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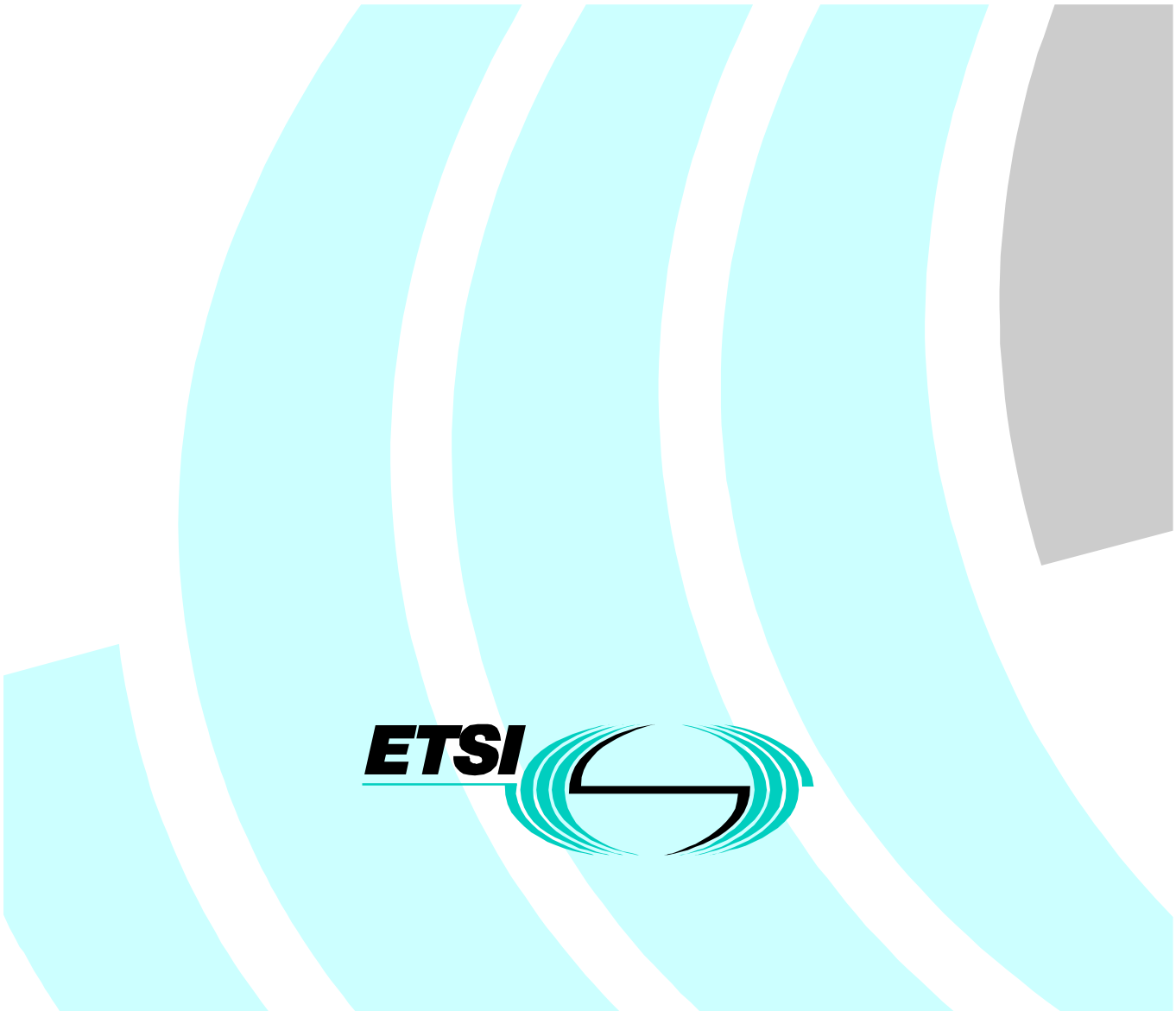
European Standard (Telecommunications series)

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



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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

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

The present document is intended to cover a variety of systems designed for a variety of services, applications, performance objectives and deployment conditions. Therefore it is necessary to include in the present document different sets of system parameters. In the present document these set of parameters are referred to as "system types".

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

National transposition dates	
Date of adoption of this EN:	16 February 2001
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Introduction

The main field of application of Point-to-Multipoint (P-MP) systems, using the Fixed Service (FS), is to provide access to both public and private networks (Public Switched Telephone Network (PSTN), Public Data Network (PDN), etc.). By means of P-MP systems the network service area may cover scattered subscriber locations. The systems may be applied to build new access networks by means of a multi cellular architecture, covering both urban and regional 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 (e.g. 2-wire loop, and Integrated Services Digital Network (ISDN) ranging from basic rate to n × primary rate).

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 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 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* subscribers can share *n* radio channels (*m* being larger than *n*), allowing a better use of the available frequency spectrum at a lower equipment costs. 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 network node (service node) and the subscriber equipment communicate with each other without being aware of the radio link.

1 Scope

The present document specifies the minimum requirements for system parameters of Frequency Division Multiple Access (FDMA) Point-to-Multipoint (P-MP) radio systems in the terrestrial Fixed Service (FS) operating in the bands 3 GHz to 11 GHz.

