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*European Standard (Telecommunications series)*

**Fixed Radio Systems;  
Point-to-multipoint equipment;  
Time Division Multiple Access (TDMA);  
Point-to-multipoint digital radio systems  
in frequency bands in the range 3 GHz to 11 GHz**

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Reference

REN/TM-04146

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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.

| <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 Networks (PSTN), Private Data Networks (PDN)). By means of P-MP systems the network service area may be extended to cover both distant and scattered user locations and the systems may be applied to build new access networks covering both urban and rural areas.

Users are offered the full range of services by the particular public or private network. Users have access to these services by means of the various standardized user network interfaces (2 wire loop, new data services and Integrated Services Digital Network (ISDN) ranging from basic rate to  $n \times$  primary rate).

P-MP systems provide standard network interfaces and transparently connect users to the appropriate network node. These systems allow a service to be connected to a number of users ranging from a few to several thousands 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 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 over difficult topography. Moreover, a small number of sites are required for these installations, thus facilitating rapid implementation and minimizing maintenance requirements of the systems.

Concentration means that "m" users can share "n" radio channels (m being larger than n), allowing a better use to be made of the available frequency spectrum and at a lower equipment cost. The term "multi-access" derives from the fact that every user has access to every channel (instead of a fixed assignment as in most multiplex systems). When a demand arises an available channel (or channels) is allocated to it. When the demand is terminated, the channel is released for other use.

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 network node and the user terminal communicate with each other without being aware of the radio path.

Efficient use of the radio spectrum is generally achieved by reusing frequency sets at base stations in a cellular pattern.

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# 1 Scope

The present document covers equipment, which may operate in frequency bands that have paired frequencies, which can be used by either equipment employing Frequency Division Duplex (FDD) or Time Division Duplex (TDD) techniques. For use with Time Division Duplex only one frequency of the frequency pair will be used and for the purpose of the present document the tx/rx separation will be zero. The channel spacing is intended to be the same in downlink and uplink directions.

This revision extends the scope to cover systems employing basically TDMA multi-access but which also allows for additional methods (such as OFDMA) combined with TDMA, to be used to provide another dimension of multiple access.

## 1.1 Applications

The present document specifies the minimum and optional requirements for system parameters of Time Division Multiple Access (TDMA) Point-to-Multipoint (P-MP) Radio Systems in the terrestrial Fixed Service operating in frequency bands in the range 3 GHz to 11 GHz.

The present document covers the following typical Point-to-MultiPoint (P-MP) applications:

- voice;
- fax;
- voice-band data;
- telex, related to analogue interfaces;
- data up to 64 kbit/s or beyond with optional interfaces;
- ISDN;
- digital video;
- digital audio, related to digital interfaces.

Radio terminals from different manufacturers are not intended to inter-work at radio frequency (i.e. no common air interface).

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

Testing to the present document will be undertaken with the guidance of a generic test methods document EN 301 126-2-1 [22], EN 301 126-2-3 [23] and EN 301 126-3-2 [24].

## 1.2 Frequencies

The present document covers fixed P-MP services operating in the 3,5 GHz, 3,7 GHz and 10,5 GHz bands, having the frequency plans as given in CEPT/ERC Recommendations 14-03 [7], 12-08 [25], 12-05 [8] and in ITU-R Recommendation F.1491 [34].

## 1.3 Access method

The present document covers Time Division Multiple Access (TDMA) systems. Optionally, for certain of the system types defined in the present document, other access methods (e.g. Orthogonal Frequency Division Multiple Access (OFDMA)) may be used in conjunction with TDMA to provide another dimension of multiple access.

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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 and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <http://docbox.etsi.org/Reference>.

- [1] ETSI ETS 300 012: "Integrated Services Digital Network (ISDN); Basic user-network interface Layer 1 specification and test principles".
- [2] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
- [3] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of digital exchanges".
- [4] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".
- [5] 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".
- [6] ITU-T Recommendation R.20: "Telegraph modem for subscriber lines".
- [7] 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".
- [8] CEPT/ERC Recommendation 12-05: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10,0 - 10,68 GHz".
- [9] ETSI EN 300 019-1: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Sub-parts 1-1 to 1-7: Classification of environmental conditions".
- [10] ETSI EN 300 019-2: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Sub-parts 2-1 to 2-7: Specification of environmental tests".
- [11] ETSI ETS 300 132 (Parts 1 and 2): "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current sources; Part 2: Operated by direct current (dc)".
- [12] ETSI EN 301 489-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements".
- [13] ETSI EN 301 489-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 4: Specific conditions for fixed radio links and ancillary equipment and services".
- [14] ETSI EN 300 385: "Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for fixed radio links and ancillary equipment".
- [15] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s adaptive differential pulse code modulation (ADPCM)".



- [16] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".
- [17] ITU-R Recommendation F.697: "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".
- [18] ITU-T Recommendation G.729: "Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)".
- [19] ETSI EN 300 324-1: "V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN); Part 1: V5.1 interface specification".
- [20] ETSI ETS 300 347-1: "V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN); Part 1: V5.2 interface specification".
- [21] ITU-R Recommendation F.1191: "Bandwidths and unwanted emissions of digital radio-relay systems".
- [22] ETSI EN 301 126-2-1: "Fixed Radio Systems; Conformance testing; Part 2-1: Point-to-Multipoint equipment; Definitions and general requirements".
- [23] ETSI EN 301 126-2-3: "Fixed Radio Systems; Conformance testing; Part 2-3: Point-to-Multipoint equipment; Test procedures for TDMA systems".
- [24] ETSI EN 301 126-3-2: "Fixed Radio Systems; Conformance testing; Part 3-2: Point-to-Multipoint antennas - Definitions, general requirements and test procedures".
- [25] CEPT/ERC Recommendation 12-08: "Harmonised radio frequency channel arrangements and blocks allocations for low, medium and high capacity systems in the band 3 600 MHz to 4 200 MHz".
- [26] ITU-T Recommendation G.131: "Control of talker echo".
- [27] ETSI EN 300 011-1: "Integrated Services Digital Network (ISDN); Primary rate User Network Interface (UNI); Part 1: Layer 1 specification".
- [28] 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".
- [29] CEPT/ERC Recommendation 74-01: "Spurious emissions".
- [30] ITU-R Recommendation SM.329: "Spurious emissions".
- [31] ITU-R Recommendation F.1488: "Frequency block arrangements for fixed wireless access systems in the range 3 400-3 800 MHz".
- [32] ITU-T Recommendation G.826: "End-to-end error performance parameters and objectives for international, constant bit-rate digital paths and connections".
- [33] 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".
- [34] ITU-R Recommendation F.1491: "Error performance objectives for real digital radio links used in the national portion of a 27 500 km hypothetical reference path at or above the primary rate".
- [35] ITU-R Recommendation F.557: "Availability objective for radio-relay systems over a hypothetical reference circuit and a hypothetical reference digital path".
- [36] ITU-T Recommendation G.723: "Dual rate speech coder for multimedia communications transmitting at 5,3 and 6,3 kbit/s".
- [37] ETSI EG 202 306 (V1.2.1): "Transmission and Multiplexing (TM); Access networks for residential customers".

- [38] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".
- [39] ITU-T Recommendation G.957: "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".
- [40] ITU-R Radio Regulations, Article S5.482: "Frequency allocations".

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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:

**gross bit rate:** defined as the transmission bit rate over the air

NOTE: In case of a transmitter working in burst mode the gross bit rate is the instantaneous maximum transmission bit rate during the burst. The gross bit rate has a unique relationship to the symbol rate through the implemented modulation format. In the case of OFDMA this relationship is unique when all OFDMA sub carriers are in use. Gross bit rate for TDMA/OFDMA systems is the aggregate bit rate of all OFDMA sub carriers transmitting simultaneously.

**OFDM-sub-carrier:** physical sub-division of the channel as determined by the manufacturer for OFDM and OFDMA systems

NOTE: The complete set of discrete sub-carriers is distributed throughout the assigned channel. With OFDM (and OFDMA), individual symbols are represented by all (or some) of the sub-carriers operating in concert rather than by individual sub-carriers.

**Orthogonal Frequency Division Multiplexing (OFDM):** transmission method where the transmitted signal is composed of multiple narrow band OFDM-sub-carriers, all modulated in parallel

**Orthogonal Frequency Division Multiple Access (OFDMA):** variant of OFDM where only a subset of the OFDM-sub-carriers are used by any single transmitter, allowing multiple transmitters to transmit at the same time on disjoint sets of OFDM-sub-carriers

NOTE: When used in conjunction with TDMA this applies burst by burst.

**OFDMA-sub-channel:** logical channel for transmission or control purposes, comprising a set of physical OFDM sub-carriers

NOTE: The specific sub-carriers associated with a particular sub-channel are usually dynamically distributed throughout the whole channel bandwidth. The minimum number of sub-carriers that may comprise a sub-channel is dependent on the system design.

