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*European Standard (Telecommunications series)*

**Fixed Radio Systems;  
Point-to-multipoint equipment;  
Frequency Hopping Code Division  
Multiple Access (FH-CDMA);  
Point-to-multipoint digital radio systems  
in frequency bands in the range 3 GHz to 11 GHz**

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**Reference**

REN/TM-04111-21

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**Keywords**CDMA, DRRS, multipoint, radio, RLL,  
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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 present document is a revision of EN 301 253 (V1.1.1), in which the clauses 3.3 and 5.4.3 have been modified to take into account the additional requirements for spectral lines present in the spectrum. The OAP only applies to these clauses.

The former title of the present document was "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Frequency Hopping Code Division Multiple Access (FH-CDMA); Point-to-multipoint DRRS in frequency bands in the range 3 GHz to 11 GHz".

<b>Proposed national transposition dates</b>	
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

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## Introduction

The main field of application of Point-to-Multipoint (P-MP) Systems is to provide access to both public and private networks (Public Switched Telephone Network (PSTN), Private Data Network (PDN),...). By means of P-MP systems the network service area may be extended to cover both distant and scattered subscriber locations; and the systems may be applied to build new access networks covering both urban and rural areas.

Subscribers are offered the full range of services by the particular public or private network. Subscribers have access to these services by means of the various standardized user network interfaces (2-wire loop, new data services).

P-MP systems provide standard network interfaces and transparently connect subscribers to the appropriate network node. These systems allow a service to be connected to a number of subscribers ranging from a few to several thousand, and over a wide range of distances.

P-MP systems are generally configured as Pre-Assigned Multiple Access (PAMA) Radio Systems or as Demand Assigned Multiple Access (DAMA) Radio Systems.

The essential features of a typical P-MP DAMA Radio System are:

- efficient use of the radio spectrum;
- concentration;
- transparency.

Radio is often the ideal way of obtaining communications at low cost and almost independent of distance, and difficult topography. Moreover, a small number of sites is required for these installations, thus facilitating rapid implementation and minimizing maintenance requirements of the systems.

Concentration means that  $m$  subscribers can share  $n$  radio channels ( $m$  being larger than  $n$ ), allowing better use to be made of the available frequency spectrum and at a lower equipment cost. The term "multi-access" means that every subscriber has access to every channel (instead of a fixed assignment as in most multiplex systems). When a call is initiated an available channel is allocated to it. When the call is terminated, the channel is released for another call.

Concentration requires the use of distributed intelligent control which in turn allows many other operation and maintenance functions to be added.

Transparency means that the exchange and the subscriber equipment communicate with each other without being aware of the radio link.

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# 1 Scope

## 1.1 Applications

The scope of the present document covers the following typical P-MP applications, delivered directly or indirectly, or in any superimposed transport network layer:

- voice;
- fax;
- voiceband data;
- telex;
- data;
- integrated Services Digital Network (ISDN);
- Internet access.

## 1.2 Frequency bands and channel arrangements

The present document covers Fixed Service allocations in the 3 GHz to 11 GHz bands. Bands presently identified and provided with specific channel arrangements by CEPT for point to multipoint applications between 3 GHz and 11 GHz are:

- 3 410 MHz to 3 600 MHz CEPT/ERC Recommendation 14-03 [3];
- 3 600 MHz to 4 200 MHz CEPT/ERC Recommendation 12-08 [2];
- 10,15 GHz to 10,3 GHz paired with 10,50 GHz to 10,65 GHz CEPT/ERC Recommendation 12-05 [1].

The present document may cover equipment which uses either Frequency Division Duplexing or Time Division Duplexing.

NOTE: As with other point-to-multipoint standards, attention should be given to assigning spectrum so as to allow different systems to operate in adjacent assigned frequencies without unacceptable mutual interference. This is the responsibility of the regulatory authorities who are advised to note any guidelines produced by CEPT, particularly those with reference to spectrum where different duplex methods are to be used.

## 1.3 Access Method

The standard covers Frequency Hopping (FH) - Code Division Multiple Access (FH-CDMA) systems.

NOTE: The method described in the present document applies slow FH defined in TR 101 274 [30], with a hopping period up to 400 ms. During the dwell time, several different links in the same area may operate on different sub-channels in a manner which resembles the characteristics and properties of FDMA systems. The sub-channel supporting each link may be further subdivided using frequency division, time division or a combination of both techniques. (The terms "hopping period", "dwell time" and "sub-channel" are defined in clause 3.1).

## 1.4 Compatibility

The present document is not intended to ensure that a Central Station (CS) from one manufacturer will inter-operate with a Terminal Station (TS) or Repeater Station (RS) from another manufacturer.

