TECHNICAL FREQUENCY ASSIGNMENT CRITERIA

For low capacity fixed point-to-point radio services with digital modulation operating in the bands 1350-1375 MHz paired with 1492-1517 MHz.

349P 0001 00

June 2003

Blank Page.

Foreword

It is required by the Wireless Telegraphy Act, 1949 (as modified by the Post Office Act, 1969) that no radio apparatus shall be installed or used in the United Kingdom, except under the authority of a licence granted by the Secretary of State. It is a condition of such a licence that the performance of the radio equipment meets certain minimum standards laid down in the appropriate Technical Regulation or National Standard. Compliance will have been demonstrated by submitting the equipment for a type approval test at an accredited test house.

This document details the frequency assignment criteria and principles that will be employed by the RA in the selection of frequencies for use by fixed point to point, type approved, digital radio equipments operating in the band or frequency range specified.

These assignment criteria are subject to updating and amendment, and intending operators / manufacturers should consult the latest version of this document complete with any amendments. Single copies of this document are available free from the RA library at either the main or temporary address below:

MAIN ADDRESS:

Radiocommunications Agency
Library Services
Wyndham House
189 Marsh Wall
Docklands
London E14 9SX.

TEMPORARY ADDRESS:

Radiocommunications Agency
Library Services
New King's Beam House
22 Upper Ground
London SE1 9SA

Switchboard and 24 hour enquiry service (for either address):

Telephone: 0171 211 0211

Fax: 0171 211 0507

Blank Page.

CONTENTS

Blank Page.

1. General

1.1 Introduction

This document outlines the frequency assignment criteria and principles that will be employed in the selection of frequencies for use by all fixed point to point radio services operating in the bands 1350 - 1375 MHz paired with 1492 - 1517 MHz. There exists a technical regulation MPT 1717 that details the equipment and antenna options available for the UK from the European Standards ETS 300-630 and ETS 300-631. The technical regulation is currently (August 1998) undergoing the EC Directive 83/189 procedure before final publication.

1.2 Licensee's responsibility

The Foreword of this document states that the establishment, use or installation of transmitting or receiving apparatus is subject to the issue of a licence by the Secretary. The licensee must ensure that equipment conforms with and is maintained to the standard set out in the appropriate Technical Regulation. Licences will only be granted for equipment which has been type approved.

1.3 Link Length Policy

The RA operates a link length policy to promote the use of the highest possible frequency band for the distance over which the link is to operate. Although there is no minimum path length policy for links with a capacity of 704kbit/s or less the RA may refuse a license for links over short distances where radio is considered an inappropriate transfer medium. However for links with capacities of 2Mbit/s, occupying a 1 MHz bandwidth, and 2x2 Mbit/s, occupying a 2 MHz bandwidth, the minimum path length is 30km. For systems transmitting at least 2 Mbit/s and occupying 500 kHz of bandwidth the minimum path length is 15 kms. At distances below this it is expected that a higher frequency band could be used, depending on the availability of frequencies and equipment.

2. Transmitting and receiving installations

2.1 General

The transmitting and receiving installations shall conform to clauses 2.3 and 2.4 below. The installations shall be in accordance with good engineering practice consistent with maintaining the integrity of the link over its expected lifetime.

.

2.2 Permitted antenna classes

The antenna standard ETS 300-631 details three classes of antenna for use in this frequency band.

Class 1 will be permitted for systems employing channel widths up to 250 kHz.
Class 2 will be permitted for systems employing channel widths up to 500 kHz.
Class 3 will be permitted in any system.

UK Technical Regulation MPT 1717 clause 4.2 also refers.

2.3 Antenna directivity

The co-polarised and cross-polarised directivity of the antenna installed at licensed premises shall be such that the RPE in the horizontal plane at any azimuth does not exceed the value specified in the antenna standard of clause 2.2.