### 3.2 Symbols

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

|            |                                 |
|------------|---------------------------------|
| $\Delta F$ | Channel Spacing                 |
| dB         | deciBel                         |
| dBm        | deciBel relative to 1 milliwatt |
| GHz        | GigaHertz                       |
| Hz         | Hertz                           |
| kbit/s     | kilobits per second             |
| kHz        | kiloHertz                       |
| Mbit/s     | Megabits per second             |
| MHz        | MegaHertz                       |
| ms         | millisecond                     |

### 3.3 Abbreviations

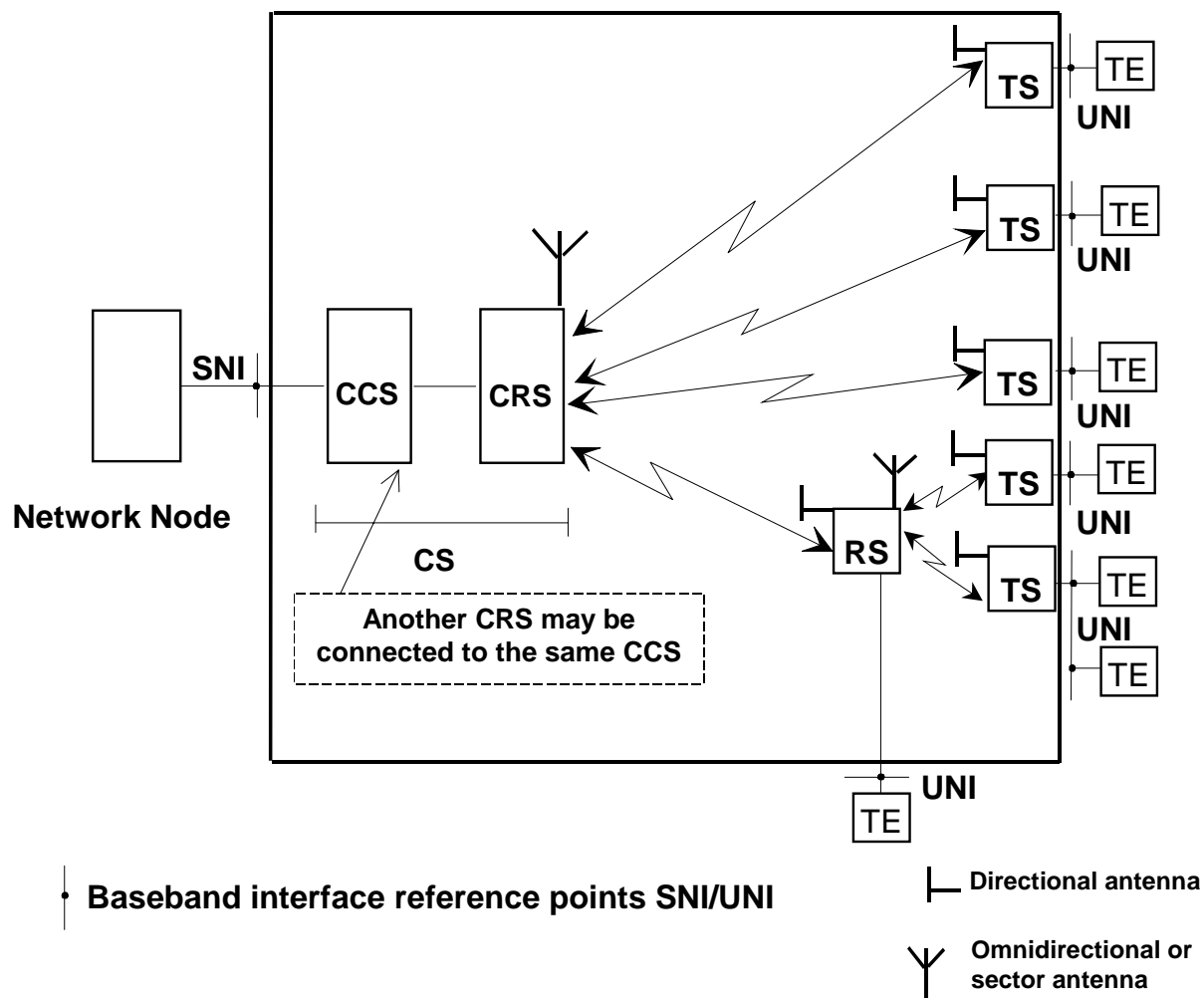
For the purposes of the present document, the following abbreviations apply:

|            |  |
|------------|--|
| BER        | Bit Error Rate   |
| CCS        | Central Controller Station   |
| CRS        | Central Radio Station  |
| CS         | Central Station  |
| EMC        | ElectroMagnetic Compatibility  |
| ERC        | European Radiocommunications Committee   |
| HC         | High Coexistence   |
| ISDN       | Integrated Services Digital Network  |
| LD CELP    | Low Delay Code Excited Linear Prediction   |
| MGBR       | Minimum Gross Bit Rate   |
| MOS        | Mean Opinion Score   |
| OFDM       | Orthogonal Frequency Division Multiplexing   |
| OFDMA      | Orthogonal Frequency Division Multiple Access  |
| PRBS       | Pseudo-Random Binary Sequence  |
| QDU        | Quantization Distortion Unit   |
| RBER       | Residual BER   |
| RS         | Repeater Station   |
| rx         | Receiver   |
| TDMA       | Time Division Multiple Access  |
| TDMA/OFDMA | Time Division Multiple Access used in combination with Orthogonal Frequency Division Multiple Access |
| TE         | Terminal Equipment   |
| TS         | Terminal Station   |
| tx         | Transmitter  |

## 4 General system architecture

### 4.1 Sub-system types

A system could consist of several sub-systems as follows (see figure 1):



**Figure 1: General system architecture**

- CS:** The Central Station, which interfaces the network. It can be integrated or divided 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. One CCS may control more than one CRS.
- TS:** The Terminal Station (outstations with subscriber interfaces). A TS may serve more than one Terminal Equipment (TE).
- RS:** The Repeater Station (radio repeater outstations with or without subscriber interfaces). An RS may serve one or more TS.
- TE:** Terminal Equipment.
- SNI:** Service Node Interface (see EG 202 306 [37]).
- UNI:** User Network Interface (see EG 202 306 [37]).

The central station performs the interconnection with the network node carrying out a concentration function by sharing the total number of available channels in the system. The central station is linked either directly to all Terminal Stations (TS) via Repeater Stations (RS) by microwave transmission paths. Whenever an existing digital transmission link is available, separating the CCS installed at the network node site and the CRS can optimize the network implementation.

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

- 1) system characteristics;
- 2) radio characteristics;
- 3) type of services/user equipment and network interfaces;
- 4) power supply, mechanical and environmental characteristics.

## 4.2 System characteristics

The following characteristics shall be used.

### 4.2.1 System capacity

The present document defines eight System Types A, B C, D, E, F, G and HC. These systems represent different spectral efficiency in term of gross-bit-rate/Hz; the gross bit rate, defined in clause 3.3, has a unique relation to the symbol rate through the implemented modulation format:

- A and E : lower complexity modulation formats (e.g. 4 states or equivalent);
- HC: lower complexity modulation formats as System Type A (e.g. 4 states or equivalent), but with higher requirements for receiver sensitivity and tolerance to interference;
- B and F: medium complexity modulation formats (e.g. 16 states or equivalent);
- C: lower complexity modulation formats (e.g. 4 states or equivalent) for systems with a gross bit rate below 2 Mbit/s and limited to TDD operation only;
- D and G: higher complexity modulation formats (e.g. 64 states or equivalent).

The E, F and G system types are intended for OFDM modulation including TDMA/OFDMA systems.

The minimum gross bit rates for different channel spacing and system types are given in clause 5.2.

The manufacturer shall declare the actual system traffic carrying capacity, the gross bit rate and the system type.

The system minimum gross bit rate (MGBR) shall be defined for a fully loaded system. For example, for a TDMA/OFDMA system, in any single TDMA burst any single OFDMA TS may be dynamically assigned a subset of the OFDMA-sub-channels. Multiple TS are allowed to transmit at the same time on disjoint sets of OFDM-sub-carriers, so the MGBR is defined when all available OFDM-sub-carriers are in use at the same time.

### 4.2.2 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 [5] following the criteria defined in ITU-R Recommendation F.697 [17] for the local grade portion of the digital connection.

Equipment with system rate equal 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 [32] and G.827 [33] following the criteria defined in ITU-R Recommendations F.1491 [34] and F.557 [35] for the national portion of the digital connection.

### 4.2.3 Round trip delay for speech services

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 delay introduced by the system into the transmission network does not degrade the quality of the telephone communication, compliance with ITU-T Recommendation G.131 [26] shall be ensured.

### 4.2.4 Transparency

The system shall be fully transparent: the network node and the user equipment (points F and G in the Reference Model, see figure 1) communicate with each other without being aware of the radio link. The system shall be transparent to analogue or digital subscriber equipment signalling 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 a means to maintain the above transparency is used.

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

- 64 kbit/s: according to ITU-T Recommendation G.711 [38], which will provide full transparency and permit a direct digital interface to digital switches;
- 32 kbit/s: according to ITU-T Recommendation G.726 [15];
- 16 kbit/s: according to ITU-T Recommendation G.728 [16] for Low Delay Code Excited Linear Prediction (LD CELP);
- 8 kbit/s: according to ITU-T Recommendation G.729 [18];
- 6,3 kbit/s: according to ITU-T Recommendation G.723 [36].

Other voice coding methods may be employed if the quality (measured for example in Quantization Distortion Units (QDU) or Mean Opinion Score (MOS)) shall be equivalent to the above.

### 4.2.5 Synchronization

Systems employing digital interfaces shall include methods enabling internal and external synchronization to the network. Synchronization tolerance should meet the requirements of ITU-T Recommendation G.703 [2].

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## 5 Radio characteristics

### 5.1 Frequency bands

Bands allocated to the fixed service in the range 3 GHz to 11 GHz shall be used.

## 5.2 Proposed channel arrangements

Table 1 gives details of frequency bands which have been considered within CEPT, the European Radiocommunications Committee (ERC) and ITU-R.

**Table 1: Frequency bands**

| Frequency band  | Band limits  | Transmit/receive spacing<br>(applies to channels/blocks)  |
|---|--|---|
| 3,5 GHz   | 3,4 GHz to 3,6 GHz   | 50 MHz or 100 MHz,<br>CEPT/ERC Recommendation 14-03 [7]<br>ITU-R Recommendation RA 9/1005-E [31]        |
| 3,7 GHz   | 3,6 GHz to 3,8 GHz   | 50 MHz or 100 MHz<br>CEPT/ERC Recommendation 12-08 [25]<br>ITU-R Recommendation 9B/TEMP/79[Rev1]-E [31] |
| 10,5 GHz  | 10,15 GHz to 10,3 GHz paired with<br>10,5 GHz to 10,65 GHz | 350 MHz,<br>CEPT/ERC Recommendation 12-05 [8]   |
| NOTE: Administrations may assign further parts of Fixed Service bands in the range 3 GHz to 11 GHz to systems defined in the present document in accordance with appropriate CEPT Recommendations. When applied to TDD equipment, references in the present document to tx/rx separation should be disregarded. |  |   |

Table 2 gives the Minimum Gross Bit Rate (MGBR) for channel spacing based on  $N \times 1,75$  MHz, 2 MHz and 30 MHz.

