1 x STM-1 on each polarization, that allows the transmission of two STM-1 signals, in the same frequency band.

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 should 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 allow operation with respect to existing PDH systems using 16 QAM modulation and transmitting 140 Mbit/s applying a channel spacing of 40 MHz.

The parameters specified fall into two categories:

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

NOTE: 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.

Baseband interfaces have to be considered for STM-1 signals in accordance with ITU-T Recommendations G.707 [1] and G.957 [2]. PDH interfaces according to ITU-T Recommendation G.703 [3] for signals mapped into STM-1 signals according to ITU-T Recommendation G.707 [1] could be used.

Safety aspects will not be considered in the present document.

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

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

[3] ITU-T Recommendation G.703 (1998): "Physical/electrical characteristics of hierarchical digital interfaces".

[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] ITU-R Recommendation F.635-5: "Radio-frequency channel arrangements based on a homogeneous pattern for radio-relay systems operating in the 4 GHz band".

[6] ITU-R Recommendation F.1099-3: "Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4 400 MHz to 5 000 MHz) band".

[7] CEPT/ERC Recommendation 14-02: "Radio-frequency channel arrangements for medium and high capacity analogue or high capacity digital radio-relay systems operating in the band 6 425 MHz to 7 125 MHz".

[8] ITU-R Recommendation F.384-7: "Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band".

[9] CEPT/ERC Recommendation 12-06: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10,7 GHz to 11,7 GHz".

[10] ITU-R Recommendation F.387-8: "Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band".

[11] ITU-T Recommendation G.826 (1999): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[12] ITU-T Recommendation G.827 (2000): "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".

[13] 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".

[14] ITU-R Recommendation F.557-4: "Availability objective for radio-relay systems over a hypothetical reference circuit and a hypothetical reference digital path".

[15] 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 hypothethical reference path".

[16] 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".

[17] ITU-R Recommendation F.752-1: "Diversity techniques for radio-relay systems".

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

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

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

[21] ETSI ETS 300 119 (all parts): "Equipment Engineering (EE); European telecommunication standard for equipment practice".

[22] 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".

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

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

[25] ETSI EN 300 417-7-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 7-1: Equipment management and auxiliary layer functions".

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

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

[28] ITU-T Recommendation G.784 (1999): "Synchronous digital hierarchy (SDH) management".

[29] IEC 60154 (all parts): "Flanges for waveguides".

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

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

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

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

[34] ITU-T Recommendation O.181 (1996): "Equipment to assess error performance on STM-N interfaces".

[35] CEPT/ERC Recommendation 74-01: "Spurious emissions".

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

[37] ITU-R Recommendation F.1191-1: "Bandwidths and unwanted emissions of digital radio-relay systems".

[38] 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".

[39] ETSI TR 101 036-1: "Fixed Radio Systems; Point-to-point equipment; Generic wordings for standards on digital radio systems characteristics; Part 1: General aspects and point-to-point equipment parameters".

# 3 Symbols and abbreviations

## 3.1 Symbols

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

| | |
|---|---|
| dB | deciBel |
| dBm | deciBel relative to 1 mW |
| GHz | GigaHertz |
| Hz | Hertz |
| kHz | kiloHertz |
| km | kilometer |
| Mbit/s | Megabits per second |
| MHz | MegaHertz |
| ns | nanosecond |
| ppm | part per million |

## 3.2 Abbreviations

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

| | |
|---|---|
| ATPC | Automatic Transmit Power Control |
| BBER | Background Block Error Rate |
| BER | Bit error rate |
| CCDP | Co-Channel Dual Polar |
| CMI | Coded Marked Inverted |
| CS | Channel Spacing |
| CSmin | minimum practical Channel Separation (for a given radio-frequency channel arrangement) |
| CW | Continuous Wave |
| DC | Direct Current |
| EMC | Electro Magnetic Compatibility |
| Fc | Cut-off Frequency |
| IF | Intermediate Frequency |
| IPI | Inter Port Isolation |
| LO | Local Oscillator |
| NFD | Net Filter Discrimination |
| PDH | Plesiochronous Digital Hierarchy |
| PRBS | Pseudo Random Bit Sequence |
| QAM | Quadrature Amplitude Modulation |
| RCSOH | Radio Complementary Section Overhead |
| RF | Radio Frequency |
| RL | Return Loss |
| RSL | Receive Signal Level |
| RX | Receiver |
| S/I | Signal to Interference Ratio |
| SOH | Section OverHead |
| S/XPI | Signal to Cross Polar Interference ratio |
| SDH | Synchronous Digital Hierarchy |
| STM | Synchronous Transfer Module |
| TMN | Telecommunications Management Network |
| TX | Transmitter |
| XPD | Cross Polar Discrimination |
| XPI | Cross Polar Interference |
| XPIC | Cross Polar Interference Canceller |

# 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 frequency range is 3,6 GHz to 4,2 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 12-08 [4], annex A, Part 1 or ITU-R Recommendation F.635-5 [5], with 40 MHz channel spacing. The centre gap is 80 MHz.

**5 GHz**

The frequency range is 4,4 GHz to 5 GHz. The channel plan shall be in accordance with ITU-R Recommendation F.1099-3 [6] with 40 MHz channel spacing. The centre gap is 60 MHz.

**U6 GHz**

The frequency range is 6 425 GHz to 7 110 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 14-02 [7] or ITU-R Recommendation F.384-7 [8] with 40 MHz channel spacing. The centre gap is 60 MHz.

**11 GHz**

The frequency range is 10,7 GHz to 11,7 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 12-06 [9] or ITU-R Recommendation F.387-8 [10] with 40 MHz channel spacing. The centre gap is 130 MHz, 90 MHz or 50 MHz according to the frequency arrangement.