2.4 Antenna polarisation

The plane of polarisation of emissions for a particular radio link will be specified by the Radiocommunications Agency and will be either horizontal or vertical linear polarisation. The polarisation will be determined from consideration of sharing with other services. The antenna alignment surface shall be aligned as precisely as possible to the true vertical or true horizontal and the misalignment shall be no greater than 3°.

2.5 Equivalent isotropically radiated power (EIRP)

The EIRP for a particular link must not exceed the assigned value which will be a condition of the licence. A tolerance of ±3dB will be allowed in practice. The maximum EIRP to be assigned will be 40 dBW.

3. Principles of assignment

3.1 Normal assignment

A normal frequency assignment for a single or multi-section bi-directional link shall comprise a pair of radio frequencies of corresponding channel number, one from each of the low and high frequency groups.

3.2 Multi-section links

In the case of a multi-section link the direction of transmission of the two frequencies shall alternate for successive repeater sections so that the transmitter frequency assigned to any station shall be taken from only one of the frequency groups in the lower or upper half of the band.

3.3 Go - Return separation

The frequency difference between a pair of corresponding go and return frequencies in the band shall be 142 MHz.

3.4 Parallel links

In assessing the interference potential between parallel links, it is assumed that the wanted and interfering signals suffer correlated fading. Therefore protection from interference is derived from frequency separation and cross polar discrimination (if any). Table 4.1 lists the co and cross polar minimum frequency separations for like parallel systems. For mixed systems, the appropriate minimum separations are derived by the sum of half of the individual minimum separations given. The assignment software identifies available channels which meet the minimum frequency separation criteria, in accordance with the channel plan defined in clause 4.

Table 4.1 : Parallel route minimum frequency separations.

Typical capacity	Minimum separation between carriers on a parallel route	
	Co - polar (kHz)	Cross polar (kHz)
9.6 kbit/s	25	25
64 kbit/s	75	75
192 kbit/s	250	250
704 kbit/s	500	500
2 Mbit/s	1000	1000
2x2 Mbit/s	2000	2000

3.5 Antenna discrimination

In assigning frequencies for radio frequency channels which are in the same geographical area due consideration shall be taken of the antenna discriminations available, as shown in the antenna standard of clause 2.2.

3.6 Assumptions

The following Table 4.2 indicates the channel capacities envisaged for the two classes of ETSI equipment allowed in MPT 1717.

Table 4. 2 : Indicative channel capacities.

Channel Spacing	System Class	Maximum Channel Capacity (indicative)
25 kHz	Class 2	32 kbit/s
	Class 3	64 kbit/s
75 kHz	Class 2	95 kbit/s
	Class 3	190 kbit/s
250 kHz	Class 2	325 kbit/s
	Class 3	650 kbit/s
500 kHz	Class 3	1300 kbit/s
1 MHz	Class 3	2600 kbit/s
2MHz	Class 3	5200 kbit/s

Higher gross bit rates would be allowed in any particular channel so long as the limits of the relevant spectral power density mask are not exceeded and an appropriate C/I ratio is used for interference and assignment purposes.

It will usually be assumed that each hop has a clearance from obstructions of 0.577F between the transmitting and receiving antennas at the two stations under conditions corresponding to values of the ratio K greater than 0.7. The path attenuation of each hop shall be assumed to be equal to the attenuation in free space.

F : First Fresnel Zone Clearance
K : Ratio of effective earth radius to real earth radius

Table 4.3 : Receiver input levels.

Capacity	Input level (dBW)	
	Class 2	**Class 3**
9.6 kbit/s	-138 dBW + M	-131 dBW + M
64 kbit/s	- 133 dBW + M	-131 dBW + M
192 kbit/s	-127 dBW + M	-127 dBW + M
704 kbit/s	-	-120 dBW + M
2 Mbit/s	-	-116 dBW + M
2x2 Mbit/s	-	-113 dBW + M

NOTE 1: M = fade margin
NOTE 2: A minimum fade margin of 10dB will be allowed
NOTE 3: All measurements referenced to point C on the system block diagram in the UK Technical Regulation of clause 2.2.

