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**Transmission and Multiplexing (TM);
Specification of new generation high capacity digital radio
systems carrying 2xSTM-1 Synchronous Digital Hierarchy (SDH)
signals in frequency bands with 40 MHz
channel spacing**

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Foreword

This ETSI Technical Report (ETR) has been produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI).

ETRs are informative documents resulting from ETSI studies which are not appropriate for European Telecommunication Standard (ETS) or Interim European Telecommunication Standard (I-ETS) status. An ETR may be used to publish material which is either of an informative nature, relating to the use or the application of ETSs or I-ETSs, or which is immature and not yet suitable for formal adoption as an ETS or an I-ETS.

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1 Scope

This ETSI Technical Report (ETR) provides proposals for a new generation of high capacity Digital Radio Relay Systems (DRRS) carrying 2 Synchronous Transport Module -1 (2xSTM-1) Synchronous Digital Hierarchy (SDH) signals in frequency bands with 40 MHz channel spacing.

Three different system concepts have been proposed.

The main aspects of each of these systems are described in clause 4, in order to provide a better understanding of commonalities and differences among them.

In clause 5 remarks on performance of Co-Channel Dual Polar (CCDP) systems are reported, because two systems among the proposed ones make use of frequency reuse.

A list of systems parameters and the values which have been proposed for the three systems are given in clause 6.

The topics mentioned "under study" identify areas needing further investigation.

2 References

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

- [1] ITU-R Recommendation F. 635: "Radio frequency channel arrangements based on a homogeneous pattern for radio relay systems operating in the 4 GHz band".
- [2] ITU-R Recommendation F. 384: "Radio frequency channel arrangements for medium and high capacity analogue or digital radio relay systems operating in the upper 6GHz band".
- [3] ITU-R Recommendation F. 387: "Radio frequency channel arrangements for radio relay systems operating in the 11 GHz band".
- [4] ITU-R Recommendation F.750: "Architectures and functional aspects of radio-relay systems for SDH-based networks".
- [5] ITU-R Recommendation F. 751: "Transmission characteristics and performance requirements of radio-relay systems for SDH-based networks".
- [6] ETS 300 019, Parts 1 and 2: "Equipment Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment Part 1: Classification of environmental conditions and Part 2: Specification of environmental tests".
- [7] ETS 300 132: "Equipment Engineering (EE); Power supply interface at the input to telecommunications equipment".
- [8] CEPT Recommendation T/L 04-04: "Harmonisation of 140 Mbit/s digital radio relay systems for operation below 10 GHz utilising 64 QAM at about 30 MHz spacing".
- [9] ITU-T Recommendation G.708 (1990): "Network node interface for the synchronous digital hierarchy".
- [10] ITU-T Recommendation G.709 (1990): "Synchronous multiplexing structure".

- [11] ITU-T Recommendation G.773: "Protocol suites for Q-Interfaces for management of transmission systems".
- [12] ITU-T Recommendation G.784: "Synchronous Digital Hierarchy (SDH) management".
- [13] ITU-R Recommendation F. 1099: "Radio frequency channel arrangements for high capacity digital radio relay systems in the 5 GHz (4 400 - 5 000 MHz) band".
- [14] prETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); Radio specific functional blocks for transmission of Mx STM-N".
- [15] ITU-T Recommendation G.703: "Physical/electrical characteristics of hierarchical digital interfaces".
- [16] ETS 300 119: "Equipment Engineering (EE); European telecommunication standard for equipment practice".
- [17] ETS 300 234: "Transmission and Multiplexing (TM); High capacity digital radio relay systems carrying 1 x STM-1 signals and operating in frequency trends with about 30 MHz channel spacing and alternated arrangements".

3 Symbols and abbreviations

3.1 Symbols

For the purposes of this ETR, the following symbols apply:

dB	decibel
dBm	decibel relative to 1 mW
GHz	GigaHertz
km	kilometre
Mbit/s	Mega-bit per second
MHz	MegaHertz
m/s	metres per second
ns	nanosecond
ppm	parts per million
W/m ²	Watts per square metre

3.2 Abbreviations

For the purposes of this ETR, the following abbreviations apply:

ACDP	Adjacent Channel Dual Polar
ATPC	Automatic Transmit Power Control
BB	BaseBand
BER	Bit Error Rate
CCDP	Co-Channel Dual Polar
C/I	Carrier to Interference (ratio)
DRRS	Digital Radio Relay System
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
IF	Intermediate Frequency
IF/RF	Intermediate Frequency/Radio Frequency
LO	Local Oscillator
L4	Lower 4 GHz band
PRBS	Pseudo-Random Binary Sequence
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
RX	Receive (Receiver)

SDH	Synchronous Digital Hierarchy
SOH	Section OverHead
SRL	Spectrum Reference Level
STM-1	Synchronous Transport Module-level 1
TCM	Trellis-Coded Multiplexing
TMN	Telecommunications Management Network
TWT	Travelling Wave Tube
TX	Transmit (Transmitter)
U6	Upper 6 GHz band
VSWR	Voltage Standing Wave Ratio
XPD	Cross-Polar Discrimination
XPIC	Cross-Polar Interference Canceller
XIF	Cross Polarization Improvement factor

4 Considerations regarding the system proposals

4.1 General system characteristics

System A

The initial requirement for this system was to provide increased cost-effectiveness and spectrum utilisation. It was also required to operate in, for example, the 4 GHz band on the same hop, as existing trunk 140 Mbit/s systems using the same Radio Frequency (RF) branching equipment as a 16 QAM (Quadrature Amplitude Modulation) channel. The time schedule for introduction of such a system was also to be as short as possible. The utilisation of existing branching equipment, if available, is a contributor to the cost-effectiveness of the system, together with the transmission of two carriers per transceiver. The system concept was initially aimed at two 140 Mbit/s channels per transceiver, but after the ITU-T agreement on the SDH, it was changed to the provision of two STM-1 channels.

The utilisation of frequency reuse is the primary factor which provides the increased spectrum utilisation compared the existing systems. The achievement of acceptable performance for the system depends on the utilisation of adaptive Cross-Polar Interference Cancellers (XPIC). With their use, the system proposers are confident that the required performance objectives will be met.

Recent rapid increases in the utilisation of high capacity optical fibre systems for trunk applications has reduced the level of requirements for trunk systems in some countries, and the consideration of compatibility with 16 QAM systems and their RF branching has therefore reduced in importance. However, application in regional networks, where nodal interference effects and limitation on space for antennas are more important, will exist. This type of application is considered by the system proposers to be more suited to 64 QAM, rather than a higher order of modulation.

System B

Primary requirements for this system were to provide a cost-effective system whilst retaining a full compatibility with existing analogue and digital systems operating in bands where 40 MHz channel spacings are utilised.

The proposed system is based on a conventional single carrier arrangement and a 512 Trellis-Coded Multiplexing (TCM) modulation format. This approach represents a more direct solution from the point of view of technical aspects and system management compared to multicarrier and/or frequency reuse systems. Moreover, the proposers consider the cost-effectiveness of this system quite clear and a decisive feature.

The system concepts specifically relies on the use of a higher level modulation, rather than frequency reuse to achieve increased spectrum utilisation over existing systems. The reason for this is that the system proposers consider that dependence on Cross-Polar Discrimination (XPD), even if suitable XPIC could be provided, is dangerous because of lack of reliable experimental data. The higher complexity of the proposed modulation scheme is considered to be achievable with existing technology, especially in the digital signal processing field.

Moreover the choice of field-proven TCM modulation, together with traditional single carrier transmission technique, guarantees for reliable operation and fulfilment of ITU-T and ITU-R specifications.

System C

Primary requirements of this system are to provide 2xSTM-1 capacity for each 40 MHz channel, where the relative channel plans in the previous generation equipment provide a transmission capacity of 140 Mbit/s with alternated polarization, whilst retaining the following objectives:

- full compatibility with existing analogue and digital systems;
- accordance with ITU-R Recommendations;
- same performance on the same hops of the previous generation equipment.

The system concept specifically relies on the use of the relatively low level modulation scheme 32 QAM, used together with a baseband cross-polar interference canceller to obtain frequency reuse.

The most relevant advantage of this solution is that a 32 QAM system has a slightly lower system gain (using same RF devices) with respect to a 16 QAM system of the same capacity, whereas the signature characteristic may be also better. This fact allows the possibility of the reuse of same infrastructures and sites of the 16 QAM/140 Mbit/s systems with, as a consequence, a very effective impact on the cost of the complete link.

Moreover, in principle, this system allows the reuse of already installed transceivers of the previous generation.

All the previous advantages are achievable on the assumption that the XPIC device gives a cross-polar interference reduction factor high enough to cancel the effect of the reused cross-polar channel adverse propagation conditions.

This assumption is now confirmed not only by many laboratory tests, but also by means of successful experimental hop results already available.

The main aspects of each of this systems are listed in table 1, in order to provide a better understanding of commonalities and differences among them.

Table 1: Comparison of the main characteristics

	System A	System B	System C
Frequency bands	4 GHz to ITU-R Recommendation F.635 [1] (10 MHz raster) (3,4-4,2 GHz) 5 GHz to ITU-R Recommendation F.1099 [13] (4,4-5,0 GHz) U6 GHz to ITU-R Recommendation F.384 [2] (6,43-7,11 GHz) 11 GHz to ITU-R Recommendation F.387 [3] (10,7-11,7 GHz)	L4 GHz to ITU-R Recommendation F.635 [1] (3,6-4,2 GHz) 5 GHz to ITU-R Recommendation F.1099 [13] (4,4-5,0 GHz) U6 GHz to ITU-R Recommendation F.384 [2] (6,43-7,11 GHz) 11 GHz to ITU-R Recommendation F.387 [3] (10,7-11,7 GHz)	L4 GHz to ITU-R Recommendation F.635 [1] (3,6-4,2 GHz) 5 GHz to ITU-R Recommendation F.1099 [13] (4,4-5,0 GHz) U6 GHz to ITU-R Recommendation F.384 [2] (6,43-7,11 GHz) 11 GHz to ITU-R Recommendation F.387 [3] (10,7-11,7 GHz)
RF channel spacing	80 MHz	40 MHz	40 MHz
RF channel arrangement	Co-channel	Alternate	Co-channel
Total band capacity (number of STM-1 streams) (no protection channel)			
- 4 GHz	14	14	14
-5 GHz	14	14	14
- U6 GHz	16	16	16
- 11 GHz	20	24	24
Transmission capacity per transceiver	2xSTM-1	2xSTM-1	1xSTM-1
Number of carriers per transceiver	2	1	1
Modulation method (FEC type)	64 QAM (serial FEC coding-Modulation Matched Coding)	512TCM-4D (Trellis Coded Modulation-4 Dimensions)	32 QAM Cross (MLCM- Multi Level Code Modulation)
Roll-off factor	≈0,35	≈0,2	≈0,3
Use of ATPC	Optional	Optional in regional applications, typically foreseen for hops longer than 30 Km	Optional
Type of Diversity reception	Space division for hops>30 Km Frequency Division optional	Division for hops>30 Km Space and/or Frequency	Space and/or Frequency depending on hop length (w/o space division<40 Km, w/i space division >40 Km)
		(continued)	

Table 1 (concluded): Comparison of the main characteristics

	System A	System B	System C
Type of combiner	IF (one common for the 2 subcarriers per RX)	IF	IF or Baseband
XPIC	Yes	No (Not applicable)	Yes
Protection switching	Optional per subcarrier	Per carrier	One STBY channel per polarization
System available for network introduction	1992, 1st quarter	1996	1995
Date of the introduction of the system concept into the draft report	Thessaloniki 11/89	Thessaloniki 11/89	Athens 12/91
Date of the last revision of system parameters	Vouliagmeni 5/95	Chester 10/94	Chester 10/94

4.2 Specific system characteristics

4.2.1 System A

4.2.1.1 Compatibility requirements

Relevant system parameters assumed are:

Digital system:	2x155 Mbit/s Transmit spectrum: figure A2 Output power per carrier: +28 dBm
Analogue system:	2 700 voice channels Transmit power: +43 dBm

4.2.1.1.1 Compatibility with analogue channels on the same route

- 4 GHz band: not relevant;
- U6 GHz and 11 GHz bands: yes for RF channel separation > 80 MHz.