NOTE: With a frequency arrangement providing a central gap of 50 MHz, common TX/RX operation of the nearest channels is not required.

## 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 must 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 other solutions) additional losses ranging from 3 dB to 6 dB must 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 must 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 Error performance and availability requirements

Equipment shall be designed in order to meet network error performance and availability requirements foreseen by ITU-T Recommendations G.826 [11] and G.827 [12] following the criteria defined in ITU-R Recommendations F.695 [13], F.557-4 [14], F.1092-1 [15] and F.1189-1 [16] 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.752-1 [17], F.1093-1 [18], F.1101 [19], F.1092-1 [15] and F.1189-1 [16] 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 [20] 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 [20] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [20] 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 [20], 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 [21].

Other mechanical arrangement which can be made compatible with ETS 300 119 [21] 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 [22] and ETS 300 132-2 [23].

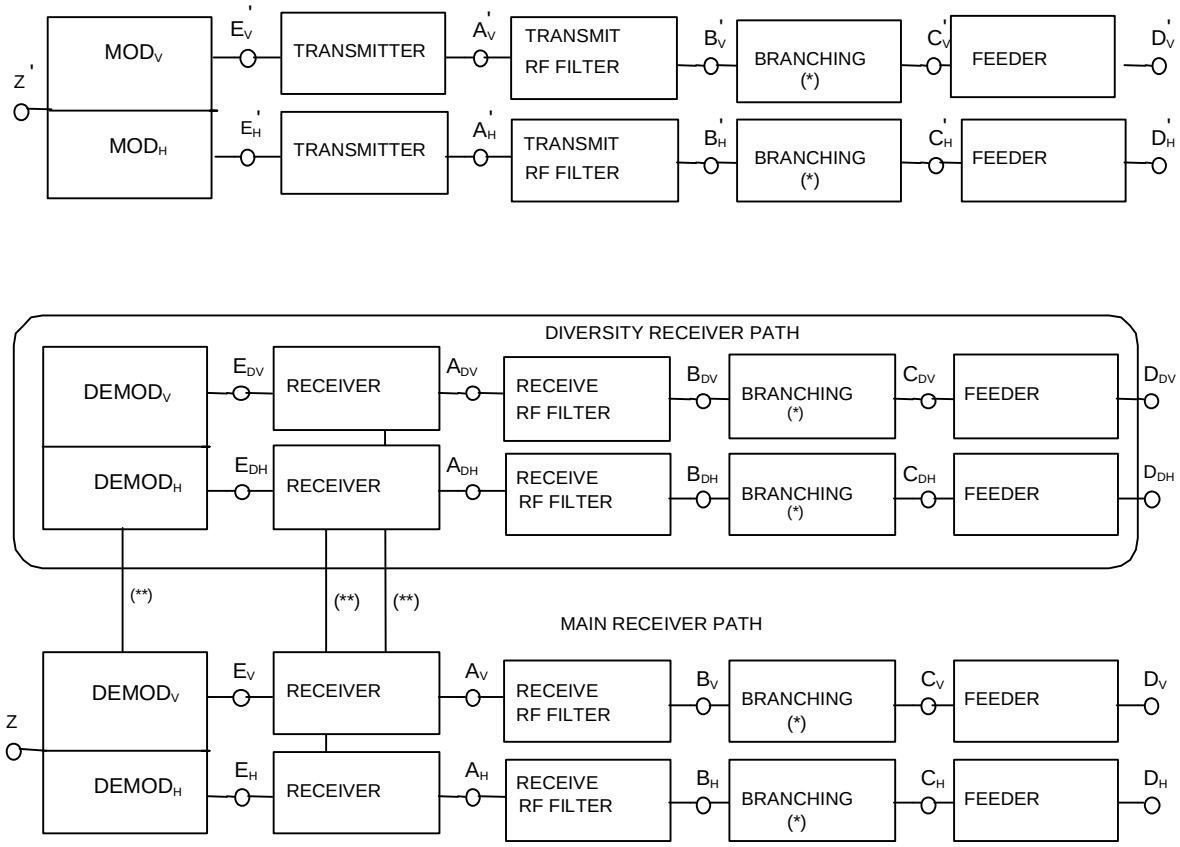
NOTE: Some applications may require secondary voltages that are not covered by ETS 300 132-1 [22] and ETS 300 132-2 [23].

For DC systems, the positive pole of the voltage supply shall be earthen at the source.

## 4.8 Electromagnetic compatibility

Equipment shall operate under the conditions specified in EN 300 385 [24].

## 4.9 Block diagram




(*) No filter included.
(**) Connection at if or Baseband.
NOTE 1: A 2 x STM-1 or 2 x 140 Mb/S interface is used at Z and Z'.
NOTE 2: For the purpose of defining the measurement points, the branching network does not include a hybrid.
NOTE 3: The points shown above are reference points only; points C and C', D and D' in general coincide.
NOTE 4: Points B and C, B' and C' may coincide when simple duplexer is used.
NOTE 5: Diversity is an optional feature.

**Figure 1: Block Diagram**

## 4.10 TMN interface

Where provided, TMN interface shall follow relevant ITU-T and ITU-R Recommendations, and ENs/ETSs.

NOTE: The standardization of TMN interface functionalities is under responsibility and development in ETSI TC TMN (formerly in TM2), and will be applicable to the radio relay systems considered in the present document.

The management requirements (i.e. fault management, performance management, etc.) shall be compliant with the specification for a STM-1 rate defined in EN 300 417-7-1 [25], EN 301 167 [26] and in ITU-T Recommendations G.783 [27] and G.784 [28].

# 4.11 Branching feeder and antenna requirements

## 4.11.1 Antenna radiation pattern

The radiation pattern shall be in accordance with EN 300 833 [38]. See also annex A, clause A.1.