The Radiocommunications Agency will in general examine applications for the use of radio links on the assumption that the median signal level of the receiver input is as outlined in Table 4.3 and a transmitter power shall be assigned accordingly. The levels in Table 4.3 are derived from a link budget as given in Annex A.

The maximum allowable availability values are as follows:

99.99%.......................... to be agreed with RA on a case-by-case basis.
99.9% .... for all other services.

NOTE: Throughout this specification, availability will be taken to mean propagation availability.

3.6.1 Fade margin

The total multi-path fade margin, M_2 depends on path length and terrain, service availability required and a geoclimatic factor. The method used by the RA to calculate multi-path fade is constantly reviewed. Current fade margin calculations (June 1999) are shown in Annex C.

3.7 Assignment of frequencies

The Radiocommunications Agency will, as far as possible, assign frequencies on the basis that the estimated levels of single-entry interferences are limited as described in clause 3.7.1, below.

3.7.1 W/U Ratios

The maximum co-channel and adjacent channel like-interference, at the receiver input, from a single unwanted source is shown in Tables 4.4 and 4.5. W/U ratios for single-entry interferers, relating to mixed capacity digital systems, are given by the matrices in Annex B, for frequency separations up to 3 XS.The above limits are made on the basis that the wanted signal is at the reference sensitivity receiver input level of Table 4.3

Cross-polar channels are assumed to be suppressed by the antennas alone with no further filter protection.

3.8 Multiple interferers

In Tables 4.4 and 4.5 as well as Annex B, the single-entry digital W/U ratios include allowances for multiple interferers. The allowances are 4dB for co-channel interferers and 6 dB for adjacent channel interferers independent of bit-rate.

The cumulative level of interference that is not to be exceeded in the wanted channel is -23 dB (for Class 2), and -30 dB (for Class 3) with respect to the reference sensitivity receiver input level of Table 4.3.

3.9 Interference limits

The interference limits of Tables 4.4 and 4.5 are derived as follows:

Interference limit = Reference sensitivity input level for the channel bandwidth and equipment class required (see Tables 4.2 and 4.3) - W/U

3.10 Adjacent channel limits

The adjacent channel limits given in Table 4.5 do not apply to links with correlated fading (such as links operating over the same hop).

Adjacent channel links operating over the same hop would generally be planned to equal free space (unfaded) levels.

NOTE: Planning requirements for partially correlated links are under study.

Table 4.4 : Single entry co channel interference limits.

Capacity	W/U (dB Class 2	Co-channel interference limit (dBW)	W/U (dB) Class 3	Co-channel interference limit (dBW)
9.6 kbit/s	27	-165	34	-165
64 kbit/s	27	-160	34	-165
192 kbit/s	27	-154	34	-161
704 kbit/s	-	-	34	-154
2 Mbit/s	-	-	34	-150
2x2 Mbit/s	-	-	34	-147

Table 4.5 : Single entry adjacent channel interference limits.

Capacity	W/U (dB) Class 2 and 3.	Adjacent channel interference limit (dBW) Class 2	Adjacent channel interference limit (dBW) Class 3
9.6 kbit/s	6	-144	-137
64 kbit/s	6	-139	-137
192 kbit/s	6	-133	-133
704 kbit/s	6	-	-126
2 Mbit/s	6	-	-122
2x2 Mbit/s	6	-	-119

4. Channel Plan

4.1 Derivation of radio frequency channels for the band 1350-1375 MHz paired with 1492-1517 MHz.

The channel arrangement is based on CEPT Recommendation T/R13-01. It is a symmetric 1MHz raster based on CCIR Recommendation 701 which offers the maximum amount of possible channels. Further channel plans for the transmission of lower bit rates are derived from the basic pattern by means of subdivision.

See Figure 4.1.

