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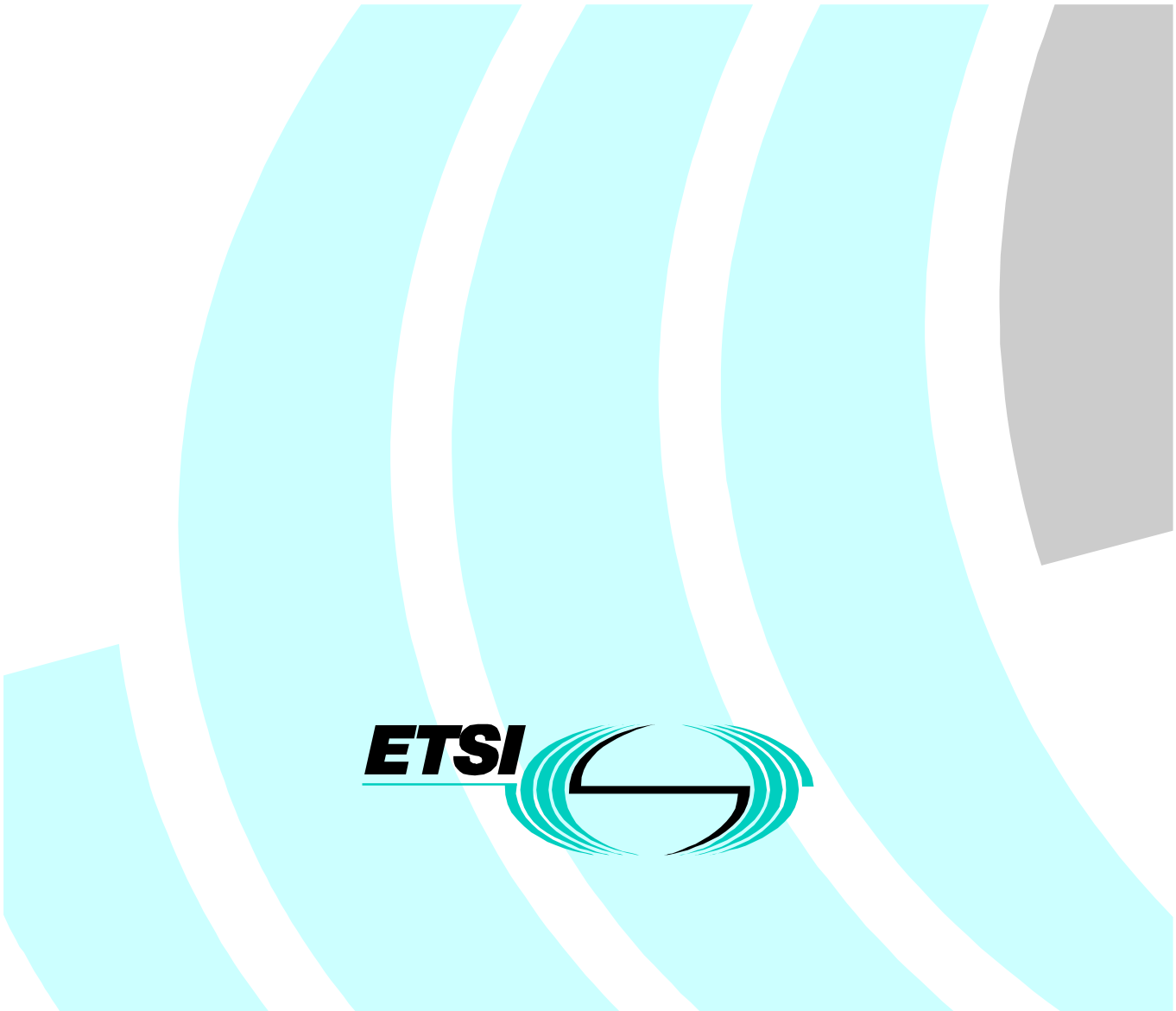
European Standard (Telecommunications series)

Fixed Radio Systems;
Point-to-point equipment;
High capacity digital radio systems carrying STM-4 in two 40 MHz channels or 2 x STM-1 in a 40 MHz channel with alternate channel arrangement



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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).

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

The present document specifies parameters for digital radio-relay systems with Transport Module-level 4, (1 x STM-4), interface, and in addition, optional 140 Mbit/s PDH interfaces.

The present document is applicable to systems carrying an STM-4 signal over a pair of RF channels each with a capacity of 2 x Synchronous Transport Module-level 1, (2 x STM-1), designed to operate in defined bands utilizing 40 MHz between adjacent crosspolar channels. Optionally, a single RF channel can be used to transport 2 x Synchronous Transport Module-level 1, (2 x STM-1), signals.

The parameters specified fall into two categories:

a) those required to provide compatibility between channels from different sources of equipment on the same route, connected either to separate antennas, or to separate polarizations of the same antenna. This category also includes parameters providing compatibility with the existing radio-relay network;

b) parameters defining the transmission quality of the proposed systems.

