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European Standard (Telecommunications series)

**Fixed Radio Systems;
Point-to-point equipment;
Plesiochronous Digital Hierarchy (PDH);
Low and medium capacity digital radio systems operating
in the 13 GHz, 15 GHz and 18 GHz frequency bands**



Reference

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Contents

Intellectual Property Rights	5
Foreword.....	5
1 Scope	6
2 References	6
3 Symbols and abbreviations.....	8
3.1 Symbols	8
3.2 Abbreviations	8
4 General characteristics	8
4.1 Frequency bands and channel arrangements	8
4.1.1 Channel plans	8
4.1.2 Channel Spacing (CS)	9
4.2 Compatibility requirements between systems.....	9
4.3 Performance and availability requirements	9
4.4 Environmental conditions	9
4.4.1 Equipment within weather protected locations (indoor locations)	9
4.4.2 Equipment for non-weather protected locations (outdoor locations)	10
4.5 Electromagnetic compatibility conditions.....	10
4.6 Power supply.....	10
4.7 Telecommunications Management Network (TMN) requirements	10
4.8 Block diagram	11
4.9 Mechanical specifications for Radio Frequency (RF) interfaces	11
5 Baseband characteristics.....	11
5.1 Plesiochronous Digital Hierarchy (PDH) interfaces	11
6 Transmitter characteristics	12
6.1 Output power	12
6.1.1 Automatic Transmit Power Control (ATPC).....	12
6.2 RF spectrum masks	12
6.3 Discrete CW components exceeding the spectrum mask limit	14
6.3.1 Spectral lines at the symbol rate	14
6.3.2 Other spectral lines	14
6.4 Spurious emissions.....	15
6.4.1 Spurious emissions - external.....	15
6.4.2 Spurious emissions - internal.....	15
6.5 Radio frequency tolerance.....	15
6.6 Return loss	16
7 Receiver characteristics.....	16
7.1 Receiver spurious emissions	16
7.1.1 Spurious emissions - external.....	16
7.1.2 Spurious emissions - internal.....	16
7.2 Input level range	16
7.3 Return loss	17
8 System characteristics without diversity	17
8.1 BER as a function of receiver input level	17
8.2 Equipment background bit errors.....	18
8.3 Interference sensitivity	18
8.3.1 Co-channel external interference.....	18
8.3.2 Adjacent channel interference	19
8.3.3 Front-end non-linearity requirements (two-tone Continuous Wave (CW) interference).....	19
8.3.4 CW interference	20
8.4 Distortion sensitivity	20

Annex A (informative): Additional information	21
A.1 Automatic Transmit Power Control (ATPC)	21
A.2 Spectrum masks.....	21
A.3 Lightning protection.....	21
A.4 Generic mechanical requirements	21
History	22

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM), and is now submitted for the ETSI standards One-step Approval Procedure.

The former title of the present document was: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Plesiochronous Digital Hierarchy (PDH); Low and medium capacity DRRS operating in the 13 GHz, 15 GHz and 18 GHz frequency bands".

The present document is a revision of EN 301 128 (V1.1.1), in which the clauses 3.2 and 6.3 have been modified to take in account the additional requirements for spectral lines present in the spectrum. The OAP applies to these clauses.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

1 Scope

The present document specifies the minimum performance parameters for terrestrial fixed service digital radio communications equipments operating in the 13 GHz, 15 GHz and 18 GHz frequency bands.

Digital Radio Relay Systems (DRRS) are used for point-to-point connections in local, regional and national networks at data rates between 2 Mbit/s and 34 Mbit/s.

As harmonized channel spacings lower than 13,75 MHz are not available in the 18 GHz frequency band at the drafting date of the present document, capacities lower than 2 x 8 Mbit/s are consequently not considered in this frequency band. However the present document can be considered as a guideline when national frequency plans based on a 3,5 MHz channel spacing exist.

Systems considered in the present document are able to respect ITU-R Recommendation national or international grade performance objectives, i.e. ITU-R Recommendations F.1189-1 [9] for national, ITU-R Recommendation F.1092-1 [8] for international and ITU-T Recommendation G.826 [11]. Maximum hop lengths of about 35 km are normally achievable according to the considered frequency bands.

The parameters to be specified fall into two categories:

- a) those that are required to provide compatibility between channels from different sources of equipment on the same route, connected either to:
 - separate antennas; or to
 - separate polarizations of the same antenna.
- b) parameters defining the transmission quality of the proposed system.