## 4.11.2 Antenna cross-polar discrimination

The cross polarization discrimination shall be in accordance with EN 300 833 [38]. See also annex A, clause A.1.

## 4.11.3 Antenna inter-port isolation (IPI)

See annex A, clause A.1.

## 4.11.4 Waveguide flanges

If a waveguide flange is used at point C/C', the following type shall be used in accordance with IEC 60154 [29].

**Table 1: RF Waveguide Interfaces**

| Frequency band | Waveguide flange |
|---|---|
| 4 GHz | UDR/UBR/PBR/CBR 40 |
| 5 GHz | UDR/UBR/PBR/CBR 48 |
| U6 GHz | UDR/UBR/PBR/CBR 70 |
| 11 GHz | UDR/PDR/CDR 100 UBR/PBR/CBR 100<br>UDR/PDR/CDR/120 UBR/PBR/CBR 120 |

## 4.11.5 Return loss (RL)

The minimum return loss of the branching system shall be 24 dB for indoor systems and 20 dB for partially outdoor systems. The measurement shall be referred to reference point C/C' towards the radio equipment and across a frequency band greater than or equal to 1,3 times the maximum symbol frequency foreseen for the equipment.

For feeder/antenna RL information see annex A, clause A.1.

## 4.11.6 Intermodulation products

Each intermodulation product caused by different transmitters linked to the same antenna should be less than -110 dBm referenced to point C with an output power relevant to the Ranges A to D (table 2) per transmitter.

# 5 Parameters for digital systems

## 5.1 Transmission capacity

The transmission capacities considered in the present document are: 2 x STM-1 (311,04 Mbit/s) and 2 x 139 264 Mbit/s in a 40 MHz RF channel using CCDP operation.

## 5.2 Baseband Parameters

### 5.2.1 Plesiochronous interfaces

The PDH interfaces at 140 Mbit/s may be used. They shall be compliant with ITU-T Recommendation G.703 [3]. 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 STM-1 signal as described in ITU-T Recommendation G.707 [1].

Parameters for service channels and wayside traffic channels are outside the scope of the present document.

### 5.2.2 SDH baseband interface

The SDH baseband interface shall be in accordance with ITU-T Recommendations G.703 [3], G.707 [1], G.783 [27], G.784 [28] and G.957 [2], and ETS 300 635 [30].

Two STM-N interfaces are possible:

- STM-N optical interface (ITU-T Recommendation G.957 [2]);
- STM-1 CMI electrical interface (ITU-T Recommendation G.703 [3]).

The use of reserved bytes contained in the SOH, and their termination shall be in accordance with ITU-R Recommendation F.750-3 [31]. Further details on the possible use of the SOH bytes including additional RFCOH or RCSOH are given in ETSI TM4 document TR 101 035 [32].

## 5.3 Transmitter characteristics

The specified transmitter characteristics shall be met with the appropriate baseband signals applied at reference points Z' of figure 1. For PDH interfaces this shall be a PRBS in accordance with ITU-T Recommendation O.151 [33], for SDH interfaces this shall be in accordance with ITU-T Recommendation O.181 [34].

### 5.3.1 Transmitter Power Range

The value of the nominal output power referred to point B' should be in the ranges shown in the table 2 not including the ATPC.

**Table 2: TX output power**

| | P | P |
|---|---|---|
| **Range A** | +21 dBm | +26 dBm |
| **Range B** | +26 dBm | +31 dBm |
| **Range C** | +31 dBm | +34 dBm |
| **Range D** | +34 dBm | +38 dBm |
| NOTE: Equipment of different output power ranges are not considered to require individual type approval. However this is subject to individual national agreement. | | |

### 5.3.2 Automatic Transmit Power Control

ATPC is an optional feature.

The manufacturer shall declare if the equipment is designated with ATPC as a fixed permanent feature.

If implemented, the ATPC range shall not be less than 10 dB.

NOTE: For hop lengths of more than about 35 km an ATPC device with a range of more than 20 dB may be required for use on the same polarization on different antennas on the same route.

Equipment with ATPC will be subject to Manufacturer declaration of ATPC range and related tolerances.

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

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

Further information on ATPC is given in annex A, clause A.2.

### 5.3.3 Transmitter Output Power Tolerance

The tolerance of the nominal output power shall be within:

- nominal output power ±2 dB for systems operating within non-weather protected locations;
- nominal output power ±1 dB for systems operating within weather protected locations.

### 5.3.4 TX local oscillator frequency arrangements

There shall be no requirement on transmitter LO frequency arrangement.

### 5.3.5 RF Spectrum Mask

The spectrum masks are shown in figure 3.

The 0 dB level shown on the spectrum masks relates to the spectral power density of the actual centre frequency disregarding residual carrier.

The masks do not include frequency tolerance.

The masks given in figure 3 fix a lower limit of -95 dB in order to control local interference between transmitters and receivers on same polarization.

Since, for spectrum analyser distortion and sensitivity limits, it is not possible to measure attenuation values up to -95 dB, values above 65 dB should be verified by adding a measured filter characteristic to the spectrum measured at reference point A'.

The spectrum analyser settings for measuring the RF spectrum mask detailed in figure 3 are shown in table 3.

**Table 3: Spectrum Analyser Settings for RF Power Spectrum Measurement**

| Parameter | Setting |
|---|---|
| RF Centre Frequency | Spectrum Centre |
| Amplitude Scale | 10 dB/div |
| IF Bandwidth | 100 kHz |
| Sweep Width | 100 MHz |
| Scan Time | Automatic |
| Video Bandwidth Filter | 100 Hz |

## 5.3.6 Discrete CW lines exceeding the spectrum mask limit

### 5.3.6.1 Spectral lines at the symbol rate

The power level (Reference point B') of spectral lines at a distance from the channel frequency equal to the symbol rate shall be less than -37 dBm.