Compatibility requirements with analogue and digital systems on the same hop and at nodes are examined. However, they cannot be defined with exactness due to the fact that analogue systems and some digital systems are not standardized. Compatibility requirements are, therefore, limited to allowing the operation of digital and analogue channels on separate ports of the same antenna (see annex B).

The standardization includes the following specifications:

a) transmitter and receiver characteristics;

b) baseband and Radio Frequency (RF) interface characteristics;

c) diversity system characteristics;

d) STM-4, or STM-1 baseband transport interface;

e) PDH baseband transport interfaces mapped onto an SDH frame.

Baseband interfaces have to be considered for STM-4 signals and STM-1 signals are in accordance with ITU-T Recommendations G.957 [37] and G.707 [33] respectively.

Safety aspects are outside the mandate of ETSI and they will not be considered in the present document.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] CEPT/ERC Recommendation 12-08: "Harmonised radio frequency channel arrangements and block allocations for low, medium and high capacity systems in the band 3600 MHz to 4200 MHz".

[2] CEPT/ERC Recommendation 14-02: "Radio-frequency channel arrangements for medium and high capacity analogue or high capacity digital radio-relay systems operating in the band 6 425 MHz - 7 125 MHz".

[3] 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".

[4] ETSI EN 300 645 (V1.2.1): "Telecommunications Management Network (TMN); Synchronous Digital Hierarchy (SDH) radio relay equipment; Information model for use on Q interfaces".

[5] ETSI ETR 019: "Transmission and Multiplexing (TM); Specification of new generation high-capacity digital radio systems carrying 2 x STM-1 Synchronous Digital Hierarchy (SDH) signals in frequency bands with 40 MHz channel spacing".

[6] ETSI ETS 300 019 (all parts): "Equipment engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

[7] ETSI ETS 300 132-1: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 1: Operated by alternating current (ac) derived from direct current (dc) sources".

[8] ETSI ETS 300 132-2: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment; Part 2: Operated by direct current (dc)".

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

[10] ETSI EN 300 417-1-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 1-1: Generic processes and performance".

[11] ETSI EN 300 417-1-2: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 1-2: General information about Implementation Conformance Statement (ICS) proforma".

[12] ETSI EN 300 417-2-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 2-1: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions".

[13] ETSI EN 300 417-2-2: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 2-2: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions; Implementation Conformance Statement (ICS) proforma specification".

[14] ETSI EN 300 417-3-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 3-1: Synchronous Transport Module-N (STM-N) regenerator and multiplex section layer functions".

[15] ETSI EN 300 417-3-2: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 3-2: Synchronous Transport Module-N (STM-N) regenerator and multiplex section layer functions; Implementation Conformance Statement (ICS) proforma specification".

[16] ETSI EN 300 417-4-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 4-1: Synchronous Digital Hierarchy (SDH) path layer functions".

[17] ETSI EN 300 417-5-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 5-1: Plesiochronous Digital Hierarchy (PDH) path layer functions".

[18] ETSI EN 300 417-6-1: "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 6-1: Synchronization layer functions".

[19] ETSI ETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Radio specific functional blocks for transmission of M x STM-N".

[20] 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".

[21] ETSI EN 301 167: "Transmission and Multiplexing (TM); Management of Synchronous Digital Hierarchy (SDH) transmission equipment; Fault management and performance monitoring; Functional description".

[22] ITU-R Recommendation F.1092-1: "Error performance objectives for constant bit rate digital path at or above the primary rate carried by digital radio-relay systems which may form part of the international portion of a 27 500 km hypothetical reference path".

[23] ITU-R Recommendation F.1099-3: "Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4 400 MHz to 5 000 MHz) band".

[24] ITU-R Recommendation F.1189-1: "Error performance objectives for constant bit rate digital paths at or above the primary rate carried by digital radio-relay systems which may form part or all of the national portion of a 27 500 km hypothetical reference path".

[25] ITU-R Recommendation F.1191-1: "Bandwidths and unwanted emissions of digital radio-relay systems".

[26] ITU-R Recommendation F.384-7: "Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band".

[27] ITU-R Recommendation F.387-8: "Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band".

[28] ITU-R Recommendation F.635-5: "Radio-frequency channel arrangements based on a homogeneous pattern for radio-relay systems operating in the 4 GHz band".

[29] ITU-R Recommendation F.750-3: "Architectures and functional aspects of radio-relay systems for SDH-based networks".

[30] ITU-R Recommendation F.751-2: "Transmission characteristics and performance requirements of radio-relay systems for SDH-based networks".

[31] ITU-R Recommendation F.752-1: "Diversity techniques for radio-relay systems".

[32] ITU-T Recommendation G.703 (1991): "Physical/electrical characteristics of hierarchical digital interfaces".

[33] ITU-T Recommendation G.707 (1996): "Network node interface for the Synchronous Digital Hierarchy (SDH)".

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

[35] ITU-T Recommendation G.783 (1997): "Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks".

[36] ITU-T Recommendation G.784 (1994): "Synchronous Digital Hierarchy (SDH) management".