**Table 2: Channel spacing/minimum gross bit rate**

| Channel spacing (MHz)           | < 1,75 (see note) | 1,75/2 | 3,5 | 7  | 14 | 28/30 |
|---------------------------------|-------------------|--------|-----|----|----|-------|
| <b>System Type A, E</b>         |                   |        |     |    |    |       |
| Minimum gross bit rate (Mbit/s) | < 2               | 2      | 4   | 8  | 16 | 32    |
| <b>System Type B, F</b>         |                   |        |     |    |    |       |
| Minimum gross bit rate (Mbit/s) | < 4               | 4      | 8   | 16 | 32 | 64    |
| <b>System Type C</b>            |                   |        |     |    |    |       |
| Minimum gross bit rate (Mbit/s) | < 2               | NA     | NA  | NA | NA | NA    |
| <b>System Type D, G</b>         |                   |        |     |    |    |       |
| Minimum gross bit rate (Mbit/s) |                   | 6      | 12  | 24 | 48 | 96    |
| <b>System Type HC</b>           |                   |        |     |    |    |       |
| Minimum gross bit rate (Mbit/s) |                   | 2      | 4   | 8  | 16 | 32    |
| NOTE: See note of table 3.      |                   |        |     |    |    |       |

The ERC recommendations allow other channel spacings (see CEPT/ERC Recommendation 14-03 [7], annexes A.1 and B.1, CEPT/ERC Recommendation 12-08 [25], annex B and CEPT/ERC Recommendation 12-05 [8], annex A). For channel spacing not defined in table 2 the MGBR (Mbits/s) shall meet the following equation:

$$MGBR = \frac{4}{7} \Delta F \frac{\log(s)}{\log(2)}$$

Where S is the number of states or equivalent for the particular equipment class given in clause 4.2.1.

CEPT/ERC Recommendations 14-03 [7] and 12-08 [25] require the channel spacing to be based on 0,25 MHz slots for point to multipoint systems in the bands 3,5 GHz and 3,7 GHz. CEPT/ERC Recommendation 12-05 [8] require the channel spacing to be based on 0,5 MHz slots.

For regulatory purposes in national procedures for licensing radio equipments according to the present document, the above system types shall be identified by the "system type codes" reported in annex A.

## 5.3 Transmitter (tx) characteristics

### 5.3.1 Tx power range

The maximum value of output power, referred to point C' of the RF block diagram in figure 2 shall not exceed 35 dBm.

ITU-R Radio Regulations S5.482 [40] states that in the band 10,6 GHz to 10,68 GHz, stations of the Fixed and Mobile, except Aeronautical Mobile, services shall be limited to a maximum equivalent isotropically radiated power of 40 dBW and the power delivered to the antenna shall not exceed -3 dBW.

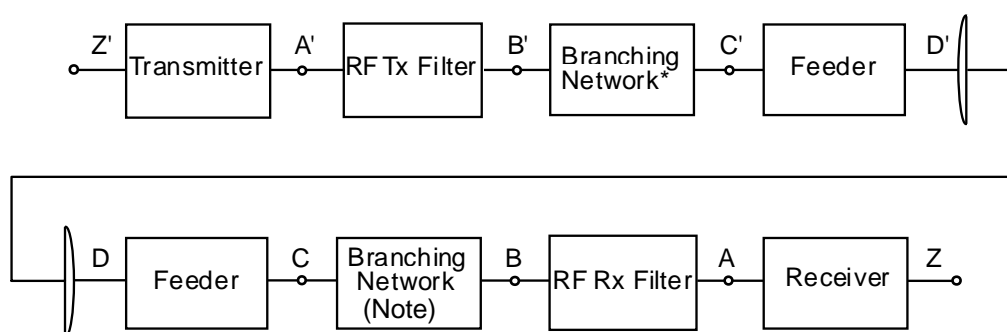
If for proper operation of the system or for regulatory purposes, a reduced range of output power is required, then a built in or added means of adjustment shall be provided.

The tolerance of the nominal output power should be within  $\pm 2$  dB for systems operating within non weather protected locations and  $\pm 1$  dB for systems operating within weather protected locations. However, in respect of the essential requirement, for the purpose of the R&TTE Directive, the tolerance shall be  $\pm 2$  dB in all cases.

The transmitted output power means the value measured when the output is connected to a dummy load, i.e. power meter or spectrum analyser. The transmitted carrier shall be modulated with a signal representing the normal traffic, under all conditions of loading and services.

Two different measurement methods can be used:

- 1) spectrum analyser with resolution bandwidth and video bandwidth greater than 1 MHz; or
- 2) power meter.



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

**Figure 2: Radio Frequency (RF) block diagram**

### 5.3.2 Automatic Transmit Power Control (ATPC)

ATPC is considered to be 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 level corresponding to:

- ATPC set manually to a fixed value for system performance;
- ATPC set at the nominal output power declared by the manufacturer.

### 5.3.3 Spectrum masks

#### 5.3.3.1 Spectrum density mask

Spectrum masks are given in figures 3, 4 and 5.

The transmitted output power spectrum is defined as: the spectrum when modulated with a signal representing the normal traffic, under all conditions of loading and services.



The spectrum measurement at point 'C' of the system block diagram shall be performed with the "maximum hold" function selected on the spectrum analyser.

The reference level of the output spectrum means that the 0 dB level is the top of the modulated spectrum. In the case of TDMA/OFDMA systems, the 0 dB reference level of the spectrum mask is the absolute power when all available sub-channels are transmitting at full power. For a TDMA/OFDMA TS, it is recognized that the number of available sub-channels may be less than the total number assigned to the system and the manufacturer shall be required to declare the number of sub-channels such a TS station can support. If a TDMA/OFDMA TS only supports a number of sub-channels ( $n$ ) which is less than the total number of sub-channels available to the system as a whole ( $m$ ), the reference level for the spectrum masks for that TS shall be:  $(m/n) \times$  the maximum power density, within the whole channel, when all " $n$ " available channels are active at maximum power (see notes 3 and 4 in table 6).

Tables 3, 4, and 5 give the reference points for channel spacing based on  $N \times 1,75$  MHz, 2 MHz and 30 MHz.

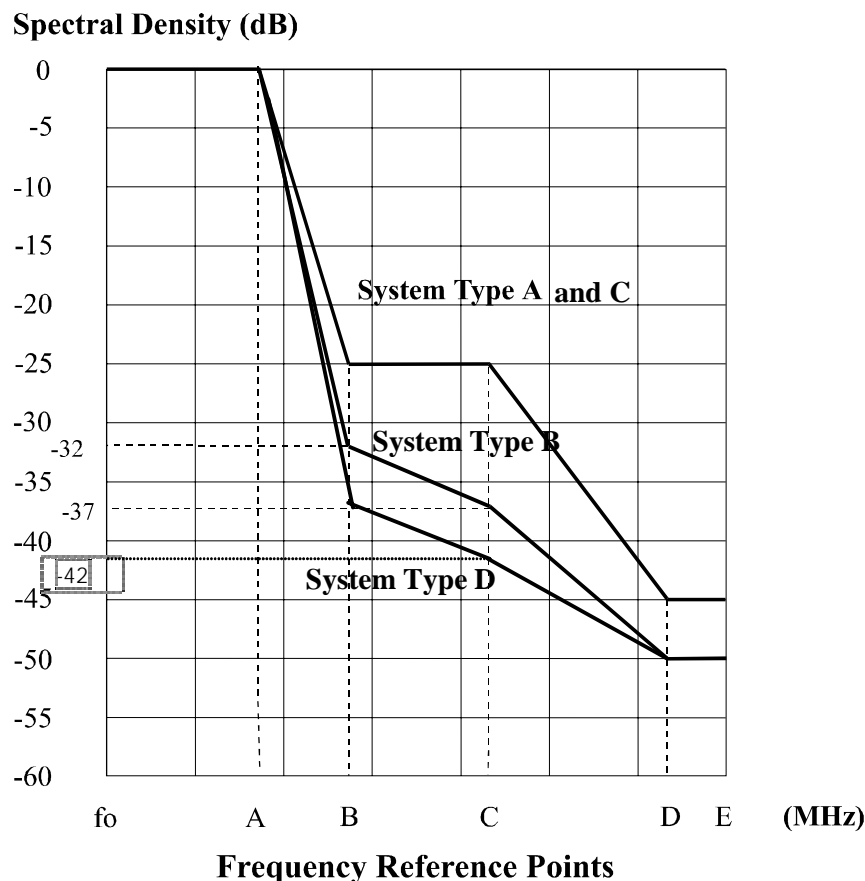


Figure 3: Power spectrum masks for system type A, B, C and D ( $f_0$  = actual carrier frequency)