The system will provide access to both public and private networks (Public Switched Telephone Network (PSTN), Public Data Network (PDN), etc.) by means of the various standardized network interfaces (e.g. 2-wire loop, Integrated Services Digital Network (ISDN) and 2 Mbit/s).

The system may be applied to build access networks by means of a multi cellular architecture, covering urban, suburban, and regional areas.

The FDMA P-MP system will transmit a Radio Frequency (RF) signal from the customer site to the Central Station (CS) only utilizing a spectral bandwidth corresponding to that capacity which is requested from and assigned to the customer by pre-assignment or by Demand Assigned Multiple Access (DAMA). The CS receives from each customer site a single modulated carrier being processed independently within the CS. Thus the CS is receiving a FDMA signal.

The present document covers the following typical P-MP applications:

The transmission of:

- voice;
- fax;
- voice band data;
- telex;

related to analogue interfaces and:

- 64 Kbit/s;
- ISDN;
- digital video;
- digital audio;

related to digital interfaces.

Further applications like Asynchronous Transport Mode (ATM) may also be provided.

Two classes of systems have been defined in order to take into account the large variety of possible applications due to access network implementations and type of service to be provided.

The equipment covered by the present document should be designed to be able to meet the network performance requirements foreseen by ITU-R Recommendations F.696-2 [1] and F.697-2 [2], for medium, local grade or ITU-R Recommendation F.1189-1 [3] national portion (access or short haul) of the digital connection following the criteria defined in ITU-T Recommendation(s) G.821 [4] and/or G.826 [5]. It should be noted that the values for B and C are provisional taking also into account note 5 of ITU-R Recommendation F.1189-1 [3].

The availability requirements are under further study by the relevant bodies.

Network operators may choose different performance and availability requirements in order to extend the possible area of application thus fitting to their network needs.

Radio terminals from different manufacturers are not intended to interwork 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.

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.

[1] ITU-R Recommendation F.696-2: "Error performance and availability objectives for hypothetical reference digital sections forming part or all of the medium-grade portion of an ISDN connection at a bit rate below the primary rate utilizing digital radio relay systems".

[2] ITU-R Recommendation F.697-2: "Error performance and availability objectives for the local-grade portion at each end of an ISDN connection a bit rate below the primary rate utilizing digital radio-relay systems".

[3] 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 the national portion of a 27 500 km hypothetical reference path".

[4] 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".

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

[6] 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".

[7] CEPT/ERC Recommendation 12-05: "Harmonized radio frequency channel arrangements for digital terrestrial fixed systems operating in the band 10.0 to 10.68 GHz".

[8] ETSI ETS 300 019: "Equipment engineering (EE); Environmental conditions and environmental tests for telecommunication equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations and Part 1-4: Classification of environmental conditions Stationary use at non-weatherprotected locations".

[9] ETSI ETS 300 132 (all parts): "Equipment engineering (EE); Power supply interface at the input to telecommunications equipment".

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

[11] ITU-T Recommendation G.773: "Protocol suites for Q-interfaces for management of transmission systems".

[12] ITU-T Recommendation G.810: "Definitions and terminology for synchronization networks".

[13] ITU-T Recommendation G.812: "Timing requirements of slave clocks suitable for use as node clocks in synchronization networks".

[14] ITU-T Recommendation G.823: "The control of jitter and wander within digital networks which are based on the 2 048 kbit/s hierarchy".

[15] ITU-T Recommendation G.813: "Timing characteristics of SDH equipment slave clocks (SEC)".

[16] ITU-T Recommendation G.825: "The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)".

[17] ETSI EN 300 833: "Fixed Radio Systems; Point to Point Antennas; Antennas for point-to-point fixed radio systems operating in the frequency band 3 GHz to 60 GHz".

[18] ETSI EN 302 085: "Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 3 GHz to 11 GHz band".

[19] ITU-T Recommendation G.703: "Physical / electrical characteristics of hierarchical digital interfaces".

[20] ITU-T Recommendation G.131: "Control of talker echo".

[21] ITU-T Recommendation G.711: "Pulse code modulation (PCM) of voice frequencies".

[22] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[23] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code excited linear prediction".

[24] 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".

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

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

[27] CEPT/ERC Recommendation 74-01: "Spurious Emissions".

[28] ITU-T Recommendation Q.552: "Transmission characteristics at 2-wire analogue interfaces of digital exchanges".

[29] ITU-T Recommendation Q.553: "Transmission characteristics at 4-wire analogue interfaces of digital exchanges".

[30] ITU-T Recommendation R.20: "Telegraph modem for subscriber lines".

[31] ITU-T Recommendation V-series: "Data communication over the telephone network".

[32] ITU-T Recommendation X-series: "Data networks and open system communication".

[33] ITU-T Recommendation G.961: "Digital transmission system on metallic local lines for ISDN basic rate access".

[34] ETSI ETS 300 012: "Integrated Services Digital Network (ISDN); Basic user-network interface; Layer 1 specification and test principles".

[35] ETSI ETS 300 011: "Integrated Services Digital Network (ISDN); Primary rate user-network interface; Layer 1 specification and test principles".

[36] ITU-T Recommendation G.962: "Access digital line section for ISDN primary rate at 2 048 kbit/s".