[37] ITU-T Recommendation G.957 (1995): "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy".

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

[39] ITU-R Recommendation SM.329-7: "Spurious emissions".

3 Symbols and abbreviations

3.1 Symbols

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

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

3.2 Abbreviations

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

ATPC	Automatic Transmit Power Control
BER	Bit Error Rate
CMI	Code Mark Inversion
CS	Channel Separator
CSmin	minimum practical Channel Separation (for a given radio-frequency channel arrangement)
CW	Continuous Wave
DRRS	Digital Radio-Relay System
EN	European Norm
IF	Intermediate Frequency
LO	Local Oscillator
NFD	Net Filter Discrimination
QAM	Quadrature Amplitude Modulation
RCSOH	Radio Complementary Section OverHead
RF	Radio Frequency
RFCOH	Radio Frame Complementary OverHead
RSL	Receiver Signal Level
Rx	Receive (Receiver)
S/I	Signal to Interference ratio
SDH	Synchronous Digital Hierarchy
SOH	Section OverHead
STM-1	Synchronous Transport Module-level 1
STM-4	Synchronous Transport Module-level 4
t.c.	Telephony Channel
TMN	Telecommunications Management Network
Tx	Transmit (Transmitter)
U6	Upper 6 (GHz band)
XPD	Crosspolar Discrimination

4 Network and system considerations

The main area of application of these digital radio-relay systems is expected to be in regional and trunk networks meeting the objectives of ITU-R Recommendations F.1092-1 [22] and F.1189-1 [24]. These digital radio-relay systems may also be utilized in local links.

Systems considered in the present document shall comply with the relevant ITU-R performance objectives.

The systems considered should operate in these networks having regard for existing hop lengths, which are considered to be normally up to about 60 km. Hop lengths greater than this length, up to about 100 km, may be used in special cases.

Primary requirement for this system is to provide direct interface at STM-4 with cost-effectiveness whilst retaining full compatibility with existing analogue and digital systems operating in bands where 40 MHz channel spacing are utilized.

5 General characteristics

The system is based on a conventional single carrier arrangement.

5.1 Baseband interface

5.1.1 Synchronous Digital Hierarchy

The SDH baseband interface shall be in accordance with:

- ITU-T Recommendations G.703 [32], G.707 [33], G.783 [35], G.784 [36] and G.957 [37];
- ETS 300 635 [19], EN 300 417-1-1 [10], EN 300 417-1-2 [11], EN 300 417-2-1 [12], EN 300 417-2-2 [13], EN 300 417-3-1 [14], EN 300 417-3-2 [15], EN 300 417-4-1 [16], EN 300 417-5-1 [17] and EN 300 417-6-1 [18].

At least one of the following baseband interfaces shall be implemented:

- STM-4 optical interface (ITU-T Recommendation G.957 [37]);
- STM-1 optical interface (ITU-T Recommendation G.957 [37]);
- STM-1 CMI electrical interface (ITU-T Recommendation G.703 [32]).

The use of reserved bytes contained in the SOH, and their termination shall be in accordance with ITU-R Recommendation F.750-3 [29]. Further details on the possible use of the SOH bytes including additional RFCOH or RCSOH are given in EN 301 390 [3].

5.1.2 Plesiochronous digital hierarchy

The PDH interface at 140 Mbit/s, in compliance with ITU-T Recommendation G.703 [32] may be used. These baseband signals shall be carried "open port", i.e., in a transparent manner independent of their content, and they shall be mapped into an SDH frame in accordance with ITU-T Recommendation G.707 [33].

5.2 Frequency bands and channel arrangements

The equipment shall operate on one or more of the channels as defined below.

The systems shall be required to operate in the following frequency bands, in accordance with the CEPT/ERC and ITU-R Recommendations specified, with 40 MHz channel spacing, using alternated channel arrangement.

5.2.1 4 GHz

The frequency range is 3,6 GHz to 4,2 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 12-08 [1], annex A, Part 1 and ITU-R Recommendation F.635-5 [28]. The centre gap is 80 MHz between transmitters and receivers as specified in ITU-R Recommendation F.635-5 [28].

5.2.2 5 GHz

The frequency range is 4,4 GHz to 5,0 GHz. The channel plan shall be in accordance with ITU-R Recommendation F.1099-3 [23], annex 2, and with the centre gap of 60 MHz between transmitters and receivers.

5.2.3 Upper 6 GHz

The frequency range is 6,425 GHz to 7,110 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 14-02 [2], and ITU-R Recommendation F.384-7 [26]. The centre gap is 60 MHz between transmitters and receivers as specified in ITU-R Recommendation F.384-7 [26].

5.2.4 11 GHz

The frequency range is 10,7 GHz to 11,7 GHz. The channel plan shall be in accordance with CEPT/ERC Recommendation 12-06, and ITU-R Recommendation F.387-8 [27], annex 2. The centre gap is 130 MHz between transmitters and receivers as specified in ITU-R Recommendation F.387-8 [27].