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## 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] CEPT/ERC Recommendation 12-05: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10,0 - 10,68 GHz".
- [2] 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".
- [3] CEPT/ERC Recommendation 14-03: "Harmonized radio frequency channel arrangements for low and medium capacity systems in the band 3 400 MHz to 3 600 MHz".
- [4] ETSI ETS 300 012: "Integrated Services Digital Network (ISDN); Basic user-network interface Layer 1 specification and test principles".
- [5] ETSI ETS 300 019: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".
- [6] ETSI ETS 300 132: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment".
- [7] 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".
- [8] ETSI ETS 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".
- [9] ETSI ETS 300 324: "V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN)".
- [10] ETSI ETS 300 347: "V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN)".
- [11] ETSI EN 300 385: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment".
- [12] IEC 60169: "Radio-frequency connectors".
- [13] IEC 60339: "General purpose rigid coaxial transmission lines and their associated flange connectors".
- [14] 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".
- [15] 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".
- [16] ITU-T Recommendation G.131: "Control of talker echo".

- [17] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
- [18] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".
- [19] ITU-T Recommendation G.723.1: "Dual rate speech coder for multimedia communications transmitting at 5,3 and 6,3 kbit/s".
- [20] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".
- [21] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".
- [22] ITU-T Recommendation G.729: "C source code and test vectors for implementation verification of the G.729 8 kbit/s CS-ACELP speech coder".
- [23] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".
- [24] 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".
- [25] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".
- [26] ITU-T Recommendation G.827: "Availability parameters and objectives for path elements of international constant bit-rate digital paths at or above the primary rate".
- [27] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".
- [28] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of digital exchanges".
- [29] ITU-T Recommendation R.20: "Telegraph modem for subscriber lines".
- [30] ETSI TR 101 274: "Transmission and Multiplexing (TM); Digital Radio Relay Systems (DRRS); Point-to-multipoint DRRS in the access network: Overview of different access techniques".
- [31] CEPT/ERC Recommendation 74-01: "Spurious emissions".
- [32] ISO/IEC 8802-3: "Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".
- [33] ITU-T Recommendation V series: "Data communication over the telephone network".
- [34] ITU-T Recommendation X series: "Data networks and open system communications".

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## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

**Radio Frequency channel (RF channel):** partition of a radio frequency band as assigned by the authorities in accordance with CEPT or ITU-R Recommendations on channel arrangement (see figure 1)

NOTE: CEPT/ERC Recommendation 14-03 [3] allows considerable flexibility for national authorities to define their channel plans. For example, some plans may be based on 1,75 MHz, 3,5 MHz, 7 MHz and 14 MHz channels and others may be based on 5 MHz, 10 MHz, 15 MHz, 20 MHz, 30 MHz and 40 MHz channels - but these are not the only RF arrangements compatible with CEPT/ERC Recommendation 14-03 [3]. Considerable flexibility is also allowed by CEPT/ERC Recommendation 12-08 [2] and CEPT/ERC Recommendation 12-05 [1]. No specific channel plan is assumed by the present document, but certain tables show values of parameters for 1,75 MHz, 3,5 MHz, 7 MHz and 14 MHz channels as examples only, with general expressions given for parameter values corresponding to other channels.

**channel spacing:** separation between the centre frequencies of neighbouring RF channels. In cases where the RF channel is not clearly defined, or where the channel spacing is less than the manufacturer's declared sub-channel bandwidth, the channel spacing is defined as the minimum continuous segment of bandwidth made available to the FH-CDMA system

**assigned band:** aggregation of all RF channels assigned to a FH-CDMA system. The assigned band may consist of several non-contiguous RF channels (see figure 1)

**sub-channel:** integer sub-division of the RF channel(s) as determined by the equipment manufacturer (see figure 1)

**Frequency Hopping (FH):** spread spectrum technique whereby individual radio links are continually switched from one sub-channel to another. Such links are not constrained to a single RF channel

**dwelt time:** duration of a transmission on a particular sub-channel

**transition time:** period between successive transmissions on different sub-channels during which no transmission is made

**hopping sequence:** sequence of sub-channels which a particular link follows

**hopping period:** time between the starts of successive transmissions on a different sub-channel. This is the sum of dwell time and transition time

**slow frequency hopping:** FH technique where the hopping period is larger than the symbol period

**round trip delay:** sum of the delays from points F to G and from G to F in figure 2, including any repeaters if appropriate

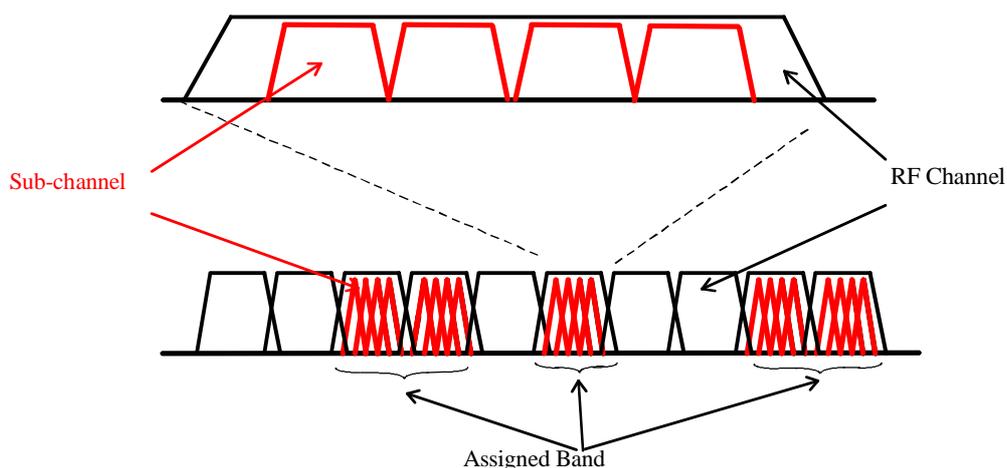


Figure 1: Relationship between "sub-channel", "RF channel" and "assigned band"