The present document deals with Radio Frequency (RF) and baseband characteristics relevant to low and medium capacity Plesiochronous Digital Hierarchy (PDH) transmission. Antenna/feeder system requirements are covered in EN 300 833 [18].

As the maximum transmission rate in a given bandwidth depends on system spectral efficiency, different classes are defined:

Class 1: equipment based on a minimum 4-state modulation scheme (e.g. 4-FSK, 4-QAM, or equivalent).

Class 2: equipment based on a minimum 16-state modulation scheme (e.g. 16-QAM, or equivalent).

Safety aspects are outside the mandate of ETSI and they are not 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, 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] ITU-R Recommendation F.497-6: "Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band".

[2] ITU-R Recommendation F.636-3: "Radio-frequency channel for radio-relay systems operating in the 15 GHz band".

- [3] ITU-R Recommendation F.595-6: "Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band".
- [4] ETSI EN 300 019-1-2: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-2: Classification of environmental conditions; Transportation".
- [5] ETSI EN 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".
- [6] ETSI EN 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".
- [7] ITU-T Recommendation G.703 (1988): "Physical/electrical characteristics of hierarchical digital interfaces".
- [8] 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".
- [9] 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".
- [10] ITU-T Recommendation G.773 (1999): "Protocol suites for Q-interfaces for management of transmission systems".
- [11] ITU-T Recommendation G.826 (1993): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".
- [12] ETSI EN 300 385: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment".
- [13] ITU-R Recommendation F.1101: "Characteristics of digital radio-relay systems below about 17 GHz".
- [14] ITU-R Recommendation F.1102: "Characteristics of radio-relay systems operating in frequency bands above about 17 GHz".
- [15] CEPT/ERC Recommendation T/R 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".
- [16] CEPT/ERC Recommendation T/R 12-07: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 15,23 to 15,35 GHz".
- [17] CEPT/ERC Recommendation T/R 12-03: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 17,7 GHz to 19,7 GHz".
- [18] 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".
- [19] ITU-R Recommendation SM.329-7: "Spurious emissions".
- [20] ITU-R Recommendation F.1191-1: "Bandwidths and unwanted emissions of digital radio-relay systems".
- [21] ITU-R Recommendation F.758-1: "Considerations in the development of criteria for sharing between the terrestrial fixed service and other services".
- [22] IEC 60154: "Flanges for waveguides".
- [23] CEPT/ERC Recommendation 74-01: "Spurious emissions".

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
kg	kilogramme
kHz	kiloHertz
km	kilometre
Mbit/s	Mega-bits per second
MHz	MegaHertz
ppm	parts per million
ns	nanosecond

3.2 Abbreviations

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

ATPC	Automatic Transmit Power Control
BBER	Background Bit Error Rate
BER	Bit Error Rate
C/I	Carrier to Interference ratio
CS	Channel Separation
CSmin	minimum practical Channel Separation (for a given radio-frequency channel arrangement)
CW	Continuous Wave
F _c	cut-off Frequency
FSK	Frequency Shift Keying
IF	Intermediate Frequency
NFD	Net Filter Discrimination
PDH	Plesiochronous Digital Hierarchy
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
RSL	Receive Signal Level
TMN	Telecommunications Management Network
TX	Transmit

4 General characteristics

4.1 Frequency bands and channel arrangements

4.1.1 Channel plans

The systems are required to operate in the 13 GHz, 15 GHz or 18 GHz frequency bands.

These channel plans based on a 3,5 MHz homogeneous channel pattern using vertical and horizontal polarizations shall be in accordance with the ITU-R Recommendations F.497-6 [1], F.636-3 [2], F.595-6 [3] and the CEPT/ERC Recommendations T/R 12-02 [15], T/R 12-07 [16] and T/R 12-03 [17].

All the GO channels shall be in one frequency half band and all the RETURN channels in the other half band.

4.1.2 Channel Spacing (CS)

For systems operating on different antennas or different polarization of the same antenna, on the same route.

Table 1a: Channel spacings: 13 GHz & 15 GHz frequency bands

	Bit rate Mbit/s	2 Mbit/s	2 x 2 Mbit/s	8 Mbit/s	2 x 8 Mbit/s	34 Mbit/s	2 x 34 Mbit/s
Channel	Class 1	1,75 MHz	3,5 MHz	7 MHz	14 MHz	28 MHz	-
Spacing	Class 2	-	1,75 MHz	3,5 MHz	7 MHz	14 MHz	28 MHz

NOTE: n x 2 Mbit/s and n x 8 Mbit/s bit rates may be used where appropriate.