5.3 Modes of operation

The mode of operation shall make use of alternate polarizations for adjacent channels in all frequency bands. Single carrier with a modulation technique allowing a spectral density of at least 7,776 bit/s/Hz, and error correction shall be employed.

5.4 Environmental conditions

The equipment shall be required to meet the environmental conditions set out in ETS 300 019 [6] 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.

5.4.1 Equipment within weather protected locations (indoor locations)

Equipment intended for operation within temperature controlled locations or partially temperature controlled locations shall meet the requirements of ETS 300 019 [6] classes 3.1 and 3.2 respectively.

Optionally, the more stringent requirements of ETS 300 019 [6] classes 3.3 (non-temperature controlled locations), 3.4 (sites with heat trap), and 3.5 (sheltered locations) may be applied.

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

Equipment intended for operation within non-weather protected locations shall meet the requirements of ETS 300 019 [6], class 4.1 or 4.1E.

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

5.4.3 Electromagnetic compatibility

Equipment shall operate under the conditions specified in EN 300 385 [9].

For enclosure emissions and immunity to RF electromagnetic fields, the range of frequencies is extended to cover frequencies up to 2 GHz.

5.5 Power supply

The power supply interface shall be in accordance with the characteristics of one or more of the secondary voltages foreseen in ETS 300 132-1 [7] and ETS 300 132-2 [8].

NOTE: Some applications may require secondary voltages that are not covered by ETS 300 132-1 [7] and ETS 300 132-2 [8].

For DC systems, the positive pole of the voltage supply will be earthed at the source.

5.6 Telecommunications Management Network (TMN) interface

For Synchronous Digital Hierarchy (SDH) equipment standards:

- EN 300 417-1-1 [10], EN 300 417-1-2 [11], EN 300 417-2-1 [12], EN 300 417-2-2 [13], EN 300 417-3-1 [14], EN 300 417-3-2 [15], EN 300 417-4-1 [16], EN 300 417-5-1 [17], EN 300 417-6-1 [18], EN 301 167 [21];
- ITU-T Recommendations G.784 [36] and G.773 [34];
- ITU-R Recommendations F.750-3 [29] and F.751-2 [30];

give the general requirements for TMN interface and functionality, and

- ETS 300 635 [19] and EN 300 645 [4];

give the radio specific functional block description and the related radio fragment information model respectively.

When the system is configured with STM-4 NNI interface (i.e., the two 40 MHz channels are composing a single STM-4 air interface), it shall be managed accordingly (e.g., when one or more STM-1 content is lost the overall STM-4 is considered faulty). When the system is configured in n x STM-1 or 140 Mbit/s PDH tributary arrangements it shall be managed as a single or multiple STM-1 system.

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

5.7 System block diagram

The system block diagram including reference points is shown in figure 1. These points are reference points only and not necessarily measurement points. Although an implementation of carrying STM-4 signal on two RF channels is not defined by ITU-R, functional blocks shall be similar to those given in the ITU-R Recommendations F.750-3 [29] and F.751-2 [30]. The receiver diversity path shown in the block diagram refers only to combining techniques.