## 3.2 Symbols

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

dB	decibel
dBm	decibel relative to 1 mW
GHz	Gigahertz
Hz	Hertz
kbit/s	kilobits per second
kHz	kilohertz
Mbit/s	millions of bits per second
MHz	Megahertz
ms	millisecond
mW	milliwatt
ppm	parts per million
s	second
V	volt
$\Omega$	ohm

## 3.3 Abbreviations

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

AC	Alternating Current
ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
BW	BandWidth
CCS	Central Controller Station
CRS	Central Radio Station
CS	Central Station
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
<u>CSmin</u>	<u>minimum practical Channel Separation (for a given radio-frequency channel arrangement)</u>
CW	Continuous Wave
DAMA	Demand Assigned Multiple Access
EMC	ElectroMagnetic Compatibility
$F_0$	Centre of an radio frequency channel
FH	Frequency Hopping
FH-CDMA	Frequency Hopping Code Division Multiple Access
FSK	Frequency Shift Keying
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
MOS	Mean Opinion Score

PAMA	Pre-Assigned Multiple Access
PDN	Private Data Network
P-MP	Point-to-MultiPoint
PRBS	Pseudo Random Bit Sequence
PSTN	Public Switched Telephone Network
QDU	Quantization Distortion Unit
RF	Radio frequency
RS	Repeater Station
RTPC	Remote Transmit Power Control
Rx	Receiver
TE	Terminal Equipment
TMN	Telecommunications Management Network
TS	Terminal Station
Tx	Transmitter

## 4 General system architecture

A system could consist of physical sub systems as follows (see figure 2).