The following interference levels result for parallel operation in the highest base band channel of the analog system:

Channel separation (MHz)	60	80
Noise power (pW0p)	16	<0,1

For the less critical case of analogue into digital interference the following values for C/I result:

Channel separation (MHz)	60	80
C/I (dB)	66	123

4.2.1.1.2 Compatibility with 16 QAM systems on the same route

80 MHz separation between 16 QAM carrier and centre frequency for new channels.

4.2.1.1.3 Compatibility with analogue/digital systems at radio node

Nodal interference considerations are based on a permissible noise level in the analogue system of 10 pW0p and a maximum threshold degradation for the digital system of 1 dB (minimum C/I=27 dB).

The required isolation values (to be provided by antenna angular discrimination) are given in the table below versus RF channel separation assuming identical path length and antenna gain for the interfering links.

The distorted analogue signal is assumed to suffer up to 5 dB relative fading. For the digital signal, relative fading as high as the fade margin of 35 dB is assumed.

Channel separation (MHz)	0	40	60	80
2xSTM-1 64 QAM → FM 2 700	63	63	3	0
2xSTM-1 64 QAM → 16 QAM	62	62	27	0

4.2.2 System B

4.2.2.1 Compatibility requirements

4.2.2.1.1 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:

Max output power of 2xSTM-1 system	34 dBm
Output power of a 1 800 t.c. analogue system	33 dBm
Output power of a 2 700 t.c. analogue system	38 dBm
ATPC range	10 dB
XPD	28 dB

Noise interference levels are:

- a) 2xSTM-1 512 TCM → Analogue radio system.

Assuming the RF output spectrum mask reported in figure 10, the following values of noise, introduced into adjacent (40 MHz) cross-polar 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 → 2xSTM-1 512 TCM.

This case is less severe than the previous one. The level of interference is so low with respect to the digital signal to cause no degradation.

4.2.2.1.2 Compatibility with 16 QAM systems on the same route

40 MHz separation between cross-polar 16 QAM and 512TCM systems are considered. For 8-1' channels of U6 GHz band, suitable TX and RX filtering have to be used.

- a) 2xSTM-1 512 TCM → 140 Mbit/s-16 QAM.

NFD values of 15 to 20 dB have been computed.

- b) 140 Mbit/s-16 QAM → 2xSTM-1 512 TCM.

NFD values of 26 dB have been computed.

In both cases different power levels are to be taken into account. ATPC use may be helpful.

4.2.2.1.3 Compatibility with analogue/digital systems at radio node

The following hypotheses are assumed:

Nominal received signal levels	2xSTM-1 512TCM: - 26 dBm 16 QAM 140 Mbit/s: -30 dBm 2 700 t. ch.: -22 dBm 1 800 t. ch. :-27 dBm
ATPC range	10 dB
Degradation at BER=10 ⁻³ threshold	2xSTM-1 512TCM: 2 dB 140 Mbit/s 16 QAM: 1 dB
Additional noise level on analogue systems	10 pW0p

The following compatibility cases have been examined:

a) 2 700 analog channels ↔ 2xSTM-1 512 TCM
b) 1 800 analog channels ↔ 2xSTM-1 512 TCM
c) 2xSTM-1 512 TCM ↔ 140 Mbit/s 16 QAM
d) 2xSTM-1 512 TCM ↔ 2xSTM-1 512 TCM

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

4.2.3 System C

4.2.3.1 Compatibility requirements

4.2.3.1.1 Compatibility with analogue channels on the same route

2xSTM-1 ↔ 2 700 analog channels

	40 MHz	60 MHz	80 MHz
(Same level) Noise power	140 000 pW0p	7 pW0p	<0,2 pW0p
(Analog +10 dB) Noise power	14 000 pW0p	0,7 pW0p	<0,02 pW0p
(Analog + 10 dB) 1xSTM-1 crosspolar + XPD=33 dB (*)	7 pW0p	negligible	negligible

(*) That means that compatibility with a 40 MHz analog system is achievable excluding the co-polar reused digital channel.

The effect of analog on digital in this situation is negligible.

4.2.3.1.2 Compatibility with 16 QAM systems on the same route

For digital 16 QAM at 40 MHz, compatibility is obtained by excluding the co-polar reused channel and using a proper high XPD antenna.

At 80 MHz we have full compatibility.

4.2.3.1.3 Compatibility with analogue/digital systems at radio node

Hypothesis of received level:	- 2 700 analog = -25 dBm
	- 2xSTM-1 = -35 dBm
	- 140 Mbit/s = -35 dBm

a) 2 700 analog channels \leftrightarrow 2xSTM-1

For the analog system <10 pW0p are obtained with 62 dB of antenna discrimination.

For the digital system a value <2 dB degradation of the threshold (i.e. -75 dBm, 40 dB margin) requires 75 dB of antenna discrimination.

b) 140 Mbit/s 16 QAM \leftrightarrow 2xSTM-1

A degradation <2 dB for the 2xSTM-1 system and <1 dB for the 16 QAM system is obtained for 65 dB of antenna discrimination.

4.2.3.2 Branching arrangement in frequency re-use operation

Examples of branching interconnection for frequency re-use systems are shown in figure 1 (configuration with only one antenna) and in figure 2 (configuration with two antennas).

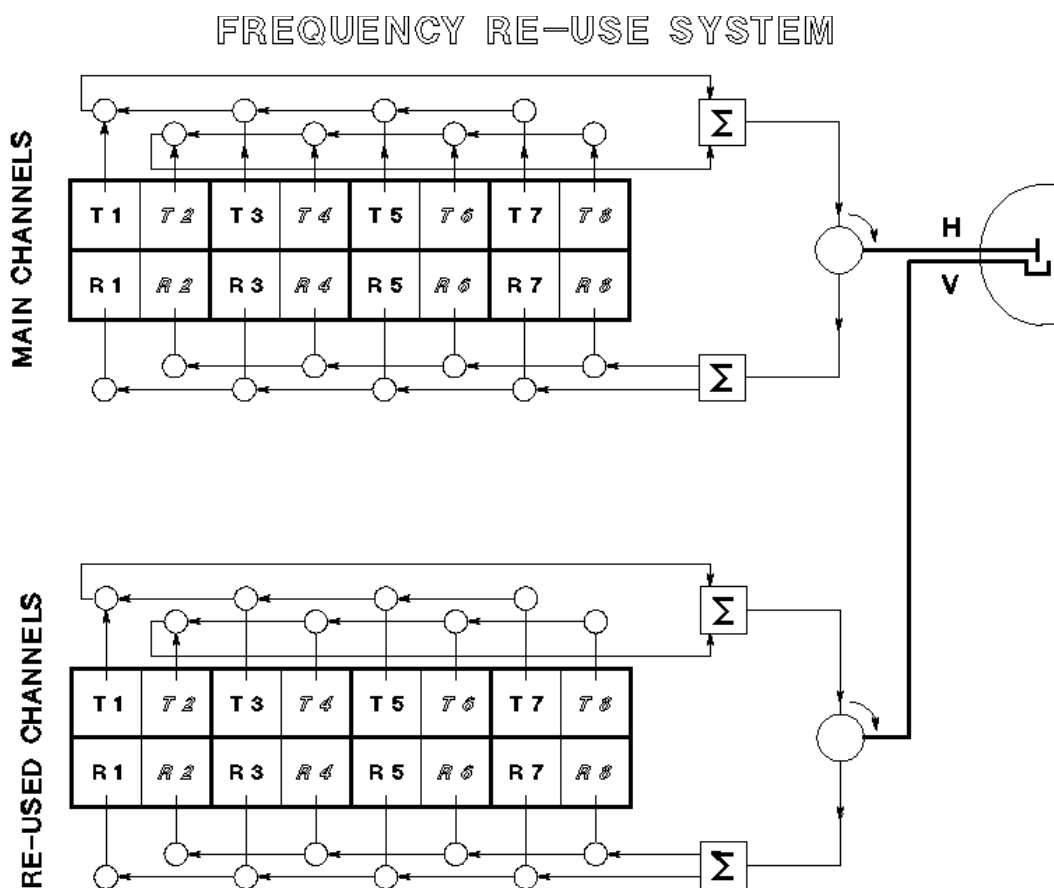


Figure 1: Example of branching arrangement (with one antenna)