Table 1b: Channel spacings: 18 GHz frequency band

	Bit Rate Mbit/s	2 x 8 Mbit/s	34 Mbit/s	2 x 34 Mbit/s
Channel	Class 1	13,75 MHz	27,5 MHz	-
Spacing	Class 2	-	13,75 MHz	27,5 MHz

NOTE: n x 2 Mbit/s and n x 8 Mbit/s bit rates may be used where appropriate.

4.2 Compatibility requirements between systems

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

Different manufacturer equipment may be used on different polarization of one antenna but there shall be no requirement to multiplex different manufacturer's equipment on the same polarization of the same antenna.

4.3 Performance and availability requirements

Equipments shall be designed in order to meet network performance and availability requirements foreseen by ITU-T Recommendation G.826 [11], following the criteria reported in ITU-R Recommendations F.1092-1 [8] and F.1189-1 [9] for international and national portions of the digital connection. The implication of the link design on the performance is recognized and the general design criteria reported in ITU-R Recommendations F.1101 [13] and F.1102 [14] shall be applied.

4.4 Environmental conditions

Both indoor and partially outdoor installations are considered.

The equipment shall be required to meet the environmental conditions set out in EN 300 019-1-2 [4] 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.

4.4.1 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 EN 300 019-1-2 [4] classes 3.1 and 3.2, respectively.

Optionally, the more stringent requirements of EN 300 019-1-2 [4] classes 3.3 (non-temperature controlled locations), 3.4 (sites with heat trap) and 3.5 (sheltered locations) may be applied.

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

Equipment intended for operation within non-weather protected locations shall meet the requirements of EN 300 019-1-2 [4] classes 4.1 or 4.1E.

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

For systems supplied within a specific radio cabinet, which gives full protection against precipitation, wind, etc. EN 300 019-1-2 [4] classes 3.3, 3.4 and 3.5 may also be applied to equipment intended for operation in non-weather protected locations.

4.5 Electromagnetic compatibility conditions

Equipments shall operate under the conditions specified in EN 300 385 [12].

4.6 Power supply

The equipment shall operate from any of the secondary supplies within the ranges specified in EN 300 132-2 [6]. According to the present document, the following nominal value and tolerance is specified:

Table 2a: Power supplies-48 V DC

For 48 V DC nominal:	-40,5 V DC to -57 V DC
----------------------	------------------------

Also a nominal value of 60 V DC shall be considered, with the following tolerance value:

Table 2b: Power supplies-60 V DC

For 60 V Dc nominal:	-50,0 V DC to -72 V DC
----------------------	------------------------

It may be required to operate from a secondary supply according to EN 300 132-1 [5], with the following nominal values and tolerances:

Table 2c: Power supplies-AC

For 230 V AC nominal:	207 V AC to 253 V AC	50 Hz \pm 2 Hz
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For DC systems, the positive pole of the voltage supply shall be earthed at the source.

A primary supply of +24 V or -24 V DC or 110 V AC, which is not covered by EN 300 132-1 [5], may be required.

Table 2d: Power supplies-other

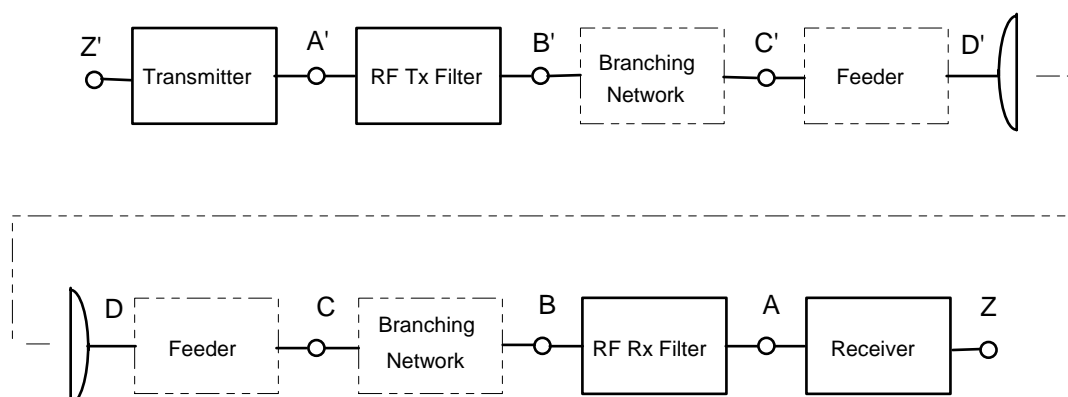
For 24 V DC nominal:	21,8 V DC to 28,15 V DC	
For 110 V AC nominal:	99 V AC to 121 V AC	60 Hz \pm 2 Hz

4.7 Telecommunications Management Network (TMN) requirements

Any TMN interface should be in accordance with ITU-T Recommendation G.773 [10].