Let:

f_o be the centre frequency of **1433.5** MHz

f_n be the centre frequency of the radio-frequency channel in the lower half of the band

$f_{n'}$ be the centre frequency of the radio-frequency channel in the upper half of the band

TX/RX separation = **142** MHz

Separation band = **117** MHz

Individual channel frequencies are expressed by the following relationships with f_o and f_n in MHz:

a) For systems with a carrier spacing of 2 MHz:

lower half of the band: $f_n = f_o - 84 + 2n$

upper half of the band: $f_{n'} = f_o + 58 + 2n$ where n = 1,.....12

b) For systems with a carrier spacing of 1 MHz:

lower half of the band: $f_n = f_o - 83.5 + 1n$

upper half of the band: $f_{n'} = f_o + 58.5 + 1n$ where n = 1, ... 24

c) For systems with a carrier spacing of 500kHz:

lower half of the band: $f_n = f_o - 83.25 + 0.5n$

upper half of the band: $f_{n'} = f_o + 58.75 + 0.5n$ where n = 1, ... 48

d) For systems with a carrier spacing of 250kHz:

lower half of the band:	$f_n = f_o - 83.125 + 0.25n$	
upper half of the band:	$f_{n'} = f_o + 58.875 + 0.25n$	where n = 1, ... 96

e) For systems with a carrier spacing of 75kHz:

lower half of the band:	$f_n = f_o - 83.0375 + 0.075n$	
upper half of the band:	$f_{n'} = f_o + 58.9625 + 0.075n$	where n = 1, ... 320

f) For systems with a carrier spacing of 25kHz:

lower half of the band:	$f_n = f_o - 83.0125 + 0.025n$	
upper half of the band:	$f_{n'} = f_o + 58.9875 + 0.025n$	where n = 1, .. 960