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

[38] ITU-T Recommendation G.964: "V-Interfaces at the digital local exchange (LE) - V5.1 interface (based on 2 048 kbit/s) for the support of access network (AN)".

[39] ITU-T Recommendation G.965: "V-Interfaces at the digital local exchange (LE) - V5.2 interface (based on 2 048 kbit/s) for the support of access network (AN)".

[40] ITU-T Recommendation G.957: "Optical interfaces for equipment and systems relating to synchronous digital hierarchy".

[41] ETSI ETS 300 324: "V interfaces at the digital Local Exchange (LE); V5.1 interface for the support of Access Network (AN)".

[42] ETSI ETS 300 347 (all parts): "V interfaces at the digital Local Exchange (LE); V5.2 interface for the support of Access Network (AN)".

[43] ETSI EG 202 306: "Transmission and Multiplexing (TM); Access networks for residential customers".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Full Capacity Load (FCL): maximum number of 64 kbit/s signals or the equivalent which can be transmitted and received by a single Central Radio Station (CRS) within a specified RF bandwidth, fulfilling a given performance and availability objectives in respect to fading conditions

round trip delay: sum of the delay between point F to G plus G to F in figure 1 including any repeaters as appropriate

nominal output power: maximum output power of the CRS, Terminal Station (TS) or Repeater Station (RS) referred to point C' (figure 2) under Full Load Condition (FLC), as declared by the manufacturer

3.2 Symbols

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

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

3.3 Abbreviations

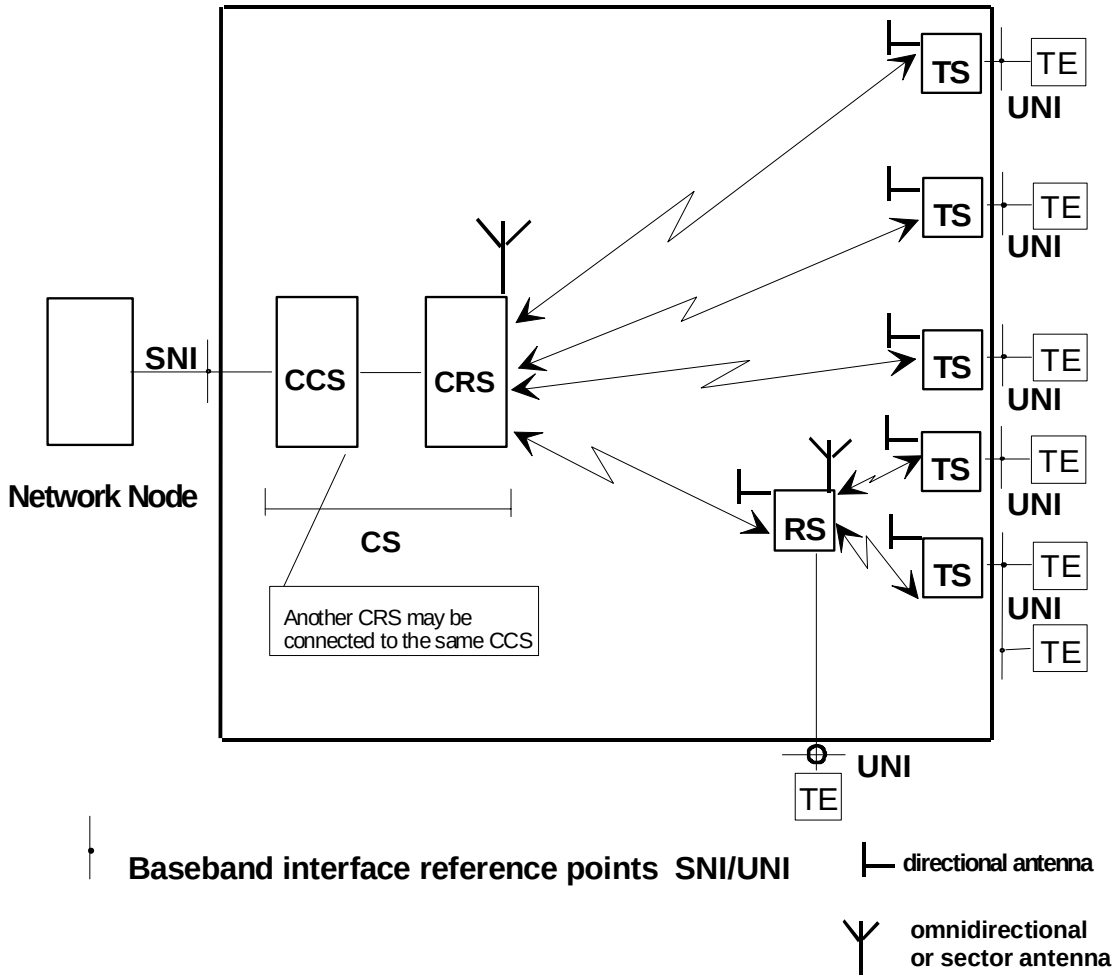
For the purposes of the present document, the following abbreviations apply:

