OfW 31
Fixed Point-to-Point Radio Services with Analogue Modulation Operating in the Frequency Ranges 31.0 to 31.3 GHz paired with 31.5 to 31.8 GHz

Published: September 2004

Version: 1.1

Foreword

The Wireless Telegraphy Acts, 1949 and 1998 request that only radio apparatus that the Office of Communications (Ofcom) has authorised a licence for can be installed and used in the United Kingdom. This is under the condition that the radio equipment meets certain minimum standards set in the Interface Requirement 2000 (IR 2000).

This document details the technical frequency assignment criteria and principles that Ofcom will employ in the selected frequencies for use by compliant fixed terrestrial (point-to-point) digital radio equipment operating in the specified band or frequency range. It is further used for the basis of assessing both 1) new link applications and 2) treating technical reconfiguration of links on application form OfW 85 for fixed terrestrial (point-to-point) links.

These assignment criteria are subject to updating and amendment.

Operators and manufacturers can obtain the latest copy of this document from the Ofcom website. If you do not have access to the internet, you can request a printed copy to be posted to you from the Ofcom Contact Centre by telephoning 0845 456 3000.

Please see below for full contact details:

Ofcom website: www.ofcom.org.uk

Ofcom Contact Centre

Riverside House
2a Southwark Bridge Road
London SE1 9HA

Tel: 0845 456 3000
Fax: 0845 456 3333

Email: contact@ofcom.org.uk

Contents

Section		Page
1	General	3
1.1	Introduction	3
1.2	Licensee's responsibility	3
1.3	Minimum path length policy	3
2	Transmitting and Receiving Installations	4
2.1	General	4
2.2	Antenna directivity	4
2.3	Antenna polarisation	4
2.4	Equivalent isotropically radiated power (EIRP)	4
3	Principles of Assignment and EIRP Derivation	4
3.1	Normal assignment	4
3.1.1	Normal assignment flow diagram	4
3.2	Multi-section links and repeater stations	5
3.2.1	Multi-section links	5
3.2.2	Passive Repeaters	5
3.3	Go - return separation	5
3.4	Parallel links operating over the same path	5
3.5	Antenna discrimination	6
3.6	Path clearance	6
3.6.1	Obstructed paths	6
3.7	Path loss	7
3.7.1	Median path loss	7
3.7.2	Gaseous absorption	7
3.8	Availability	7
3.9	Receiver signal levels	7
3.10	Fade margin	8
3.10.1	Overall fade margin	8
3.10.2	Clear-air fade margin	8
3.10.3	Combined rain/sleet fade margin	8
3.10.4	Equivalent isotropically radiated power calculation	9
4	Interference Assessment	9
4.1	General	9
4.2	Interference limits	10
4.3	Co- and adjacent channel limits	10
4.4	Multiple interferers	10
5	Radio Frequency Channel Plan for the Band 31.0 to 31.3 GHz paired with 31.5 to 31.8 GHz	11
Annex A	Wanted to Unwanted Levels	12
Annex B	Normal Assignment Process Flow Diagram	13
Annex C	High-Level Flow Diagram for Recommendation ITU-R P.452	14
Annex D	Assigning Passive Repeater Stations	15
Annex E	UK Rain Rates in MM/HR for 99.99% Availability by National Grid Square	16
	Document History	17

Section 1

General

1.1 Introduction

This document outlines the technical frequency assignment criteria and principles that Ofcom will employ when selecting frequencies for fixed terrestrial (point-to-point) security video analogue radio services operating in the frequency bands 31.0 to 31.3 GHz paired with 31.5 to 31.8 GHz.

The 31.0 to 31.8 GHz band is based on a UK national channel plan with 38 x 28 MHz interleaved simplex channels (i.e. it does not use ECC Recommendation (02)02, which refers only to the frequency band 31.0 to 31.3 GHz). Please refer to section 5 for the applied channel plan.

This document takes into account the equipment standard EN 300 632.