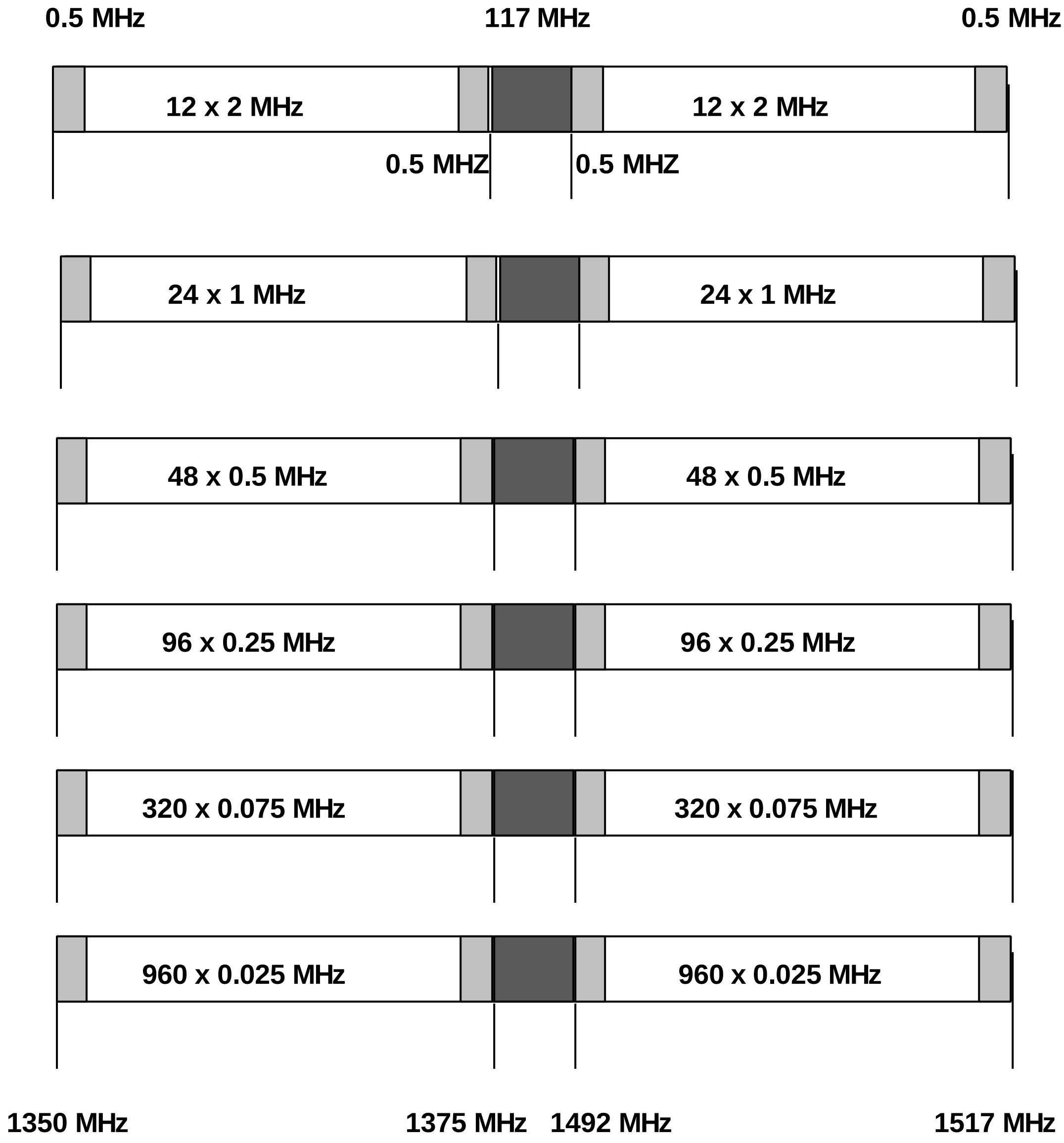

Figure 4.1 Channel Arrangement

Blank Page.

Annex A : Indicative receiver input levels and interference levels.

Receiver input levels and maximum permitted interference levels for digital systems operating in the frequency band 1350-1375 MHz paired with 1492-1517 MHz.

Table A.1 : Noise budget and interference calculations for Class 2 digital systems.

Channel Bandwidth:	25 kHz	75 kHz	250 kHz
Typical Bit Rate (Note 5)	9.6kbits Class2	64kbits Class 2	192kbits Class 2
Assumed modulation:	4PSK	4PSK	4PSK
Thermal Noise KT (dBW/Hz)	-204	-204	-204
RX Bandwidth B (dBHz)	43	48	54
Receiver Noise KTB (dBW)	-161	-156	-150
Noise Figure (dB)(Note 3)	4	4	4
S/N for BER=10^{-6} without coding gain (Note 4)	13.5	13.5	13.5
S/N for BER=10^{-6} with coding gain (Note 4)	-	-	-
Fixed System Losses (dB)(Note 2)	4.5	4.5	4.5
Interference Margin (dB)	1	1	1
Reference Sensitivity for BER 10^{-6} (dBW)(Note 3)	-138	-133	-127
Sensitivity for BER 10^{-3} (dBW)	-142	-137	-131
Median RX Input Level (dBW)(Note 1)	$-138+M_2$	$-133+M_2$	$-127+M_2$
Planned co-channel Interference limit (dBW)	-165	-160	-154

NOTE 1: M_2 is fade margin, dependent on path length, polarisation and availability required.(See 3.6.1).

NOTE 2: Includes Modulation/Demodulation losses, other implementation factors and branching network losses for single channel to points C, C'.(See system diagram in the UK Technical Regulation of clause 2.2.).

NOTE 3: Referred to point C of the system block diagram in the UK Technical Regulation of clause 2.2.

NOTE 4: Reference ITU-R Recommendation F1101. All S/N values refer to average carrier power.

NOTE 5: Equipment employing 4 level modulation schemes (e.g. 4-PSK) as a minimum is **Class 2** equipment.

Table A.2 : Indicative noise budget and interference calculations for Class 3 digital systems.