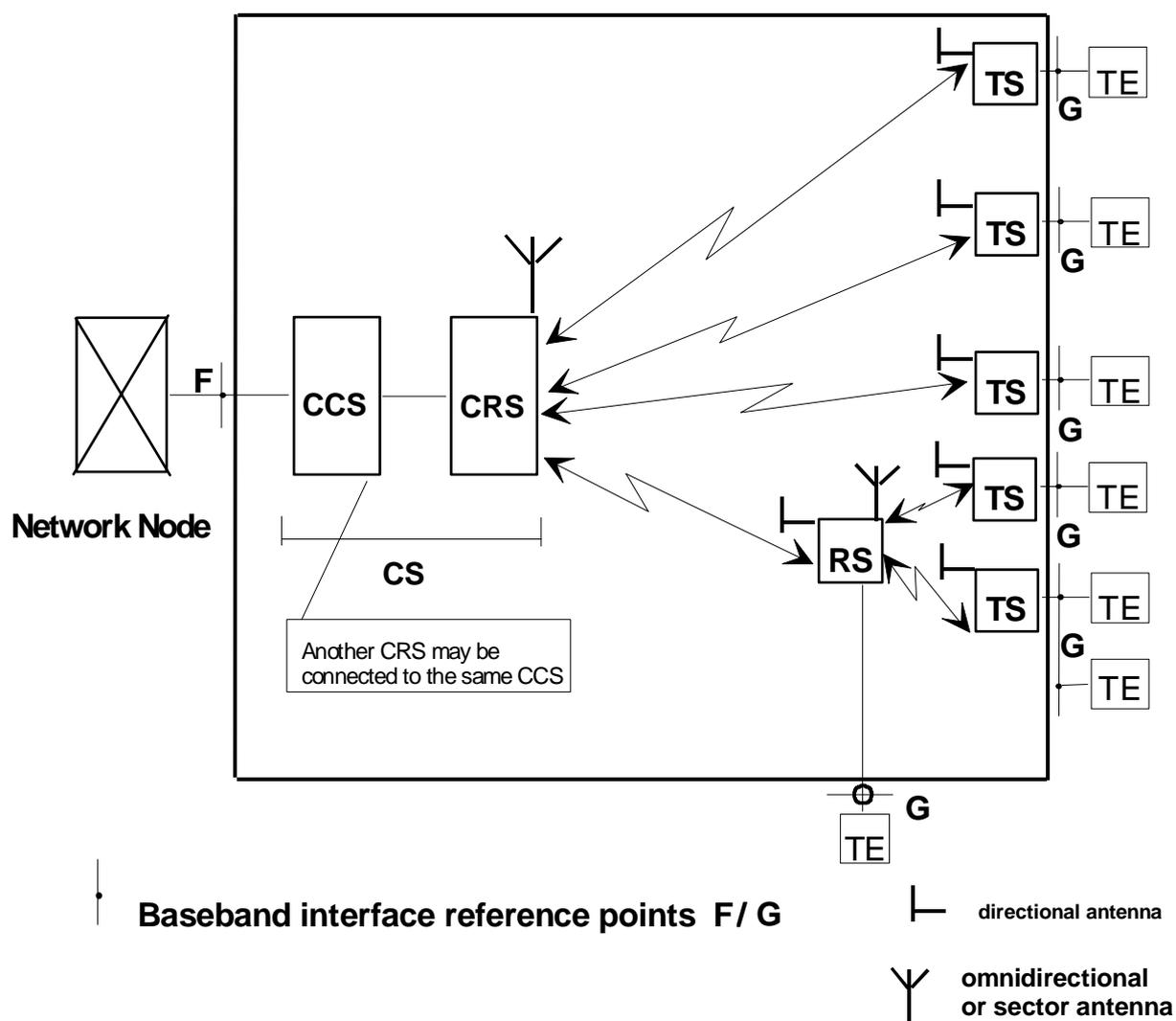


Figure 2: General System Architecture

## 4.1 Sub-System Components

- TS:** Terminal station (TS) (outstations with subscriber interfaces). A TS may serve more than one Terminal Equipment (TE).
- RS:** Repeater Station (radio repeater outstations with or without subscriber interfaces). A RS may serve one or more TS.
- F:** Point of connection to the network node (such as a local switch).
- G:** Point(s) of connection for subscriber equipment.
- CS:** Central Station (CS) which may be subdivided into two units:
- the Central Controller Station (**CCS**) also called the exchange unit which is the interface to the local switch;
  - the Central Radio Station (**CRS**) also called the radio unit which is the central baseband/radio transceiver equipment. More than one CRS may be controlled by one CCS.

The central station performs the interconnection with the network node (local exchange) carrying out a concentration function by sharing the total number of available channels in the system. The central station is linked by microwave transmission paths to each TS either directly or via one or more RS.

Whenever an existing digital transmission link is available, the network implementation can be optimized by separating the CCS, installed at the exchange site, and the CRS.

The general characteristics which are typical for P-MP systems are considered in the present document. These characteristics have been categorized under four headings.

- 1) System characteristics.
- 2) Radio characteristics.
- 3) Types of subscriber equipment and network exchange interface.
- 4) Power supply and environmental characteristics.

## 4.2 System characteristics

### 4.2.1 Transmission Error Performance

Equipment with system rate lower than  $32 \times 64$  kbit/s, or equivalent, shall be designed in order to meet network performance and availability requirements specified by ITU-T Recommendation G.821 [24] following the criteria defined in ITU-R Recommendation F.697-2 [14] for the local grade portion of the digital connection.

Equipment with system rate equal to or higher than  $32 \times 64$  kbit/s, or equivalent, shall be designed in order to meet network performance and availability requirements foreseen by ITU-T Recommendations G.826 [25] and G.827 [26] following criteria defined in ITU-R Recommendations F.1189-1 [15] and ITU-R Recommendation F.697-2 [14] for the national portion of the digital connection.

### 4.2.2 Round Trip Delay

The round trip delay for a 64 kbit/s traffic channel shall not exceed 20 ms.

Longer round trip delays may result at other bit rates and when using speech coding at rates lower than 64 kbit/s. In order to guarantee that the additional delay introduced by the system into the transmission network does not degrade the quality of telephone communication, compliance with ITU-T Recommendation G.131 [16] shall be ensured.

### 4.2.3 Transparency and voice coding methods

The system shall be transparent: the exchange and the subscriber equipment (points F and G in figure 2) communicate with each other without being aware of the radio link. The system should be transparent to analogue or digital subscriber equipment and to voiceband data signals. However, advantage may be taken of coding methods at rates lower than 64 kbit/s to conserve radio spectrum, provided that the above transparency is maintained.

At least one of the following standard coding methods could be employed:

- 64 kbit/s: ITU-T Recommendation G.711 [18]  
(which will permit full transparency and a direct digital interface to digital switches);
- 32 kbit/s: ITU-T Recommendation G.726 [20];
- 16 kbit/s: ITU-T Recommendation G.728 [21];
- 8 kbit/s: ITU-T Recommendation G.729 [22];
- 6,3 kbit/s: ITU-T Recommendation G.723.1 [19].

Other voice coding methods may be employed if the quality (measured for example in Quantization Distortion Unit (QDU) or Mean Opinion Score (MOS)) is equivalent to the above. The coding method used shall be declared by the manufacturer.

### 4.2.4 Telecommunications Management Network (TMN) interface

TMN interface, if any, shall be in accordance with ITU-T Recommendation G.773 [23].

### 4.2.5 Synchronization

Systems employing digital interfaces shall include methods enabling internal and external synchronization to the network.