### 5.3.6.2 Other spectral lines

In case some CW components exceed the spectrum mask, an additional allowance is given.

Those lines shall not:

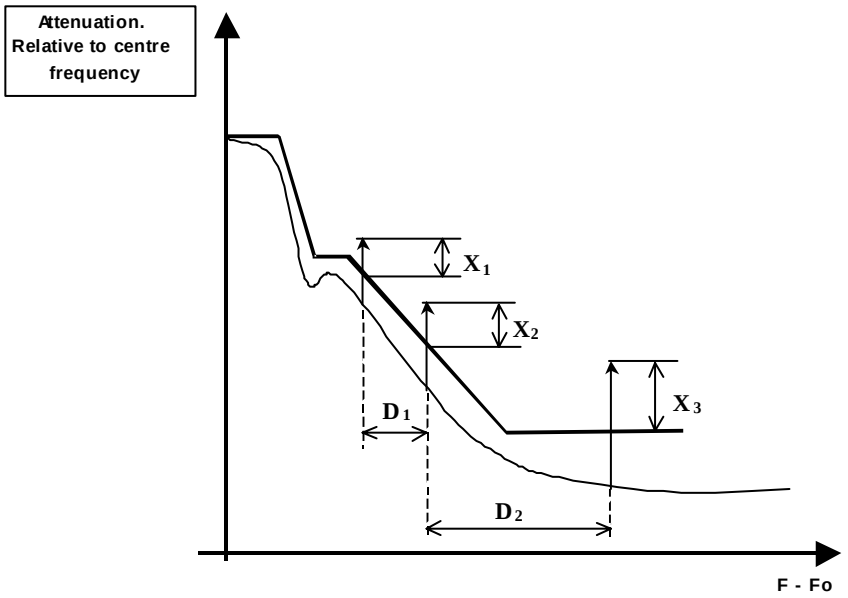
- exceed the mask by a factor more than {10 log (CSmin/IFbw) - 10} dB;
- be spaced each other in frequency by less than CSmin.

Where:

CSmin = 10 000 kHz for 4 GHz, 5 GHz, U6 GHz and 11 GHz bands.

IFbw is the recommended resolution bandwidth, expressed in kHz, reported in table 3.

Figure 2 shows a typical example of this requirement.




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

$D_1, D_2 \geq$ CSmin

**Figure 2: CW lines exceeding the spectrum mask (typical example)**

### 5.3.7 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 [35] based on ITU-R Recommendations SM.329-7 [36] and F.1191-1 [37];

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 where the specific limits given for 'internal' interference are required to be no greater than the 'external' level limits at reference point B' for indoor systems and C' for outdoor systems (where a common TX/RX duplexer is used).

#### 5.3.7.1 Spurious emissions - external

According to CEPT/ERC Recommendation 74-01 [35] 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 [35] together with the frequency range to consider for conformance measurement, shall apply.

#### 5.3.7.2 Spurious emissions - internal

Being the requirement to multiplex equipment from different manufacturers on different polarization of the same antenna, the levels of the spurious emissions from the transmitter, referenced to reference point C' are specified in table 4.

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

**Table 4: Internal levels for the transmitter spurious consideration**

| 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 |

### 5.3.8 Radio frequency tolerance

Maximum radio frequency tolerance shall not exceed ±30 ppm. These limits include both short-term factors (environmental effects) and long-term ageing effects.

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

## 5.4 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 XPIC.

The system shall operate loaded with 2 x STM-1 signals at the baseband interfaces. The BER shall be measured on anyone of the STM-1 signals.

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

For receiver operation under XPI-conditions see clause 5.6.

### 5.4.1 Input Level Range

The input level range for a BER < $10^{-3}$ shall extend from the upper limit of -17 dBm to the limit specified for BER = $10^{-3}$ in clause 5.5.1.

The input level range for a BER < $10^{-10}$ shall extend from the upper limit of -21 dBm to the limit specified for BER = $10^{-10}$ in clause 5.5.1.

For systems which are required to operate only with ATPC enabled on a permanent basis, the maximum input level for BER @ $10^{-3}$ and BER @ $10^{-10}$ may be relaxed to -27 dBm and -31 dBm respectively.

These limits apply without interference and are referenced to point B of figure 1.

### 5.4.2 RX local oscillator frequency arrangements

There shall be no requirement on receiver LO frequency arrangement.

### 5.4.3 Spurious emissions

#### 5.4.3.1 Spurious emissions - external

At reference point C, the limit values of CEPT/ERC Recommendation 74-01 [35] shall apply.

#### 5.4.3.2 Spurious emissions - internal

Spurious emissions which fall within receivers half band shall be:

< -105 dBm, for systems with multichannel branching networks.

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 networks (i.e. single transceiver with duplexer) there will be no requirement.

### 5.4.4 Receiver image rejection

If applicable, 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.

## 5.5 System Performance without diversity

All parameters are referred to reference point B or C of figure 1. Losses in RF couplers used for protected systems are not taken into account.

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

### 5.5.1 BER as a function of receiver input signal level RSL

Receiver BER thresholds (dBm) referred to reference point C (for systems with simple duplexer) or B (for system with multi-channel branching system) of the System Block Diagram (figure 1) for BER of $10^{-3}$, $10^{-6}$ and $10^{-10}$ shall be equal to or lower than those stated in table 5 (These levels do not include any hybrid loss). The values of table 5 shall be measured with the same input level on both polarizations.