FREQUENCY RE-USE SYSTEM

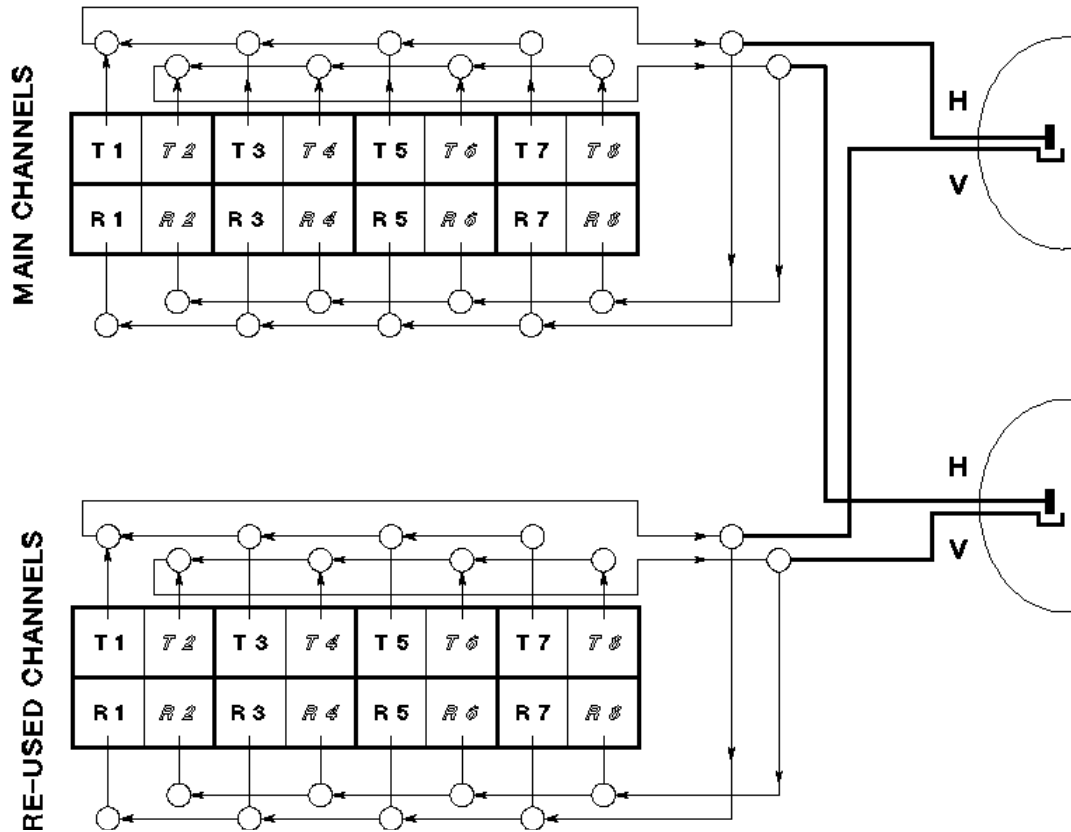
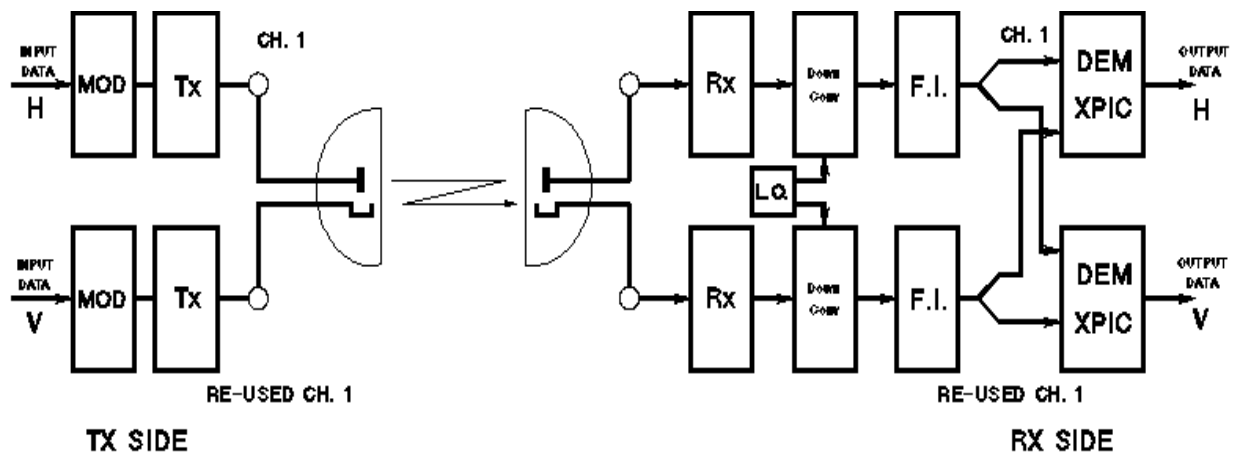


Figure 2: Example of branching arrangement (with two antennas)

4.2.3.3 Frequency re-use system configuration

In the following figure is shown a block diagram of a typical frequency re-use system operating with a Cross Polar Interference Canceller (XPIC) according with System C general description.



FREQUENCY RE-USE SYSTEM

Figure 3: Frequency reuse system operating with an XPIC (System C)

5 Remarks on performance of CCDP systems

5.1 Cross-Polar Interference Canceller (XPIC) Improvement Factor (XIF)

XIF is defined by the ratio between the C/I-threshold (for a defined BER) measured without XPIC to the C/XPI-threshold (same BER) measured with XPIC.

$$XIF = (C/I)_{th} - (C/XPI)_{th}$$

$(C/I)_{th}$ is defined as the value of the co-channel interference that generate the separation of 1 dB from the BER curve without interference.

$(C/XPI)_{th}$ is defined as the value of the co-channel cross-polar interference that generate the separation of 1 dB from the BER curve without interference.

According with the model described as "System C", with a 32 MLCM modulation scheme, we can assume, for example, for a BER = 10^{-3} :

- $(C/I)_{th} = 24$ dB;
- $(C/XPI)_{th} = 4$ dB (using XPIC operation);
- The XPIC Improvement Factor results: XIF = 20 dB.

Regarding the estimation of the factor $(C/XPI)_{th}$, it depends on the phase-relationship between the direct channel HH (or VV) and the interference cross-polar contribution of the channel HV (or VH), according to the model of the interfering test set described in figure 4.

In this case, we can assume that the estimation of the factor $(C/XPI)_{th}$ depends on a "best case" or a "worst case" in relation to the phase-position of SF4 and SF1 (or SF2 and SF3) in the described model. Consequently, we can define two values for the XIF, depending on the phase-relationship between the direct and interference way into the interfering test set.

5.2 Antenna XPD

The measured effective cross-polar discrimination XPD_0 should be at least the same as specified in ETS 300 234 [17] subclause 10.1.1 for Adjacent Channel Dual Polar (ACDP) systems. That is $XPD > 28$ dB on typical hops, i.e. 50 km at frequencies below 11 GHz.

Remarks:

It must be noted that critical hops may require higher values of XPD.

Modern XPD-improved antennas provide $XPD > 35$ dB within the 1 dB contour of the pattern. Experience shows (compare [A],[B]) that with these antennas typically $XPD_{0+Q} = 50$ dB can be achieved. In connection with a (C/XPI) -threshold of 7 dB an interference fade margin of 43 dB results which is approximately not dependent on hop length. Obviously the Interference Fade Margin (IFM) tends to be higher than typical thermal fade margins (normally below 40 dB for 50 km hop length and decreasing with increasing length). So we can expect that frequency reuse gives rise to only marginal decrease of system performance.

A direct comparison between ACDP systems and CCDP systems is possible and interesting. Obviously the parameter "net filter discrimination (NFD)" (typical 19 dB in ACDP using 16 QAM) which is relevant in ACDP systems is replaced by XIF (as seen, 20 dB in CCDP using 32MLCM) which is of the same relevance for IFM in a CCDP-system. Due to the C/N threshold difference of about 1 dB between 16 QAM and 32MLCM, the figures NFD = 19 dB and XIF = 20 dB are equivalent in term of in-field performance. Therefore the positive experience with BER-performance gained in ACDP-systems already in use make it almost sure that CCDP systems with the parameters specified here will perform equally well.

5.3 Characterisation and measurement of XPIC performance

As said before, an XPIC may be used to combat depolarization effects caused by multipath propagation and/or rain attenuation. The XPIC behaviour is proposed to be described by three characteristic values.

1. The asymptotic (or residual) XPD which is the limiting value of C/I achieved at the output of the XPIC for large values of C/I at the receiver inputs.
2. The XPD improvement factor XIF in case of flat crosstalk and co-channel fading (rain model).
3. The XPD improvement factor XIF in case of dispersive co-channel fading and dispersive crosstalk (multipath model).

The flat-fading model is just described in subclause 5.1 for the definition of the XIF parameter.

In case of multipath propagation the "flat model" is no longer applicable. An XIF value which is conservative with respect to planning calculations can be defined and measured as follows:

In both transmission channels (HH and VV) a notch depth is adjusted to find the depth of signature specified for the system and used to estimate outage due to dispersive fading. The notch frequencies are varied over the signal band and shifted parallel with the same frequency difference as compared to carrier frequency.

In these conditions we can have a family of signature curves depending on the C/I value fixed in no-dispersive conditions.

We can define as XIF the difference between the $(C/XPI)_{\text{sign}}$ value (obtained for a variation of 1 dB of the limit of the signature area) in case of XPIC operation and the $(C/I)_{\text{sign}}$ value (obtained for the same variation of the signature) in normal operation without XPIC.

According with the same 32 MLCM modulation scheme of the System C used into the considerations for the flat-fading model (cap. 3.1), we can consider the following results:

$(C/I)_{\text{sign}} = 35 \text{ dB}$ for a signature degradation of 1 dB at the central frequency.

$(C/XPI)_{\text{sign}} = 17 \text{ dB}$ for a signature degradation of 1 dB at the central frequency with XPIC.

So in this case we have: $XIF = (C/I)_{\text{sign}} - (C/XPI)_{\text{sign}} = 18 \text{ dB}$.

Also in this case, the results depends from the phase-relationship between the direct channel HH (or VV) and the interference cross-polar contribution of the channel HV (or VH), according with the model of the interfering test set described in the figure below.

The following figure shows the test set for the estimation of the performances of the XPIC operation.

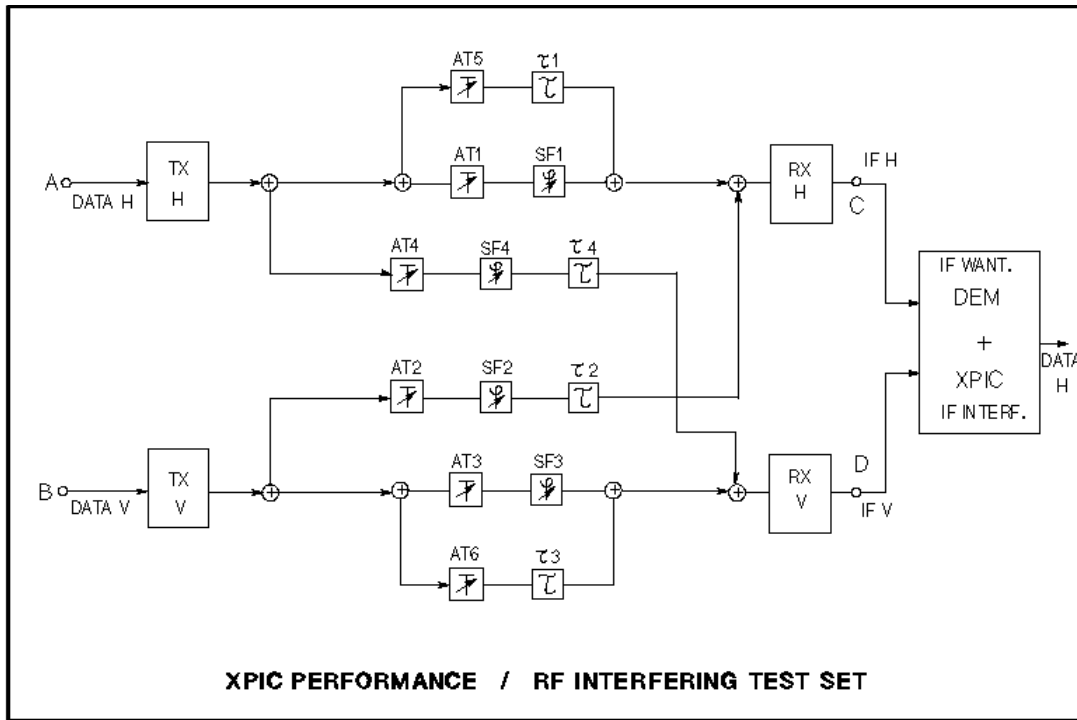


Figure 4: XPIC performance interfering test set

6 Technical parameters

6.1 Generality

This ETR specifies parameters for digital radio-relay systems with a channel capacity of 2xSTM-1 designed to operate in defined bands up to 11 GHz utilising alternate or co-channel dual polarised arrangements with about 40 MHz channel spacing.