4.8 Block diagram

The system block diagram is shown in figure 1. The intersection points are for reference only and not necessarily for measurement purposes, nor do they indicate a specific design structure.



NOTE 1: For the purpose of defining the measurement points, the branching network does not include a hybrid.

NOTE 2: Points B and C, B' and C' may coincide.

Figure 1: System block diagram

4.9 Mechanical specifications for Radio Frequency (RF) interfaces

If a waveguide flange is used at point C/C', the following type shall be used in accordance with IEC 60154 [22].

Table 3: RF waveguide interfaces

Frequency bands	Waveguide flange
13 GHz	UBR/UDR/PBR/CBR 120 or 140
15 GHz	UBR/UDR/PBR/CBR 140
18 GHz	UBR/PBR/CBR 220

5 Baseband characteristics

5.1 Plesiochronous Digital Hierarchy (PDH) interfaces

PDH interfaces at 2 Mbit/s, 8 Mbit/s and 34 Mbit/s shall comply with ITU-T Recommendation G.703 [7]. Parameters for service channels and wayside traffic channels are outside the scope of the present document.

6 Transmitter characteristics

6.1 Output power

The maximum value of output power, referred to point C' shall not exceed +40 dBm under any conditions. If for proper operation of the system, a lower transmitter output power is required, then an internal or external means of adjustment shall be provided.

The maximum nominal value shall be declared by the manufacturer.

The tolerance value around the nominal or selected value of output power is ± 2 dB for outdoor operating systems and ± 1 dB for indoor operating systems.

6.1.1 Automatic Transmit Power Control (ATPC)

ATPC is an optional feature.

The ATPC range is defined as the power interval from the maximum (including tolerances) output power level to the lowest transmitter output power level (at point B').

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

NOTE: For hop lengths of more than about 35 km, which are of interest at least in the 13 GHz band, an ATPC device with a range of more than 20 dB may be required.

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 (see clause 8);
- ATPC set at maximum power for Transmit (TX) performance (see clauses 6.1 to 6.5).

Further information on ATPC is given in annex A.

6.2 RF spectrum masks

The spectrum masks relative to standard channel spacings are shown in figure 2 and in table 4. The related spectrum analyser settings for measurement purposes are shown in table 5.

The equipment shall comply with the digital RF power spectrum mask given in figure 2.

The 0 dB level shown on the spectrum masks relates to the spectral power density of the actual centre frequency disregarding residual carrier. These masks do not include an allowance for frequency tolerance.

In some particular circumstances as mentioned in clause A.2, tighter spectrum masks are required.

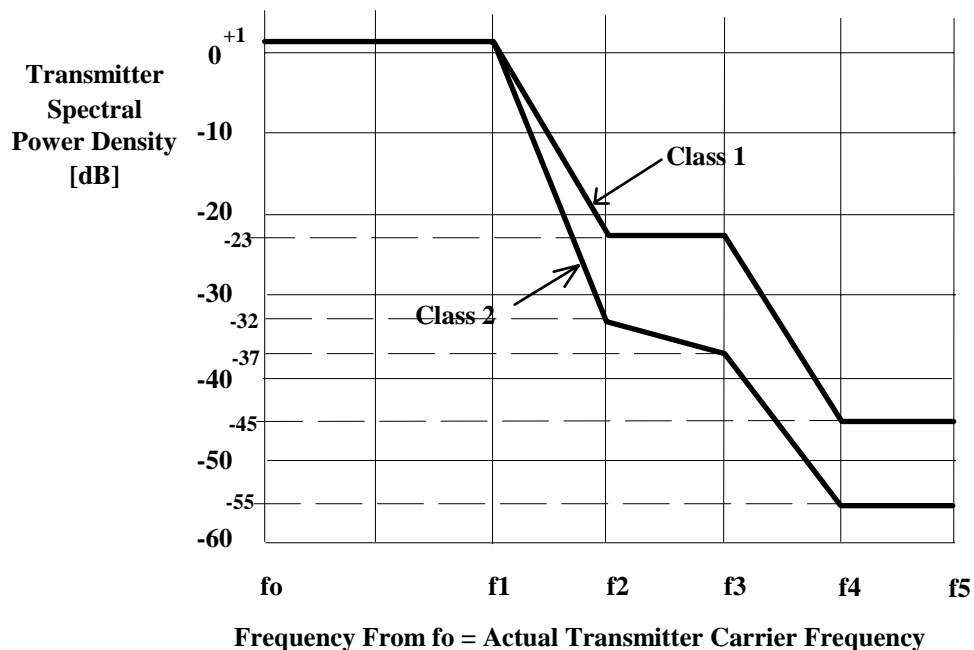


Figure 2: Limits of spectral power density

Reference frequencies f_1 to f_5 are reported in table 4 for the considered bit rate and channel spacings.