1.2 Licensee's responsibility

The establishment, use or installation of transmitting or receiving apparatus is subject to the issue of a licence by Ofcom. The licensee must ensure that equipment conforms with and is kept to the standards referenced in UK IR 2000.

1.3 Minimum path length policy

For the 31 GHz frequency band there is no minimum path length.

Section 2

Transmitting and Receiving Installations

2.1 General

The transmitting and receiving installations will conform to Sections 2.2 and 2.3 below. They will be implemented in accordance with good engineering practice.

2.2 Antenna directivity

The antenna installation will be at the licensed premises.

The antenna pattern will be within the Class 2, or better, co-polar and cross-polar Radiation Pattern Envelope or RPE (given in ETSI standard EN 302 217 and EN 301 215).

The zero degree datum will be the boresight path between the two stations.

2.3 Antenna polarisation

The emissions' polarisation plane will be specified by Ofcom for each radio link.

It will normally be vertical or horizontal linear polarisation.

The antenna alignment surface will be as precise as possible to the true vertical or true horizontal.

The misalignment will be limited to 3°.

2.4 Equivalent isotropically radiated power (EIRP)

The licence will state the assigned value of EIRP.

Ideally, this must not be exceeded. However, in practice, a tolerance of ±3 dB will be allowed.

The maximum EIRP normally assigned will be +30 dBW.

Section 3

Principles of Assignment and EIRP Derivation

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 frequency groups

- one from each of the high frequency groups

3.1.1 Normal assignment flow diagram

Please see Annex B.

3.2 Multi-section links and repeater stations

3.2.1 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 each station transmits only in one half (either the lower or upper half) of the band.

3.2.2 Passive repeaters

Passive repeater operation using either back-to-back antennas or planar reflectors will be allowed only under certain specific conditions. Use of these systems will be judged on a case-by-case basis. Passive repeaters are expected to be used only for availabilities of 99.99% or less in situations where:

a) the site for the repeater station is remote and power provision is extremely difficult;

b) there is a clear spectrum saving by the use of one repeater station to overcome the obstructed path rather than going around the obstruction with two or more conventional links;

c) use of the higher power needed for this operation does not unnecessarily sterilise the surrounding area and block further normal assignments; and

d) higher-performance antennas (if available) are be used at the end stations along with as large as reasonably possible repeater station antennas to maximise the repeater gain.

Detail of the assignment process modifications to deal with passive repeater operation is given in Annex D.

3.3 Go - return separation

In order to preserve spectrum, there is no specific HI/LO frequency pairing arrangement in the 31 GHz band in the UK; therefore there is no GO – RETURN separation requirement. The national channel plan does, however, have both a high and a low sub-band. These are both occupied by 38 simplex channels (i.e. each sub-band has 10 x 28 MHz vertically polarised channels, which are interleaved with 9 x 28 MHz horizontally polarised channels; see Section 5 for a graphical representation).

This simplex arrangement has been agreed so that there is the option to control remote equipment using one common frequency. (For example, ten cameras in a single system will use a total of 11 simplex frequencies rather than ten pairs of frequencies, as would be utilised with mandatory HI/LO pairing.)

3.4 Parallel links operating over the same path

The interference potential between parallel links operating over the same path is assessed with the assumption that the wanted and interfering signals suffer correlated fading. Therefore, protection from interference is derived from frequency separation and cross-polar discrimination (if any).

To be classed as operating over the same path, the stations (located at a site at the end of each link) must be within 10 m of each other in the horizontal plane and within 2 m in the vertical plane.

Table 1 lists the minimum frequency separations for like systems operating under these conditions.

Modulation	Minimum separation between carriers on a parallel route operating over the same path (MHz)	
	Co-polar (MHz)	Cross-polar (MHz)
Analogue	28	14

Table 1: Frequency separations

The assignment software identifies available channels that meet the minimum frequency separation criteria, in accordance with the channel plan defined in Section 5.

3.5 Antenna discrimination

Antenna discrimination will be taken into account when assigning frequencies for links in the same geographical area. Available data derived from a manufacturer's guaranteed RPE will be used. Otherwise, the appropriate RPE specified in ETSI standard EN 302 217 or EN 301 215 will be presumed.