The parameters listed 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.

The task of defining compatibility requirements with analogue and digital systems on the same hop and at nodes is made complex by the fact that analogue systems and some digital systems are not standardised. Compatibility requirements are, therefore, limited to allowing the operation of digital and analogue channels on separate ports of the same antenna.

The standardisation includes the following specifications:

- transmitter and receiver characteristics;
- baseband and RF interface characteristics;
- diversity system characteristics.

Two possible baseband interfaces have to be considered:

- one for Synchronous Transport Module-level 1 (STM-1) signals (electrical and/or optical) in accordance with ITU-R Recommendation F. 750 [4]; and
- one for 140 Mbit/s plesiochronous signals (only electrical), according to ITU-T Recommendation G.703 [15].

The 140 Mbit/s signals should be carried "open-port", i.e. in a transparent manner independent of their content. They should be mapped into a 155 Mbit/s STM-1 signal as described in ITU-T Recommendations G.708 [9] and G.709 [10].

As regards the STM-1 signal the Section Overhead (SOH) processing is covered in ITU-R Recommendation F. 750 [4].

6.2 Network and system considerations

The area of application of these digital radio-relay systems is foreseen to be in regional and trunk networks. Consideration is given to the special requirement in the case of a regional network, e.g. simpler towers with less space for antenna, different network structures with high density nodes. Application may also be envisaged for local links and unidirectional connections.

Systems considered in this ETR should be able to respect ITU-R high grade 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 30 km - 40 km for regional and about 60 km for trunk networks, respectively. Hop lengths greater than this latter length, up to about 100 km, are used in special applications.

6.3 Table of technical parameters

Table 2: Technical parameters

PARAMETERS	SYSTEM A	SYSTEM B	SYSTEM C
GENERAL CHARACTERISTICS			
Frequency bands and channel arrangements	<p>L4 GHz ITU-R Recommendation F. 635 [1] with 80 MHz channel spacing and centre gap of 80 MHz.</p> <p>5 GHz ITU-R Recommendation F. 1099 [13] with 80 MHz channel spacing and centre gap of 60 MHz.</p> <p>U6 GHz ITU-R Recommendation F. 384 [2] with 80 MHz channel spacing and centre gap of 65 MHz.</p> <p>11 GHz ITU-R Recommendation F. 387 [3] with 80 MHz channel spacing and centre gap of 75 MHz.</p>	<p>L4 GHz ITU-R Recommendation F. 635 [1] with 40 MHz channel spacing and centre gap of 80 MHz.</p> <p>5 GHz ITU-R Recommendation F. 1099 [13] with 40 MHz channel spacing and centre gap of 60 MHz. Go and return channels on the same antenna are on different polarizations.</p> <p>U6 GHz ITU-R Recommendation F. 384 [2] with 40 MHz channel spacing and centre gap of 60 MHz.</p> <p>11 GHz ITU-R Recommendation F. 387 [3] with 40 MHz channel spacing and centre gap of 50 MHz. Channels 12 and 1' cannot co-exist on the same antenna.</p>	<p>L4 GHz ITU-R Recommendation F. 635 [1] with 40 MHz channel spacing and centre gap of 80 MHz.</p> <p>5 GHz ITU-R Recommendation F. 1099 [13] with 40 MHz channel spacing and centre gap of 60 MHz.</p> <p>U6 GHz ITU-R Recommendation F. 384 [2] with 40 MHz channel spacing and centre gap of 60 MHz.</p> <p>11 GHz ITU-R Recommendation F. 387 [3] with 40 MHz channel spacing and centre gap of 50 MHz. Channels 12 and 1' cannot co-exist on the same antenna.</p>
Modes of operation	The mode of operation is co-channel dual polarized (CCDP) for all frequency bands up to 11 GHz.	The mode of operation makes use of alternate polarization's for adjacent channels in all frequency bands up to 11 GHz .	The mode of operation is co-channel dual polarized (CCDP) for all frequency bands up to 11 GHz. In defining system characteristics for CCDP systems it should be taken into account that in the branching network there may be losses included which will reduce the overall system gain by 3 or 6 dB.

(continued)

Table 2 (continued): Technical parameters

Type of installation	Only indoor installations are foreseen.	Only indoor installations are foreseen.	Only indoor installations are foreseen.
Environmental condition	The equipment will meet the environmental conditions set out in ETS 300 019, Part 1-2 [6]. For equipment designed for stationary use in weatherprotected locations (indoor installation), only classes 3.1 or 3.2 apply.	The equipment will meet the environmental conditions set out in ETS 300 019, Part 1-2 [6]. For equipment designed for stationary use in weatherprotected locations (indoor installation), only classes 3.1 or 3.2 apply.	The equipment will meet the environmental conditions set out in ETS 300 019, Part 1-2 [6]. For equipment designed for stationary use in weatherprotected locations (indoor installation), only classes 3.1 or 3.2 apply.
Electromagnetic compatibility conditions	Equipment is designed to operate under the conditions specified in relevant standards produced by the appropriate European standard organisations (under study in ETSI RES 9). For enclosure emissions and immunity to RF electromagnetic fields, the range of frequencies is extended to cover frequencies up to 2 GHz.	Equipment is designed to operate under the conditions specified in relevant standards produced by the appropriate European standard organisations (under study in ETSI RES 9). For enclosure emissions and immunity to RF electromagnetic fields, the range of frequencies is extended to cover frequencies up to 2 GHz.	Equipment is designed to operate under the conditions specified in relevant standards produced by the appropriate European standard organisations (under study in ETSI RES 9). For enclosure emissions and immunity to RF electromagnetic fields, the range of frequencies is extended to cover frequencies up to 2 GHz.
Mechanical dimensions	Slim rack version 120 mm. Height ≤ 2 200 mm	The mechanical dimensions for indoor installations are in agreement with ETS 300 119 [16].	The mechanical dimensions for indoor installations are in agreement with ETS 300 119 [16].
Power supply	The equipment operates from any of the primary supplies within the ranges specified in draft prETS 300 132 [7].	The equipment operates from any of the primary supplies within the ranges specified in draft prETS 300 132 [7].	The equipment operates from any of the primary supplies within the ranges specified in draft prETS 300 132 [7].
Safety considerations	Maximum radiated power density under normal operating conditions is in accordance with current World Health Organisation figures.	Maximum radiated power density under normal operating conditions is in accordance with current World Health Organisation figures.	Maximum radiated power density under normal operating conditions is in accordance with current World Health Organisation figures.
TMN interface	A TMN interface will follow relevant ITU-T and ITU-R Recommendations and ETSI Standard.	A TMN interface will follow relevant ITU-T and ITU-R Recommendations and ETSI Standard.	A TMN interface will follow relevant ITU-T and ITU-R Recommendations and ETSI Standard.
	(continued)		

Table 2 (continued): Technical parameters

System block diagram	The system block diagram including reference points is shown in figure 4.	The system block diagram including reference points is shown in figure 9.	The system block diagram including reference points is shown in figure 13.
Intermediate Frequency (IF)	The If centre frequency f_0 is 140 MHz, the subcarriers frequencies are symmetrically arranged around 140 MHz $\Delta f \approx \pm 17.5$ MHz	If any, the IF should preferably be 70 MHz.	If any, the IF should be 70 MHz or 140 MHz.
Local oscillator arrangements	The local oscillator frequencies for both, transmitters and receivers, is in the same half-band as their associated transmitter or receiver carrier frequencies.	The local oscillator frequencies for both, transmitters and receivers, is in the same half-band as their associated transmitter or receiver carrier frequencies.	The local oscillator frequencies for both, transmitters and receivers, is in the same half-band as their associated transmitter or receiver carrier frequencies.
TRANSMITTER CHARACTERISTICS			
Output power	Referred to point B' the value of the output power is less or equal to +38 dBm and greater or equal to +25 dBm, all tolerances included. For the purpose of system engineering three classes of nominal output power are defined: Class A: +26 dBm/+31 dBm Class B: +29 dBm/+34 dBm Class C: +34 dBm/ +38 dBm	Referred to point B' the value of the output power is less or equal to +38 dBm and greater or equal to +25 dBm, all tolerances included. For the purpose of system engineering three classes of nominal output power are defined: Class A: +26 dBm/+31 dBm Class B: +29 dBm/+34 dBm Class C: +34 dBm/ +38 dBm	Referred to point B' the value of the output power is less or equal to +38 dBm and greater or equal to +25 dBm, all tolerances included. For the purpose of system engineering three classes of nominal output power are defined: Class A: +26 dBm/+31 dBm Class B: +29 dBm/+34 dBm Class C: +34 dBm/ +38 dBm
ATPC	ATPC is an optional feature, information on ATPC is given in the informative notes.	ATPC is an optional feature, information on ATPC is given in the informative notes.	ATPC is an optional feature, information on ATPC is given in the informative notes.
RF spectrum masks	The spectrum mask is given in figure 6 for all frequency bands considered.	The spectrum mask is given in figure 10 for all frequency bands considered.	The spectrum mask is given in figure 14 for all frequency bands considered.
Spectrum line at the symbol rate	To facilitate sharing with analogue systems the power level of spectral lines at a distance from the subcarrier frequencies equal to the symbol rate is less than or equal to -37 dBm.	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 is less than or equal to -37 dBm.	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 is less than or equal to -37 dBm.
(continued)			