Table 4: Reference frequencies relating to the class of the equipment and channel spacing

Spectrum efficiency class	Bit-rate [Mbit/s]	Channel spacing [MHz]	f_1 [MHz]	f_2 [MHz]	f_3 [MHz]	f_4 [MHz]	f_5 [MHz]
1	2	1,75	0,7	1,4	1,75	3,5	4,375
	2 x 2	3,5	1,4	2,8	3,5	7	8,75
	8	7	2,7	5,6	6,5	13	17,5
	2 x 8	14 (13,75)	5,4	11,2	13	26	35
	34	28 (27,5)	11	19	25	45	70
2	2 x 2	1,75	0,7	1,4	1,75	3,5	4,375
	8	3,5	1,4	2,8	3,5	7	8,75
	2 x 8	7	2,8	5,6	7	14	17,5
	34	14 (13,75)	5,6	11,2	14	28	35
	2 x 34	28 (27,5)	11,2	22,4	28	56	70

NOTE: Values in parenthesis refer to the 18 GHz band.

Table 5: Spectrum analyser settings for RF power spectrum measurements

Channel spacing [MHz]	1,75	3,5	7	14 (13,75)	28 (27,5)
Centre frequency	actual	actual	actual	actual	actual
Sweep width [MHz]	10	20	40	80	160
Scan time	auto	auto	auto	auto	auto
IF bandwidth [kHz]	30	30	30	30	100
Video bandwidth [kHz]	0,1	0,1	0,3	0,3	0,3

6.3 Discrete CW components exceeding the spectrum mask limit Spectral lines at symbol rate

6.3.1 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 not be more than -30 dBm (reference point B') or shall fall within the relevant RF spectrum mask defined in clause 6.2, whichever is the less stringent requirement.

6.3.2 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 $\{10 \log (CS_{min}/IFbw) - 10\}$ dB (Note)
- be spaced each other in frequency by less than CS_{min}

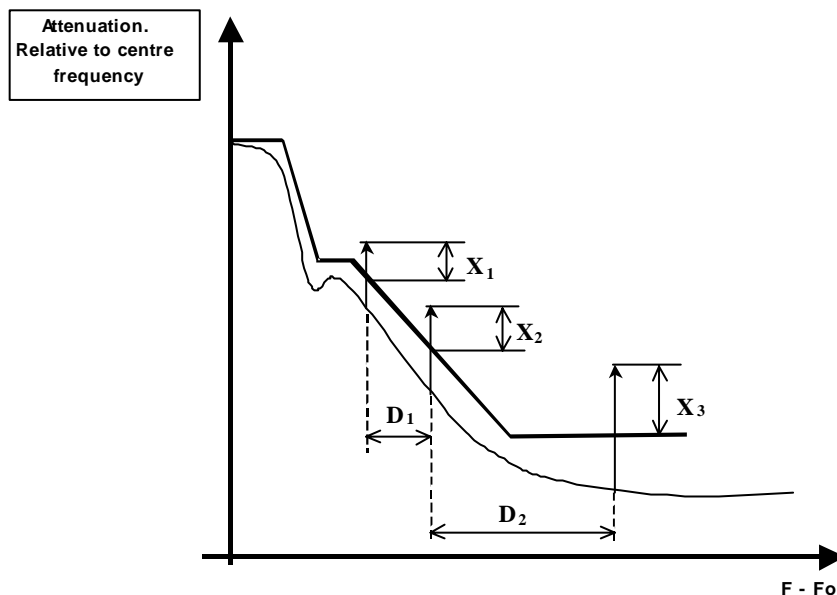
Where:

$$CS_{min} = 1\,750 \text{ kHz for all bands 13 GHz, 15 GHz and 18 GHz}$$

IFbw is the recommended resolution bandwidth, expressed in kHz, reported in table 5.