### 4.2.6 FH characteristics

The hopping period shall not exceed 400 ms.

## 5 Radio characteristics

### 5.1 Frequency bands

The present document is intended to be generic and does not contain specific frequency plans. It may be applied to fixed service allocations in the range 3 GHz to 11 GHz. Bands identified by the Conférence Européenne des administrations des Postes et Télécommunications (CEPT) for P-MP applications in this range are shown in table 1. Assignment of these frequencies is subject to the relevant (national) authorities.

### 5.2 Channel arrangements

**Table 1: Frequency bands**

Frequency band	Band limits	Recommendation
3,5 GHz	3 410 MHz to 3 600 MHz	CEPT/ERC Recommendation 14-03 [3]
3,7 GHz	3 600 MHz to 4 200 MHz	CEPT/ERC Recommendation 12-08 [2]
10,5 GHz	10,15 GHz to 10,3 GHz paired with 10,50 GHz to 10,65 GHz	CEPT/ERC Recommendation 12-05 [1]

## 5.3 Maximum System Capacity

The supplier shall declare the maximum number of simultaneous duplex 64 kbit/s channels or the bit rates which the equipment is designed to carry for each channel spacing supported. Such declared capacity shall not be less than either  $8 \times 64$  kbit/s channels or 500 kbit/s for each 1 MHz of channel spacing. Examples of the required capacity appear in table 2.

**Table 2: System capacity for some typical channel spacings**

Channel spacing (MHz)	1,0	2,0	3,5	7,0	14,0
Minimum number of 64 kbit/s channels	8	16	28	56	112
Equivalent Bit Rate (Mbit/s)	0,5	1,0	1,75	3,5	7,0

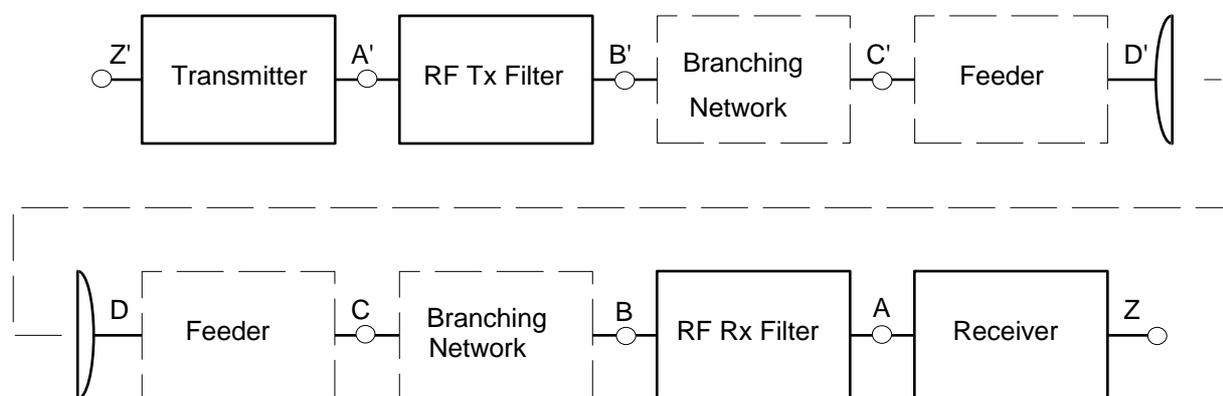
NOTE: Any other equivalent transmission capacity may be transported, e.g. instead of  $112 \times 64$  kbit/s a capacity of  $56 \times 128$  kbit/s can be transmitted.

## 5.4 Transmitter (Tx) characteristics

### 5.4.1 Tx power range

The output power for a fully loaded system shall not exceed 35 dBm at point C' of the RF System block diagram (figure 3), except for the 10,5 GHz band, where the output power shall not exceed 27 dBm. An internal or external means of adjustment shall be provided.

The transmitted output power means the value measured where the output is connected to a dummy load i.e. power meter or spectrum analyser. The transmitter is then modulated with a 64 kbit/s Pseudo Random Bit Sequence (PRBS) test data signal (or lower rate if the system uses compressed voice techniques) to simulate traffic.



NOTE: Points B and C and B' and C' will coincide if branching networks are not used.

**Figure 3: RF System Block diagram**

### 5.4.2 Transmit Power Control

#### 5.4.2.1 Automatic Transmit Power Control (ATPC)

ATPC is an optional feature. Equipment with ATPC will be subject to manufacturer declaration of the ATPC ranges and related tolerances. Testing shall be carried out with output power levels corresponding to:

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

### 5.4.2.2 Remote Transmit Power Control (RTPC)

RTPC is an optional feature. Equipment with RTPC will be subject to manufacturer declaration of the RTPC ranges and related tolerances. Testing shall be carried out with output power levels corresponding to:

- RTPC set manually to the maximum and to the minimum values for system performance;
- RTPC set at a maximum provided output power for Tx performance;
- RF spectrum mask shall be verified at three points (lower medium and upper part of the assigned band) if applicable. Tx power control shall be set to the maximum value.