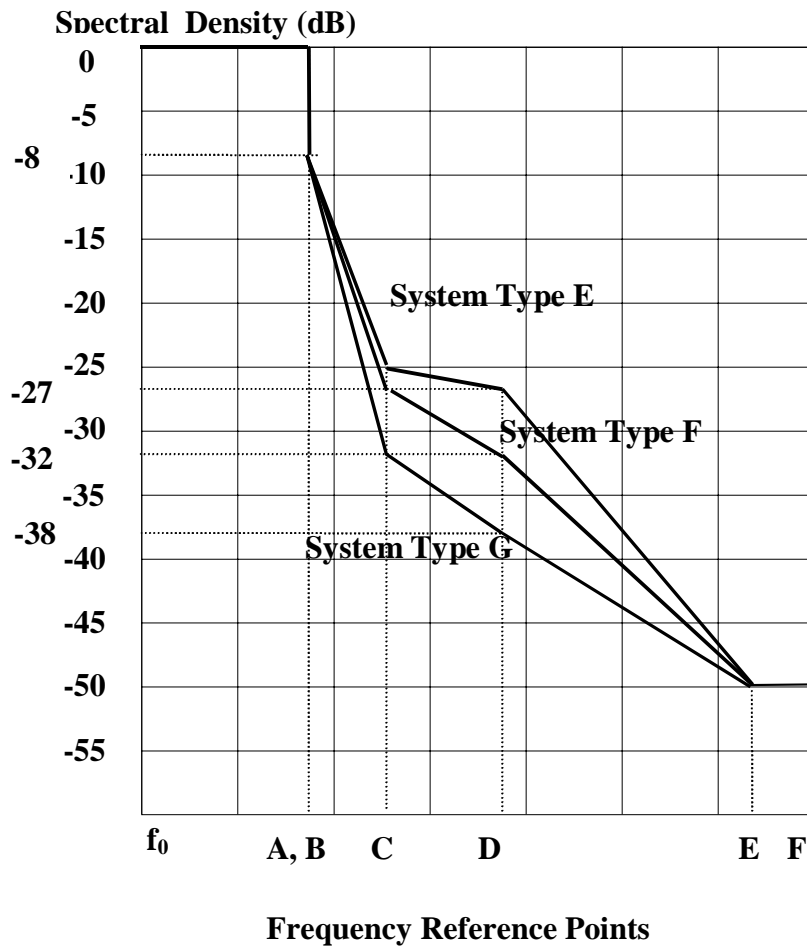
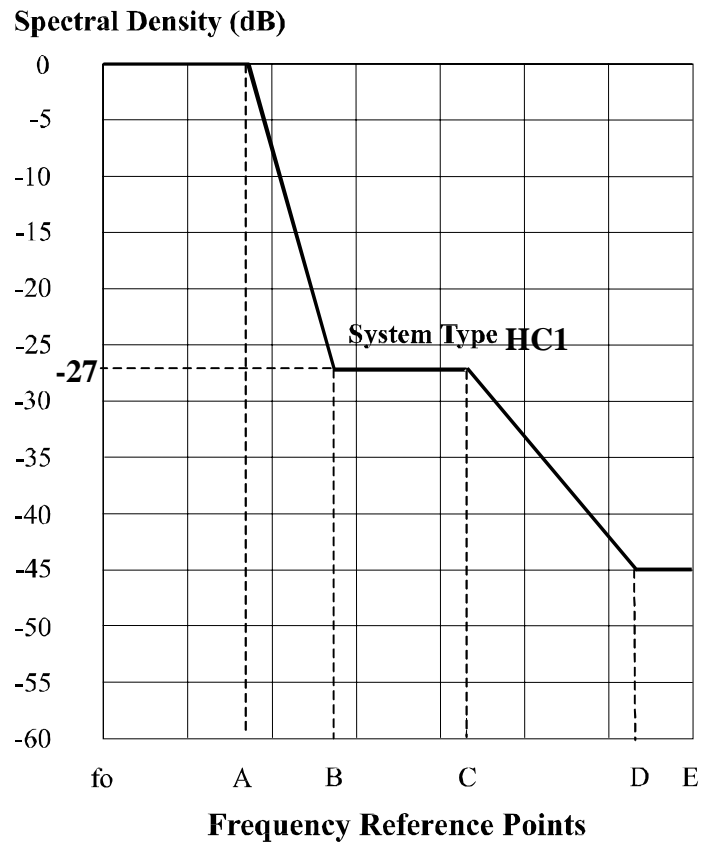


Figure 4: Power spectrum masks for system type E, F and G ( $f_0$  = actual carrier frequency)



**Figure 5: Power spectrum masks for system type HC ( $f_0$  = actual carrier frequency)**

Table 3: Reference frequencies for spectrum masks, system type A, B, C and D

| System Type A<br>Points figure 3 |                                 | Frequency offset (MHz)    |                           |                           |                           |                          |
|----------------------------------|---------------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| Channel spacing, (MHz)           | Minimum gross bit rate (Mbit/s) | Point A<br>0 dB           | Point B<br>-25 dB         | Point C<br>-25 dB         | Point D<br>-45 dB         | Point E<br>-45 dB        |
| (see note)                       | < 2                             | 1,7 x Symbol Rate (Mbaud) | 2,6 x Symbol Rate (Mbaud) | 3,6 x Symbol Rate (Mbaud) | 6,4 x Symbol Rate (Mbaud) | 10 x Symbol Rate (Mbaud) |
| 1,75                             | 2                               | 0,75                      | 1,15                      | 1,6                       | 2,8                       | 4,375                    |
| 2                                | 2                               | 0,85                      | 1,3                       | 1,8                       | 3,2                       | 5,0                      |
| 3,5                              | 4                               | 1,5                       | 2,5                       | 3,7                       | 6,8                       | 8,75                     |
| 7                                | 8                               | 2,8                       | 5,6                       | 7                         | 14                        | 17,5                     |
| 14                               | 16                              | 5,6                       | 11,2                      | 14                        | 28                        | 35                       |
| 28/30                            | 32                              | 11,2                      | 22,4                      | 28                        | 56                        | 70                       |
| System Type B<br>Points figure 3 |                                 | Frequency offset (MHz)    |                           |                           |                           |                          |
| Channel spacing, (MHz)           | Minimum gross bit rate (Mbit/s) | Point A<br>0 dB           | Point B<br>-32 dB         | Point C<br>-37 dB         | Point D<br>-50 dB         | Point E<br>-50 dB        |
| (see note)                       | < 4                             | 1,7 x Symbol Rate (Mbaud) | 2,6 x Symbol Rate (Mbaud) | 3,6 x Symbol Rate (Mbaud) | 6,4 x Symbol Rate (Mbaud) | 10 x Symbol Rate (Mbaud) |
| 1,75                             | 4                               | 0,8                       | 1,4                       | 1,85                      | 3,5                       | 4,375                    |
| 3,5                              | 8                               | 1,5                       | 2,5                       | 3,7                       | 7,0                       | 8,75                     |
| 7                                | 16                              | 2,8                       | 5,6                       | 7                         | 14                        | 17,5                     |
| 14                               | 32                              | 5,6                       | 11,2                      | 14                        | 28                        | 35                       |
| 28/30                            | 64                              | 11,2                      | 22,4                      | 28                        | 56                        | 70                       |
| System Type C<br>Points figure 3 |                                 | Frequency offset (MHz)    |                           |                           |                           |                          |
| Channel spacing, (MHz)           | Minimum gross bit rate (Mbit/s) | Point A<br>0 dB           | Point B<br>-25 dB         | Point C<br>-25 dB         | Point D<br>-45 dB         | Point E<br>-45 dB        |
| (see note)                       | < 2                             | 1,7 x Symbol Rate (Mbaud) | 2,6 x Symbol Rate (Mbaud) | 3,6 x Symbol Rate (Mbaud) | 6,4 x Symbol Rate (Mbaud) | 10 x Symbol Rate (Mbaud) |
| System Type D<br>Points figure 3 |                                 | Frequency offset (MHz)    |                           |                           |                           |                          |
| Channel spacing, (MHz)           | Minimum gross bit rate (Mbit/s) | Point A<br>0 dB           | Point B<br>-37 dB         | Point C<br>-42 dB         | Point D<br>-50 dB         | Point E<br>-50 dB        |
| 1,75                             | 6                               | 0,8                       | 1,4                       | 1,85                      | 3,5                       | 4,375                    |
| 2                                | 6,5                             | 0,85                      | 1,6                       | 2                         | 4                         | 5                        |
| 3,5                              | 12                              | 1,5                       | 2,9                       | 3,7                       | 7,0                       | 8,75                     |
| 7                                | 24                              | 2,8                       | 5,6                       | 7                         | 14                        | 17,5                     |
| 14                               | 48                              | 5,6                       | 11,2                      | 14                        | 28                        | 35                       |
| 28/30                            | 96                              | 11,2                      | 22,4                      | 28                        | 56                        | 70                       |

NOTE: TDMA systems with minimum gross bit rates < 2 Mbit/s for system type A and C or < 4 Mbit/s for system type B may use various channel spacing within blocks of slots assigned to an operator according to CEPT/ERC Recommendations 14-03 [7], 12-05 [8] or 12-08 [25]. The manufacturer shall declare the symbol rate and channel spacing, from which the break points A, B, C and D for the spectrum mask can be calculated.