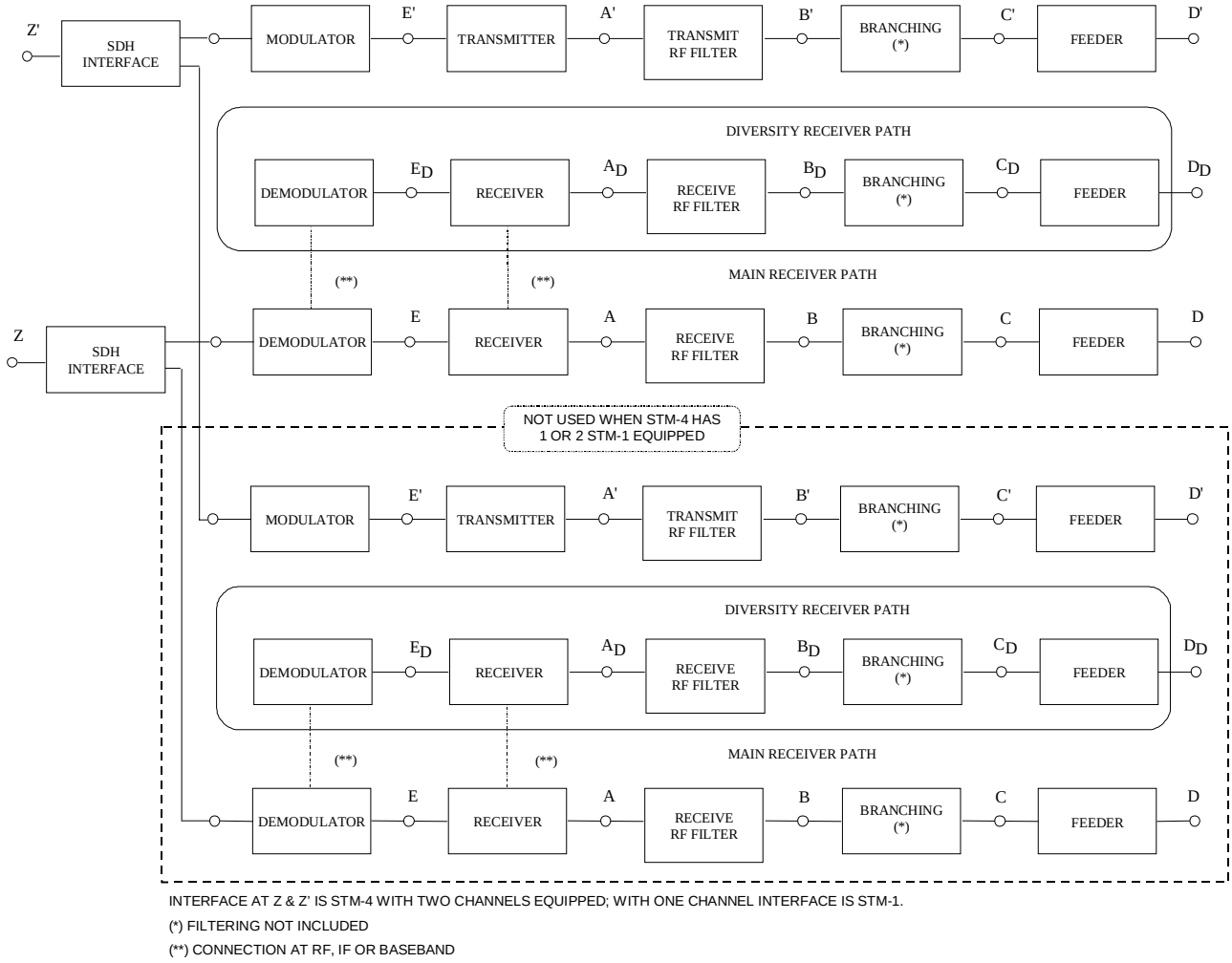


Figure 1: Block diagram

5.8 Antenna system

The parameters and values specified for the antenna system are essential prerequisites for the system specifications given in the present document.

5.8.1 Crosspolar Discrimination (XPD)

EN 300 833 [20], clause 5, XPD category 1 requirements shall apply.

5.8.2 Intermodulation products

Each third order intermodulation product (2 x A - B type) caused by transmitters linked at point C', and measured at point C, shall be less than -96 dBm, with an output power of 37 dBm per transmitter, referenced to point B'. This measurement shall be made using a test set with a return loss higher than 23 dB.

5.8.3 Interport isolation

Interport isolation shall not be less than 35 dB.

5.8.4 Return loss

Return loss shall not be less than 24 dB at the antenna flange (points D, D').

6 Transmitter characteristics

6.1 Output power

Referred to point B', the value of the output power shall not exceed +37 dBm and shall not be less than +20 dBm, without the ATPC option, including all tolerances.

The nominal output power tolerance shall be within:

- ± 1 dB for all classes.

NOTE: For the purpose of system engineering three classes of nominal output power are defined (see intervals in table 1).

Equipment of different output power classes are not considered to require individual type approval however, this is subject to individual national agreements.

Table 1

	P	P
Class A	≥ +20 dBm	< +27 dBm
Class B	≥ +27 dBm	< +30 dBm
Class C	≥ +30 dBm	≤ +37 dBm

The measurement shall be carried out using the appropriate SDH test signal.

6.2 Automatic Transmit Power Control (ATPC)

ATPC is an optional feature; information on ATPC is given in annex A.

6.3 RF spectrum mask

The three main factors considered in recommending a mask are:

a) control of interference into analogue channels operating on the adjacent channel allocation on the orthogonal polarization;

b) control of interference into digital channels from a different manufacturer's equipment operating on the adjacent channel allocation on the orthogonal polarization;

c) different transmitter characteristics.

The spectrum mask given in figure 2, applicable to all frequency bands, is based on the level of compatibility required. It allows compatibility between systems defined in the present document and those specified in the ITU-R Recommendations F.635-5 [28], F.1099-3 [23], F.384-7 [26], and F.387-8 [27].

The spectrum mask marked in figure 2 shall be verified directly by measurement (referenced to point B'), with an STM-4 test signal at the baseband interface.

The spectrum mask is referenced to the spectral power density of the nominal centre frequency disregarding residual carrier. The frequency tolerance is not included in the mask.

The spectrum analyser settings for measuring the RF spectrum masks are given below, in table 2.