Table 2 (continued): Technical parameters

PARAMETERS	SYSTEM A	SYSTEM B	SYSTEM C
GENERAL CHARACTERISTICS			
Spurious emissions			
Spurious emissions-external	<p>The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values referenced to at point C' are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm</p> <p>NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.</p>	<p>The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values referenced to at point C' are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm</p> <p>NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.</p>	<p>The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values referenced to at point C' are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm</p> <p>NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.</p>
Spurious emissions-internal	<p>The levels of the spurious emissions from the transmitter [including \pm IF (LO Freq), \pm 2 x IF (unwanted sideband) and \pm IF, \pm 3 x IF (unwanted sideband at 2nd IF harmonic)], referenced to point B' are specified as follows:</p> <p>- 90 dBm [Within receiver half-band] - 60 dBm [Within transmitter half-band]</p>	<p>The levels of the spurious emissions from the transmitter [including \pm IF (LO Freq), \pm 2 x IF (unwanted sideband) and \pm IF, \pm 3 x IF (unwanted sideband at 2nd IF harmonic)], referenced to point B' are specified as follows:</p> <p>- 90 dBm [Within receiver half-band] - 60 dBm [Within transmitter half-band]</p>	<p>The levels of the spurious emissions from the transmitter [including \pm IF (LO Freq), \pm 2 x IF (unwanted sideband) and \pm IF, \pm 3 x IF (unwanted sideband at 2nd IF harmonic)], referenced to point B' are specified as follows:</p> <p>- 90 dBm [Within receiver half-band] - 60 dBm [Within transmitter half-band]</p>
Radio frequency tolerance	<p>Maximum radio frequency tolerance does not exceed \pm 30 ppm for all frequency bands considered. This limit includes both short-term factors (environmental effects) and long-term ageing effects.</p>	<p>Maximum radio frequency tolerance does not exceed \pm 30 ppm for all frequency bands considered. This limit includes both short-term factors (environmental effects) and long-term ageing effects.</p>	<p>Maximum radio frequency tolerance does not exceed \pm 30 ppm for all frequency bands considered. This limit includes both short-term factors (environmental effects) and long-term ageing effects.</p>
Return loss	<p>Minimum return loss is 26 dB at point C' over the full RF band and measured back in the direction to the transmitter.</p>	<p>Minimum return loss is 26 dB at point C' over the full RF band and measured back in the direction to the transmitter.</p>	<p>Minimum return loss is 26 dB at point C' over the full RF band and measured back in the direction to the transmitter.</p>
(continued)			

Table 2 (continued): Technical parameters

RECEIVER CHARACTERISTICS			
Receiver image rejection	For the frequency bands as given in the following, the receiver image rejection is: 120 dB at L4 and 5 GHz band 100 dB at U6 GHz band For the 11 GHz band the limit is: 90 dB.	For the frequency bands as given in the following, the receiver image rejection is: 95 dB at L4 and 5 GHz band 80 dB at U6 and 11 GHz band	For the frequency bands as given in the following, the receiver image rejection is: 120 dB at L4 and 5 GHz band 100 dB at U6 GHz band For the 11 GHz band the limit is: 90 dB.
Spurious emissions			
Spurious emissions-external	The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values measured at point C are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.	The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values measured at point C are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.	The frequency range in which the spurious emission specifications apply is 30 MHz to 40 GHz. The limit values measured at point C are: 30 MHz to 21,2 GHz - 60 dBm 21,2 GHz to 40,0 GHz - 30 dBm NOTE: These values are provisional; final values are subject to consultation with CEPT and other relevant parties.
Spurious emissions-internal	For spurious emissions at the local oscillator frequency a provisional limit of < - 110 dBm for all bands applies (referenced to point B).	For spurious emissions at the local oscillator frequency a provisional limit of < - 110 dBm for all bands applies (referenced to point B).	For spurious emissions at the local oscillator frequency a provisional limit of < - 110 dBm for all bands applies (referenced to point B).
Input level range	The lower limit for the receiver input level is given by the threshold level for Bit Error Ratio (BER) = 10^{-3} . The upper limit for the receiver input level, where a BER of 10^{-3} is not exceeded is -17 dBm; a BER of 10^{-10} may only be exceeded for levels greater than -21 dBm. These limits apply without "external" interference and are referenced to point B.	The lower limit for the receiver input level is given by the threshold level for Bit Error Ratio (BER) = 10^{-3} . The upper limit for the receiver input level, where a BER of 10^{-3} is not exceeded is -17 dBm; a BER of 10^{-10} may only be exceeded for levels greater than -21 dBm. These limits apply without interference and are referenced to point B.	The lower limit for the receiver input level is given by the threshold level for Bit Error Ratio (BER) = 10^{-3} . The upper limit for the receiver input level, where a BER of 10^{-3} is not exceeded is -17 dBm; a BER of 10^{-10} may only be exceeded for levels greater than -21 dBm. These limits apply without "external" interference and are referenced to point B.

(continued)

Table 2 (continued): Technical parameters

Overall receiver selectivity for innermost channels	No special requirements	No special requirements	[Under study]
Return loss	Minimum return loss measured at point C is 26 dB over the full RF band and measured in the direction to the receiver.	Minimum return loss measured at point C is 26 dB over the full RF band and measured in the direction to the receiver.	Minimum return loss measured at point C is 26 dB over the full RF band and measured in the direction to the receiver.
SYSTEM CHARACTERISTICS WITHOUT DIVERSITY			
Equipment background BER	Equipment background BER is measured under simulated operating conditions over an artificial hop without "external" interference with a signal level at point B which is between 15 dB and 40 dB above the lower level which gives BER = 10 ⁻³ . In a measurement period of 24 hours the number of bit errors, measured at 1xSTM-1 or 140 MB/s level, is less than 10 (BER 10 ⁻¹²).	Equipment background BER is measured under simulated operating conditions over an artificial hop without interference with a signal level at point B which is between 15 dB and 40 dB above the lower level which gives BER = 10 ⁻³ . In a measurement period of 24 hours the number of bit errors, measured at 1xSTM-1 or 140 MB/s level, is less than 10 (BER 10 ⁻¹²).	Equipment background BER is measured under simulated operating conditions over an artificial hop without "external" interference with a signal level at point B which is between 15 dB and 40 dB above the lower level which gives BER = 10 ⁻³ . In a measurement period of 24 hours the number of bit errors, measured at 1xSTM-1 or 140 MB/s level, is less than 10 (BER 10 ⁻¹²).
BER as a function of receiver input level	Frequency band L4 -5 -U6 GHz/11 GHz BER ≤ 10 ⁻³ - 73 dBm /- 72 dBm BER ≤ 10 ⁻⁶ - 69,5 dBm /- 68,5 dBm BER ≤ 10 ⁻¹⁰ - 65,5 dBm /- 64,5 dBm	Frequency band L4 -5 -U6 GHz/11 GHz BER ≤ 10 ⁻³ - 64 dBm /- 62.5 dBm BER ≤ 10 ⁻⁶ - 60.5 dBm /- 59 dBm BER ≤ 10 ⁻¹⁰ - 56.5 dBm /- 55 dBm	Frequency band L4 -5 GHz / U6GHz /11 GHz BER ≤ 10 ⁻³ - 77 dBm /- 76.5 dBm/-76 dBm BER ≤ 10 ⁻⁶ - 74 dBm /- 73.5 dBm/-73 dBm BER ≤ 10 ⁻¹⁰ - 71 dBm /- 70.5 dBm/-70 dBm
Interference sensitivity			
Co-channel "external" interference sensitivity	For all frequency bands the limits of the co-channel interference sensitivity are given in figure 7.	For all frequency bands the limits of the co-channel interference sensitivity are given in figure 11.	For all frequency bands the limits of the co-channel interference sensitivity are given in figure 15.
Adjacent channel interference sensitivity	For all frequency bands the limits of the adjacent channel interference sensitivity are given in figure 8.	For all frequency bands the limits of the adjacent channel interference sensitivity are given in figure 12.	For all frequency bands the limits of the adjacent channel interference sensitivity are as given in figure 16.
		(continued)	

Table 2 (continued): Technical parameters

CW spurious interference	Under study.	Under study.	Under study.
Distortion sensitivity (for a single 2xSTM-1 System in 40MHz Channel Spacing)	<p>For a delay of 6,3 ns and a BER of 10^{-3} the width of the signature does not exceed ± 16 MHz relative to the carrier frequency of either carrier and the depth is not less than 18 dB. For a delay of 6,3 ns and a BER of 10^{-6} the width of the signature does not exceed ± 17 MHz relative to the carrier frequency of either carrier and the depth is not less than 16 dB. These limits are valid for both minimum and non-minimum phase cases and include co-channel interference due to frequency reuse.</p> <p>NOTE: The test set is as in figure 4 of subclause 5.3 with cross polar (HV and VH paths) attenuation = 28 dB (for this value see subclause 6.6.1.1). Notch position and depth are equal for both HH and VV paths.</p>	<p>For a delay of 6,3 ns and a BER of 10^{-3} the width of the signature does not exceed ± 23 MHz relative to the channel assigned frequency and the depth is not less than 18 dB. For a delay of 6,3 ns and a BER of 10^{-6} the width of the signature does not exceed ± 26 MHz relative to the channel assigned frequency and the depth is not less than 15 dB. These limits are valid for both minimum and non-minimum phase cases.</p>	<p>For a delay of 6,3 ns and a BER of 10^{-3} the width of the signature does not exceed ± 16 MHz relative to the channel assigned frequency and the depth is not less than 18 dB. For a delay of 6,3 ns and a BER of 10^{-6} the width of the signature does not exceed ± 17 MHz relative to the channel assigned frequency and the depth is not less than 17 dB. These limits are valid for both minimum and non-minimum phase cases and include co-channel interference due to frequency reuse.</p> <p>NOTE: The test set is as in figure D of subclause 3.3, with cross polar (HV and VH paths) attenuation (XPD) = 28 dB (for this value see 4.6.1.1). Notch position and depth are equal for both HH and VV paths.</p>
SYSTEM CHARACTERISTICS WITH DIVERSITY			
Differential delay compensation	It is possible to compensate for differential absolute delays due to antennas, feeders and cable connections on the two diversity paths. The range of adjustment is at least 75 ns of differential absolute delay.	It is possible to compensate for differential absolute delays due to antennas, feeders and cable connections on the two diversity paths. The range of adjustment is at least 75 ns of differential absolute delay.	It is possible to compensate for differential absolute delays due to antennas, feeders and cable connections on the two diversity paths. The range of adjustment is at least 75 ns of differential absolute delay.

(continued)

Table 2 (concluded): Technical parameters

BER performance	When both receiver inputs (main and diversity, points B and B _D) are fed with low level input signals of the same level at an arbitrary phase difference, input level limits for specified BER values is: - 2,5 dB below, for IF, or baseband combining systems; - 1,5 dB below, for RF combining systems; those given for the case without diversity.	When both receiver inputs (main and diversity, points B and B _D) are fed with low level input signals of the same level at an arbitrary phase difference, input level limits for specified BER values is: - 2,5 dB below, for IF, or baseband combining systems; - 1,5 dB below, for RF combining systems; those given for the case without diversity.	When both receiver inputs (main and diversity, points B and B _D) are fed with low level input signals of the same level at an arbitrary phase difference, input level limits for specified BER values is: - 2,5 dB below, for IF, or baseband combining systems; - 1,5 dB below, for RF combining systems; those given for the case without diversity.
CROSS POLAR INTERFERENCE SENSITIVITY			
Co-channel "internal" sensitivity in flat fading conditions	Refer to clause 3	Not applicable	Refer to Clause 3
Co-channel "internal" sensitivity in dispersive fading conditions	Refer to clause 3	Not applicable	Refer to Clause 3

6.4 Informative notes

6.4.1 Branching/feeder/antenna requirements

The parameters and values specified below are essential prerequisites for the system specification given in this ETR.