Table 4: Reference frequencies for spectrum masks, system type E, F and G

| System Type E<br>Points figure 4 |                                       | Frequency offset (MHz) |                  |                   |                   |                   |                   |
|----------------------------------|---------------------------------------|------------------------|------------------|-------------------|-------------------|-------------------|-------------------|
| Channel spacing,<br>(MHz)        | Minimum<br>gross bit rate<br>(Mbit/s) | Point A<br>0 dB        | Point B<br>-8 dB | Point C<br>-25 dB | Point D<br>-27 dB | Point E<br>-50 dB | Point F<br>-50 dB |
| 1,75                             | 2                                     | 0,875                  | 0,875            | 1,25              | 1,85              | 3,5               | 4,375             |
| 2                                | 2                                     | 1,00                   | 1,00             | 1,42              | 2,11              | 4                 | 5                 |
| 3,5                              | 4                                     | 1,75                   | 1,75             | 2,5               | 3,7               | 7,0               | 8,75              |
| 7                                | 8                                     | 3,5                    | 3,5              | 5,0               | 7,4               | 14                | 17,5              |
| 14                               | 16                                    | 7,0                    | 7,0              | 10,0              | 14,8              | 28                | 35                |
| 28/30                            | 32                                    | 14,0                   | 14,0             | 20,0              | 29,6              | 56                | 70                |
| System Type F<br>Points figure 4 |                                       | Frequency offset (MHz) |                  |                   |                   |                   |                   |
| Channel spacing,<br>(MHz)        | Minimum<br>gross bit rate<br>(Mbit/s) | Point A<br>0 dB        | Point B<br>-8 dB | Point C<br>-27 dB | Point D<br>-32 dB | Point E<br>-50 dB | Point F<br>-50 dB |
| 1,75                             | 4                                     | 0,875                  | 0,875            | 1,25              | 1,85              | 3,5               | 4,375             |
| 2                                | 4                                     | 1,00                   | 1,00             | 1,42              | 2,11              | 4                 | 5                 |
| 3,5                              | 8                                     | 1,75                   | 1,75             | 2,5               | 3,7               | 7,0               | 8,75              |
| 7                                | 16                                    | 3,5                    | 3,5              | 5,0               | 7,4               | 14                | 17,5              |
| 14                               | 32                                    | 7,0                    | 7,0              | 10,0              | 14,8              | 28                | 35                |
| 28/30                            | 64                                    | 14,0                   | 14,0             | 20,0              | 29,6              | 56                | 70                |
| System Type G<br>Points figure 4 |                                       | Frequency offset (MHz) |                  |                   |                   |                   |                   |
| Channel spacing,<br>(MHz)        | Minimum<br>gross bit rate<br>(Mbit/s) | Point A<br>0 dB        | Point B<br>-8 dB | Point C<br>-32 dB | Point D<br>-38 dB | Point E<br>-50 dB | Point F<br>-50 dB |
| 1,75                             | 6                                     | 0,875                  | 0,875            | 1,25              | 1,85              | 3,5               | 4,375             |
| 2                                | 6                                     | 1,00                   | 1,00             | 1,42              | 2,11              | 4                 | 5                 |
| 3,5                              | 12                                    | 1,75                   | 1,75             | 2,5               | 3,7               | 7,0               | 8,75              |
| 7                                | 24                                    | 3,5                    | 3,5              | 5,0               | 7,4               | 14                | 17,5              |
| 14                               | 48                                    | 7,0                    | 7,0              | 10,0              | 14,8              | 28                | 35                |
| 28/30                            | 96                                    | 14,0                   | 14,0             | 20,0              | 29,6              | 56                | 70                |

Table 5: Reference frequencies for spectrum masks, system type HC

| System type HC<br>Points figure 5 |                 | Frequency offset (MHz) |                   |                   |                   |  |
|-----------------------------------|-----------------|------------------------|-------------------|-------------------|-------------------|--|
| Co-polar channel spacing<br>(MHz) | 0 dB<br>Point A | -27 dB<br>Point B      | -27 dB<br>Point C | -45 dB<br>Point D | -45 dB<br>Point E |  |
| 1,75                              | 0,75            | 1,15                   | 1,6               | 2,8               | 4,375             |  |
| 2                                 | 0,85            | 1,3                    | 1,8               | 3,2               | 5,0               |  |
| 3,5                               | 1,5             | 2,8                    | 3,7               | 7                 | 8,75              |  |
| 7                                 | 2,8             | 5,6                    | 7                 | 14                | 17,5              |  |
| 14                                | 5,6             | 11,2                   | 14                | 28                | 35                |  |
| 28/30                             | 11,2            | 22,4                   | 28                | 56                | 70                |  |

For channel spacing not defined in table 2 the reference points can be linearly interpolated from the above tables using the following equations:

System Types A, B, D and HC:

For  $\Delta F < 1,75$  MHz and MGBR  $< 2$  MBps (see note in table 3).

For  $\Delta F < 3,5$  MHz:

$$\text{Point A (MHz)} = 0,429 \Delta F \text{ [system types A and HC]}$$

$$= 0,8 + 0,7 (0,571 \Delta F - 1) \text{ [system types B and D]}$$

$$\begin{aligned}
 \text{Point B (MHz)} &= 1,15 + 1,35 (0,571 \Delta F - 1) \text{ [system type A]} \\
 &= 1,4 + 1,1 (0,571 \Delta F - 1) \text{ [system type B]} \\
 &= 1,4 + 1,5 (0,571 \Delta F - 1) \text{ [system type D]} \\
 &= 1,15 + 1,65 (0,571 \Delta F - 1) \text{ [system type HC]} \\
 \text{Point C (MHz)} &= 1,6 + 2,1 (0,571 \Delta F - 1) \text{ [system types A and HC]} \\
 &= 1,057 \Delta F \text{ [system types B and D]} \\
 \text{Point D (MHz)} &= 2,8 + 4,0 (0,571 \Delta F - 1) \text{ [system type A]} \\
 &= 2,0 \Delta F \text{ [system types B and D]} \\
 &= 2,8 + 4,2 (0,571 \Delta F - 1) \text{ [system type HC]} \\
 \text{Point E (MHz)} &= 2,5 \Delta F
 \end{aligned}$$

For  $\Delta F$  between 3,5 MHz and 7 MHz:

$$\begin{aligned}
 \text{Point A (MHz)} &= 1,5 + 1,3 (0,286 \Delta F - 1) \\
 \text{Point B (MHz)} &= 2,5 + 3,1 (0,286 \Delta F - 1) \text{ [system types A and B]} \\
 &= 2,9 + 2,7 (0,286 \Delta F - 1) \text{ [system type D]} \\
 &= 0,8 \Delta F \text{ [system type HC]} \\
 \text{Point C (MHz)} &= 3,7 + 3,3 (0,286 \Delta F - 1) \\
 \text{Point D (MHz)} &= 6,8 + 7,2 (0,286 \Delta F - 1) \text{ [system type A]} \\
 &= 2,0 \Delta F \text{ [system types B, D and HC]} \\
 \text{Point E (MHz)} &= 2,5 \Delta F
 \end{aligned}$$

For  $\Delta F$  more than 7 MHz:

$$\begin{aligned}
 \text{Point A (MHz)} &= 0,4 \Delta F \\
 \text{Point B (MHz)} &= 0,8 \Delta F \\
 \text{Point C (MHz)} &= 1,0 \Delta F \\
 \text{Point D (MHz)} &= 2,0 \Delta F \\
 \text{Point E (MHz)} &= 2,5 \Delta F
 \end{aligned}$$

System Types E, F and G:

$$\begin{aligned}
 \text{Point A (MHz)} &= 0,5 \Delta F \\
 \text{Point B (MHz)} &= 0,5 \Delta F \\
 \text{Point C (MHz)} &= 0,714 \Delta F \\
 \text{Point D (MHz)} &= 1,057 \Delta F \\
 \text{Point E (MHz)} &= 2,0 \Delta F \\
 \text{Point F (MHz)} &= 2,5 \Delta F
 \end{aligned}$$

**Table 6: Spectrum analyser settings for RF power spectrum measurement**

| RF channel spacing (MHz)   | CRS only |               |            |           |               | TS                       |
|--|----------|---------------|------------|-----------|---------------|--------------------------|
|  | < 1,75   | ≥ 1,75 to 3,5 | > 3,5 to 7 | > 7 to 14 | > 14 to 28/30 | Any                      |
| Centre frequency   | actual   | actual        | actual     | actual    | actual        | actual                   |
| Sweep width (MHz)  | 6 × ΔF   | 6 × ΔF        | 6 × ΔF     | 6 × ΔF    | 6 × ΔF        | same as equivalent CRS   |
| Scan time  | auto     | auto          | auto       | auto      | auto          | auto                     |
| IF bandwidth (kHz)   | 30       | 30            | 30         | 30        | 100           | (see notes 1, 2,3 and 4) |
| Video bandwidth (kHz)  | 0,1      | 0,1           | 0,3        | 0,3       | 0,3           |                          |
| <p>NOTE 1: The Spectrum Analyser Settings for RF Power Spectrum Measurement for Terminal Stations are dependent on the burst duration. For example, a pure TDMA TS with a burst duration of ca. 50 μs, the recommended settings are: IF bandwidth = ca. 30 kHz and video bandwidth = ca. 3 kHz.</p> <p>NOTE 2: For other burst durations, the recommended settings are as follows:<br/> - IF bandwidth = ca. 30 kHz × 50 μs/(burst duration in μs);<br/> - Video bandwidth = ca. 3 kHz × 50 μs/(burst duration in μs).</p> <p>NOTE 3: When mixed OFDMA/TDMA systems are concerned, the IF and video bandwidths would depend also on the OFDMA symbols duration.</p> <p>NOTE 4: The manufacturer shall declare the TDMA burst and, if appropriate, the OFDMA symbol, durations and the spectrum analyser settings. It should be noted that, having separate limits for CW emissions (see clause 5.3.3.2), any change of spectrum analyser bandwidth does not impact the interference potential of the emission.</p> |          |               |            |           |               |                          |

### 5.3.3.2 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;
- be spaced each other in frequency by less than  $CS_{min}$ .