ATM	Asynchronous Transport Mode
ATPC	Automatic Transmit Power Control
BBER	Background BER
BER	Bit Error Ratio
CCS	Central Controller Station
CEPT	Conférence des Administrations Européennes des Postes et Télécommunications
CRS	Central Radio Station
CS	Central Station
CSmin	minimum practical Channel Separation (for a given radio-frequency channel arrangement)
CW	Continuous Wave
DAMA	Demand Assigned Multiple Access
EMC	ElectroMagnetic Compatibility
ERC	European Radiocommunications Committee
FCL	Full Capacity Load
FDMA	Frequency Division Multiple Access
FLC	Full Load Condition
FS	Fixed Service
IF	Intermediate Frequency
ISDN	Integrated Services Digital Network
LO	Local Oscillator
PDH	Plesiochronous Digital Hierarchy

PDN	Public Data Network
P-MP	Point to Multipoint
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RS	Repeater Station
RSL	Receiver input Signal Level
Rx	Receiver
SDH	Synchronous Digital Hierarchy
TE	Terminal Equipment
TMN	Telecommunications Management Network
TS	Terminal Station
Tx	Transmitter

4 General characteristics

4.1 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. More than one CRS may be controlled by one CCS.

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.

SNI: Service Node Interface. (EG 202 306 [43]).

UNI: User Network Interface. (EG 202 306 [43]).

TE: Terminal Equipment.

NOTE 1: CCS may control more than one CRS.

NOTE 2: A TS may serve more than one TE.

Figure 1: General system architecture

The CS performs the interconnection with the local switching exchange (service node) carrying out a concentration function by sharing the total number of available channels in the system. The CS is linked either directly to all TSs or via a RS by microwave transmission paths.

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

4.2 Frequency bands and channel arrangements

4.2.1 Channel plan

Table 1 gives details of those frequency bands in the range 3 GHz to 11 GHz which have been identified by CEPT/ERC for P-MP applications. The present document is also applicable for additional bands within the frequency range 3 GHz to 11 GHz which may be made available for P-MP application by CEPT/ERC (and ITU-R) in the future.

Table 1: Frequency bands

Frequency band (GHz)	Band limits (GHz)	Recommendation	Transmit / receive spacing (MHz)	Channel spacing (MHz)
3,5	3,4 to 3,6	CEPT/ERC Recommendation 14-03 [6]	50/100	0,5 (slots)
10,5	10,15 to 10,3 paired with 10,50 to 10,65	CEPT/ERC Recommendation 12-05 [7]	350	0,5 (slots)

4.2.2 Proposed channel arrangements

The system shall meet at least one of the channel arrangements listed in table 2.

Table 2: Channel arrangement

Channel spacing (MHz)	1	1,75	2	3,5	7	14	28	30
Minimum CRS transmission capacity (kbit/s) 4 state modulation (or equivalent) (see note 1)	12 × 64	21 × 64	24 × 64	42 × 64	84 × 64; 4 × 2 048	8 × 2 048	16 × 2 048	17 × 2 048
Minimum CRS transmission capacity (Kbit/s) 8 state modulation (or equivalent) (see note 1)	18 × 64	31 × 64	36 × 64	62 × 64	5 × 2048	10 × 2 048	20 × 2 048	22 × 2 048
Minimum CRS transmission capacity (Kbit/s) 16 state modulation (or equivalent) (see note 1)	24 × 64	42 × 64	48 × 64	84 × 64; 4 × 2 048	8 × 2048	16 × 2 048	32 × 2 048	34 × 2 048

NOTE 1: "or equivalent" means: providing the same capacity regardless of the actual modulation scheme.
NOTE 2: Allocated RF channels may be occupied by systems using smaller RF-channel spacing as long as the spectrum mask for the allocated RF channel is not exceeded.
NOTE 3: Any other equivalent transmission capacity may be transported, e.g. instead of 42 × 64 Kbit/s a capacity of 21 × 128 Kbit/s can be transmitted.

4.3 Compatibility requirements

There is no requirement to operate the CRS from one manufacturer with the TS and RS from another manufacturer.

4.4 Environmental conditions

The equipment shall be required to meet the environmental conditions set out in ETS 300 019 [8] which defines weather protected and non-weather protected locations, classes and test severity.

The manufacturer shall state which class the equipment is designed to withstand.

4.4.1 Equipment within weather protected locations (indoor locations)

The equipment intended for operation within temperature controlled locations or partially temperature controlled locations shall meet the requirements of ETS 300 019 [8] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [8] classes 3.3 (non-temperature controlled locations), 3.4 (sites with heat trap) and 3.5 (sheltered locations) may be applied.

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

Equipment intended for operation in non-weather protected locations shall meet the requirements of ETS 300 019 [8], class 4.1 or 4.1E.

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

For systems supplied within specific radio cabinets which gives full protection against precipitation, wind, etc. the ETS 300 019 [8] classes 3.3, 3.4 and 3.5 may be applied also for equipment intended for operation in non-weather protected locations.

4.5 Power supply

The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in ETS 300 132 [9], Parts 1 and 2 [9].

NOTE: Some applications may require a power supply that is not covered by ETS 300 132 [9].

4.6 Electromagnetic Compatibility (EMC) conditions

The system shall operate under the conditions specified in EN 300 385 [10].

4.7 Telecommunications Management Network (TMN) interfaces

TMN interfaces, if any, shall be in accordance with ITU-T Recommendation G.773 [11].

