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**Transmission and Multiplexing (TM);
Digital Radio Relay Systems (DRRS);
Sub-STM-1 DRRS operating in the 13 GHz, 15 GHz and 18 GHz
frequency bands with about 14 MHz
co-polar channel spacing**

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Foreword

This final draft European Telecommunication Standard (ETS) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI), and is now submitted for the Voting phase of the ETSI standards approval procedure.

This ETS contains the minimum technical requirements to ensure compatibility of products and conformance with radio regulations across ETSI member states. Radio terminals from different manufacturers are not required to interwork at radio frequency (i.e. no common air interface).

This ETS defines the requirements of radio terminal and radio-relay equipment and associated interfaces. The requirements for multiplex, network management and antenna / feeder equipment may be addressed elsewhere.

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

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1 Scope

This ETS specifies the minimum performance parameters for terrestrial fixed services radiocommunications equipment, as given below, for operation in the 13 GHz (12,75 GHz to 13,25 GHz), 15 GHz (14,5 GHz to 15,35 GHz) and 18 GHz (17,7 GHz to 19,7 GHz) frequency bands.

This ETS covers equipment for the transmission of sub-STM-1 digital signals with a VC3 payload capacity. The standardization of sub-STM-1 radio systems for 13 GHz, 15 GHz and 18 GHz bands has been prepared to ensure the compatibility with the existing plesiochronous and the new synchronous systems concerning frequency plans and performance.

The application of these digital radio-relay systems is anticipated to be for point-to-point links in local, regional and national networks, mobile base station connections, customer and access links. Consideration has to be given to special requirements of the local and access network, e.g. simple towers with less space for antenna, different network structures with high density nodes.

The systems considered shall operate in these networks having regard for existing hop lengths, which mainly depend on the frequency band envisaged, the performance objectives set by relevant ITU-R Recommendations or national Network Operators requirements and existing propagation characteristics. The hop lengths are considered to be normally up to 37 km in the 13 GHz band, up to 30km in the 15 GHz band and up to 20 km in the 18 GHz band.

The parameters to be specified fall into two categories:

- a) Those that are required to provide compatibility between RF channels occupied by different sources of equipment on the same route connected either to:
 - separate antennas; or to
 - separate polarization of the same antenna.

NOTE: Equipment supplied by different manufactures on the same path and using different polarizations shall operate on different frequencies.

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

The standardization deals with IF, RF and baseband characteristics relevant to Sub-STM-1 SDH transmission. Spurious emissions and EMC requirements are also included in the present document.

Safety regulations are outside the scope of this ETS.

2 Normative References

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- [1] ITU-R Recommendation F.750-3: "Architectures and functional aspects of radio-relay systems for SDH-based networks".
- [2] ITU-R Recommendation F.751-2: "Transmission characteristics and performance requirements of radio-relay systems for SDH-based networks".
- [3] ITU-R Recommendation F.634-4: "Error performance objectives for real digital radio-relay links forming part of the high-grade portion of international digital connections at a bit rate below the primary rate within an integrated services digital network".

- [4] ITU-R Recommendation F.696-2: "Error performance and availability objectives for hypothetical reference digital sections forming part or all of the medium-grade portion of an ISDN connection at a bit rate below the primary rate utilizing digital radio-relay systems".
- [5] ITU-R Recommendation F.697-2: "Error performance and availability objectives for the local-grade portion at each end of an ISDN connection at a bit rate below the primary rate utilizing digital radio-relay systems".
- [6] ITU-T Recommendation G.821: "Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an integrated services digital network".
- [7] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".
- [8] ITU-R Recommendation F.497-5: "Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band".
- [9] ITU-R Recommendation F.636-3: "Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band".
- [10] ITU-R Recommendation F.595-5: "Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band".
- [11] ETS 300 019, Parts 1 and 2: "Equipment engineering; Environmental conditions and environmental tests for telecommunications equipment Parts 1 and 2".
- [12] ETS 300 385: "Radio Equipment and Systems (RES); ElectroMagnetic Compatibility (EMC) standard for digital fixed radio links and ancillary equipment with data rates at around 2 Mbit/s and above".
- [13] ETS 300 119: "Equipment engineering (EE); European telecommunication standard for equipment practice".
- [14] ETS 300 132: "Equipment engineering (EE); Power supply interface at the input to telecommunications equipment".
- [15] ITU-T Recommendation G.784: "Synchronous digital hierarchy (SDH) management".
- [16] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".
- [17] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
- [18] ITU-T Recommendation G.707: "Network node interface for the synchronous digital hierarchy (SDH)".
- [19] ITU-T Recommendation G.781: "Structure of Recommendations on equipment for the synchronous digital hierarchy (SDH)".
- [20] ITU-T Recommendation G.782: "Types and general characteristics of synchronous digital hierarchy (SDH) equipment".
- [21] ITU-T Recommendation G.783: "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".
- [22] ITU-T Recommendation G.957: "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".