Channel Bandwidth:	25 kHz	25 kHz	75kHz	500 kHz	1 MHz	2MHz
Typical Bit Rate (Note 5)	9.6kbits Class 3	64kbits Class 3	192kbits Class 3	704kbits Class 3	2Mbits Class 3	2x2Mbits Class 3
Assumed modulation:	16 Level	16 Level	16 Level	16 Level	16 Level	16 Level
Thermal Noise KT (dBW/Hz)	-204	-204	-204	-204	-204	-204
RX Bandwidth B (dBHz)	43	43	47	55	58	61.5
Receiver Noise KTB (dBW)	-161	-161	-157	-149	-146	-143
Noise Figure (dB)(Note 3)	4	4	4	4	4	4
S/N for BER=10^{-6} without coding gain (Note 4)	20.5	20.5	20.5	20.5	20.5	20.5
S/N for BER=10^{-6} with coding gain (Note 4)	-	-	-	-	17.6	17.6
Fixed System Losses (dB)(Note 2)	4.5	4.5	4.5	4.5	4.5	4.5
Interference Margin (dB)	1	1	1	1	1	1
Reference Sensitivity for BER 10^{-6} (dBW)(Note 3)	-131	-131	-127	-120	-116	-113
Sensitivity for BER 10^{-3} (dBW)	-135	-135	-131	-124	-120	-117
Median RX Input Level (dBW)(Note 1)	$-131+M_2$	$-131+M_2$	$-127+M_2$	$-120+M_2$	$-116+M_2$	$-113 + M_2$
Planned co-channel Interference limit (dBW)	-165	-165	-161	-154	-150	-147

NOTE 1: M_2 is fade margin, dependent on path length, polarisation and availability required.(See 3.6.1).

NOTE 2: Includes Modulation/Demodulation losses, other implementation factors and branching network losses for single channel to points C, C'.(See system diagram in the UK Technical Regulation of clause 2.2.).

NOTE 3: Referred to point C of the system block diagram in the UK Technical Regulation of clause 2.2.

NOTE 4: Reference ITU-R Recommendation F1101. All S/N values refer to average carrier power.

NOTE 5: Equipment employing 16 level modulation schemes (eg 16-QAM) as a minimum is **Class 3** equipment.

Annex B: Wanted to unwanted levels.

These tables are for wanted to unwanted levels against normalised frequency for the 1400 MHz band.

Table B1 Wanted 25 kHz Class 2

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	**<0.5**	**^{3} 0.5**	**^{3} 1.0**	**^{3} 1.5**	**^{3} 2.0**	**^{3} 2.5**	**^{3} 3.0**
25/9.6 & 64	25	27	27	24	6	-9	-19	-29	-40
75/64 & 192	50	22	22	19	1	-14	-24	-34	-40
250/192	137.5	17	17	14	-4	-19	-29	-39	-40
500/704	262.5	14	14	11	-7	-22	-32	-40	-40
1000/2000	512.5	11	11	8	-10	-25	-35	-40	-40
2000/2x2000	1012.5	8	8	5	-13	-28	-38	-40	-40

Table B2 Wanted 75 kHz Class 2

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	**<0.5**	**^{3} 0.5**	**^{3} 1.0**	**^{3} 1.5**	**^{3} 2.0**	**^{3} 2.5**	**^{3} 3.0**
25/9.6 & 64	50	27	27	24	6	-9	-19	-29	-40
75/64 & 192	75	27	27	24	6	-9	-19	-29	-40
250/192	162.5	22	22	19	1	-14	-24	-34	-40
500/704	287.5	19	19	16	-4	-17	-27	-37	-40
1000/2000	537.5	16	16	13	-7	-20	-30	-40	-40
2000/2x2000	1037.5	13	13	10	-10	-23	-33	-40	-40

Table B3 Wanted 250kHz Class 2

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	**<0.5**	**^{3} 0.5**	**^{3} 1.0**	**^{3} 1.5**	**^{3} 2.0**	**^{3} 2.5**	**^{3} 3.0**
25/9.6 & 64	137.5	27	27	24	6	-9	-19	-29	-40
75/64 & 192	162.5	27	27	24	6	-9	-19	-29	-40
250/192	250	27	27	24	6	-9	-19	-29	-40
500/704	375	24	24	21	3	-12	-22	-32	-40
1000/2000	625	21	21	21	0	-15	-25	-35	-40
2000/2x2000	1125	18	18	18	-3	-18	-28	-38	-40