4.8 Synchronization of interface bit rates

Systems employing digital interfaces shall include methods enabling internal and external synchronization to the network. The principles for synchronization shall be met according to ITU-T Recommendation G.810 [12]. Tolerances shall be in accordance to ITU-T Recommendations G.812 [13] and G.823 [14] for systems providing Plesiochronous Digital Hierarchy (PDH) interfaces and/or ITU-T Recommendations G.813 [15] and G.825 [16] for systems providing Synchronous Digital Hierarchy (SDH) interfaces.

4.9 Branching / feeder / antenna requirements

4.9.1 Antenna radiation pattern

If high gain antennas (parabola antennas) are required for the TSs to cover longer hop lengths they shall comply with EN 300 833 [17]. For other hop lengths the antennas for the TS shall comply with EN 302 085 [18].

Different types of antennas are envisaged for the CRS depending on the cell structure of the radio cell covered by the CS. Those antennas shall also comply with EN 302 085 [18].

5 System parameters

NOTE: If there is a reference made to the number of states of a modulation scheme, it is also permitted to apply an equivalent modulation scheme, if the system parameters are met.

5.1 System capacity

The system capacity considered in the present document is the transmission capacity of the CRS, which is the maximum payload bit rate (i.e. the maximum number of carriers transporting simultaneously their maximum payload bit rate each (according to ITU-Recommendation G.703 [19]) transmitted simultaneously over the air between a given CRS and its linked remote stations (TSs and/or RSs)).

The maximum number of simultaneous carriers which can be supported by the CRS shall be declared by the manufacturer.

5.2 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 delay introduced by the system into the transmission network does not degrade the quality of the telephone communication, compliance to ITU-T Recommendation G.131 [20] shall be ensured.

5.3 Transparency

The system shall be fully transparent: the network node and the subscriber equipment (points F and G in figure 1) communicate with each other without being aware of the radio link.

5.4 Voice coding methods

One of the following coding methods should be used:

- 64 kbit/s ITU-T Recommendation G.711 [21];
- 32 kbit/s ITU-T Recommendation G.726 [22];
- 16 kbit/s ITU-T Recommendation G.728 [23];
- 8 kbit/s ITU-T Recommendation G.729 [24].

Other voice coding methods may be employed if the quality for voice transmission is adequate. The used coding method shall be declared by the manufacturer.

5.5 Transmitter characteristics

All transmitter characteristics are referred to a system under any load conditions.

The measurement shall be referred to point C' of figure 2.

Measurements shall be made when the CRS (at least one transceiver equipment) is under Full Load Conditions (FLC), to be declared by the manufacturer.

A Bit Error Rate (BER) lower than or equal to 10^{-6} shall be achieved at a receive level stated in clause 5.7.2.

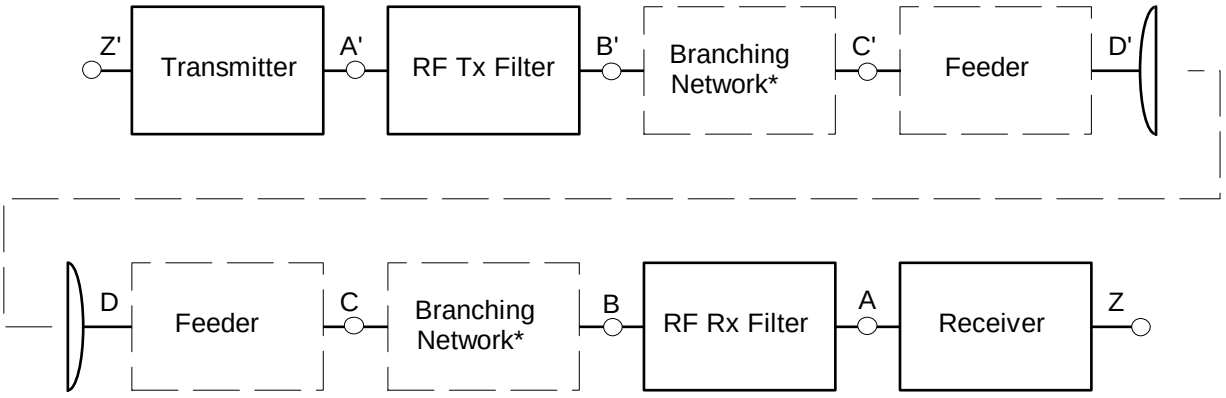
The specified transmitter characteristics shall be met with the appropriate input signals applied at point F or G of figure 1. For the PDH interface, this shall be in accordance with ITU-T Recommendation O.151 [25] and for SDH interfaces in accordance with ITU-T Recommendation O.181 [26].

5.5.1 Transmitter power range

The maximum mean output power of the transmitter for a CRS, TS and RS shall not exceed +35 dBm referenced to point C' of the RF system block diagram (see figure 2).

The manufacturer shall declare the nominal output power for the CRS, TS and RS under full load conditions.

The RF system block diagram figure 2 shows the point to point connection of the P-MP transceiver systems between the CRS and one TS (RS) and vice versa, as illustrated in figure 1.



NOTE: The points shown above are reference points only; points B, C and D, B', C' and D' may coincide.

Figure 2: RF system block diagram

A capability for output power level adjustment shall be provided by internal or external means.

5.5.2 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.