- [23] ETS 300 174: "Network Aspects (NA); Digital coding of component television signals for contribution quality applications in the range 34 - 45 Mbit/s".
- [24] Void.
- [25] 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".
- [26] ETS 300 833: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Antennas used in point-to-point DRRS operating in the frequency band 3 to 60 GHz".
- [27] Void.
- [28] DE/TM-04040: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Spurious emissions and receiver immunity at equipment antenna ports of DRRS".
- [29] 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 the 27 500 km hypothetical reference path".
- [30] 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 the 27 500 km hypothetical reference path".
- [31] Void.
- [32] ETS 300 635: "Transmission and multiplexing(TM); Synchronous digital hierarchy (SDH); Radio specific functional blocks for transmission of M x STM-N".
- [33] TR 101 035: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS)".
- [34] Void.
- [35] ETS 300 785: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Radio specific functional blocks for transmission of M x sub-STM-1".
- [36] ITU-R Recommendation F.752-1: "Diversity Techniques for radio-relay systems".
- [37] 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".
- [38] CEPT/ERC Recommendation T/R 12-07: "Harmonized radio frequency channel arrangements digital terrestrial fixed systems operating in the bands 14.5 GHz to 14.62 GHz paired with 15,23 GHz to 15,35 GHz".
- [39] 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".
- [40] ITU-T G.861: "Principles and guidelines for the integration of satellite and radio systems in SDH transport networks".

- [41] IEC 835-2: "Methods of measurement for equipment used in digital microwave radio transmission systems; Part 2: measurements on terrestrial radio-relay systems".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purpose of this ETS the following definition applies:

Sub-STM-1: Current terminology for medium capacity Synchronous Transport Module at 51,84 Mbit/s defined by ITU-T Recommendation G.707 [18] and ITU-R Recommendation F.750-3 [1], it also coincide with RR-STM. Recently renominated as STM-0 by ITU-T Recommendation G.861 [40].

3.2 Abbreviations

For the purpose of this ETS the following abbreviations apply:

ATPC	Automatic Transmit Power Control
BER	Bit Error Ratio
CMI	Code Mark Inversion
IF	Intermediate Frequency
L.O.	Local Oscillator
NFD	Net Filter Discrimination
NNI	Network Node Interface
PRBS	Pseudo-Random Binary Sequence
RCSOH	Radio Complementary Section Over Head
RF	Radio Frequency
RFCOH	Radio Frame Complementary Over Head
RX	Receiver
SDH	Synchronous Digital Hierarchy
SOH	Section OverHead
SRL	Spectrum Reference Level
STM-1	Synchronous Transport Module level 1
Sub-STM-1	Customary wording for RR-STM (Synchronous Transport Module)
TMN	Telecommunications Management Network
TX	Transmitter

3.3 Symbols

For the purpose of this ETS the following symbols apply.

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

4 General characteristics

4.1 Frequency Bands and Channel Arrangements

The frequency bands covered by the present document are the 12,75 GHz to 13,25 GHz band, the 14,5 GHz to 15,35 GHz band and the 17,7 GHz to 19,7 GHz band for fixed services.

The channelling arrangements according to ITU-R F. Recommendations, the co-polar channel spacing and the centre gap are stated in table 1.

The use of co-channel dual polarized (CCDP) operation is also envisaged.

Table 1 Frequency bands and channel arrangements

Description	Frequency bands		
	13 GHz	15 GHz	18 GHz
ITU-R Recommendation F	497-5 [8]	636-3 [9]	595-5 [10]
CEPT/ERC Recommendation	T/R 12-02 [37]	T/R 12-07 [38]	T/R 12-03 [39]
Co-polar adjacent channel spacing (MHz)	14	14	13,75
Centre gap (MHz)	70	N x 28 (> 84 MHz)	61,25

4.2 Performance and availability requirements

Equipment shall be designed in order to meet network performance and availability requirements foreseen by ITU-T Recommendation(s) G.821 [6] or/and G.826 [7], following the criteria defined in ITU-R Recommendations F.634-4 [3], F.695 [25], F.696-2 [4], F.697-2 [5], F.1092-1 [29] and F.1189-1 [30] for high or medium or local grade or international or national portion 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.752-1 [36], is to be applied.

4.3 Types of Installation

Both indoor and partially outdoor installations are considered.

The equipment shall be required to meet the environmental conditions set out in ETS 300 019 [11] 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 Environmental Conditions

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 ETS 300 019 [11] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [11] 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 not-weather protected locations (outdoor locations)

Equipment intended for operation within non-weather protected locations shall meet the requirements of ETS 300 019 [11], class 4.1 or 4.1E.

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

4.5 Electromagnetic compatibility conditions

Equipment shall operate under the conditions specified in relevant standard produced by ETSI (ETS 300 385) [12].

4.6 Mechanical requirements

The mechanical dimensions for indoor installations shall be in agreement with ETS 300 119 [13].

For outdoor installation each of the outdoor unit shall be weather proof or weather protected.

The outdoor unit shall be separable from the antenna.

4.7 Power supply

The equipment shall operate from any of the supply voltages within the ranges specified in draft ETS 300 132 [14]. For DC systems, the positive pole of the battery will be earthed at the source.

NOTE: Some countries may require to use a primary supply of 24 V DC or 110 V AC, which is not covered by ETS 300 132 [14].