Table 2

Parameter	Setting
Centre frequency	channel centre frequency
IF bandwidth	100 kHz
Total sweep width	100 MHz
Amplitude	10 dB/division
Sweep	Auto
Video filter	Auto

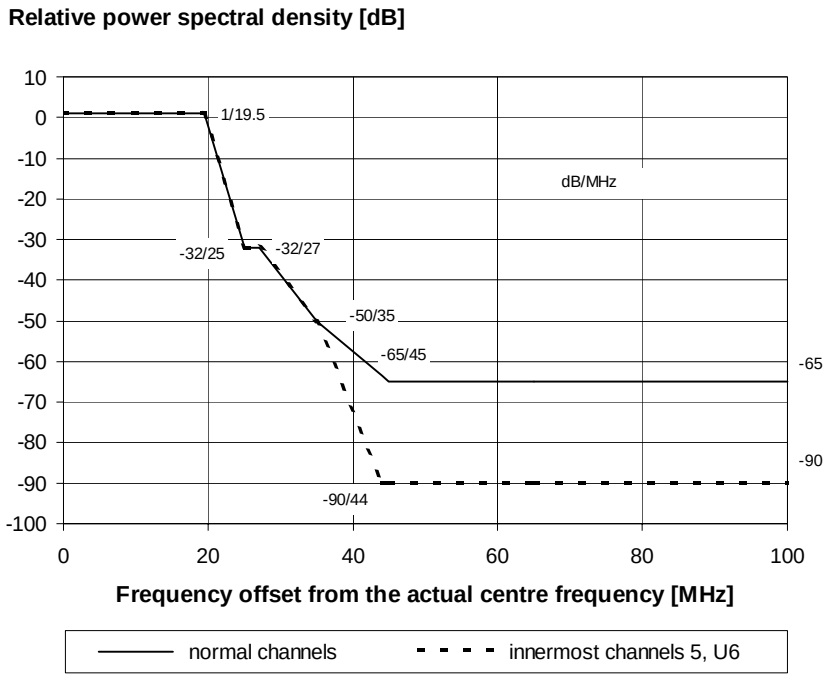


Figure 2: Limits of spectral power density (reference point B')

6.4 Discrete CW lines exceeding the spectrum mask limit

6.4.1 Spectral lines at the symbol rate

To facilitate sharing with analogue systems the power level of spectral lines at a distance from the channel centre frequency equal to the symbol rate shall be less than or equal to -37 dBm, measured at point B'.

6.4.2 Other spectral lines

In case some CW components exceed the spectrum mask, an additional allowance is given.

Those lines shall not:

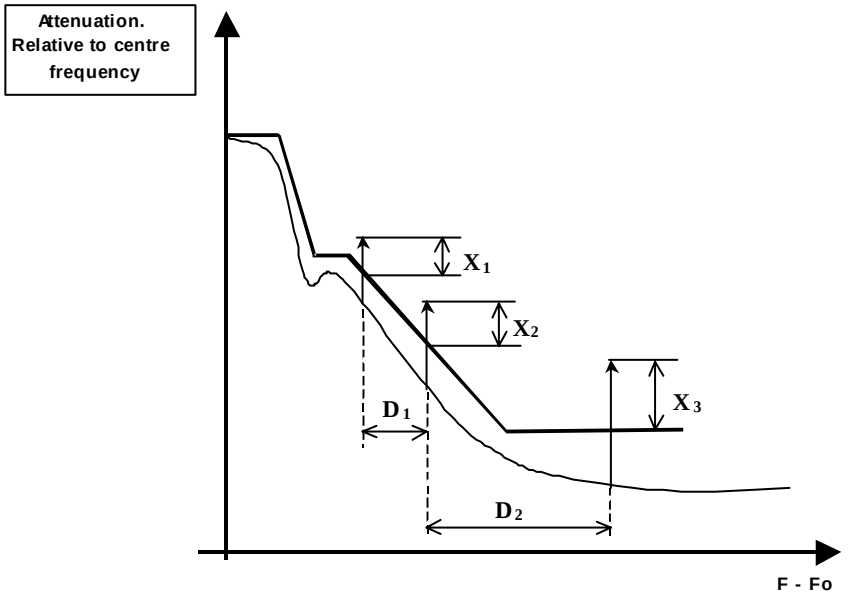
- exceed the mask by a factor more than {10 log (CSmin/IFbw) - 10} dB
- be spaced each other in frequency by less than CSmin

Where:

CSmin = 10 000 kHz for 4 GHz, 5 GHz, U6 GHz and 11 GHz bands

IFbw is the recommended resolution IF bandwidth, expressed in kHz, reported in table 2.

Figure 3 shows a typical example of this requirement.



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

$D_1, D_2 \geq$ CSmin

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

6.5 Spurious emissions

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

a) to limit interference into other systems operating wholly externally to the system channel plan (external emissions), which limits are referred by CEPT/ERC Recommendation 74-01 [38] based on ITU-R Recommendations SM.329-7 [39] and F.1191-1 [25];

b) to limit local interference within the system where transmitters and receivers are directly connected via the filter and branching systems (internal emissions).

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

6.5.1 Spurious emissions - external

According to CEPT/ERC Recommendation 74-01 [38], the external spurious emissions are defined as emissions at frequencies which are removed from the nominal carrier frequency more than ±250 % of the relevant channel separation (CS).

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 [38] together with the frequency range to consider for conformance measurement, shall apply.