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

Figure 3 shows a typical example of this requirement.



$$X_1, X_2, X_3 \text{ [dB]} \leq 10 \log (CS_{min}/IFbw) - 10$$

$$D_1, D_2 \geq CS_{min}$$

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

6.4 Spurious emissions

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

- a) to limit interference into other systems operating wholly externally to the system under consideration (external emissions) which limits are referred by CEPT/ERC Recommendation 74-01 [23] based on ITU-R Recommendations SM.329-7 [19] and F.1191-1 [20];
- b) to limit local interference within the system where transmitters and receivers are directly connected via the filter and branching systems (internal emissions).

This leads to two sets of spurious emission limits at reference point B' for indoor systems and C' for outdoor systems (where a common Tx/Rx duplexer is used).

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

6.4.1 Spurious emissions-external

According to CEPT/ERC Recommendation 74-01 [23], 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 (CS).

Outside the band of $\pm 250\%$ of the relevant channel separation (CS), the Fixed Service radio systems spurious emission limits defined by CEPT/ERC Recommendation 74-01 [23] together with the frequency range to consider for conformance measurement, shall apply.

NOTE: If a length of waveguide is used between reference point A' and C' and it is longer than twice the free space wavelength of the cut-off frequency (F_c), then the lower limit of measurement will be increased to $0,7 \times F_c$. When the length is greater than four times the free space wavelength of F_c then the lower limit of measurement will be increased to $0,9 \times F_c$.

6.4.2 Spurious emissions-internal

Because of the requirement to multiplex equipment from different manufacturers on different polarization of the same antenna, the level of the spurious emissions from the transmitter, referenced to reference point C' is specified in table 6.

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

Table 6: Spurious emission limits-internal

Spurious emission frequency relative to channel assigned frequency	Specification limit	Controlling factor for requirement application
The average level of all spurious signals both discrete/CW and noise-like (including L.O., $\pm IF$, $\pm 2 \times IF$), evaluated as total average signal level	≤ -70 dBm	If spurious signal's frequency falls within receiver half band, for digital systems with compatibility requirement as in clause 4.2
NOTE: When waveguide is used between reference point A' and C', the length of which is higher than twice the free space wavelength of the Cut-off Frequency (F_c), the lower limit of measurement can be increased to $0,7 F_c$ and $0,9 F_c$ when the length is higher than 4 times the same wavelength.		

6.5 Radio frequency tolerance

Maximum radio frequency tolerance shall not exceed ± 10 ppm. This limit includes both short-term factors (environmental effects) and long term ageing effects.

For conformance testing purposes, the manufacturer shall state the guaranteed short-term part and the expected ageing long-term part.

6.6 Return loss

The minimum return loss of the branching system shall be 15 dB for class 2 systems and 12 dB for class 1 systems. The measurement shall be referred to point C' toward the radio equipment and across a frequency band greater than or equal to 0,5 times the channel separation.

When the antenna is an integral part of the system there shall be no requirement. However, the return loss figure shall be declared by the manufacturer.

NOTE: For indoor systems, a feeder plus antenna return loss ≥ 20 dB is assumed. If this performance is not achieved, values better than the above return loss figures may be required.

7 Receiver characteristics

7.1 Receiver spurious emissions

See clause 6.4.

NOTE: If a length of waveguide is used between reference point A and C and it is longer than twice the free space wavelength of the cut-off frequency (F_c) then the lower limit of measurement will be increased to $0,7 \times F_c$. When the length is greater than four times the free space wavelength of F_c then the lower limit of measurement will be increased to $0,9 \times F_c$.

7.1.1 Spurious emissions-external

The limit values, measured at reference point B for indoor systems and C for outdoor systems (where a common Tx/Rx duplexer is used), of CEPT/ERC Recommendation 74-01 [23] shall apply.

7.1.2 Spurious emissions-internal

Spurious emissions which fall within receiver half band shall be less than -70 dBm (referenced to reference point B).

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

7.2 Input level range

The input level range for a Bit Error Ratio (BER) = 10^{-3} shall extend from the upper limit of -20 dBm or more to the limit specified for BER = 10^{-3} in clause 8.1.

For class 2 systems, the input level range for a BER = 10^{-8} shall extend from the upper limit of -20 dBm or more to the limit specified for BER = 10^{-8} in clause 8.1.

When ATPC is used, the maximum input level for BER $\leq 10^{-3}$ may be relaxed to -24 dBm and the maximum input level for BER $\leq 10^{-8}$ may be relaxed to -30 dBm.

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

7.3 Return loss

The minimum return loss of the branching system shall be 15 dB for class 2 systems and 12 dB for class 1 systems. The measurement shall be referred to point C toward the radio equipment and across a frequency band greater than or equal to 0,7 times the maximum aggregate symbol rate.