6.4.1.1 Cross Polar Discrimination (XPD)

The measured effective XPD over a typical hop under no-fading conditions should not be less than 28 dB.

6.4.1.2 Intermodulation products

Each intermodulation product caused by different transmitters linked to the same antenna is less than - 110 dBm referenced to point B with an output power of about 28 dBm per transmitter.

6.4.1.3 Interport isolation

This should not be less than 40 dB.

6.4.1.4 Return loss

This should not be less than 26 dB (Voltage Standing Wave Ratio (VSWR) = 1.10:1) at the antenna flange (points D, D').

6.4.2 Automatic Transmit Power Control (ATPC)

ATPC can be useful in many circumstances, especially:

- to improve analogue-digital compatibility in the case of antennas with poor cross-polarization 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 analog systems at nodal stations;
- to reduce the effects of up-fading propagation conditions on the system.

ATPC is an optional feature which is aimed at driving the Transmit (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 which is defined by the relative class of output power and the complete fulfilment of all the specifications defined in this ETR.

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 amplifier output level should not be less than + 10 dBm; this may result in a reduced ATPC range.

6.5 Figures

6.5.1 Figures relevant to system A

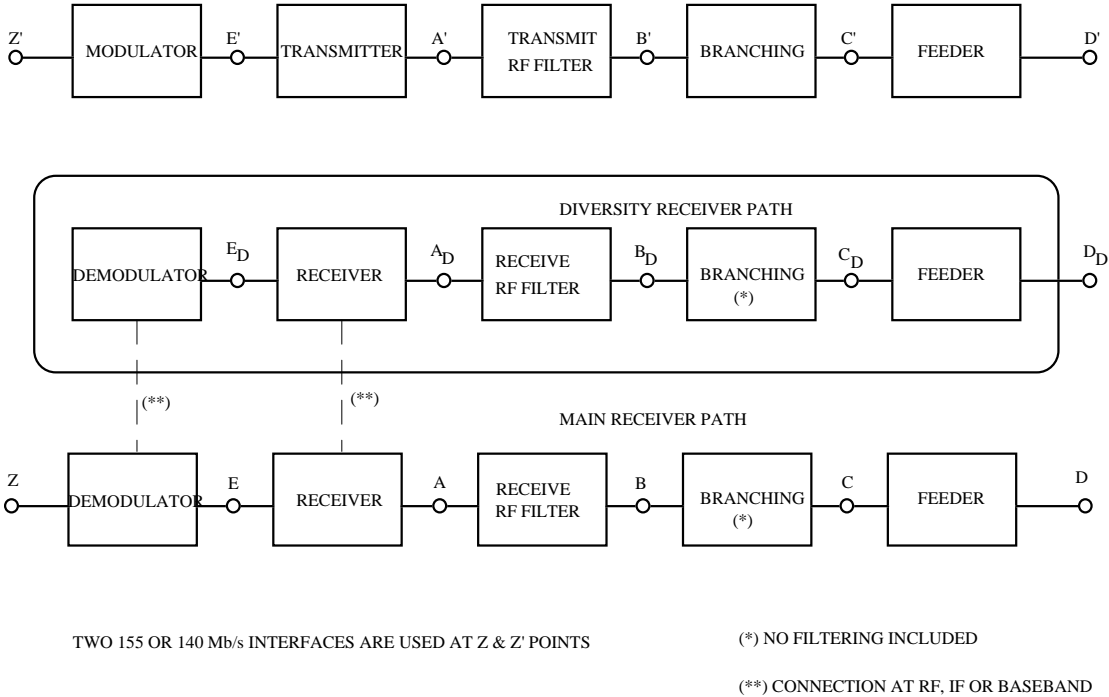
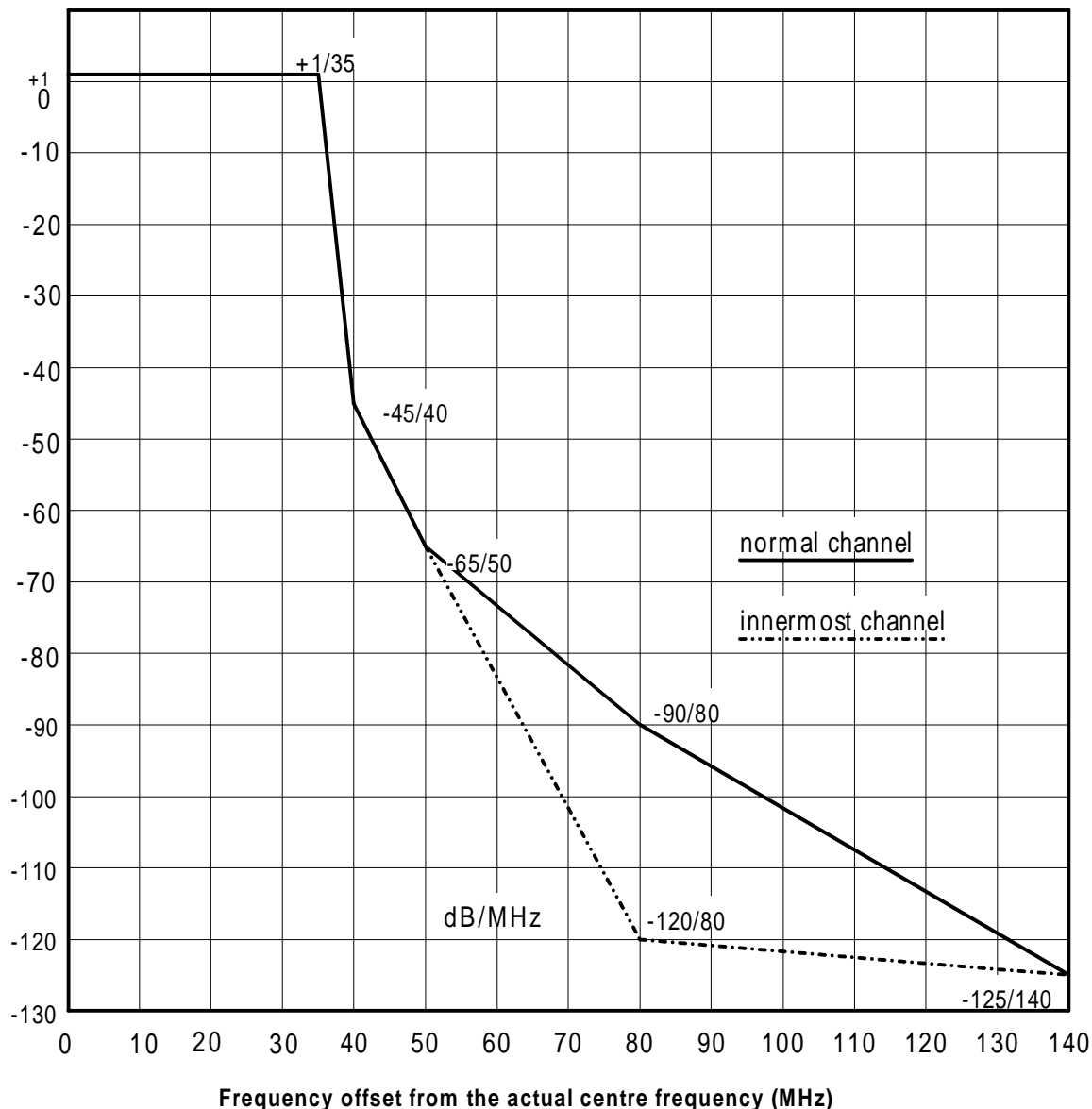


Figure 5: Block diagram

Relative power spectral density (dB)



NOTE: The mask does not include the frequency tolerance

Figure 6: Limits of power spectral density for normal channels and for the inner edges of innermost channels referred to point B'

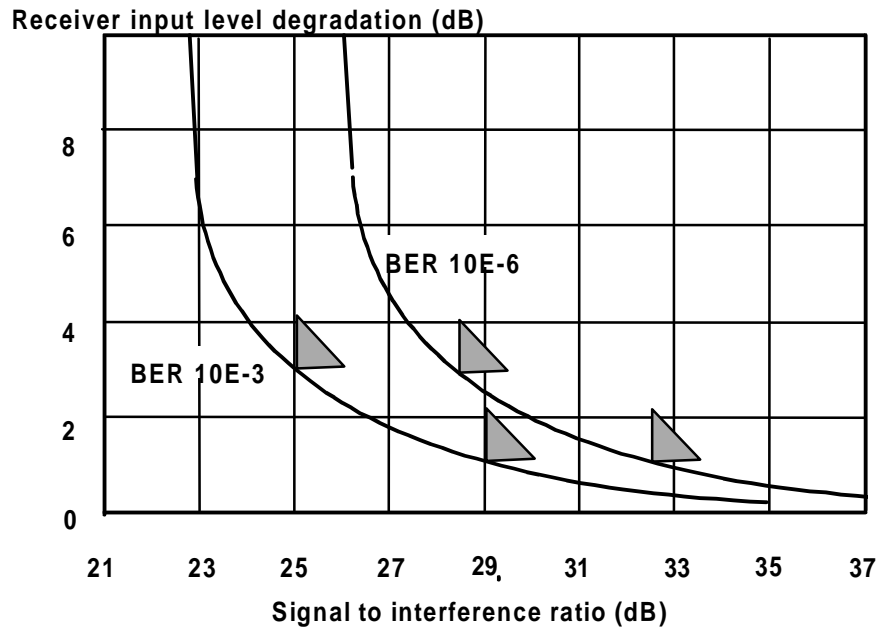


Figure 7: Co-channel "external" digital interference sensitivity limits referred to point B'

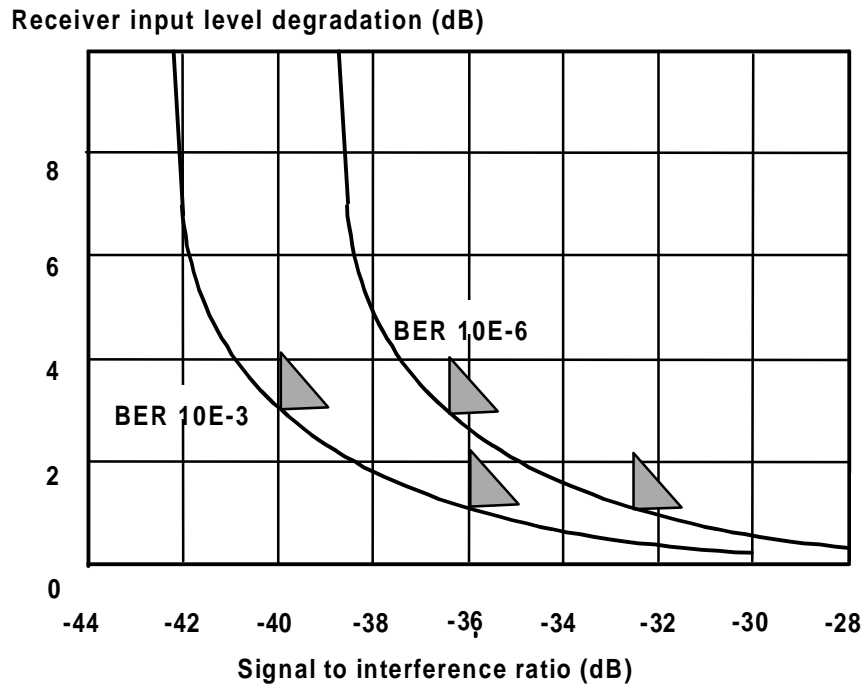


Figure 8: Adjacent-channel digital interference sensitivity limits referred to point B'