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

6.5.2 Spurious emissions - internal

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

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

Table 3: Internal levels for the transmitter spurious emissions

Spurious emission frequency relative to channel assigned frequency	Specification limit	Controlling factor for requirement application
The average level of all spurious signals both discrete CW and noise-like (including LO, ±IF, ±2 x IF), evaluated as total signal level	≤ -90 dBm	If spurious signal's frequency falls within receiver half band, for digital systems with multichannel branching networks
The average level of all spurious signals both discrete CW and noise-like (including LO, ±IF, ±2 x IF), evaluated as total signal level	≤ -70 dBm	If spurious signal's frequency falls within receiver half band, For digital systems without branching networks (i.e. with duplexer)

6.6 Radio frequency tolerance

Maximum radio frequency tolerance shall not exceed ±30 ppm for all frequency bands considered. This limit includes both short-term factors (environmental effects) and long-term ageing effects.

6.7 Return loss

Minimum return loss shall be 26 dB at point C' over the full RF band and measured back in the direction to the transmitter.

7 Receiver characteristics

7.1 Receiver image rejection

The receiver image rejection shall be:

- > 120 dB at 4 GHz and 5 GHz bands;
- > 100 dB at U6 GHz and 11 GHz bands.

7.2 Spurious emissions

See clause 6.5.

7.2.1 Spurious emissions - external

At reference point C, the limit values of CEPT/ERC Recommendation 74-01 [38] shall apply.

7.2.2 Spurious emissions - internal

Spurious emissions which fall within receivers half band shall be < -110 dBm (referenced to reference point B) for digital systems with multichannel branching networks and < -100 dBm (referenced to reference point C) for digital systems without branching networks (i.e. with duplexer).

7.3 Input level range

The lower limit for the receiver input level is defined by the threshold level for Bit Error Ratio (BER) = 10^{-3}, as given in table 4. The upper limit for the receiver input level, where a BER of 10^{-3} is not exceeded shall be greater than -23 dBm. A BER of 10^{-10} may only be exceeded for levels greater than -27 dBm. These limits apply without interference and are referenced to point B.

7.4 Return loss

Minimum return loss measured at point C shall be 26 dB over the full RF band, measured in the direction to the receiver.

8 System characteristics without diversity

8.1 Equipment background BER

Equipment background BER is measured, under simulated operating conditions over an artificial hop without interference. The signal level at point B is set to a value between 12 dB and 30 dB above the lower limit which gives BER = 10^{-3}. The background BER shall be equal or less than 10^{-12} at STM-1 level, and 10^{-13} at STM-4 level.

8.2 BER as a function of receiver input level

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

The BER values shall be less or equal to the values given in table 4 for the corresponding signal levels and frequency bands.

Table 4

	Frequency band		
	4/5 GHz	**U6 GHz**	**11 GHz**
BER < 10^{-3}	-63,0 dBm	-62,5 dBm	-61,5 dBm
BER < 10^{-6}	-60,0 dBm	-59,5 dBm	-58,5 dBm
BER < 10^{-10}	-54,0 dBm	-53,5 dBm	-52,5 dBm

8.3 Interference sensitivity

Interference sensitivity characteristics for BER = 10^{-6} are specified for cochannel, and adjacent channel whose centre frequency is 40 MHz away.

8.3.1 Cochannel interference sensitivity

Receiver input Signal Level (RSL) degradation shall not exceed the limits given in table 5.

Table 5

Reference BER	**10^{-3}**	**10^{-6}**
RSL Degradation	1 dB	3 dB
S/I (dB)	43,0	39,5

8.3.2 Adjacent channel interference sensitivity

Receiver input Signal Level (RSL) degradation shall not exceed the limits given in table 6.

Table 6

Reference BER	**10^{-3}**	**10^{-6}**
RSL Degradation	1 dB	3 dB
S/I (dB)	15,0	11,5

8.3.3 CW Spurious Interference

Under study.

8.4 Distortion sensitivity

For a delay of 6,3 ns and a BER of 10^{-3} the width of the signature shall not exceed ±21 MHz relative to the channel assigned centre frequency and the depth shall not be less than 19 dB.

For a delay of 6,3 ns and a BER of 10^{-6} the width of the signature shall not exceed ±22 MHz relative to the channel assigned centre frequency and the depth shall not be less than 16 dB.

These limits are valid for both minimum and non-minimum phase cases.

9 System characteristics with diversity

Space-, angle- and frequency-diversity techniques are applicable. In this clause only combining techniques are considered.

Space-diversity with dual-input and triple-input combining can be used.

9.1 Space/angle diversity

It shall be possible to combine at RF or IF, or baseband, signals received from two or three different antennas. These antennas may be physically separate from each other, or may be arranged as different feed horns sharing the same reflector.

9.1.1 Differential delay compensation

It shall be possible to compensate for differential absolute delays due to antennas, feeders and cable connections on diversity paths. The range of adjustment of differential absolute delay shall be at least 180 ns for dual-input, and 90 ns for triple-input receiver, with minimum step size equivalent to one half of the symbol period.

9.1.2 BER performance

When receiver inputs are fed with signals of the same level at arbitrary phase differences, input level limits for specified BER values shall be lower, by the values given below, in table 7, than those specified in clause 8.2 for the case without diversity.