Where:

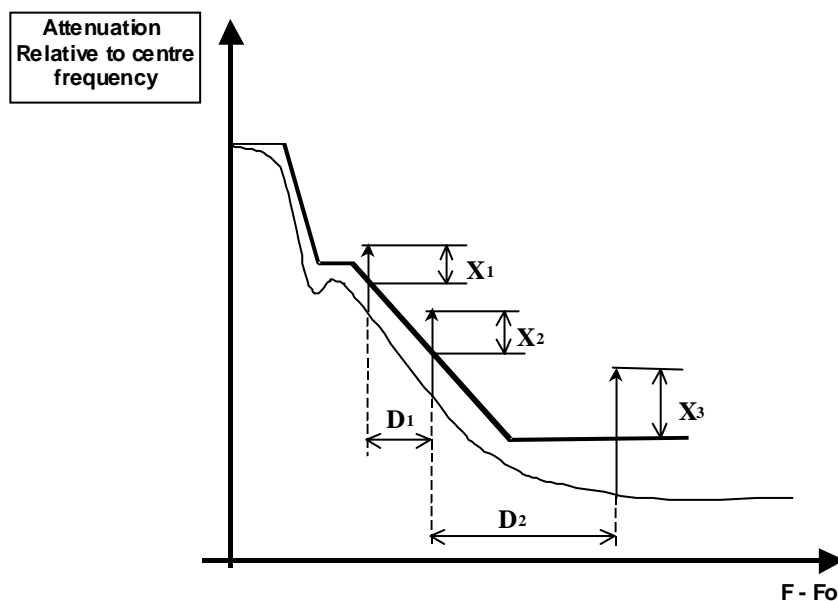
$CS_{min}$  = 500 kHz for 3,5 GHz and 3,7 GHz bands;

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

$IF_{bw}$  is the recommended resolution bandwidth, expressed in kHz reported in table 6.

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

Figure 6 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 6: CW lines exceeding the spectrum mask (typical example)

### 5.3.4 Transmitter spurious emissions

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

- 1) to limit interference into other systems operating wholly externally to the system under consideration (external emissions), which limits are specified by CEPT/ERC Recommendation 74-01 [29] based on ITU-R Recommendation SM.329 [30] and ITU-R Recommendation F.1191 [21].
- 2) to limit local interference within the system where transmitters and receivers are directly connected via the filter and branching systems (internal emissions).

This may lead to two sets of spurious emission limits at reference point B' for indoor systems and C' for outdoor systems (or where a common tx/rx duplexer is used).

#### 5.3.4.1 Spurious emissions - external

According to CEPT/ERC Recommendation 74-01 [29] the external spurious emissions are defined as emissions at frequencies, which are separated from the nominal carrier frequency more than  $\pm 250\%$  of the relevant channel separation.

Outside the band of  $\pm 250\%$  of the relevant channel separation, the Fixed Service radio systems spurious emission limits, defined by CEPT/ERC Recommendation 74-01 [29] together with the frequency range to consider for conformance measurement, shall apply.

#### 5.3.4.2 Spurious emissions - internal

Internal spurious emissions are not relevant.



### 5.3.5 Radio frequency tolerance

Maximum radio frequency tolerance shall not exceed the values defined in table 7. These limits include both short-term factors (environmental effects) and long term ageing effects.

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

**Table 7: Permitted frequency tolerance**

| Frequency band (GHz)   | Minimum gross bit rate (Mbit/s) | Frequency tolerance (kHz) |
|--|---------------------------------|---------------------------|
| 3,5/3,7  | < 0,5                           | ±4                        |
| 3,5/3,7  | 0,5 to < 2,0                    | ±50                       |
| 3,5/3,7  | ≥ 2                             | ±60                       |
| 10,5   | < 2,0                           | ±150                      |
| 10,5   | ≥ 2                             | ±220                      |
| NOTE: In frequency bands not covered by table 7, the radio frequency tolerance shall be ≤ ±20 ppm. |                                 |                           |

The equipment should be designed, manufactured, and maintained to ensure that the long-term frequency tolerance remains within the limits above.

## 5.4 Receiver characteristics

### 5.4.1 Input level range

The input level range shall be greater than 40 dB above the threshold level for a BER of  $10^{-3}$  referred to point C of the system block diagram (see figure 2).

### 5.4.2 Spurious emissions

See clause 5.3.4.

#### 5.4.2.1 Spurious emissions - external

The limit values measured at reference point C of CEPT/ERC recommendation 74-01 [29] shall apply.

#### 5.4.2.2 Spurious emissions - internal

Internal spurious emissions are not relevant.

### 5.4.3 Bit Error Rate (BER) performance

For systems with channel spacing based on  $N \times 1,75$  MHz, 2 MHz and 30 MHz the BER, measured at the user interfaces, versus receive signal power level, referred to point C of the system block diagram (see figure 2) shall be equal to or better than the values in table 8.

Table 8: BER versus receiver signal level

| Channel spacing (MHz)  | Minimum gross bit rate (Mbit/s) | BER 10 <sup>-3</sup> (dBm) | BER 10 <sup>-6</sup> (dBm) |
|--|---------------------------------|----------------------------|----------------------------|
| <b>System Type A, E</b>  |                                 |                            |                            |
| (see note 2)   | < 2                             | (see note 1)               | (see note 1)               |
| 1,75/2   | 2                               | -90                        | -86                        |
| 3,5  | 4                               | -87                        | -83                        |
| 7,0  | 8                               | -84                        | -80                        |
| 14,0   | 16                              | -81                        | -77                        |
| 28/30  | 32                              | -78                        | -74                        |
| <b>System Type B, F</b>  |                                 |                            |                            |
| (see note 2)   | < 4                             | (see note 1)               | (see note 1)               |
| 1,75/2   | 4                               | -82                        | -78                        |
| 3,5  | 8                               | -79                        | -75                        |
| 7,0  | 16                              | -76                        | -72                        |
| 14   | 32                              | -73                        | -69                        |
| 28/30  | 64                              | -70                        | -66                        |
| <b>System Type C</b>   |                                 |                            |                            |
| (see note 2)   | < 2                             | (see note 1)               | (see note 1)               |
| <b>System Type D, G</b>  |                                 |                            |                            |
| 1,75 /2  | 6                               | -76                        | -72                        |
| 3,5  | 12                              | -73                        | -69                        |
| 7,0  | 24                              | -70                        | -66                        |
| 14,0   | 48                              | -67                        | -63                        |
| 28/30  | 96                              | -64                        | -60                        |
| <b>System Type HC<br/>(see note 3)</b>   |                                 |                            |                            |
| 1,75/2   | 2                               | -93                        | -90                        |
| 3,5  | 4                               | -90                        | -87                        |
| 7,0  | 8                               | -87                        | -84                        |
| 14,0   | 16                              | -84                        | -81                        |
| 28/30  | 32                              | -81                        | -78                        |
| NOTE 1: For bit rates below 2,0 Mbit/s the reference levels for System Type A shall be calculated from the following formulas:<br>For BER = 10 <sup>-3</sup> : (-93 + 10log <sub>10</sub> [gross bit rate Mbit/s]) dBm;<br>For BER = 10 <sup>-6</sup> : (-89 + 10log <sub>10</sub> [gross bit rate Mbit/s]) dBm.<br>For bit rates below 2,0 Mbit/s for System Type C, and below 4,0 Mbit/s for System type B the reference levels shall be calculated from the following formulas:<br>For BER = 10 <sup>-3</sup> : (-85 + 10log <sub>10</sub> [gross bit rate Mbit/s]) dBm;<br>For BER = 10 <sup>-6</sup> : (-81 + 10log <sub>10</sub> [gross bit rate Mbit/s]) dBm. |                                 |                            |                            |
| NOTE 2: See note of table 3.   |                                 |                            |                            |
| NOTE 3: For (1+1) hot-standby HC type application, with both receivers sharing a single antenna part through a hybride, the above thresholds will be relaxed by 3 dB.  |                                 |                            |                            |
| NOTE 4: In the case of TDMA/OFDMA systems, the above figures apply when all OFDMA sub-channels are in use.   |                                 |                            |                            |

For channel spacing not defined in table 2 the BER measured at the user interfaces, verses receive power level, referred to point C shall be equal to or better than the values interpolated from the above table using the following equations:

System Types A and E:

$$\text{For BER } 10^{-3} \quad \text{Pr (dBm)} = -92,5 + 10 \log_{10} (\Delta F)$$

$$\text{For BER } 10^{-6} \quad \text{Pr (dBm)} = -88,5 + 10 \log_{10} (\Delta F)$$

System Types B and F:

$$\text{For BER } 10^{-3} \quad \text{Pr (dBm)} = -84,5 + 10 \log_{10} (\Delta F)$$

$$\text{For BER } 10^{-6} \quad \text{Pr (dBm)} = -80,5 + 10 \log_{10} (\Delta F)$$

System Types D and G:

$$\text{For BER } 10^{-3} \quad \text{Pr (dBm)} = -78,5 + 10 \log_{10} (\Delta F)$$

$$\text{For BER } 10^{-6} \quad \text{Pr (dBm)} = -74,5 + 10 \log_{10} (\Delta F)$$

For TDMA/OFDMA systems, the above equations shall be modified as follows:

- the values for Pr are increased by 1 dB;
- the effective bandwidth,  $\Delta F_{\text{EFF}}$  is substituted for  $\Delta F$ , where  $\Delta F_{\text{EFF}} = \Delta F \times n/m$ , where m denotes the total number of available OFDMA sub-channels and n denotes the number of active OFDMA sub-channels, received from one or more transmitters.

System Type HC:

$$\text{For BER } 10^{-3} \quad \text{Pr (dBm)} = -95,5 + 10 \log_{10} (\Delta F)$$

$$\text{For BER } 10^{-6} \quad \text{Pr (dBm)} = -92,5 + 10 \log_{10} (\Delta F)$$

## 5.4.4 Interference sensitivity

### 5.4.4.1 Adjacent channel interference

#### 5.4.4.1.1 All system types excluding HC

Adjacent channel sensitivity is defined as the ability of the receiver to receive a wanted signal in the presence of a like unwanted signal, which is one channel away.

The two signal generators shall be connected to the receiver input via a combiner, so that the impedance is matched to the nominal impedance.

The wanted signal shall be tuned to the receiver's nominal frequency and be modulated with a Pseudo-Random Binary Sequence (PRBS) signal. The interfering signal shall be turned off while the wanted signal is adjusted to the level corresponding to  $\text{BER} = 10^{-6}$  as specified in table 8.