### 5.4.3 Spectrum Mask

#### 5.4.3.1 Spectrum density mask

The spectrum mask is given in figure 4. No allowance is made for frequency tolerance.

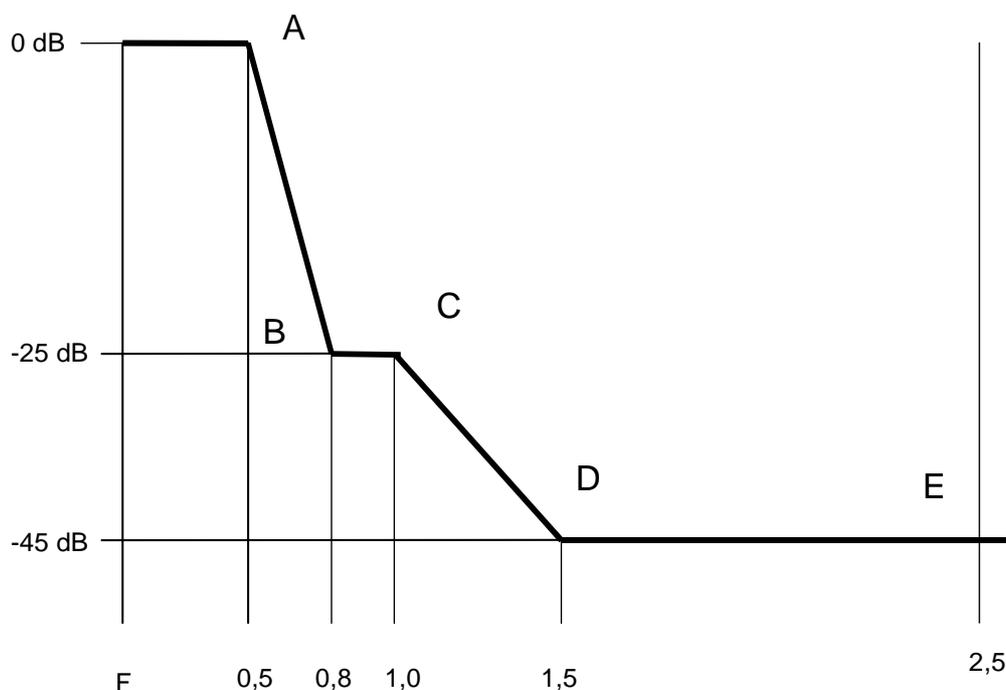
The transmitted output power spectrum is defined as: the spectrum when modulated with a test data signal that simulates a system operating with all sub-channels in the RF channel occupied.

The spectrum measurement at point C' of RF system block diagram in figure 3, shall be performed with the maximum hold function on the spectrum analyser selected.

The reference level of the output spectrum means that the 0 dB level is the top of the modulated spectrum, disregarding the residual carrier.

**Table 3: Spectrum analyser settings**

Resolution BW	Video BW	Sweep time
30 kHz	300 Hz	10 s
NOTE: Where practical, the Spectrum Analyser sweep should be synchronized to the hopping sequence.		



**Figure 4: Frequency Hopping Code Division Multiple Access (FH-CDMA) spectrum mask normalized for channel spacing**

Table 4: Spectrum mask reference points for typical channel spacings

Relative Level→	Point A 0 dB	Point B -25 dB	Point C -25 dB	Point D -45 dB	Point E -45 dB
Channel spacing (MHz) ↓	0,5 x Channel spacing (MHz)	0,8 x Channel spacing (MHz)	1,0 x Channel spacing (MHz)	1,5 x Channel spacing (MHz)	2,5 x Channel spacing (MHz)
1,0	0,5	0,8	1,0	1,5	2,5
2,0	1,0	1,6	2,0	3,0	5,0
3,5	1,75	2,8	3,5	5,25	8,75
7,0	3,5	5,6	7,0	10,5	17,5
14,0	7,0	11,2	14,0	21,0	35,0

NOTE: For other channel spacings, points A, B, C, D, E are derived from the expression in the second row of this table.

#### 5.4.3.2 Discrete CW components exceeding the spectrum mask limit (all stations)

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  $\{10 \log (CS_{\min}/IF_{bw}) - 10\}$  dB (note);
- be spaced each other in frequency by less than  $CS_{\min}$ .