4.8 TMN Interface

ITU-T Recommendations G.784 [15] and G.773 [16], ITU-R Recommendations F.750-3 [1] and F.751-2 [2] give the general requirements for TMN interface and functionality; ETS 300 635 [32] gives the radio specific functional block description and the related radio fragment information model respectively.

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

4.9 Branching / feeder / antenna requirements

4.9.1 Antenna radiation patterns

See annex A.

4.9.2 Return loss

The minimum return loss of the branching system shall be 23 dB for indoor systems and 20 dB for partially outdoor systems. The measurement shall be referred to point C/C' towards the radio equipment and across a frequency band greater than or equal to 1,3 times the maximum symbol frequency away from the actual centre frequency used for the equipment.

When the antenna is an integral part of the equipment there shall be no requirement.

4.9.3 Intermodulation Products

When multi-channel branching is used each intermodulation product measured at point C' shall not exceed -110 dBm referenced to the point B for transmitter output power levels up to the maximum nominal level.

4.9.4 Equipment Flanges

When wave guides are required at reference point C /C', standard IEC flanges should be used for the frequency bands in question (e.g. PDR/UBR/UDR120 for 13 GHz-band, PDR/UBR/UDR 140 for 15 GHz-band and either PDR/UBR/UDR180 or PDR/UBR/UDR220 for 18 GHz-band).

4.10 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.

4.11 Lightning protection

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

5 Baseband characteristics

5.1 Synchronous Digital Hierarchy

The SDH baseband interface shall be a network node interface (NNI) at the STM-1 level in accordance with ITU-T Recommendations G.703 [17], G.707 [18], G.781 [19], G.782 [20], G.783 [21], G.784 [15], G.957 [22], ETS 300 635 [32] and ETS 300 785 [35] (with possible simplifications under study in ETSI TM3 and TM4) and ITU-R Recommendation F.750-3 [1].

Two versions of the STM-1 interface are possible:

- a CMI electrical interface (ITU-T Recommendations G.703 [17], G.707 [18]); and
- an optical interface (ITU-T Recommendation G.957 [22]).

The use of reserved bytes contained in the SOH, and their termination shall be in accordance with ITU-R Recommendation F.750-3 [1]. Further details on the possible use of the SOH bytes including additional RFCOH or RCOH are given in TR 101 035 [33].

5.2 Plesiochronous Digital Hierarchy

The following optional baseband interfaces are required at the PDH level in accordance with ITU-T Recommendation G.703 [17]:

- a) 2 Mbit/s;
- b) 34 Mbit/s.

For digital video applications (ETS 300 174 covering VC2-5c concatenation) an interface at 45 Mbit/s in accordance with ITU-T Recommendation G.703 (clause 5) [17] may be required.

6 Transmitter characteristics

6.1 Output Power

The maximum absolute output power (averaged) shall not exceed +40 dBm.

The value of the nominal output power (averaged) declared by the supplier, referred to point B', shall be in the range for:

- class A $\geq +30$ dBm to $\leq +40$ dBm;
- class B $\geq +20$ dBm to $\leq +30$ dBm;
- class C $\geq +15$ dBm to $\leq +20$ dBm;

including all tolerances.

The tolerances shall be as follows:

- 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.

A means to vary the transmitter output power (for frequency co-ordination purposes) may be required.

In the case of STM-1 interface, the measurement of output power shall be carried out using an STM-1 test signal, to be defined.

In the case of PDH signals, the measurement of output power shall be carried out with the carrier modulated by a pseudo-random bit sequence of length $2^{23} - 1$ for 34 Mbit/s interface and a length of $2^{15} - 1$ for 2 Mbit/s interface.

6.2 Automatic Transmit Power Control (ATPC)

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

ATPC is an optional feature. If ATPC is implemented the range shall not be less than 10 dB.

NOTE: For hop lengths of more than about 25 km which are of interest at least in the 13 GHz band, the ATPC device with a range of 15 dB may be required.

Equipment with ATPC will be subject to Manufacturer declaration of ATPC ranges and related tolerances. Testing shall be carried out with output power level corresponding to:

- ATPC set manually to a fixed value for system performance;
- ATPC set at maximum provided power for Tx performance.

Further information on ATPC is given in an informative annex (see clause A.2).

6.3 RF Spectrum Masks

The System shall comply with the RF spectrum mask shown in figure 2 referenced to point B'. The objective of this mask is to provide the required NFD between adjacent channels with a copolar spacing of about 14 MHz. With the mask shown in figure 2 a calculated NFD of about 32 dB is achieved. However taking into account the real spectrum shape the NFD will be about 36 dB.

NOTE: On short hops or in cases where there is no interference from an adjacent channel ATPC is not required. For hop lengths of more than about 25 km which are of interest at least at the 13 GHz band, ATPC in connection with a NFD of more than 39 dB may be required.

The mask shall be measured with a modulating baseband signal. In the case of a PDH interface, a PRBS with a length of $2^{23} - 1$ for 34 Mbit/s interface and a length of $2^{15} - 1$ for 2 Mbit/s interface, shall be used. In the case of a SDH interface, a STM-1 test signal shall be defined.

The 0 dB level shown on the spectrum mask relates to the spectral power density of the actual centre frequency disregarding residual carrier (SRL). The mask is measured with a transmit output power equal to the nominal value and it shall be met in all ATPC conditions.