The interfering signal shall be tuned one channel away from the wanted signal and be modulated with a PRBS signal, which is uncorrelated to the wanted signal.

The interfering signal shall be adjusted to the same level as the wanted signal. The BER shall not be greater than  $10^{-5}$ .

The requirement shall be met on either sides of the nominal frequency.

#### 5.4.4.1.2 System type HC

The limits of adjacent channel interference (external) for system type HC shall be as given in table 9 for like modulated signals, giving maximum S/I values for 1 dB and 3 dB degradation of the  $10^{-6}$  BER limits specified in clause 5.4.3.

**Table 9: Adjacent channel interference sensitivity for system type HC**

| Description           | BER = $10^{-6}$ |          |
|-----------------------|-----------------|----------|
|                       | 1 dB            | 3 dB     |
| Threshold degradation | S/I [dB]        | S/I [dB] |
| System Type HC        | -10             | -13      |

The requirement shall be met on either sides of the nominal frequency.

## 5.4.4.2 Co-channel interference

### 5.4.4.2.1 All system types excluding HC

Co-channel sensitivity is defined as the ability of the receiver to receive a wanted signal in the presence of a like unwanted signal on the same frequency.

The two signal generators shall be connected to the receiver input via a combiner, so that the impedance is in matched to the nominal impedance of the system.

The wanted signal shall be tuned to the receiver's nominal frequency and modulated with a PRBS signal.

The interfering signal shall be turned off while the wanted signal is adjusted to the level corresponding to  $BER = 10^{-6}$  as specified in table 6.

The interfering signal shall be tuned to the same frequency as the wanted signal and modulated with a PRBS signal, which is uncorrelated to the wanted signal.

The interfering signal shall then be injected at a level, which is below the wanted signal with: 23 dB for System Type A, C and E, 30 dB for System Type B and F and 37 dB for System Type D and G.

The BER shall not be greater than  $10^{-5}$ .

### 5.4.4.2.2 System type HC

The limits of co-channel interference (external) for system type HC shall be as in table 10, giving maximum S/I values for 1 dB and 3 dB degradation of the  $10^{-6}$  BER limits specified in clause 5.4.3.

**Table 10: Co-channel interference sensitivity for system type HC**

| Description                         | BER = $10^{-6}$ |          |
|-------------------------------------|-----------------|----------|
|                                     | 1 dB            | 3 dB     |
| <b>Threshold degradation</b>        | 1 dB            | 3 dB     |
| <b>Signal to Interference level</b> | S/I [dB]        | S/I [dB] |
| <b>System Type HC</b>               | 19              | 16       |

### 5.4.4.3 CW interference

For a receiver operating at the RSL specified in clause 5.4.3 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 five times the carrier centre frequency, excluding frequencies on either side of the centre frequency of the wanted RF channel by up to 500 % of the co-polar channel spacing, shall not cause a degradation of more than 1 dB of the BER threshold as specified in clause 5.4.3 (see table 8).

The CW Interference level is under discussion within TM4. Nevertheless the above stated CW Interference specification should be applied till the final specification will be released.

## 5.4.5 Equipment Residual BER (RBER)

When equipments offers leased lines traffic options, the equipment RBER under simulated operating conditions shall be measured with a signal level which is 6 dB above the specified level for  $BER = 10^{-6}$  in clause 5.4.3 taking into account the actual test load conditions.

For different payload bit rates the measurement time and the maximum number of errors allowed are given in table 11.

**Table 11: Maximum number of errors allowed, measuring the equipment RBER**

| Payload bit rate (kbit/s) | Recording time (h) | Maximum number of errors |
|---------------------------|--------------------|--------------------------|
| $\leq 64$                 | 20                 | 5                        |
| $\geq 2\ 048$             | 15                 | 10                       |

### 5.4.6 Image frequency rejection

If applicable image frequency (frequencies) rejection shall be greater than 75 dB.

## 5.5 Antenna port characteristics

### 5.5.1 RF interface

The RF interface at reference points C and C' of the system block diagram (see figure 2) is to be declared by the manufacturer.

### 5.5.2 Return loss

For equipment without an integral antenna, the return loss at reference points C and C' of the RF system block diagram (see figure 2) shall be more than 10 dB at the reference impedance.

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## 6 Types of user equipment and service node interfaces

Table 12 lists a range of interfaces for various voice and data services. At least one of these interfaces shall be implemented in a P-MP system covered by the present document.

**Table 12: Types of interfaces**

| <b>User Network Interfaces</b>  |  |
|---|--|
| Analogue (2 wires)  | ITU-T Recommendation Q.552 [4]   |
| Analogue (4 W + E & M)  | ITU-T Recommendation Q.553 [3]   |
| Telex   | ITU-T Recommendation R.20 [6]<br>plus the V series of ITU-T Recommendations                                  |
| Digital data port   | ITU-T Recommendation G.703 [2]<br>the H series, the V series, and<br>the X series of ITU-T Recommendations   |
| ISDN basic rate   | ETS 300 012 [1] (see note 1)   |
| ISDN primary rate   | EN 300 011-1 [27]  |
| CSMA/CD Ethernet interface  | ISO/IEC 8802-3 [28]  |
| <b>Service Node Interfaces</b>  |  |
| 2 Mbit/s  | ITU-T Recommendation G.703 [2]   |
| Analogue (2 wires)  | ITU-T Recommendation Q.552 [4]   |
| Analogue (4 W + E & M)  | ITU-T Recommendation Q.553 [3]   |
| Telex   | ITU-T Recommendation R.20 [6];<br>the V series of ITU-T recommendations                                      |
| Digital data port   | ITU-T Recommendation G.703 [2]<br>the H series<br>the V series, and<br>the X series of ITU-T Recommendations |
| ISDN basic rate   | ETS 300 012 [1] (see note 2)   |
| ISDN primary rate   | EN 300 011-1 [27]  |
| Digital data port (optical)   | ITU-T Recommendation G.957 [39]  |
| ISDN + analogue subscribers + leased lines<br>2 Mbit/s interface  | V5.1: EN 300 324-1 [19]<br>V5.2: ETS 300 347-1 [20])<br>ITU-T Recommendation G.703 [2]                       |
| CSMA/CD Ethernet interface  | ISO/IEC 8802-3 [28]  |
| NOTE 1: ETS 300 012 [1] defines the S ISDN interface which is a customer premises interface and may not be suitable as a terminal station interface.  |  |
| NOTE 2: As noted above, ETS 300 012 [1] is a customer premises interface and may not be suitable as a network interface. However, exchange line interfaces for ISDN basic rate are to be vendor - specific and no single standard interface is available. |  |

## 7 Power supply and environmental characteristics

### 7.1 Power supply

The equipment shall operate from one or more of the power supplies within the ranges specified in tables 13 and 14. The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in ETS 300 132 [11].

**Table 13: Power supplies - DC**

| Nominal voltage | Voltage range                         |
|-----------------|---------------------------------------|
| 12 V            | 10,8 V to 13,6 V                      |
| 24 V            | 21,8 V to 28,1 V                      |
| 48 V            | 40,5 V to 57 V (see ETS 300 132 [11]) |
| 60 V            | 50,0 V to 72 V (see ETS 300 132 [11]) |

**Table 14: Power supplies - AC**

|                      |                |   |
|----------------------|----------------|---|
| For 110 V AC nominal | 99 V to 121 V  | 60 Hz $\pm$ 2 Hz                        |
| For 230 V AC nominal | 207 V to 253 V | 50 Hz $\pm$ 2 Hz (see ETS 300 132 [11]) |

### 7.2 Environmental conditions

The equipment shall meet the environmental conditions set out in EN 300 019-1 [9] and EN 300 019-2 [10] which defines weather protected and non-weather protected locations classes and test severities.

#### 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 EN 300 019-1 [9] and EN 300 019-2 [10], classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of EN 300 019-1 [9] and EN 300 019-2 [10], 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 EN 300 019-1 [9] and EN 300 019-2[10], 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 classes 3.3, 3.4 and 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

The equipment shall comply with EN 300 385 [14] or to relevant parts of the forthcoming multi-part standard EN 301 489-1 [12] and EN 301 489-4 [13].

## Annex A (normative): System type codes for regulatory procedures

System types reported in the present document, shall be identified with the codes reported in table A.1.

No specific system type codes are proposed for TDMA/OFDMA systems but manufacturers shall declare if TDMA/OFDMA is used. Otherwise the system type codes are as in table A.1.

**Table A.1: System type codes for radio equipment reported in EN 301 021, relevant to regulatory procedures for national licensing**

| System Type<br>↓ | Channel spacing<br>[MHz]<br>(see note 3)<br>↓ |    | Frequency band<br>(see note 1)<br>↓ | System type codes<br>(see note 2)<br>↓ |
|------------------|---|----|-------------------------------------|--|
| A                | < 1,75  |    | B1                                  | 001                                    |
|                  |   |    | B2                                  | 002                                    |
|                  |   |    | B3                                  | 003                                    |
|                  | 1,75 to < 3,5                                 |    | B1                                  | 004                                    |
|                  |   |    | B2                                  | 005                                    |
|                  |   |    | B3                                  | 006                                    |
|                  | 3,5 to < 7                                    |    | B1                                  | 007                                    |
|                  |   |    | B2                                  | 008                                    |
|                  |   |    | B3                                  | 009                                    |
|                  | 7 to < 14                                     |    | B1                                  | 010                                    |
|                  |   |    | B2                                  | 011                                    |
|                  |   |    | B3                                  | 012                                    |
|                  | 14 to < 28                                    |    | B1                                  | 013                                    |
|                  |   |    | B2                                  | 014                                    |
|                  |   |    | B3                                  | 015                                    |
|                  | 28 or greater                                 |    | B1                                  | 016                                    |
|                  |   |    | B2                                  | 017                                    |
|                  |   |    | B3                                  | 018                                    |
| < 1,75           |   |    | B1                                  | 019                                    |
|                  |   |    | B2                                  | 020                                    |
|                  |   |    | B3                                  | 021                                    |
| 1,75 to < 3,5    |   |    | B1                                  | 022                                    |
|                  |   |    | B2                                  | 023                                    |
|                  |   |    | B3                                  | 024                                    |
| 3,5 to < 7       |   | B1 | 025                                 |  |
|                  |   | B2 | 026                                 |  |
|                  |   | B3 | 027                                 |  |
| 7 to < 14        |   | B1 | 028                                 |  |
|                  |   | B2 | 029                                 |  |
|                  |   | B3 | 030                                 |  |
| 14 to < 28       |   | B1 | 031                                 |  |
|                  |   | B2 | 032                                 |  |
|                  |   | B3 | 033                                 |  |
| 28 or greater    |   | B1 | 034                                 |  |
|                  |   | B2 | 035                                 |  |
|                  |   | B3 | 036                                 |  |