6.5.2 Figures relevant to system B

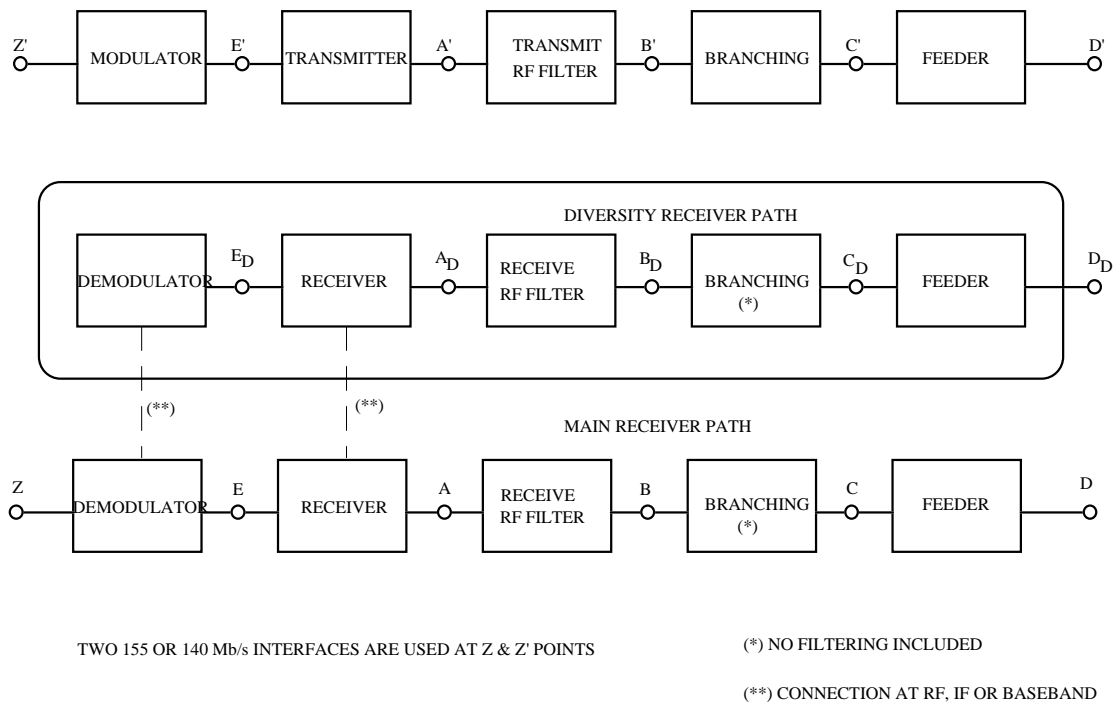


Figure 9: Block diagram

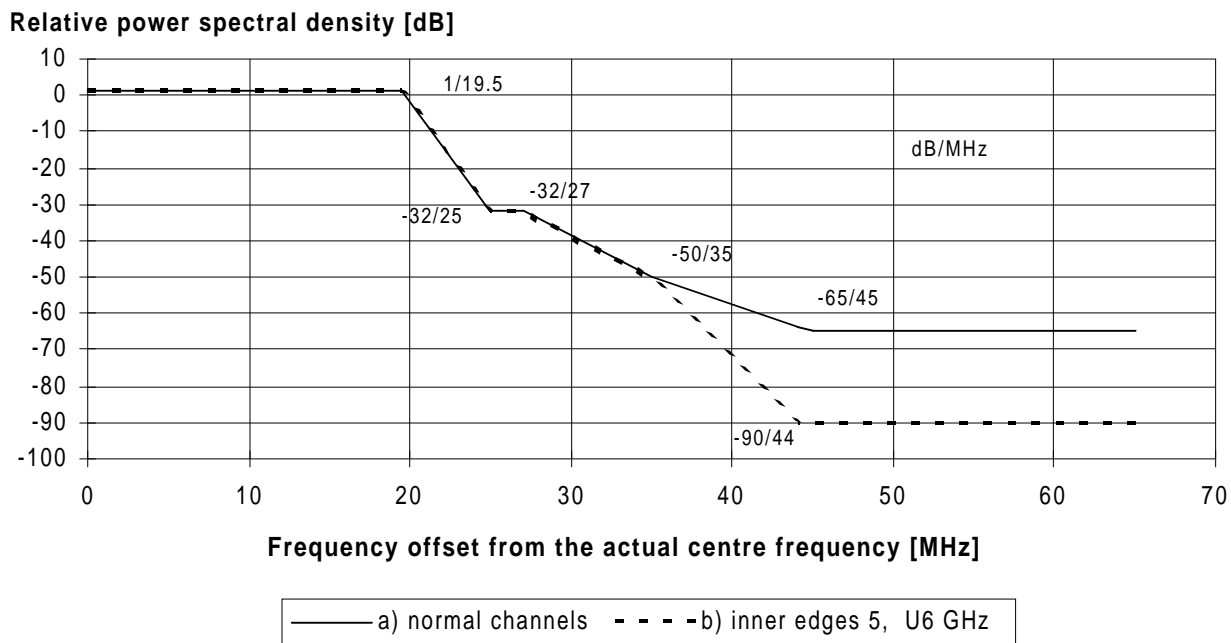


Figure 10: Limits of power spectral density for normal channels and for the inner edges of innermost channels in the 5 and U6 GHz band (centre gap 60 MHz)