**Table 5: BER performance thresholds**

| Frequency | RSL @ 4 GHz, 5 GHz and U6 GHz | RSL @ 11 GHz |
|---|---|---|
| **BER** | | |
| **$10^{-3}$** | -73 dBm | -71,5 dBm |
| **$10^{-6}$** | -69 dBm | -67,5 dBm |
| **$10^{-10}$** | -65 dBm | -63,5 dBm |
| NOTE: These limits are required when the connection to the same antenna port of even and odd channels, spaced about 40 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. | | |

### 5.5.2 Equipment residual BER

Equipment residual BER is measured under simulated conditions over an artificial hop with a signal level at point B (or C) which is between 15 dB and 40 dB above the lower level which gives BER = $10^{-3}$ and with less than 5 dB difference between the two polarizations. In a measurement period of 24 hours the number of bit errors should be less than 10 (BER $\leq 10^{-12}$).

### 5.5.3 Interference Sensitivity

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

#### 5.5.3.1 Co-channel "external" interference sensitivity

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

The limits of the co-channel interference sensitivity shall be as given in table 6a, giving maximum S/I values for 1 dB and 3 dB degradation of the $10^{-6}$ BER limit specified in clause 5.5.1 above.

**Table 6a: Degradation versus S/I in co-channel "external" interference**

| **Reference BER** | $10^{-6}$ | $10^{-6}$ |
|---|---|---|
| **RSL Degradation** | 1 dB | 3 dB |
| **S/I (dB)** | 33 | 29 |

For frequency coordination purpose intermediate values may be found in the curve supplied in informative annex A. Values are indicative.

#### 5.5.3.2 Adjacent Channel interference sensitivity

The limits of the adjacent channel interference sensitivity shall be as given in table 6b for like modulated signals spaced of 1 channel spacing, giving maximum S/I values for 1 dB and 3 dB degradation of the $10^{-6}$ BER limits specified in clause 5.5.1.

**Table 6b: 1st Adjacent Channel Interference Sensitivity**

| **Reference BER** | $10^{-6}$ | $10^{-6}$ |
|---|---|---|
| **RSL Degradation** | 1 dB | 3 dB |
| **S/I (dB)** | -4 | -8 |
| NOTE: To cope with different 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 performance prediction is under study. | | |

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

#### 5.5.3.3 CW interference

For a receiver operating at the $10^{-6}$ BER threshold given in table 8, the introduction of a CW interferer at a certain level specified below, with respect to the wanted signal and at any frequency in the range 9 kHz to the 3rd harmonic of the receiver operating frequency, excluding frequencies either side of the wanted centre frequency of the RF channel by up to 250 % the channel spacing, shall not result in a BER greater than $10^{-5}$.

The level of the CW interferer shall be: +30 dB.

NOTE: When waveguide is used between ref. points A and C, which length is higher than twice the free space wavelength of the cut-off frequency (Fc), the lower limit of measurement will be increased to 0,7 Fc and to 0,9 Fc when the length is higher than 4 times the same wavelength.

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.

### 5.5.4 Distortion sensitivity

For a delay of 6,3 ns and a BER of $10^{-3}$ the width of the signature should not exceed ±17 MHz relative the channel assigned frequency and the depth should not be less than 18 dB.

For a delay of 6,3 ns and a BER of $10^{-6}$ the width of the signature should not exceed ±19 MHz relative the channel assigned frequency and the depth should not be less than 16 dB.

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

The limits specified should 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 = $10^{-3}$ the notch depth should not be less than 17 dB (sweeping in ± half channel spacing);

- for a notch speed up to 100 MHz/s and a BER = $10^{-6}$ the notch depth should not be less than 15 dB (sweeping in ± half channel spacing).

## 5.6 Cross Polar Interference Sensitivity

This clause covers specific aspects of the performance of the system in presence of cross polarization interference not covered in the previous ones. See annex A, clause A.6 for the measurement test set.

### 5.6.1 Co-channel "internal" interference sensitivity in flat fading conditions

The following specifications applies to "internal" interferer from the cross polarized channel of the same system.

For the frequency bands given under clause 5.1 the limits of the co-channel interference sensitivity for the system shall be as given in table 7.

**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)** | 17 | 13 |

For frequency coordination purpose intermediate values may be found in the curve supplied in annex A. Values are indicative.

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

### 5.6.2 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.

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 8.

**Table 8: Degraded signature vs. XPI**

| **S/XPI [dB]** | **Signature Width [MHz]** | **Signature Depth [dB]** |
|---|---|---|
| 15 | ±23 | 10 |

## 5.7 System characteristics with diversity

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

### 5.7.1 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 75 ns of differential absolute delay.

### 5.7.2 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 shall be lower than those given under clause 5.5.1 for the case without diversity:

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

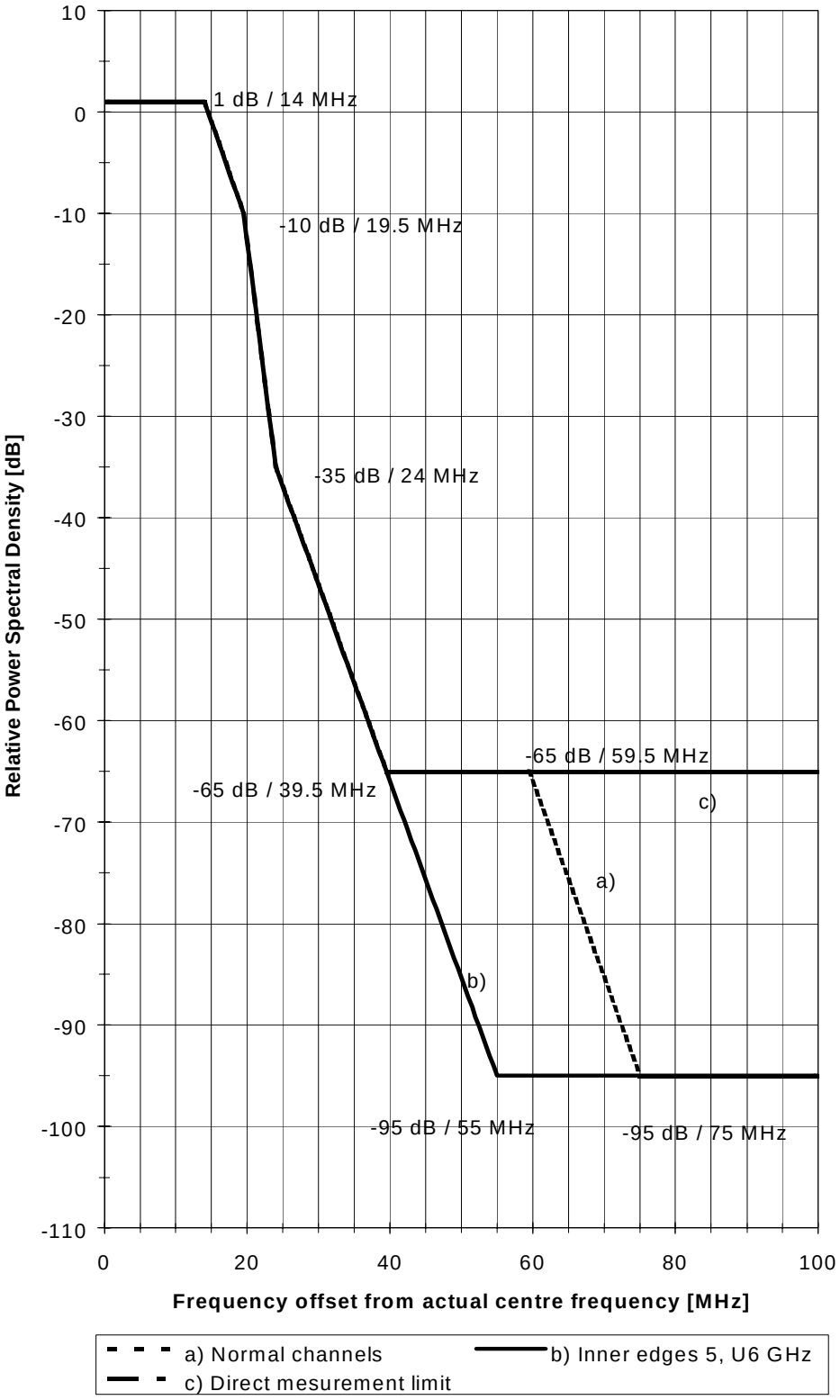



**Figure 3: Limits of power spectral density**

# Annex A (informative): Additional Information

## A.1 Antenna requirements

NOTE: The assumptions in this annex refer to EN 300 833 [38].

### A.1.1 Antenna radiation patterns

For equipment on which the antenna forms an integral part, the radiation pattern should be in accordance with EN 300 833 [38].

### A.1.2 Antenna cross-polar discrimination (XPD)

Under normal unfaded propagation conditions the antenna XPD value shall be considered as not less than 28 dB.

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

### A.1.3 Antenna inter-port isolation (IPI)

Compatibility criteria of innermost cross polarized TX and RX equipment will be guaranteed with an IPI not less than 40 dB.

### A.1.4 Feeder/antenna return loss

The minimum return loss of the feeder/antenna system connected to indoor systems should be considered not less than 24 dB. The measurement are referred to reference point C/C' towards the antenna.

## A.2 Automatic Transmit Power Control

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 during flat fading attenuation conditions.

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.

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

# A.3 Spectrum masks

The spectrum masks given in figure 3 cannot be used for the direct evaluation of the Net Filter Discrimination (NFD) with respect to an adjacent channel spaced 40 MHz apart.

The required NFD can be derived as the difference between the co-channel interference (stated in clause 5.5.3.1 table 6a: Co-channel external interference sensitivity) and the measured value of the adjacent interference sensitivity S/I referred to the same bit error ratio. This procedure is stated in ETSI document TR 101 036-1 [39].

# A.4 Co-channel (internal and external) and adjacent channel interference

The reference performance for co-channel (internal and external) and adjacent channel S/I, spaced by one channel spacing, is shown in figures A.1, A.2 and A.3.