Table B4 Wanted 25 kHz Class 3

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	**<0.5**	**^{3} 0.5**	**^{3} 1.0**	**^{3} 1.5**	**^{3} 2.0**	**^{3} 2.5**	**^{3} 3.0**
25/9.6 & 64	25	34	34	31	6	-9	-19	-29	-40
75/64 & 192	50	29	29	26	1	-14	-24	-34	-40
250/192	137.5	24	24	21	-4	-19	-29	-39	-40
500/704	262.5	21	21	18	-7	-22	-32	-40	-40
1000/2000	512.5	18	18	15	-10	-25	-35	-40	-40
2000/2x2000	1012.5	15	15	12	-13	-28	-38	-40	-40

Table B5 Wanted 75 kHz Class 3

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	³ 0.5	³ 1.0	³ 1.5	³ 2.0	³ 2.5	³ 3.0
25/9.6 & 64	50	34	34	31	6	-9	-19	-29	-40
75/64 & 192	75	34	34	31	6	-9	-19	-29	-40
250/192	162.5	29	29	26	1	-14	-24	-34	-40
500/704	287.5	26	26	23	-2	-17	-27	-37	-40
1000/2000	537.5	23	23	20	-5	-20	-30	-40	-40
2000/2x2000	1037.5	20	20	17	-8	-23	-33	-40	-40

Table B6 Wanted 500kHz Class 3

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	³ 0.5	³ 1.0	³ 1.5	³ 2.0	³ 2.5	³ 3.0
25/9.6 & 64	262.5	34	34	31	6	-9	-19	-29	-40
75/64 & 192	287.5	34	34	31	6	-9	-19	-29	-40
250/192	375	34	34	31	6	-9	-19	-29	-40
500/704	500	34	34	31	6	-9	-19	-29	-40
1000/2000	750	31	31	28	3	-12	-22	-32	-40
2000/2x2000	1250	28	28	25	0	-15	-25	-35	-40

Table B7 Wanted 1 MHz Class 3

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	³ 0.5	³ 1.0	³ 1.5	³ 2.0	³ 2.5	³ 3.0
25/9.6 & 64	512.5	34	34	31	6	-9	-19	-29	-40
75/64 & 192	537.5	34	34	31	6	-9	-19	-29	-40
250/192	625	34	34	31	6	-9	-19	-29	-40
500/704	750	34	34	31	6	-9	-19	-29	-40
1000/2000	1000	34	34	31	6	-9	-19	-29	-40
2000/2x2000	1500	31	31	28	3	-12	-22	-32	-40

Table B8 Wanted 2 MHz Class 3

Unwanted (kHz/kbit/s)	XS kHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	³ 0.5	³ 1.0	³ 1.5	³ 2.0	³ 2.5	³ 3.0
25/9.6 & 64	512.5	34	34	31	6	-9	-19	-29	-40
75/64 & 192	537.5	34	34	31	6	-9	-19	-29	-40
250/192	625	34	34	31	6	-9	-19	-29	-40
500/704	750	34	34	31	6	-9	-19	-29	-40
1000/2000	1000	34	34	31	6	-9	-19	-29	-40
2000/2x2000	2000	34	34	31	6	-9	-19	-29	-40

Annex C: Detail on Fade Margin calculation.

Explanation of the Calculation of Clear Air and Rain Fading in MWM software as used in FiLSM

1 Introduction

This Annex describes the methods used to calculate the fading due to multipath on fixed terrestrial links. The methods described are used in the MWM version 3.07 software used in FilSim. The method for multipath fading is **not** that used in Rec 530-7 but based on a simplification in ITU-R document 3M/TEMP/28-E. It is also **not** the same as the latest method which has been approved by the ITU-R SG3 for release as Rec 530-8 (ie. version 8).

2 The MULTIPATH FADE method Described

The aim is to determine the percentage time (p_w) in the average year worst month that fades equal to or greater than a given depth in dB (A) will occur. (This fading is sometimes known as mode 1 fading.)