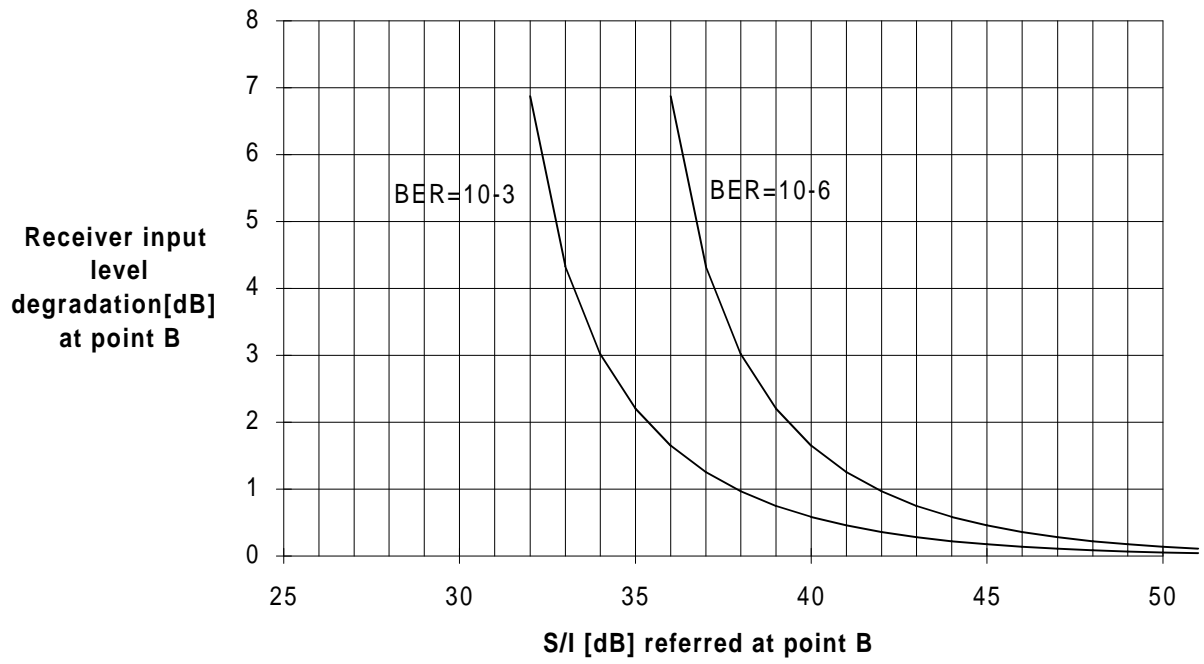


Figure 11: Co-channel digital interference sensitivity limits

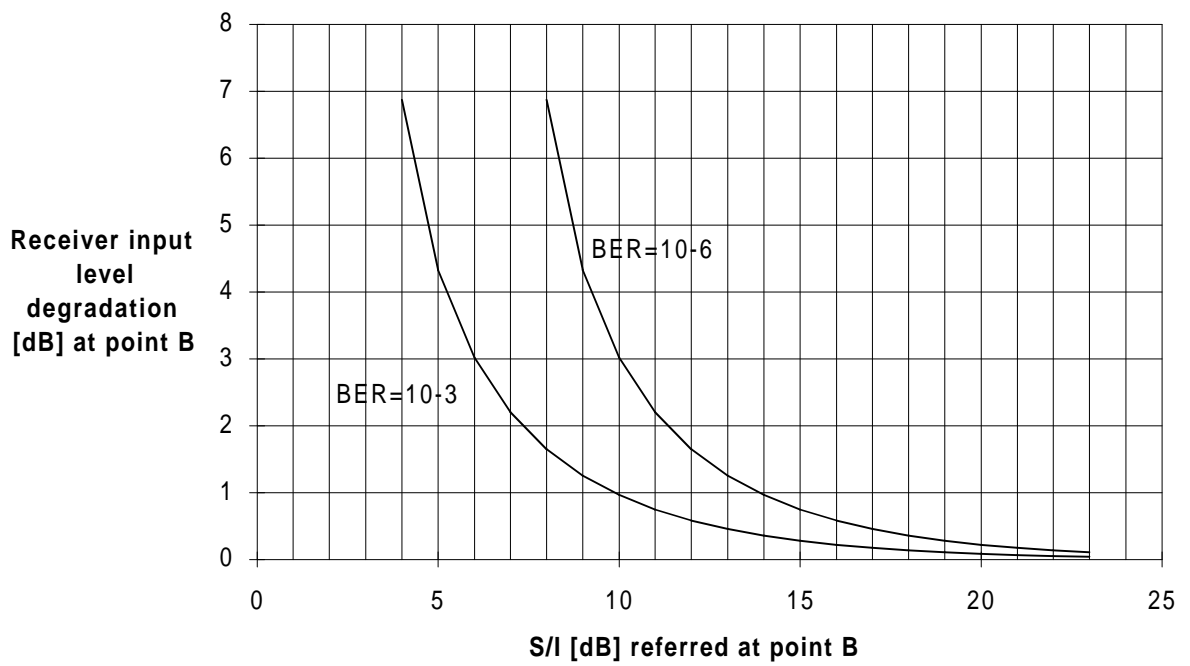


Figure 12: Adjacent-channel digital interference sensitivity limits

6.5.3 Figures relevant to system C

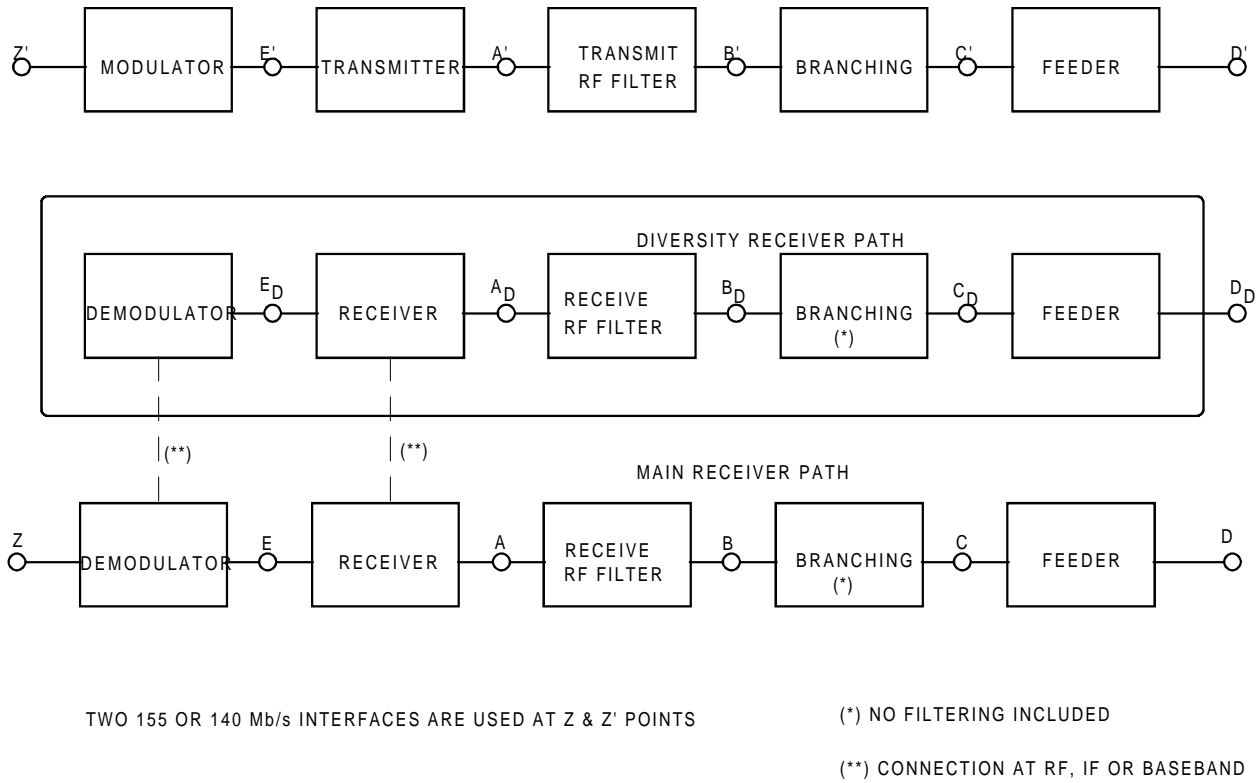


Figure 13: Block diagram

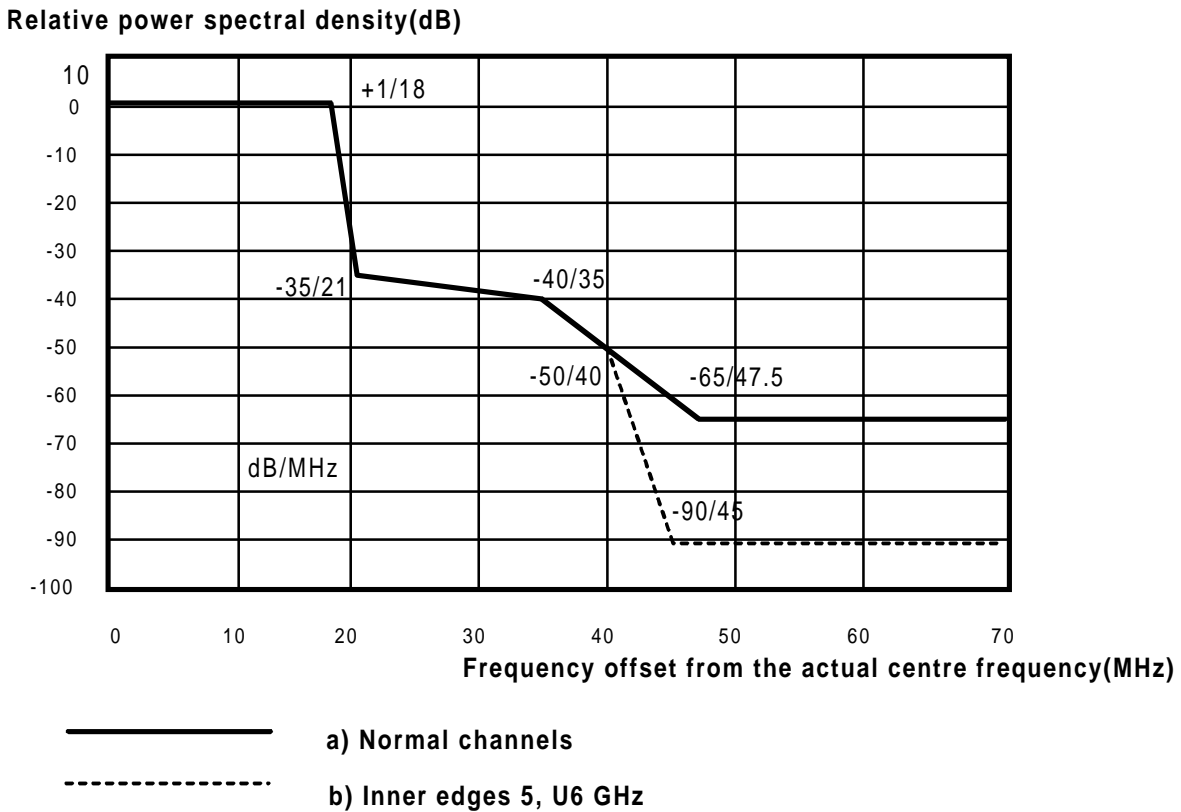
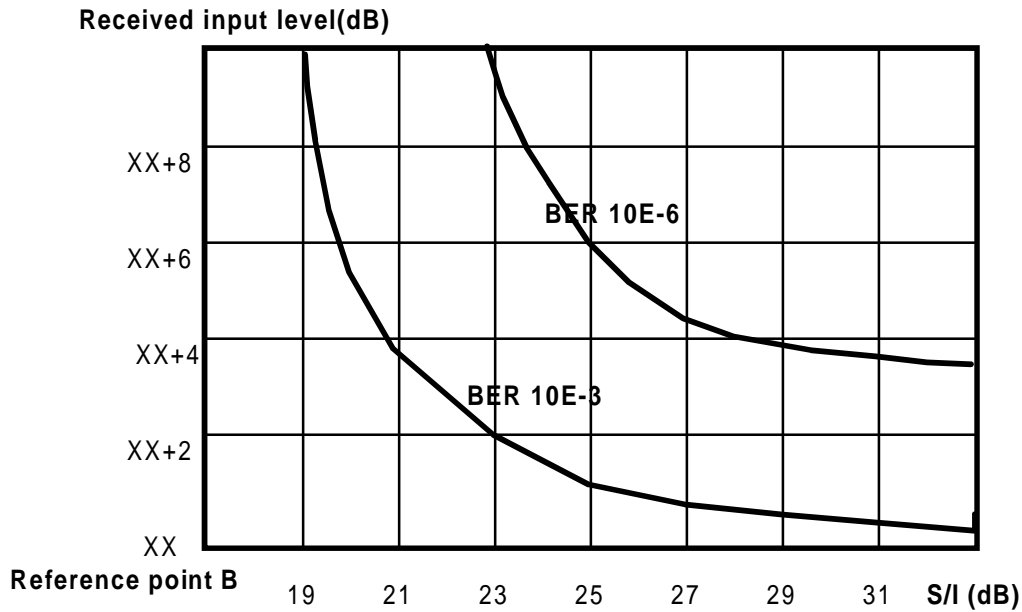
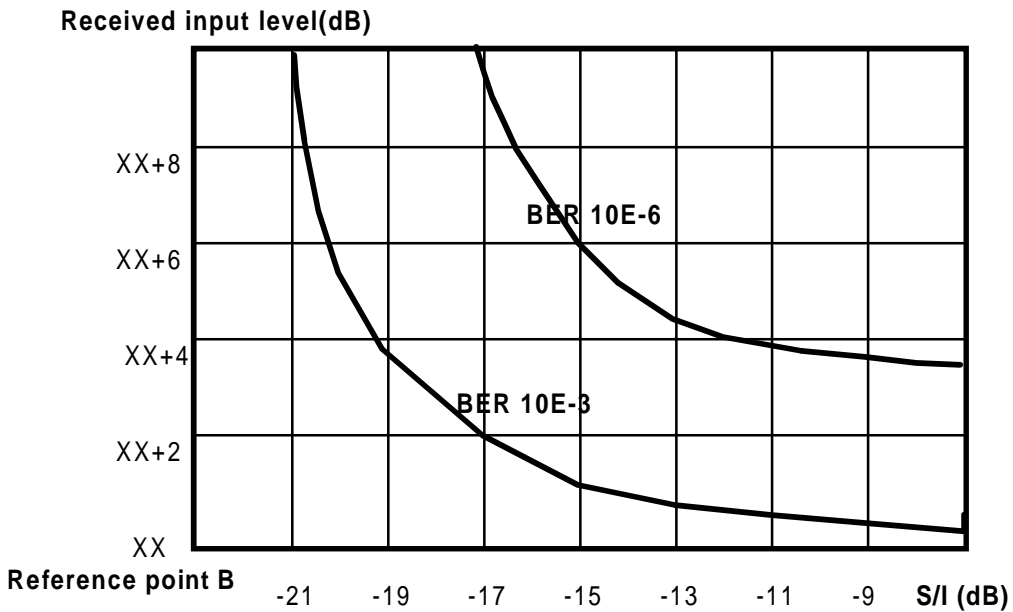


Figure 14: Limits of power spectral density for normal channels and for the inner edges of innermost channels in the 5 and U6 GHz band (centre gap 60 MHz)



XX = -77,0 dBm for L4 and 5 GHz Systems
 XX = -76,5 dBm for U6 GHz System
 XX = -76,0 dBm for 11 GHz System

Figure 15: Co-channel "external" digital interference sensitivity limits



XX = -77,0 dBm for L4 and 5 GHz Systems
 XX = -76,5 dBm for U6 GHz System
 XX = -76,0 dBm for 11 GHz System

Figure 16: Adjacent-channel digital interference sensitivity limits

Annex A: Bibliography

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History

Document history	
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