When the antenna is an integral part of the system there shall be no requirement. However, the return loss figure shall be declared by the manufacturer.

NOTE: For indoor systems, a feeder plus antenna return loss ≥ 20 dB is assumed. If this performance is not achieved, values better than the above return loss figures may be required.

8 System characteristics without diversity

8.1 BER as a function of receiver input level

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

The BER values given in table 7a and 7b for class 1 systems and 7c and 7d for class 2 systems shall not be exceeded at signal levels higher than those specified.

Table 7a: Receiver sensitivity 13 GHz & 15 GHz-class 1

CS	Minimum system bit rate	BER 10^{-3} level (dBm)	BER 10^{-6} level (dBm)
1,75 MHz	2 Mbit/s	-89	-86
3,5 MHz	2 x 2 Mbit/s	-86	-83
7 MHz	8 and 4 x 2 Mbit/s	-84	-81
14 MHz	2 x 8 and 8 x 2 Mbit/s	-81	-78
28 MHz	34 and 16 x 2 Mbit/s	-78	-75

Table 7b: Receiver sensitivity 18 GHz-class 1

CS	Minimum system bit rate	BER 10^{-3} level (dBm)	BER 10^{-6} level (dBm)
13,75 MHz	2 x 8 and 8 x 2 Mbit/s	-80	-77
27,5 MHz	34 and 16 x 2 Mbit/s	-77	-74

Table 7c: Receiver sensitivity 13 & 15 GHz-class 2

CS	Minimum system bit rate	BER 10^{-3} level (dBm)	BER 10^{-6} level (dBm)	BER 10^{-8} level (dBm)
1,75 MHz	2 x 2 Mbit/s	-83	-80	-78
3,5 MHz	8 and 4 x 2 Mbit/s	-81	-78	-76
7 MHz	2 x 8 and 8 x 2 Mbit/s	-79	-76	-74
14 MHz	34 and 16 x 2 Mbit/s	-76	-73	-71
28 MHz	2 x 34 Mbit/s	-73	-70	-68

Table 7d: Receiver sensitivity 18 GHz-Class 2

Channel Spacing	Minimum System Bit Rate	BER 10 ⁻³ level (dBm)	BER 10 ⁻⁶ level (dBm)	BER 10 ⁻⁸ level (dBm)
13,75 MHz	34 and 16 x 2 Mbit/s	-75	-72	-70
27,5 MHz	2 x 34 Mbit/s	-72	-69	-67

NOTE: When the present document is used as a guideline for smaller channel spacings in the 18 GHz band, a 1 dB relaxation of the figures of tables 7a and 7c is applicable.

8.2 Equipment background bit errors

The measurement is made under simulated operating conditions without interference at point C with a signal level, which is 10 dB above the level giving a 10⁻⁶ BER (as specified in clause 8.1). All measurements will be made at the payload bit rate defined in clause 4.1. Measurement period and maximum number of errors allowed are given in table 8.

Table 8: Measurement period and maximum allowed number of errors

Bit-rate	Minimum recording time	Maximum errors number
2 Mbit/s	16 hours	12
8 Mbit/s	4 hours	12
34 Mbit/s	10 hours	12

NOTE: As the measurement is made on the tributaries, the requirement for the 2 Mbit/s rate is also applicable to n x 2 Mbit/s systems.

8.3 Interference sensitivity

All receive signal levels and Carrier to Interference ratio (C/I) measurements shall be referred to point B of the block diagram in figure 1.

8.3.1 Co-channel external interference

The limits of co-channel interference shall be as in table 9a, giving maximum Carrier to Interference ratio (C/I) values for 1 dB and 3 dB degradation of the 10⁻⁶ BER limits specified in clause 8.1.

Table 9a: Co-channel external interference sensitivity

		RSL @BER →	RSL @ 10 ⁻⁶	
		degradation →	1 dB	3 dB
System Class ↓↓	Bit Rate [Mbit/s] ↓	Channel spacing [MHz] ↓↓		
1	2	1,75	23	19
	2 x 2	3,5	23	19
	8	7	23	19
	2 x 8	14 (13,75)	23	19
	34	28 (27,5)	23	19
2	2 x 2	1,75	30	26,5
	8	3,5	30	26,5
	2 x 8	7	30	26,5
	34	14 (13,75)	30	26,5
	2 x 34	28 (27,5)	30	26,5

NOTE: Figures in parenthesis refer to the 18 GHz band.