5.5.3 Transmitter (Tx) Local Oscillator (LO) frequency arrangements

There is no requirement on LO frequency arrangement.

5.5.4 RF spectrum mask

5.5.4.1 RF spectrum mask for the central radio station

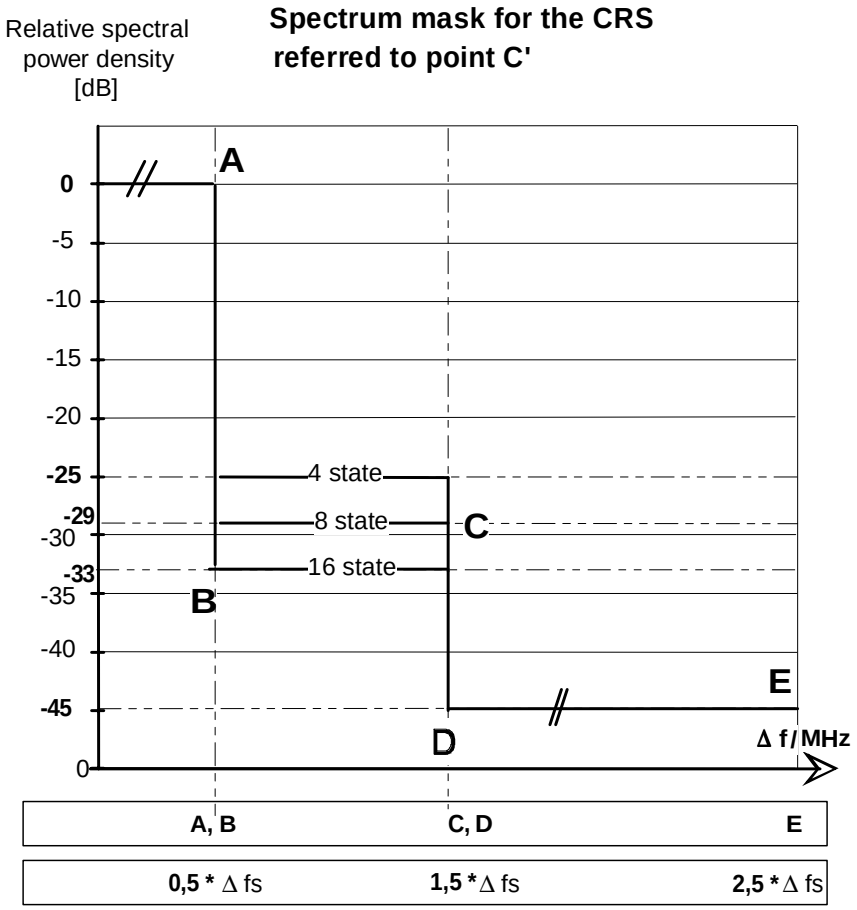
The 0 dB level shown on the spectrum masks is the maximum of the modulated spectrum disregarding residual carriers.

General test load conditions to measure the spectrum mask for the CRS transceiver:

- number (N) of carriers transmitted over one CRS transceiver should correspond with the FCL of the measured CRS. The number N shall be declared by the manufacturer;
- the output power for each carrier shall be 1/N of the nominal output power of the CRS referred to point C';
- the capacity of the CRS shall be equally distributed among the N single carriers.

NOTE: Under operational conditions the output power of some carriers may be greater than 1/N of the nominal output power.

The spectrum mask for the CRS transceiver is shown in figure 3.



NOTE 1: The different spectral power density levels for C are related to different modulation schemes.
NOTE 2: Frequency tolerances are not included in the mask.

Δ fs: RF-channel spacing (copolar) between the centre frequencies of two adjacent CRS.

Figure 3: Spectrum mask for the CRS

The spectrum analyser settings for measuring the RF-spectrum mask are listed in table 3.

Table 3: Spectrum analyser settings for RF power spectrum measurement

RF channel spacing (MHz)	1	1,75	2	3,5	7	14	28 or 30
Centre Frequency	actual	actual	actual	actual	actual	actual	actual
Sweep width (MHz)	10	10	20	20	40	80	160
Scan time	auto	auto	auto	auto	auto	auto	auto
IF bandwidth (kHz)	30	30	30	30	30	30	100
Video bandwidth (kHz)	0,1	0,3	0,3	0,3	0,3	0,3	0,3

5.5.4.2 RF-spectrum mask for the terminal station and the repeater station

The RF-spectrum mask for the TS and the RS shall comply with the spectrum mask for the CRS transceiver.

5.5.4.3 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 (CSmin/IFbw) - 10} dB (note)
- be spaced each other in frequency by less than CSmin

Where:

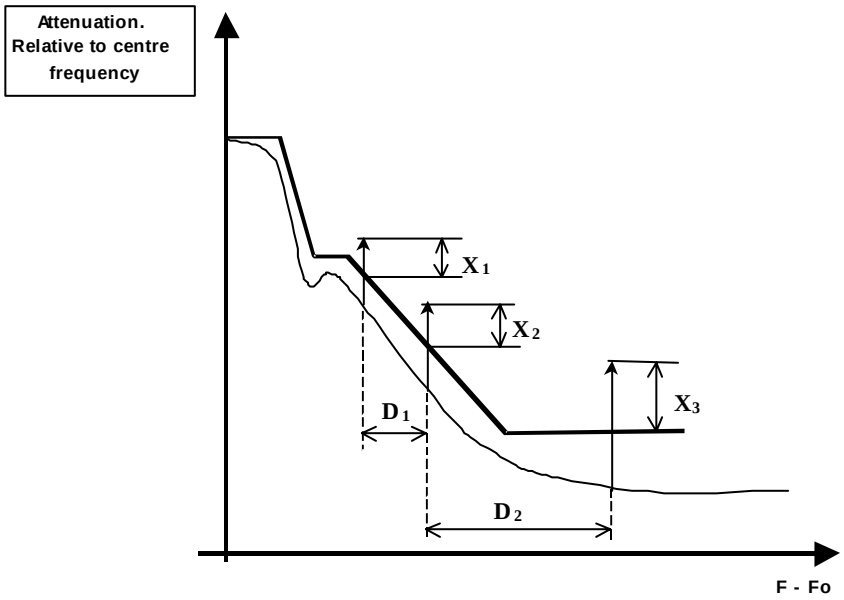
CSmin = 500 kHz for 3,5 and 3,7 GHz bands

CSmin = 1 500 kHz for 10,5 GHz band

IFbw 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 4 shows a typical example of this requirement.



X_1, X_2, X_3 [dB] ≤ $10\log(CSmin/IF_{bw})-10$

$D_1, D_2 \geq CSmin$

Figure 4: CW lines exceeding the spectrum mask (typical example)

5.5.5 RF tolerance

Maximum radio frequency tolerance shall not exceed ±10 ppm for the band 3 GHz to 11 GHz. Since this limit includes both short-term factors (environmental effects) and long-term ageing effects, the manufacturer shall state the guaranteed short-term part and the expected ageing part during the type test.

5.5.6 Spurious emissions

According to CEPT/ERC Recommendation 74-01 [27] the spurious emissions are defined as emissions at frequencies which are removed from the nominal carrier frequency more than ±250 % of the relevant channel separation.

Outside the band of ±250 % of the relevant channel separation (CS), the Fixed Service radio systems spurious emission limits, defined by CEPT/ERC Recommendation 74-01 [27] together with the frequency range to consider for conformance measurement, shall apply at reference point C'.

Table 4: Void

Table 5: Void

5.6 Receiver characteristics

5.6.1 Receiver (Rx) LO frequency arrangements

There is no requirement on LO frequency arrangement.

5.6.2 Spurious emissions

At reference point C, the limit values of CEPT/ERC Recommendation 74-01 [27] shall apply.

Table 6: Void

Table 7: Void

5.7 System performance without diversity

The parameters stated below shall be met under any load condition.

5.7.1 Dynamic level range

The dynamic level range shall exceed 50 dB. The exact value shall be declared by the manufacturer. Within the dynamic level range the BER shall be lower than 10^{-3}.

5.7.2 BER as a function of Receiver input Signal Level (RSL)

For System types A, each FDMA receiver input signal level at the BER thresholds (dBm) referred to point C (see figure 2) for BER of 10^{-3} and 10^{-6} shall be equal to or lower than those stated in table 8. For bit rates of 2 Mbit/s as a reference, taking into account forward error correction for the different modulation schemes.

The BER performance shall be measured from the CRS to the TS (outbound) and from the TS to the CRS (inbound).

Table 8: BER performance thresholds for different modulation schemes (System types A) for 2 Mbit/s

	RSL/dBm for BER ≤ 10^{-3}			RSL/dBm for BER ≤ 10^{-6}		
Frequency band (GHz)	**Modulation states**			**Modulation states**		
----	4	8	16	4	8	16
3,5	-100	-99	-94	-97,5	-96,5	-91,5
10,5	-100	-99	-94	-97,5	-96,5	-91,5

Applying other bit rates, the relevant receive levels may be calculated according to the following formulas:

- 4-state modulation schemes (or equivalent) (System types A):
  - P_e= -103 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e= -100,5 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.
- 8-state modulation schemes (or equivalent) (System types A):
  - P_e= -102 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e= -99,5 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.
- 16-state modulation schemes (or equivalent) (System types A):
  - P_e= -97 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e= -94,5 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.

For System types B, each FDMA receiver input signal level at the BER thresholds (dBm) referred to point C (see figure 2) for BER of 10^{-3}, and 10^{-6} shall be equal to or lower than those stated in table 9. For bit rates of 2 Mbit/s as a reference, the BER performance should be measured from the CRS (transceiver) to the TS (Outbound) and from the TS to the CRS (Inbound).

Table 9: BER performance thresholds for different modulation schemes (System types B) for 2 Mbit/s

RSL	RSL/dBm for BER ≤ 10^{-3}			RSL/dBm for BER ≤ 10^{-6}		
Frequency band /GHz	Modulation states			Modulation states		
----	4	8	16	4	8	16
3,5	-90	-87	-84	-86	-83	-79
10,5	-90	-87	-84	-86	-83	-79

Applying other bit rates the relevant receive levels may be calculated according the following formulas:

- 4-state modulation schemes (System types B):
  - P_e = -93 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e = -89 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.
- 8-state modulation schemes (System types B):
  - P_e = -90 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e = -86 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.
- 16-state modulation schemes (System types B):
  - P_e = -87 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-3};
  - P_e = -82 + 10 × $\log_{10}$ (bit rate in Mbit/s) dBm for BER 10^{-6}.