Where:

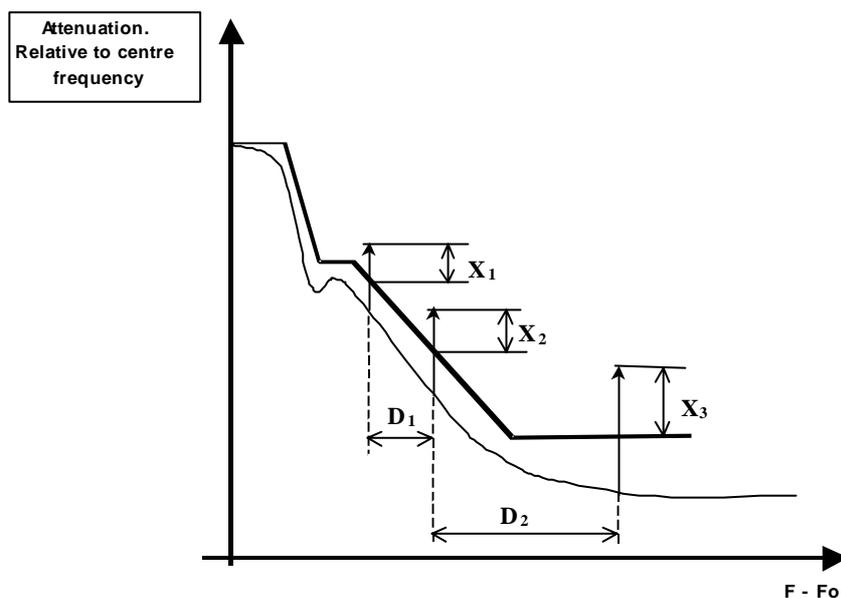
$CS_{\min} = 500$  kHz for 3,5 and 3,7 GHz bands.

$CS_{\min} = 1\ 500$  kHz for 10,5 GHz band.

$IF_{bw}$  is the recommended resolution bandwidth, expressed in kHz reported in table 3.

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

Figure 5 shows a typical example of this requirement.



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

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

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

#### 5.4.4 Transmitter spurious emissions

Outside the frequency range  $\pm 250\%$  of the relevant channel spacing, across the nominal centre frequency, CEPT/ERC Recommendation 74-01 [31] shall apply.

#### 5.4.5 Radio Frequency (RF) tolerance

Maximum RF tolerance shall not exceed 20 ppm. This includes both short term factors and long term ageing effects. For the purpose of type testing, the manufacturer shall state the guaranteed short term part and the expected ageing part.

### 5.5 Receiver (Rx) Characteristics

#### 5.5.1 Input level range

The Bit Error Ratio (BER) shall be less than  $10^{-3}$  for an input level range which exceeds 40 dB.

#### 5.5.2 Spurious Emissions

CEPT/ERC Recommendation 74-01 [31] shall apply.

### 5.5.3 BER Performance

With all sub-channels in the RF channel occupied, the BER versus receive signal power level, referred to point C of the system block diagram (See figure 3) shall be equal to, or better than, the values in table 5.

**Table 5: Receiver input levels (dBm) for BER  $10^{-3}$  and  $10^{-6}$  at various bit rates**

Bit rate	BER $10^{-3}$ (dBm)	BER $10^{-6}$ (dBm)
0,5 Mbit/s	-94	-90
1,0 Mbit/s	-91	-87
1,75 Mbit/s	-89	-85
3,5 Mbit/s	-86	-82
7,0 Mbit/s	-83	-79

NOTE: For these systems the reference levels may be calculated from the following formulas:

for BER =  $10^{-3}$   $(-91 + 10 \log_{10}[\text{bit rate Mbit/s}])$  dBm;

for BER =  $10^{-6}$   $(-87 + 10 \log_{10}[\text{bit rate Mbit/s}])$  dBm.

Incoherent demodulation may be used for packet data applications. When incoherent demodulation is used in conjunction with higher order modulation, the receiver input levels indicated in table 5 shall be incremented by 7 dB for 4FSK modulation and incremented by 15 dB for 8FSK modulation.

### 5.5.4 Interference Sensitivity

#### 5.5.4.1 Co channel interference sensitivity

All receive signal levels and interference level measurements are referred to point C of the system block diagram, given in figure 3.

For a system with all sub-channels in the RF channel occupied, each at a level greater by 1 dB or 3 dB than the level specified in table 5, for BER  $10^{-6}$ , an applied additional co-channel interferer with uncorrelated like-modulation, at the levels indicated in table 6, shall not cause the BER to exceed  $10^{-6}$ .

**Table 6: Co-Channel Sensitivity for BER =  $10^{-6}$**

Threshold Degradation →	1 dB	3 dB
Sub-channel Spacing (MHz) ↓	Interference level (dBm)	Interference level (dBm)
1,0	-117	-111
2,0	-114	-108
3,5	-112	-106
7,0	-109	-103
14,0	-106	-100

### 5.5.4.2 Adjacent channel interference sensitivity

All receive signal levels and interference level measurements are referred to point C of the system block diagram, given in figure 3. For a received signal at a level greater by 1 dB or 3 dB than the level specified in table 5, for BER  $10^{-6}$ , an applied additional adjacent channel interferer with uncorrelated like modulation, at the levels indicated in table 7 shall not cause BER to exceed  $10^{-6}$ .