The mask does not include frequency tolerance.

The spectrum analyser settings for measuring the RF spectrum mask detailed in figure 2 are shown in table 2.

Table 2: Spectrum Analyser Settings

Parameter	Setting
IF Bandwidth	100 kHz
Total Sweep Width	200 MHz
Total Scan Time	"Auto."
Video Filter Bandwidth	0,3 kHz

6.4 Spectral Lines at the Symbol Rate

The RF spectrum mask shall not apply to the spectral lines at the symbol rate.

The power level of these spectral lines at a distance from the actual channel centre frequency equal to the symbol rate shall be less than -30 dBm (reference point B').

6.5 Spurious Emissions

Spurious Emissions are defined as emissions at frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude emissions which result from the modulation process. The necessary bandwidth is defined as twice the transmitted symbol rate.

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

- a) to limit interference into systems operating wholly externally to the Sub-STM-1 system channel plan;
- b) to limit local interference within the Sub-STM-1 system where transmitters and receivers are directly connected via the filter and branching systems.

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

6.5.1 Spurious Emissions-External

When DE/TM-04040 [28] is published, it shall be used as reference for the level limits until a Recommendation is issued by CEPT. In the meantime refer to the limits stated below.

The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values measured at point C' are:

- 30 MHz to $\leq 21,2$ GHz ≤ -60 dBm in any 100 kHz band;
- $> 21,2$ GHz to 40 GHz ≤ -30 dBm in any 1 MHz band.

6.5.2 Spurious Emissions - Internal

The levels of the spurious emissions from the transmitter, referenced to point B' are specified in the table 3.

Table 3: Spurious Emission Limits - Internal

Spurious Emission Frequency Relative to Assigned Channel Frequency	Specification Limit	Controlling Factor
The level of all spurious signals (including L.O., \pm IF, $\pm 2 \times$ IF)	≤ -90 dBm	If spurious signal's frequency falls within receiver half band and if branching is used on the same polarization.
The level of all spurious signals (including L.O., \pm IF, $\pm 2 \times$ IF)	≤ -45 dBm	If spurious signal's frequency falls within transmitter half band.
The level of all spurious signals (including L.O., \pm IF, $\pm 2 \times$ IF)	≤ -70 dBm	If spurious signal's frequency falls within receiver half band. For digital systems without branching networks (i.e. with duplexer) or on different polarization
NOTE: The values stated in this table are limit values for CW signal as well as 'noise like' signals measured with the bandwidth according to 6.5.1.		

6.6 Radio Frequency Tolerance

Maximum radio frequency tolerance shall not exceed ± 15 ppm. This limit includes both long term ageing and short term effects (e.g. environmental factors).

7 Receiver characteristics

7.1 Local Oscillator Frequency Tolerance

Maximum local oscillator frequency tolerance shall not exceed ± 15 ppm. This limit includes both long term ageing and short term effects (e.g. environmental factors).

7.2 Receiver IF

If, for test and maintenance point purposes, receiver IF frequency(ies) is(are) used, one of them shall be either 35 MHz or 70 MHz or 140 MHz in order to allow the use of standard test equipment.

7.3 Receiver Image(s) Rejection

The receiver image(s) rejection, if applicable, shall be as listed in table 4.

Table 4: Receiver image rejection

Image rejection	Controlling factor
> 90 dB	a) if image frequency falls within receiver half band b) if branching on different polarizations is used.
> 60 dB	c) in a system without branching
> 110 dB	d) if branching on same polarization is used.

The receiver image rejection is referenced to point B.

7.4 Spurious Emissions

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

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

- a) to limit interference into systems operating wholly externally to the Sub-STM-1 system channel plan;
- b) to limit local interference within the Sub-STM-1 system where transmitters and receivers are directly connected via the filter and branching systems.

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

7.4.1 Spurious Emissions-External

When DE/TM-04040 [28] is published, it shall be used as reference for the level limits until a Recommendation is issued by CEPT. In the meantime refer to the limits stated below.

The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values measured at point C are:

- 30 MHz to $\leq 21,2$ GHz ≤ -60 dBm in any 100 kHz band;
- $> 21,2$ GHz to 40 GHz ≤ -30 dBm in any 1 MHz band.

7.4.2 Spurious Emissions - Internal

For spurious emissions at the local oscillator frequency provisional limits, referenced to point B, are specified in table 5.

Table 5: Limits of Spurious Emissions-Internal

Specification Limit	
≤ -110 dBm	For systems with branching on the same polarization
≤ -90 dBm	For systems without branching networks (i.e. with duplexer) or on different polarization
NOTE: The values stated in this table are limit values for CW signal as well as 'noise like' signals measured with the bandwidth according to subclause 7.4.1.	

7.5 Input Level Range

The input level range for a BER= 10^{-3} shall extend from the upper limit of -17 dBm or more to the limit specified for BER= 10^{-3} in subclause 8.2

The input level range for a BER= 10^{-10} shall extend from the upper limit of -21 dBm or more to the limit specified for BER= 10^{-10} in subclause 8.2

When ATPC is used, the maximum input level for BER = 10^{-3} may be relaxed to -26 dBm and the maximum input level for BER = 10^{-10} may be relaxed to -30 dBm.