5.7.3 Equipment Background BER (BBER)

Following ITU-T Recommendations G.821 [4] and/or G.826 [5] the equipment BBER under simulated operating conditions is measured with a signal level at reference point C (figure 2) which is 6 dB above the specified level for BER = 10^{-6} in clause 5.7.2 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 10.

Table 10: Maximum number of errors allowed, measuring the equipment BBER

Payload bit rate (kbit/s)	Minimum recording time (hours)	Maximum number of errors
≤ 64	20	5
≥ 2 048	15	10

For systems transporting voice band signals the maximum number of errors shall not exceed 10 during a minimum recording time of 24 minutes.

5.7.4 Interference sensitivity (external)

5.7.4.1 Cochannel interference

The limits of cochannel interference (external) for System types A shall be as in table 11, giving maximum Signal to Interference (S/I) values for 1 dB and 3 dB degradation of the 10^{-6} BER limit specified in clause 5.7.2.

Table 11: Cochannel interference sensitivity for System types A systems

Description	BER 10^{-6}	
Threshold degradation	1 dB	3 dB
Signal to Interference level	S/I (dB)	S/I (dB)
4 state modulation	17,5	13,5
8 state modulation	19,5	15,5
16 state modulation	26,5	22,5

For System types B, the S/I values stated in table 11 are allowed to be 5 dB higher.

5.7.4.2 Adjacent channel interference

The limits of adjacent channel interference (external) for System types A systems shall be as given in table 12 for like modulated signals, giving maximum S/I values for 1 dB and 3 dB degradation of the 10^{-6} BER limit specified in clause 5.7.2.

Table 12: Adjacent channel interference sensitivity

Description	BER 10^{-6}	
Threshold degradation	1 dB	3 dB
Signal to Interference level	S/I (dB)	S/I (dB)
4 state modulation	-15,5	-19,5
8 state modulation	-13,5	-17,5
16 state modulation	-6,5	-10,5

For System types B, the S/I values stated in table 12 are allowed to be 5 dB higher.

5.7.5 Distortion sensitivity

Distortion sensitivity due to multipath fading is not considered in the present document.

5.7.6 Continuous Wave (CW) spurious interference

The immunity of the receiver(s) to CW spurious interference is under study in TM4. This test is designed to identify specific frequencies at which the receiver may have a spurious response; e.g. image frequency, harmonics of the receive filter, etc. The actual test range should be adjusted accordingly. The test is not intended to imply a relaxed specification at all out of band frequencies elsewhere specified in the present document.

For a receiver operating at the 10^{-6} BER threshold given in tables 8 and 9 respectively, the introduction of a CW interferer at a level of +30 dB, with respect to the "wanted" signal at any frequency in the range 1 GHz to 40 GHz, excluding frequencies on either side of the "wanted frequency" (RF-channel spacing) till up to 450 % the copolar channel spacing, shall not result in a BER greater than 10^{-5}.

5.8 System performance with diversity

Diversity operation is not considered in the present document.

6 Types of interfaces at the subscriber equipment and the network node

Table 13 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 13: Types of interfaces/ranges

Interface	Proposed Standards
Subscriber equipment interfaces	
Analogue (2 wires)	ITU-T Recommendation Q.552 [28]
Analogue (4 wire plus E & M)	ITU-T Recommendation Q.553 [29]
Telex	ITU-T Recommendation R.20 [30] and V-series [31]
Digital data port (electrical)	ITU-T Recommendation G.703 [19], X-series [32] and V-series [31]
ISDN basic rate (U and S interfaces)	ITU-T Recommendation G.961 [33]; ETS 300 012 [34]
ISDN primary rate (U and S interfaces)	ITU-T Recommendation G.962 [36]; ETS 300 011 [35]
SDH interfaces	ITU-T Recommendation G.707 [37]
Network interfaces	
2 Mbit/s	ITU-T Recommendation G.703 [19]
Analogue (2 wires)	ITU-T Recommendation Q. 552 [28]
Analogue (4 wire plus E & M)	ITU-T Recommendation Q. 553 [29]
Telex	ITU-T Recommendation R.20 [30] and V-series [31]
Digital data port (electrical)	ITU-T Recommendation G.703 [19], X-series [32] and V series [31]
Digital data port (optical)	ITU-T Recommendation G. 957 [40]
ISDN + analogue subscribers + leased lines 2 Mbit/s interface	ITU-T Recommendation G.703 [19] ITU-T Recommendation G.964 [38], V5.1 ITU-T Recommendation G.965 [39], V5.2 ETS 300 324 [41] ETS 300 347 [42]
ISDN U interface	ITU-T Recommendation G.961 [33]
SDH interfaces	ITU-T Recommendations G.703 [19] G.707 [37], G.957 [40]

NOTE: Further interfaces may be implemented.

Annex A (informative): Bibliography

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

ETSI EN 301 390: "Fixed Radio Systems; Point-to-point and Point-to-Multipoint Systems; Spurious emissions and receiver immunity at equipment/antenna port of Digital Fixed Radio Systems".

ITU-R Recommendation SM.329-7: "Spurious Emissions".

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