| System Type<br>↓ | Channel spacing<br>[MHz]<br>(see note 3)<br>↓ |    | Frequency<br>band<br>(see note 1)<br>↓ | System<br>type codes<br>(see note 2)<br>↓ |
|------------------|---|----|--|---|
| D                | 1,75 to < 3,5                                 |    | B1                                     | 037                                       |
|                  |   |    | B2                                     | 038                                       |
|                  |   |    | B3                                     | 039                                       |
|                  | 3,5 to < 7                                    |    | B1                                     | 040                                       |
|                  |   |    | B2                                     | 041                                       |
|                  |   |    | B3                                     | 042                                       |
|                  | 7 to < 14                                     |    | B1                                     | 043                                       |
|                  |   |    | B2                                     | 044                                       |
|                  |   |    | B3                                     | 045                                       |
|                  | 14 to < 28                                    |    | B1                                     | 046                                       |
|                  |   |    | B2                                     | 047                                       |
|                  |   |    | B3                                     | 048                                       |
| 28 or greater    |   | B1 | 049                                    |   |
|                  |   | B2 | 050                                    |   |
|                  |   | B3 | 051                                    |   |
| E                | < 1,75  |    | B1                                     | 052                                       |
|                  |   |    | B2                                     | 053                                       |
|                  |   |    | B3                                     | 054                                       |
|                  | 1,75 to < 3,5                                 |    | B1                                     | 055                                       |
|                  |   |    | B2                                     | 056                                       |
|                  |   |    | B3                                     | 057                                       |
|                  | 3,5 to < 7                                    |    | B1                                     | 058                                       |
|                  |   |    | B2                                     | 059                                       |
|                  |   |    | B3                                     | 060                                       |
|                  | 7 to < 14                                     |    | B1                                     | 061                                       |
|                  |   |    | B2                                     | 062                                       |
|                  |   |    | B3                                     | 063                                       |
|                  | 14 to < 28                                    |    | B1                                     | 064                                       |
|                  |   |    | B2                                     | 065                                       |
|                  |   |    | B3                                     | 066                                       |
|                  | 28 or greater                                 |    | B1                                     | 067                                       |
|                  |   |    | B2                                     | 068                                       |
|                  |   |    | B3                                     | 069                                       |
| F                | < 1,75  |    | B1                                     | 070                                       |
|                  |   |    | B2                                     | 071                                       |
|                  |   |    | B3                                     | 072                                       |
|                  | 1,75 to < 3,5                                 |    | B1                                     | 073                                       |
|                  |   |    | B2                                     | 074                                       |
|                  |   |    | B3                                     | 075                                       |
|                  | 3,5 to < 7                                    |    | B1                                     | 076                                       |
|                  |   |    | B2                                     | 077                                       |
|                  |   |    | B3                                     | 078                                       |
|                  | 7 to < 14                                     |    | B1                                     | 079                                       |
|                  |   |    | B2                                     | 080                                       |
|                  |   |    | B3                                     | 081                                       |
|                  | 14 to < 28                                    |    | B1                                     | 082                                       |
|                  |   |    | B2                                     | 083                                       |
|                  |   |    | B3                                     | 084                                       |
|                  | 28 or greater                                 |    | B1                                     | 085                                       |
|                  |   |    | B2                                     | 086                                       |
|                  |   |    | B3                                     | 087                                       |



| System Type<br>↓  | Channel spacing<br>[MHz]<br>(see note 3)<br>↓ |  | Frequency<br>band<br>(see note 1)<br>↓ | System<br>type codes<br>(see note 2)<br>↓ |
|---|---|--|--|---|
| G   | 1,75 to 3,5                                   |  | B1                                     | 088                                       |
|   |   |  | B2                                     | 089                                       |
|   |   |  | B3                                     | 090                                       |
|   | 3,5 to < 7                                    |  | B1                                     | 091                                       |
|   |   |  | B2                                     | 092                                       |
|   |   |  | B3                                     | 093                                       |
|   | 7 to < 14                                     |  | B1                                     | 094                                       |
|   |   |  | B2                                     | 095                                       |
|   |   |  | B3                                     | 096                                       |
|   | 14 to < 28                                    |  | B1                                     | 097                                       |
|   |   |  | B2                                     | 098                                       |
|   |   |  | B3                                     | 099                                       |
|   | 28 or greater                                 |  | B1                                     | 100                                       |
|   |   |  | B2                                     | 101                                       |
|   |   |  | B3                                     | 102                                       |
| C   | < 1,75  |  | B1                                     | 103                                       |
|   |   |  | B2                                     | 104                                       |
|   |   |  | B3                                     | 105                                       |
|   | 1,75 to < 3,5                                 |  | B1                                     | 106                                       |
|   |   |  | B2                                     | 107                                       |
|   |   |  | B3                                     | 108                                       |
| HC  | 3,5 to < 7                                    |  | B1                                     | 109                                       |
|   |   |  | B2                                     | 110                                       |
|   |   |  | B3                                     | 111                                       |
|   | 7 to < 14                                     |  | B1                                     | 112                                       |
|   |   |  | B2                                     | 113                                       |
|   |   |  | B3                                     | 114                                       |
|   | 14 to < 28                                    |  | B1                                     | 115                                       |
|   |   |  | B2                                     | 116                                       |
|   |   |  | B3                                     | 117                                       |
|   | 28 or greater                                 |  | B1                                     | 118                                       |
|   |   |  | B2                                     | 119                                       |
|   |   |  | B3                                     | 120                                       |
| <p>NOTE 1: Option B1 refers to systems operating in frequency band 3 410 MHz to 3 600 MHz (CEPT/ERC Recommendation 14-03 [7]).<br/>Option B2 refers to systems operating in frequency band 3 600 MHz to 3 800 MHz (CEPT/ERC Recommendation 12-08, annex B part 2 [25]).<br/>Option B3 refers to systems operating in frequency band 10 150 to 10 300 paired with 10 500 MHz to 10 650 MHz (CEPT/ERC Recommendation 12-05, annex A [8]).</p> <p>NOTE 2: The system code, in the bands 3 410 MHz to 3 600 MHz and 3 600 MHz to 3 800 MHz, shall be followed by the Duplex Code:</p> <ul style="list-style-type: none"> <li>- Duplex Code "T" for TDD systems;</li> <li>- Duplex code "F50" for FDD systems with 50 MHz duplex frequency;</li> <li>- Duplex code "F100" for FDD systems with 100 MHz duplex frequency.</li> </ul> <p>NOTE 3: The system code shall end in a '-' followed by the channel spacing in MHz. This may be omitted for 2 MHz, N x 1,75 MHz or 30 MHz systems.<br/>Examples: System code "083F50" or "083F100" or "083T" are all system type F for 14 MHz Channel Spacing in 3,7 GHz band with different TD or FD duplex options.<br/>"091F100-6" is a system type G with 6 MHz channel spacing in the 3,5 GHz band.</p> |   |  |  |   |

## Annex B (informative): Example of calculated performance against tabulated values

The following compares the tabulated and calculated values for a system type G with 7 MHz channel spacing.

Minimum Gross Bit Rate

Tabulated Value (see table 2): 24 Mbits/s

Calculated Value Using:

$$MGBR = \frac{4}{7} \Delta F \frac{\log(s)}{\log(2)}$$

$$= 24 \text{ Mbits/s}$$

Spectrum Mask Points

Tabulated Values from (see table 4):

Point A 3,5 MHz

Point B 3,5 MHz

Point C 5,0 MHz

Point D 7,4 MHz

Point E 14 MHz

Point F 17,5 MHz

Equation Values:

Point A 0,5  $\Delta F$  3,5 MHz

Point B 0,5  $\Delta F$  3,5 MHz

Point C 0,714  $\Delta F$  4,998 MHz

Point D 1,057  $\Delta F$  7,399 MHz

Point E 2,0  $\Delta F$  14 MHz

Point F 2,5  $\Delta F$  17,5 MHz

BER Versus Receiver Signal Level

Tabulated Value (see table 8): BER  $10^{-3}$ : -70 dBm

BER  $10^{-6}$ : -66 dBm

Equation Values: BER  $10^{-3}$ :  $-78,5 + 10 \log_{10}(\Delta F) = -70,05$  dBm

BER  $10^{-6}$ :  $-74,5 + 10 \log_{10}(\Delta F) = -66,05$  dBm

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## Annex C (informative): Bibliography

- ITU-T Recommendation G.773 (1993): "Protocol suites for Q-interfaces for management of transmission systems".

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## History

| <b>Document history</b> |               |   |
|-------------------------|---------------|---|
| V1.1.1                  | July 1998     | Publication   |
| V1.2.1                  | May 2000      | Publication   |
| V1.3.1                  | October 2000  | Publication   |
| V1.4.1                  | August 2001   | Publication   |
| V1.5.1                  | February 2002 | Publication   |
| V1.6.1                  | February 2003 | One-step Approval Procedure      OAP 20030704: 2003-03-05 to 2003-07-04 |