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

8 System characteristics

8.1 Equipment Background BER

Equipment background BER is measured under simulated operating conditions over an artificial hop without interference with a signal level referenced at point B which is between 15 dB and 40 dB above the lower limit for receiver input level which gives BER = 10^{-3} .

In a measurement period of 24 hours the number of bit errors shall be less than 10.

8.2 BER as a Function of Receiver Input Level (without interference)

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

The receiver BER thresholds (dBm) referred to point B for BER = 10^{-3} , 10^{-6} and 10^{-10} shall be equal to or lower than those stated in table 6:

Table 6: Receiver sensitivity

BER	Receiver Sensitivity	
	13 GHz,	15 GHz, 18 GHz
10^{-3}	-77 dBm	-76 dBm
10^{-6}	-74 dBm	-73 dBm
10^{-10}	-71 dBm	-70 dBm

8.3 Interference Sensitivity

All receive signal levels and S/I measurements shall be referred to point B of the block diagram in figure 1.

8.3.1 Co-channel Interference Sensitivity

The limits of the co-channel interference sensitivity shall be as given in figure 3.

8.3.1A Method of testing co-channel interference sensitivity.

For a receiver operating at 10^{-3} and 10^{-6} BER threshold given in table 6 in absence of interference signal, the introduction of a single like interferer at the co-channel frequency at a level given in table 7 shall not result in an increase of the threshold level greater than the limits reported in table 7.

The limits of co-channel interference shall be as given in table 7, giving maximum S/I values for 1 dB and 3 dB degradation of the 10^{-6} and 10^{-3} BER limits as given in figure 3.

Table 7: Co-channel Interference Sensitivity (13GHz, 15 GHz and 18 GHz bands)

Description	BER			
	10^{-3}		10^{-6}	
Threshold degradation	1 dB	3 dB	1 dB	3 dB
Signal to Interference level	26 dB	22 dB	30 dB	26,5 dB

8.3.2 Adjacent Channel Sensitivity

The limit of the adjacent channel sensitivity with about 14 MHz spacing shall be as given in figure 4 for the 13 GHz and 15 GHz bands and as in figure 5 for the 18 GHz band respectively.

8.3.2A Method of testing adjacent channel (at about 14 MHz channel spacing) interference sensitivity.

For a receiver operating at 10^{-3} and 10^{-6} BER threshold given in table 6 in absence of interference signal, the introduction of a single like interferer at the adjacent-channel frequency at a level given in table 8 shall not result in an increase of the threshold level greater than the limits reported in table 8.

The limits of adjacent channel interference shall be as given in table 8, giving maximum S/I values for 1 dB and 3 dB degradation of the 10^{-6} BER and 10^{-3} BER limits as given in figure 4 and figure 5 respectively.

Table 8: Adjacent-channel Interference Sensitivity

Description	BER			
	10^{-3}		10^{-6}	
Threshold degradation	1 dB	3 dB	1 dB	3 dB
Channel spacing (about 14 MHz)	S/I	S/I	S/I	S/I
system in the 13 GHz and 15 GHz bands	-10dB	-14dB	-6dB	-9,5dB
system in the 18 GHz band	-6dB	-10dB	-2dB	-5,5dB

8.3.3 C W Spurious Interference

For a receiver operating at the 10^{-6} BER threshold given in table 6, the introduction of a CW interferer at a level of +30 dB, with respect to the 'Wanted' signal at any frequency in the range 1 GHz to 40 GHz, excluding frequencies either side of the wanted frequency by up to twice the co-polar channel spacing, shall not result in a BER greater than 10^{-5} .

This test is designed to identify specific frequencies at which the receiver may have a spurious response: e.g. image frequency, harmonics of the receive filter etc. The test is not intended to imply a relaxed specification at all out-of-band frequencies.

8.4 Distortion Sensitivity

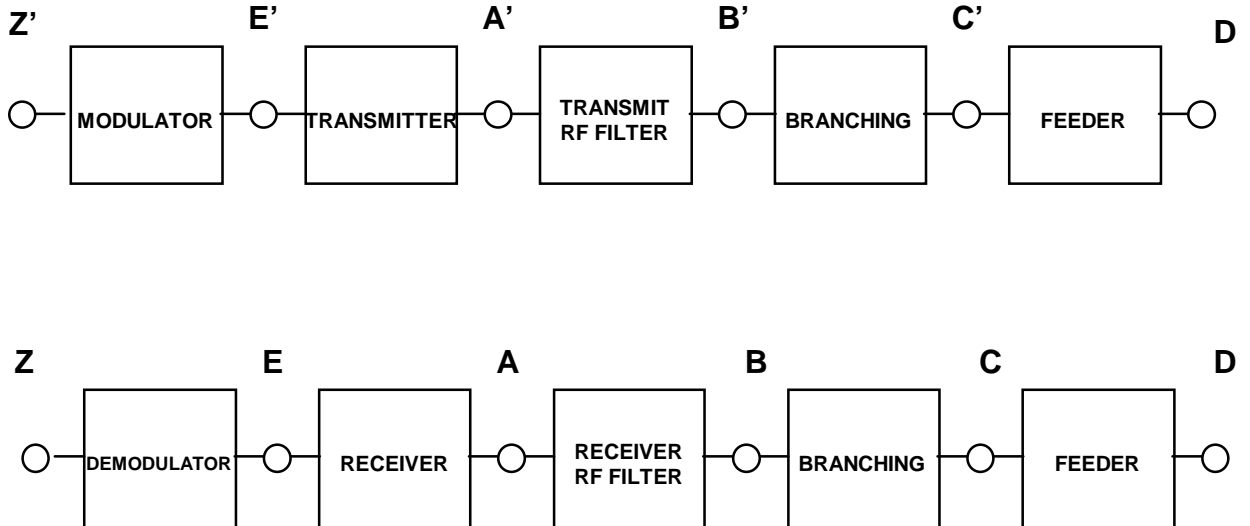
Rainfall may be the main propagation factor limiting performance and availability in the frequency bands envisaged.