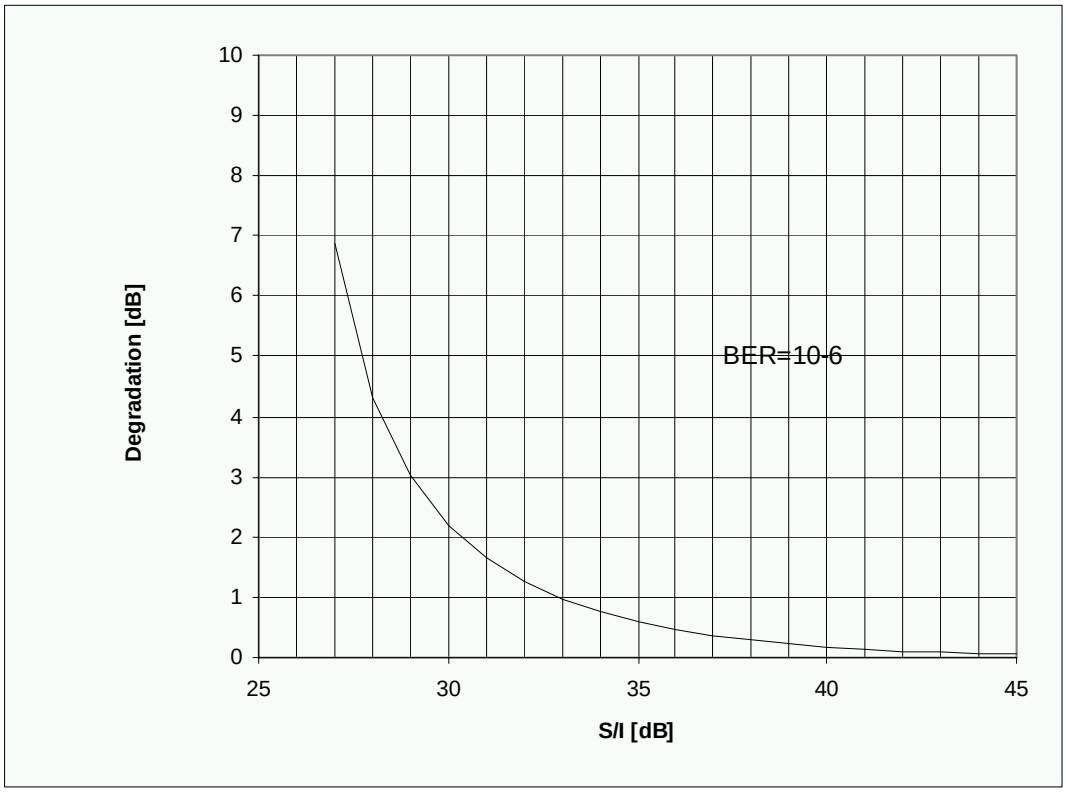



**Figure A.1: Co-channel (external) interference threshold degradation referenced at point B (or C)**

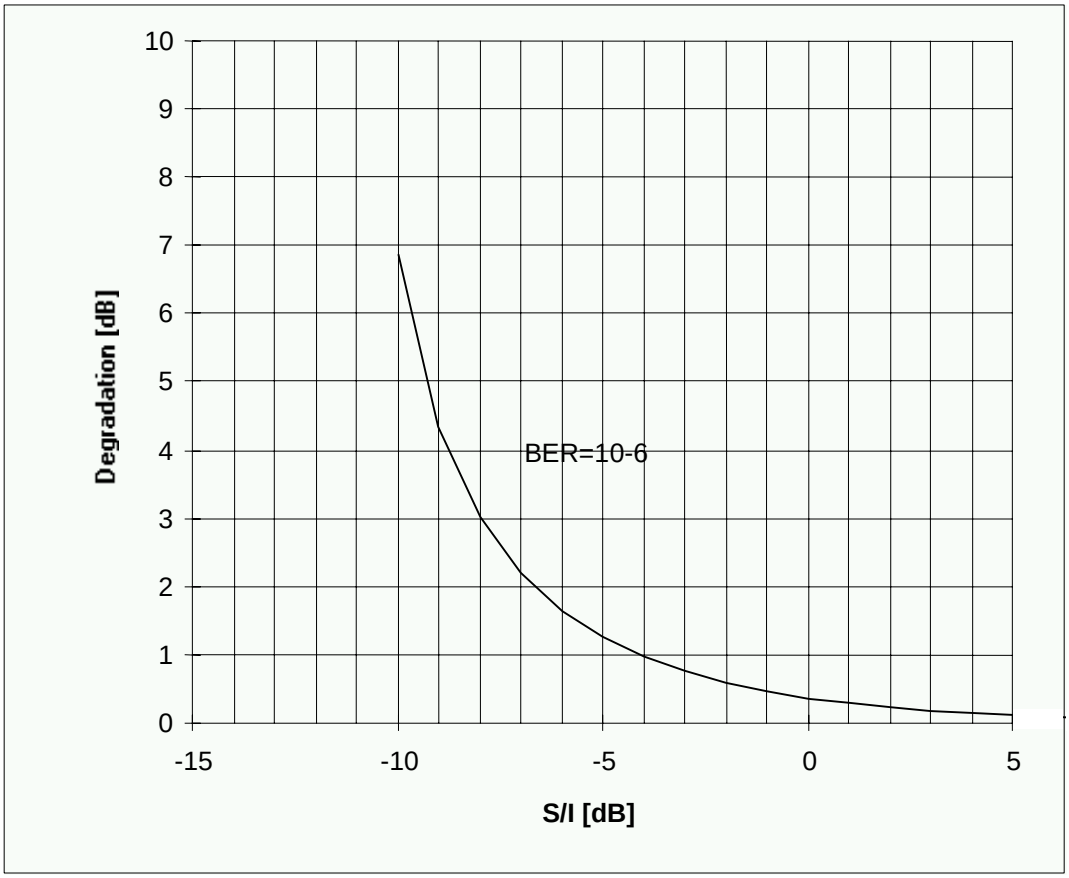



**Figure A.2: Adjacent channel interference threshold degradation referenced at point B (or C)**

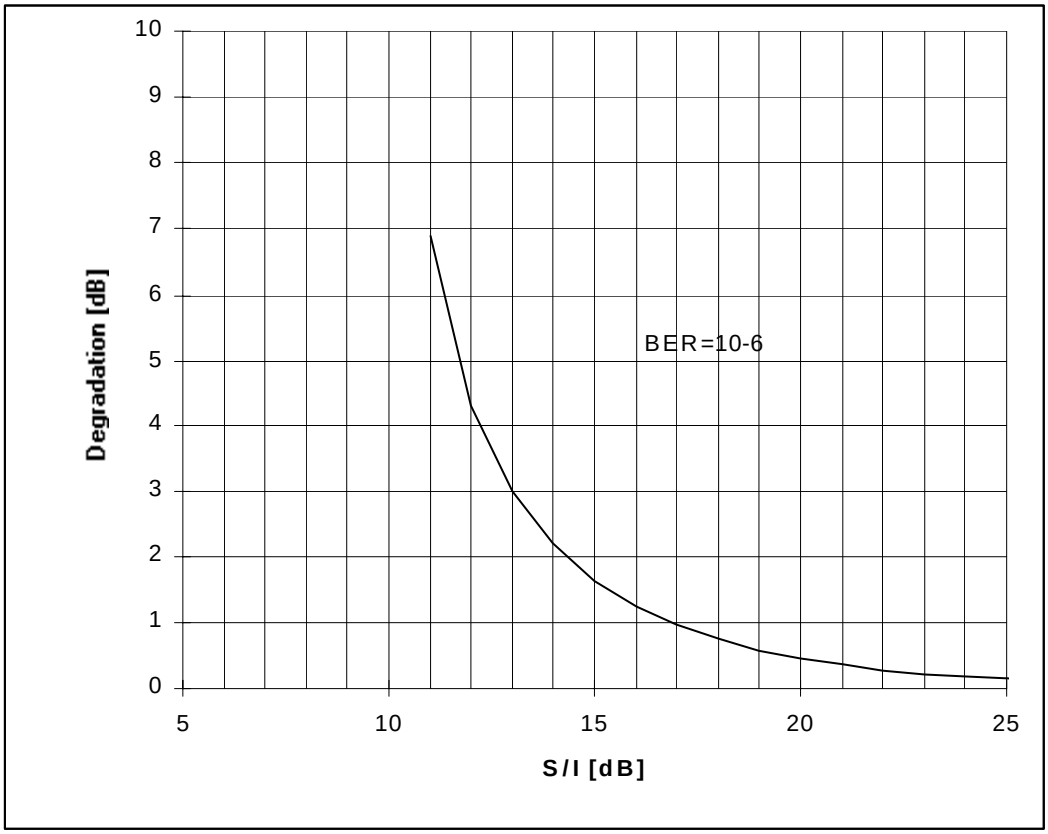



**Figure A.3: Co-channel (internal) interference threshold degradation referenced at point B (or C)**

## A.5 Lightning protection

Lightning discharge protection may be applied at the relevant points of the indoor and outdoor equipment to safeguard against damage. Detailed requirements for lightning protection are under study.