8.3.2 Adjacent channel interference

The limits of adjacent channel interference shall be as given in table(s) 9b and 9c for like modulated signals spaced by 1 CS, giving maximum C/I values for 1 dB and 3 dB degradation of the 10^{-6} BER limits specified in clause 8.1.

Table 9b: First adjacent channel interference sensitivity 13 GHz & 15 GHz bands

System class	Bit rate [Mbit/s]	Channel spacing [MHz]	RSL @ 10^{-6}	
			1 dB	3 dB
1	2	1,75	0	-4
	2 x 2	3,5	0	-4
	8	7	0	-4
	2 x 8	14	0	-4
	34	28	0	-4
2	2 x 2	1,75	-1	-5
	8	3,5	-1	-5
	2 x 8	7	-1	-5
	34	14	-1	-5
	2 x 34	28	-1	-5

Table 9c: First adjacent channel interference sensitivity 18 GHz bands

System class	Bit rate [Mbit/s]	Channel spacing [MHz]	RSL @ 10^{-6}	
			1 dB	3 dB
1	2 x 8	13,75	+1	-3
1	34	27,5	+1	-3
2	34	13,75	0	-4
2	2 x 34	27,5	0	-4

8.3.3 Front-end non-linearity requirements (two-tone Continuous Wave (CW) interference)

For a receiver operating at the Receive Signal Level (RSL) specified in clause 8.1 for 10^{-6} BER threshold, the introduction of two equal CW interferers each with a level of +19 dB, with respect to the wanted signal and located at the second and fourth adjacent channel in the receive halfband, shall not result in a BER greater than 10^{-5} .

8.3.4 CW interference

For a receiver operating at the 10^{-6} BER threshold given in table 5, the introduction of a CW interferer at a level of X dB, 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 co-polar channel spacing, shall not result in a BER greater than 10^{-5} .

This requirement is considered equivalent to a degradation of 1 dB of the 10^{-6} BER threshold.

The level X of the CW interferer shall be:

- for a channel spacing lower than or equal to 14 MHz:
 - +20 dB at any frequency either side of the wanted centre frequency of the RF channel from 250 % up to 500 % of the co-polar channel spacing;
 - +30 dB outside 500 % of the co-polar channel spacing;
- for a channel spacing greater than 14 MHz:
 - +30 dB.

NOTE: If a length of waveguide is used between reference point A and C and is longer than twice the free space wavelength of the cut-off frequency (F_c) then the lower limit of measurement will be increased to $0,7 \times F_c$. When the length is greater than four times the free space wavelength of F_c then the lower limit of measurement will be increased to $0,9 \times F_c$.

8.4 Distortion sensitivity

For the frequency bands considered in the present document rainfall may be considered as the main propagation factor limiting performance. Powerful equalizers to compensate propagation distortion are not considered for class 1 systems and frequency bands above the 13 GHz band, nor for class 2 systems operating at bit rates lower than 34 (or 16×2) Mbit/s.

Equipments with equalizers will be subject to manufacturer declaration of signature parameters for a two path propagation with a delay of 6,3 ns and a BER of 10^{-3} . Minimum and non-minimum phase cases will be both considered.

Annex A (informative): Additional information

A.1 Automatic Transmit Power Control (ATPC)

ATPC is aimed at driving the Tx Power Amplifier output level from a proper minimum, which is calculated to facilitate the radio network planning, and which is used in case of normal propagation up to a maximum value which fulfils all the specifications defined in the present document.

ATPC may be useful in some circumstances, e.g.:

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

ATPC may also be used to increase the output power above the nominal level up to the maximum level specified by administrations and operators during fading conditions. This can be useful where the main limiting factors are given by non-selective fading events.

A.2 Spectrum masks

The spectrum masks given in figure 2 are consistent with Net Filter Discrimination (NFD) figures between adjacent channels of about 25 dB for class 1 and about 28 dB for class 2. For hop lengths of more than about 35 km which are of interest at least in the 13 GHz band, higher ATPC range in connection with NFD of more than 30 dB for class 1 and 36 dB for class 2, or the use of the alternate polarization may be required for systems operating on the same route, using adjacent channels and separate antennas.

NFD is calculated according to ITU-R Recommendation F.758-1 [21] using a typical spectrum mask derived from a real signal. The actual Net Filter Discrimination for an equipment complying with one of the spectrum masks given in figure 2 is typically expected not to be lower than the NFD provided by this spectrum mask plus 6 dB.

A.3 Lightning protection

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

A.4 Generic mechanical requirements

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

For maintenance purposes, the replaceable units of the equipment may be so designed that they can be easily handled by one person. The weight of a replaceable unit may not exceed 20 kg.

History

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