For two path propagation with a delay of 6,3 ns and a BER of 10^{-3} the width of the signature shall not exceed ± 9 MHz relative to the assigned channel centre frequency, the depth shall not be less than 17 dB.

For two path propagation with a delay of 6,3 ns and a BER of 10^{-6} the width of the signature shall not exceed ± 11 MHz relative to the assigned channel centre frequency, the depth shall not be less than 15 dB.

These limits are both valid for minimum and non-minimum phase cases. They shall also be verified by the loss-of-synchronization and re-acquisition of synchronization signatures (see IEC 835-2 [41] clauses 4 and 8).

The measurement of the signatures are carried out without interference.

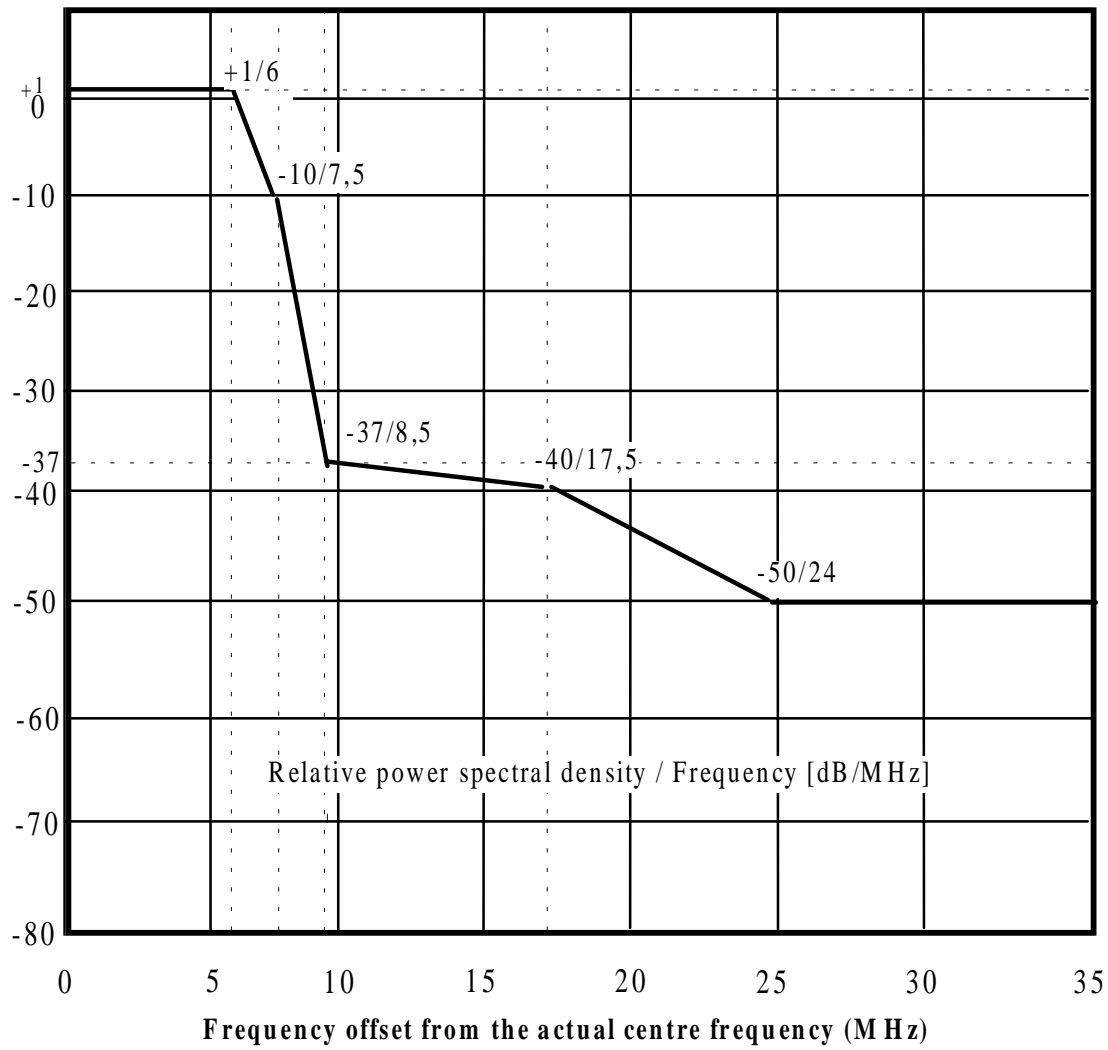


NOTE 1: Points B and C, B' and C' may coincide.