**Table 7: Adjacent Channel Sensitivity for BER =  $10^{-6}$**

Threshold Degradation →	1 dB	3 dB
Sub-channel Spacing (MHz) ↓	Interference level (dBm)	Interference level (dBm)
1,0	-101	-95
2,0	-98	-92
3,5	-96	-90
7,0	-93	-87
14,0	-90	-84

### 5.5.4.3 Broadband Continuous Wave (CW) interference rejection capability

For a Rx operating at the received signal level specified in clause 5.5.3 for  $10^{-6}$  BER threshold, the introduction of a CW interferer at a level of + 30 dB with respect to the wanted signal and at any frequency up to 26 GHz, excluding frequencies up to 450 % of the channel spacing either side of the assigned band, shall not result in a BER greater than  $10^{-5}$ . This is considered equivalent to a 1 dB degradation of the  $10^{-6}$  BER threshold.

## 5.6 Antenna Port Characteristics

### 5.6.1 RF interface

For equipment without an integral antenna, the RF interface at reference points C and C' of the RF system block diagram (figure 3) shall be either coaxial  $50 \Omega$  or an appropriate IEC normalized wave guide flange. The coaxial  $50 \Omega$  connectors shall conform with IEC 60169 [12] or IEC 60339 [13].

### 5.6.2 Return loss

For equipment without an integral antenna, the return loss at reference points C and C' of the RF system block diagram (figure 3) shall be more than 10 dB at the reference impedance.

## 6 Types of subscriber equipment and network exchange interface

The equipment covered by the present document shall use one or more ITU,ETSI or ISO/IEC (JTC1) standardized interfaces, the more common of which are listed in table 8.

**Table 8: Types of interface**

<b>Subscriber Equipment Interfaces</b>	
Analogue (2 wires)	ITU-T Recommendation Q.552 [27]
Analogue (4 W + E and M)	ITU-T Recommendation Q.553 [28]
Telex	ITU-T Recommendation R.20 [29] and ITU-T Recommendation V series [33]
Digital data port	ITU-T Recommendation G.703 [17], ITU-T Recommendation X series [34] and ITU-T Recommendation V series [33]
ISDN basic rate	ETS 300 012 [4]
CSMA/CD Ethernet interface	ISO/IEC 8802-3 [32]
<b>Network Interfaces</b>	
2 Mbit/s	ITU-T Recommendation G.703 [17]
Analogue (2 wires)	ITU-T Recommendation Q.552 [27]
Analogue (4 W + E and M)	ITU-T Recommendation Q.553 [28]
Telex	ITU-T Recommendation R.20 [29] and ITU-T Recommendation V series [33]
Digital data port	ITU-T Recommendation G.703 [17], ITU-T Recommendation X series [34] and ITU-T Recommendation V series [33]
ISDN basic rate	ETS 300 012 [4]
ISDN + Analogue subscribers + Leased lines 2 Mbit/s Interface	V5.1/V5.2 (ETS 300 324 [9]/ETS 300 347 [10]) ITU-T Recommendation G.703 [17]
CSMA/CD Ethernet interface	ISO/IEC 8802-3 [32]
NOTE:	Further ITU, ETSI or ISO/IEC (JTC1) standardized interfaces may be implemented. The use of non-standardized interfaces is outside the scope of the present document.

## 7 Power supply and environmental characteristics

### 7.1 Power Supply

If the power supply operates at one or more nominal voltages and ranges foreseen by ETS 300 132 [6], then the power supply interface shall be in accordance with the corresponding parts of that ETS. For 230 V AC and 48 V DC, the interfaces shall be in accordance with the characteristics foreseen by ETS 300 132-1 [7], and ETS 300 132-2 [8], respectively.

NOTE: Some applications may require power supply nominal voltages and ranges that are not covered by ETS 300 132 [6].

### 7.2 Environmental Conditions

The equipment shall meet the environmental conditions set out in ETS 300 019 [5] which defines weather-protected and non weather-protected locations classes and test severity.

### 7.2.1 Equipment within weather-protected locations

Equipment intended for operation in temperature controlled locations or partially temperature controlled locations shall meet the requirements of ETS 300 019 [5] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [5] classes 3.3 (Non-temperature controlled locations), 3.4 (Sites with heat trap) and 3.5 (Sheltered locations) may be applied.

### 7.2.2 Equipment for non weather-protected locations

Equipment intended for operation in non weather-protected locations shall meet the requirements of ETS 300 019 [5], class 4.1 or 4.1E.

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

Weather-protected equipment conforming to class 3.3, 3.4, 3.5 together with an enclosure or cabinet may fulfil the requirements for operating in a non weather-protected environment but this is outside the scope of the present document.

## 7.3 ElectroMagnetic Compatibility (EMC) Conditions

Equipment shall operate under the conditions of EN 300 385 [11].

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## Bibliography

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.

ETSI EN 300 339: "Electromagnetic Compatibility and Radio spectrum Matters (ERM); General ElectroMagnetic Compatibility (EMC) for radio communications equipment".

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

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## History

<b>Document history</b>		
V1.1.1	November 1999	Publication
V1.2.1	October 2000	One-step Approval Procedure OAP 20010216: 2000-10-18 to 2001-02-16