# A.6 Measurement test set for XPI characteristics

We define in figure A.4 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.

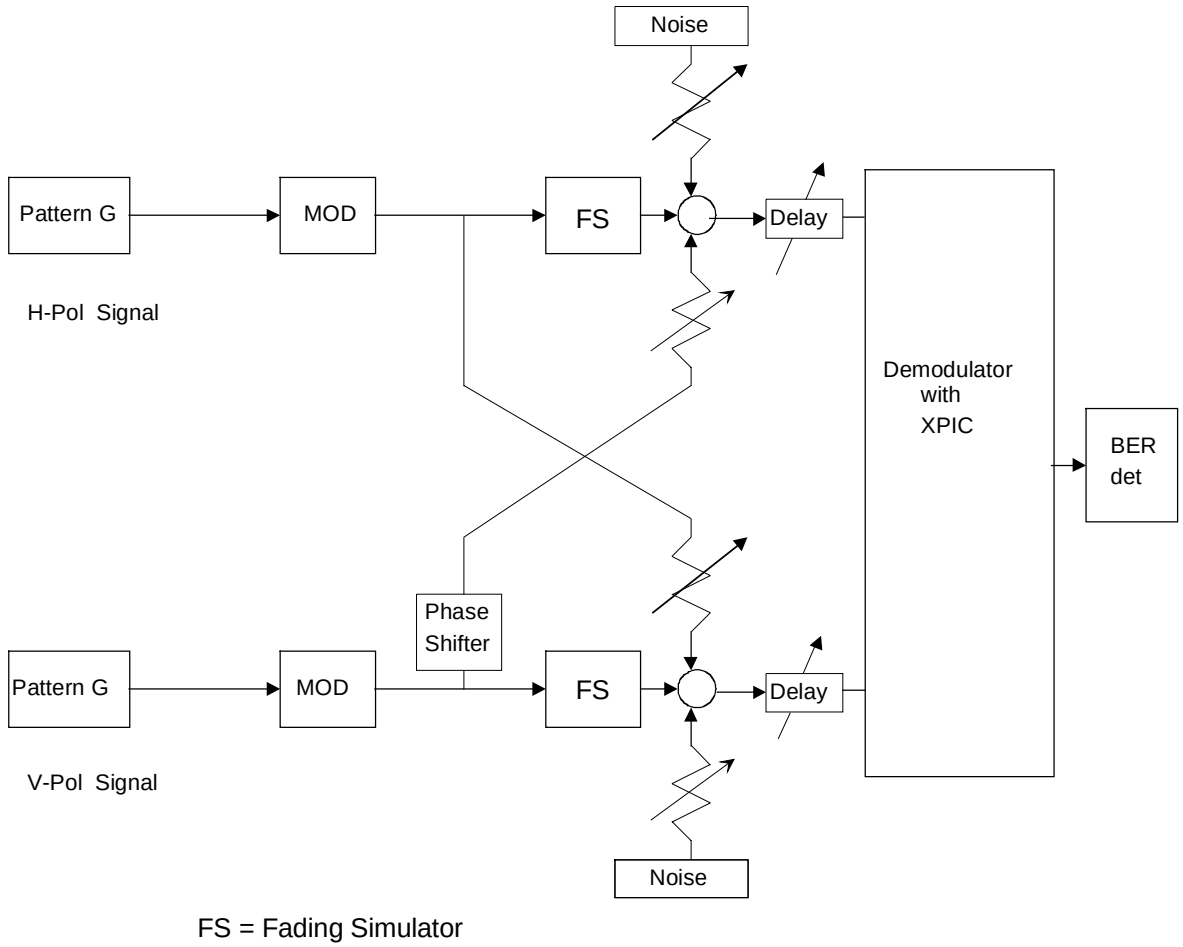



**Figure A.4: Measurement test set**

# History

| Document history | | |
|---|---|---|
| V1.1.1 | September 2000 | Publication |
| V1.2.1 | October 2000 | One-step Approval Procedure OAP 20010216: 2000-10-18 to 2001-02-16 |
| V1.2.1 | February 2001 | Publication |
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