NOTE 2: In outdoor equipment the branching network may be implemented by a common Tx-Rx duplex.

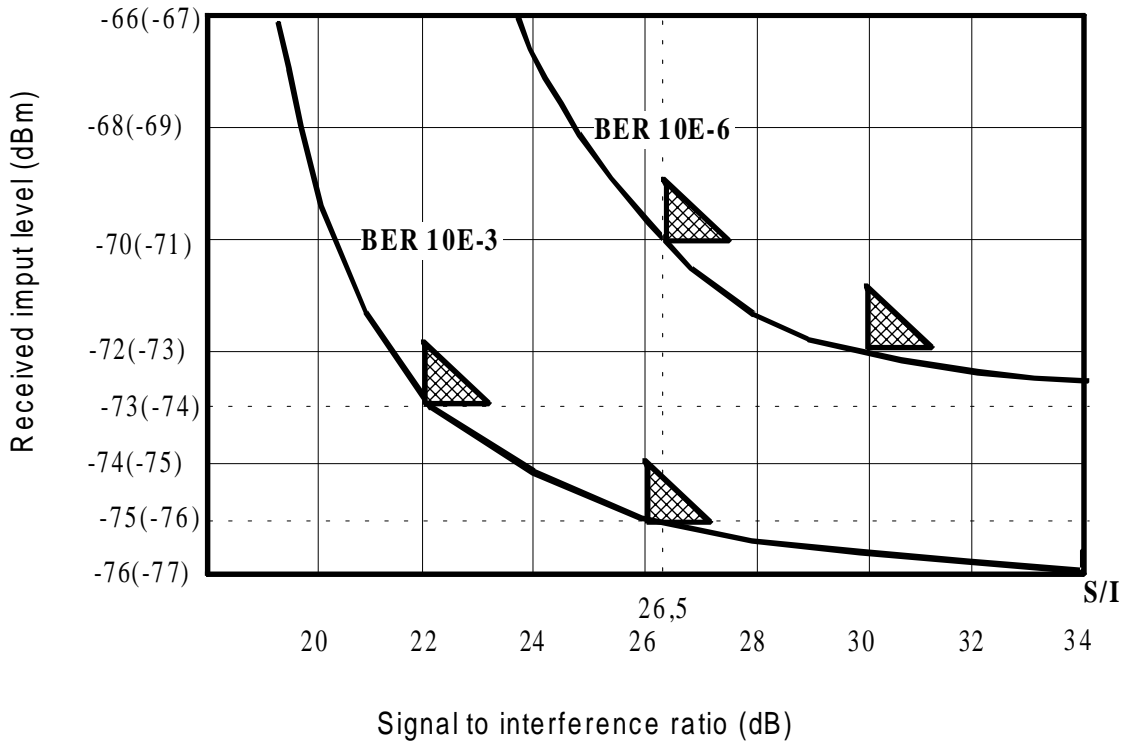
NOTE 3: For the purpose of the defining the measurement points, the branching network does not include a hybrid.

Figure 1: Block diagram



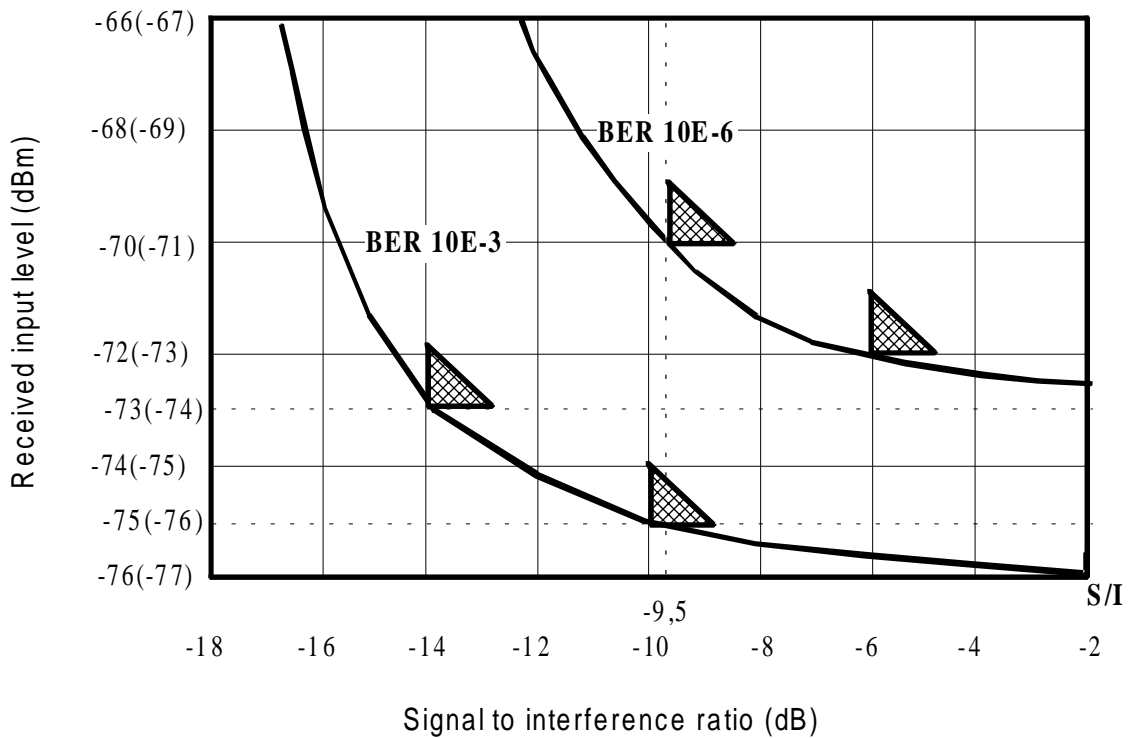
NOTE: The mask does not include the frequency tolerance.