2.1 Fades greater = 25 dB

If the fade depth is greater than or equal to 25 dB then the percentage time (pw) for the fade (A) is calculated in the following steps:

Step 1

Calculate the antenna height factor, C_0 :

C_0 = 1.7 for antennas 0 to 400 m above sea level

C_0 = 4.2 for antennas 400 to 700 m above sea level -------------------------------------(1)

C_0 = 8 for antennas above 700 m above sea level

(the above considers the lower of the two link antennas)

Step 2

Calculate the latitude factor C_{Lat} :

C_{Lat} = 0 for latitudes = 53 deg North or South

C_{Lat} = -53 + latitude for latitudes > 53 deg N or S and < 60 deg N or S -------------(2)

C_{Lat} = 7.0 for latitudes = 60 deg N or S

Step 3

Calculate the longitude factor C_{Lon} :

C_{Lon} = 3 for Europe (value taken in MWM software)

C_{Lon} = -3 for North / South America ---(3)

C_{Lon} = 0 for all other longitudes

Step 4

Calculate the path inclination or slope S_p :

$|S_p| = |hr – he|/d$ ---(4)

Where:

hr and he are the antenna heights in metres above sea level
d is the path length in km

Step 5

Calculate the geoclimatic factor K :

Obtain the fraction of the link path over sea and coastal zones from the path terrain profile. If the path passes no sea or coastal areas then it is defined as inland. Otherwise it is defined as a coastal link.

For inland links:

$K_i = 5.0 * 10^{-7} * 10^{-0.1(C0 - Clat - Clon)}\ ?_L^{1.5}$ ---(5)

Where:

$?_L$ is the % of time the refractivity of the gradient in the lowest 100 m of atmosphere is more negative than –100 N units / km in the estimated worst month.

For coastal links:

$K_c = 10^{(1 - rc)logKi + rc * logKcl}$ --(6)

Where:

r_c = the fraction of the path over sea or coast

$K_{cl} = 2.3 * 10^{-4} * 10^{-0.1*Co - 0.011|?|}$ --(7)

Where:

? is the path latitude in degrees

Then the percentage worst month time pw is:

$p_w = K*d^{3.6}*f^{0.89}*(1+|\ ,_p\ |)^{-1.4}*10^{-A/10}$

Where:

K is the geoclimatic factor; using K_i or K_c as above depending on the type of path

d is the path distance in km

f is the frequency in GHz

S_p is the path slope in milliradians

A is the fade in dB

2.2 Multipath fades less than 25 dB

Else if the fade (A) is less than 25 dB then do the following:

Step 1

Calculate the percentage time (p_t) that a fade exceeding 25 dB will occur using the equation:

$p_t = K*d^{3.6}*f^{0.89}*(1+|Sp|)^{-1.4}*10^{-A/10}$ --(8)

(Note that this is equation 19 in Rec. 530-7 .)

Where:

A = 25

d is the path distance in km

f is the frequency in GHz

Sp = path inclination in millirads,

K = geoclimatic factor. (Calculated as in section 2.1

Step 2

Calculate q'_a from:

$q'_a = -(4/5) * \log[-\ln((100-p_t)/100)]$ --(9)

Where:

p_t is the value calculated in step 1

Step 3

Calculate q_t from:

$q_t = 2.5 * (q'_a – 2.15)$ ---(10)

Step 4

Calculate q_a from:

$q_a = 2 + [1 + 0.3 * 10^{-A/20}] [10^{-0.016*A}] [q_t + 4.3 *(10^{-A/20} + A/800)]$ ---------------------(11)

Where:

A is the wanted fade in dB.

Step 5

Calculate p_w from:

$p_w = 100 * [1 – \exp(-10^{-qa*A/20})]$ ---(12)

Where:

A is the wanted fade in dB.

Blank Page.

Version	Date	Comments
349R 0001 00	25th May 1999	Sections on Link Length Policy and Fade Margins redrafted.
349P 0001 00	28th July 1999	Document approved by RSWG.