Table 7

combining at	dual-input	triple-input
IF or baseband	2,5 dB	4,2 dB

9.2 Frequency diversity

Frequency diversity function may be integrated within the radio equipment. When so provided, the relevant clauses of the ITU-R Recommendation F.752-1 [31] shall apply. See annex A (informative) for considerations on differential delay compensation.

Annex A (informative): Additional information

A.1 ATPC

ATPC can be useful in many circumstances, especially:

- to improve analogue-digital compatibility in the case of antennas with poor crosspolarization discrimination performance or in the case of high nominal output power for the Digital Radio Relay Systems (DRRS);
- to reduce digital-to-digital distant interference between hops which re-use the same frequency;
- to improve compatibility with both digital and analogue systems at nodal stations;
- to reduce the effects of signal enhancement conditions on the system.

ATPC is an optional feature which is aimed at driving the Tx power amplifier output level from a proper minimum which is calculated to facilitate the radio network planning and which is used in the case of normal propagation, up to a maximum value (nominal output power) which is defined by the relative class of output power and the complete fulfilment of all the specifications defined in the present document.

The ATPC range is the power interval from the nominal output power level to the lowest power amplifier output level (at point B') with ATPC.

The ATPC range should not exceed 25 dB. When compatibility with analogue systems is required, the lowest power output level shall not be less than +10 dBm; this may result in a reduced ATPC range.

A.2 Differential delay compensation range

When frequency diversity function is integrated within the radio equipment it is desirable to provide the means to compensate for differential absolute delays due to antennas, feeders, cable connections, and relative velocities on different RF channels.

The range of adjustment of differential absolute delay in the order of about 600 ns with a minimum step size equivalent to the symbol period is considered adequate for most applications.

Annex B (informative): Compatibility

The compatibility of the system described in the present document with analogue and digital systems has been examined in ETR 019 [5]. The results are presented below.

B.1 Compatibility with analogue channels on the same route

The compatibility of the system with analogue and digital systems has been examined with the following input parameters.

Table B.1

Power Output	2 x STM-1 system (at maximum)	34 dBm
	1 800 t.c. analogue system	33 dBm
	2 700 t.c. analogue system	38 dBm
ATPC range		10 dB
XPD		28 dB

Noise interference levels are:

a) 2 x STM-1 512 QAM into Analogue radio system.

Assuming the RF output spectrum mask given in figure 2, the following values of noise, introduced into adjacent (40 MHz) crosspolar analogue systems, have been evaluated with ATPC activated:

- < 2 pW0p for 1 800 t.c;
- < 55 pW0p for 2 700 t.c.

A more realistic computation with a typical transmitted spectrum leads to the following values:

- < 2 pW0p for 1 800 t.c. (at the maximum transmit power);
- < 27 pW0p for 2 700 t.c. (with ATPC activated).

b) Analogue radio system into 2 x STM-1 512 QAM.

This case is less severe than the previous one. The level of interference is very low with respect to the digital signal to cause any degradation.

B.2 Compatibility with 16 QAM systems on the same route

40 MHz separation between crosspolar 16 QAM and 512 QAM systems is considered. For channels 8 and 1' of U6 GHz band, suitable Tx and Rx filtering have to be used.

For negligible Receiver Input Level degradation the following Net Filter Discrimination (NFD) values are required.

a) 2 x STM-1 512 QAM → 140 Mbit/s - 16 QAM: 20 dB;

b) 140 Mbit/s 16 QAM → 2 x STM-1 512 QAM: 26 dB.

In both cases different power levels are to be taken into account. ATPC may reduce the NFD requirements.

Compatibility with analogue/digital systems at radio node.

The following compatibility cases have been examined:

a) 2 700 analogue channels ↔ 2 x STM-1 512 QAM;

b) 1 800 analogue channels ↔ 2 x STM-1 512 QAM;

c) 2 x STM-1 512 QAM ↔ 140 Mbit/s 16 QAM;

d) 2 x STM-1 512 QAM ↔ 2 x STM-1 512 QAM.

The following parameters are assumed for the purpose of the analysis.

Table B.2

Nominal received signal levels	2 x STM-1 512 QAM	-26 dBm
	140 Mbit/s - 16 QAM	-30 dBm
	2 700 t. c.	-22 dBm
	1 800 t. c.	-27 dBm
ATPC range		10 dB
Degradation at BER = 10^{-3} threshold	2 x STM-1 512 QAM	2 dB
	140 Mbit/s - 16 QAM	1 dB
Additional noise level on analogue systems		10 pW0p

The antenna discrimination required to meet the assumed values of degradation ranges from 57 dB to 78,5 dB.

Annex C (informative): Bibliography

ETSI EN 300 371 (V1.3.1): "Telecommunications Management Network (TMN); Plesiochronous Digital Hierarchy (PDH) information model for the Network Element (NE) view".

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ITU-R Recommendation F.1093-1: "Effects of multipath propagation on the design and operation of line-of-sight digital radio-relay systems".

ITU-R Recommendation F.1101: "Characteristics of digital radio-relay systems below about 17 GHz".

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History

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