Figure 2: Power Spectral Density Mask



NOTE: Values for received input level refer to the 15 GHz and 18 GHz bands, values in brackets refer to 13 GHz band.

Figure 3: Limits of co-channel interference, referred to point B, for the systems in the bands 13 GHz, 15 GHz and 18 GHz



NOTE: Values for received input level refer to the 15 GHz and 18 GHz bands, values in brackets refer to 13 GHz band.

Figure 4: Limits of adjacent channel interference, referred to point B, for systems in the 13 GHz and 15 GHz bands

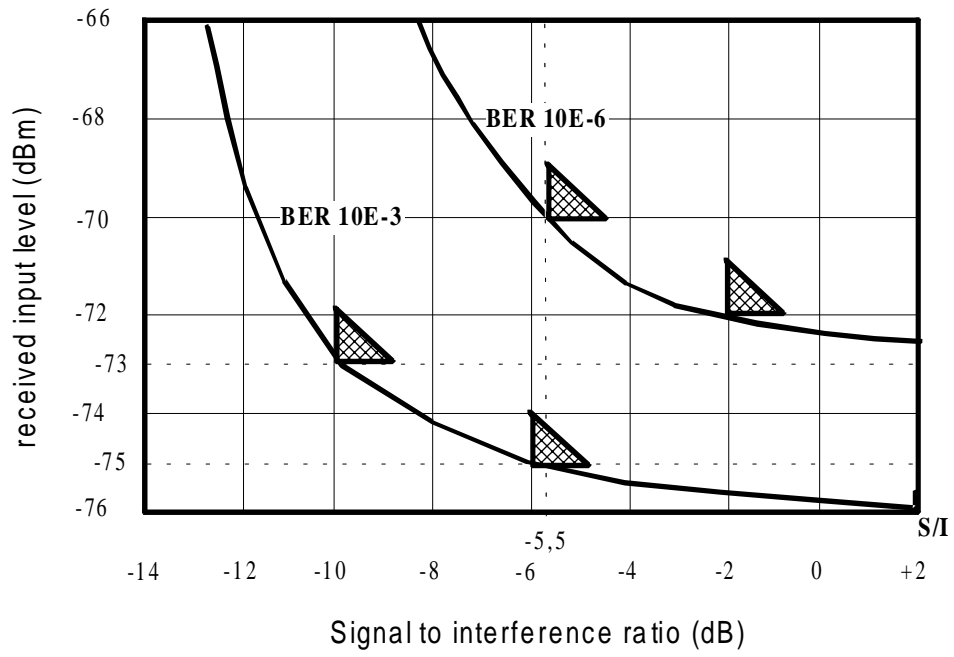


Figure 5: Limits of adjacent channel interference, referred to point B, for systems in the 18 GHz band

Annex A (informative): Additional information

A.1 Branching / feeder / antenna requirement

The parameters and values stated below are important for the system performance characteristics given in the present document and have to be taken into account when connecting an antenna system to the equipment.

A.1.1 Antenna requirements

TM4 has started activities to standardize antennas radiation patterns and integral antennas which are defined in ETS 300 833 [26].

A.1.1.1 Antenna radiation patterns

See ETS 300 833 [26].

A.1.1.2 Return Loss

Minimum return loss measured in the direction toward the antenna at point C or C' should be not less than 23 dB. This limit applies in a frequency band greater than or equal to 1,3 times the maximum symbol frequency away from the actual centre frequency used for the equipment referred to the nominal Tx and Rx channels centre frequencies.

For partially outdoor equipment using a duplexer the minimum return loss at point C' or C in the direction toward the antenna should be not less than 20 dB. This limit applies in a frequency band greater than or equal to 1,3 times the maximum symbol frequency used for the equipment referred to the nominal Tx and Rx channels centre frequencies.

A.2 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.

Automatic Transmit Power Control (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 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 because in frequency ranges above 13 GHz the main limiting factors are given by non-selective fading events.

Bibliography

ITU-R Recommendation F.403: "Intermediate-frequency characteristics for interconnection of analogue radio-relay systems".

ITU-R Recommendation F.746: "Radio-frequency channel arrangements for radio-relays systems".

History

Document history			
August 1996	Public Enquiry	PE 112:	1996-08-19 to 1996-12-13
August 1998	Vote	V 9843:	1998-08-25 to 1998-10-23