3.6 Path clearance

For values of the ratio K > 0.7:

It will be presumed that each hop has a clearance from obstructions of minimum 0.577F between the transmitting and receiving antennas at the two stations.

F: First Fresnel Zone Clearance

K: Ratio of effective earth radius to real earth radius

3.6.1 Obstructed paths

Obstructed paths will be allowed an EIRP increased up to a maximum of 6 dB above the normal assignment level if:

1. The need is clearly justified
2. The maximum limit of +30 dBW is not exceeded. (If above these levels, operators will be expected to accept the possibility of lower link availability.)

The following conditions will apply:

a) the higher power needed for this operation will only sterilise the surrounding area and block further normal assignments if absolutely necessary;

b) the increase in EIRP will be allowed only if the obstruction cannot be overcome by increasing the antenna height;

c) higher-performance antennas (if available) should be used to minimise the sterilisation of surrounding areas, considering the higher-than-normal EIRP associated with this type of operation; and

d) the increased EIRP will only be allowed on link availabilities $\geq$ 99.9% and $\leq$ 99.99%.

Detail of the assignment process modifications to deal with operation over an obstructed path is given in Annex C.

3.7 Path loss

3.7.1 Median path loss

The median path loss between two stations is equal to the free-space-path-loss (FSPL) plus the atmospheric gaseous absorption (see section 3.7.2).

FSPL = 92.45 + 20log(d) + 20log(f)

Median path loss (dB) = FSPL + gaseous absorption

where: d = distance between the stations in km; and
f = frequency of operation in GHz.

3.7.2 Gaseous absorption

In addition to the basic FSPL, the link budget shall include contributions from gaseous absorption. Gaseous absorption is calculated for both go and return carrier frequencies based on oxygen and water vapour data obtained from ITU-R Recommendation P.676-2.

3.8 Availability

Availabilities greater than 99.99% are to be agreed with Ofcom on a case-by-case basis.

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

3.9 Receiver signal levels

The receive signal level (RSL) values for this frequency band is shown in Table 2.

System	Receiver median signal level (RSL + fade margin)
Analogue	-101 dBW + M
NOTE 1: M = Fade Margin. See Section 3.10.	
NOTE 2: A minimum fade margin of 10 dB will be allocated.	
NOTE 3: In the case of protected equipment an extra allowance, agreed on a case-by-case-basis with Ofcom, may be allowed for receiver signal level.	
NOTE 4: The level is referenced to point C on the system block diagram in EN 302 217.	
NOTE 5: RSL = Receiver sensitivity level	

Table 2: Receiver median signal levels

Generally, Ofcom will examine applications for the use of radio links on the assumption that the median signal level of the receiver input is as detailed in Table 2. A transmitter power shall be assigned accordingly.

3.10 Fade margin

3.10.1 Overall fade margin

Fade margins are calculated for clear-air, hydrometeor (rain) and sleet fading.

Clear-air and rain fades are calculated according to Recommendation ITU-R P.530-9.

Note:

The Recommendation refers to clear-air fading as due to "multipath and related factors" (i.e. the more general term "clear-air" is used here).

An extension of the rain attenuation method in Recommendation ITU-R P.530-9 §2.4 is used to include the effects of sleet.

Calculation of the overall fade margin is by allocating the overall permissible unavailability between clear-air and combined rain/sleet fading.

The assignment software utilises the equations for clear-air and combined rain/sleet fading to iterate for the value of fade.

The fade value is the sum of the individual (clear-air and combined rain/sleet) unavailabilities which equals the required overall unavailability.

It is assumed that the fade mechanisms are unlikely to occur simultaneously.

- For cases where the ratio of outage times for clear-air and combined rain/sleet either >40 or 1/40, only the dominant method is calculated.
- Links with a calculated fade of <10 dB will be allocated a fade margin of 10 dB.

3.10.2 Clear-air fade margin

The fade margin required for clear-air effects depends on:

- frequency
- path length
- radio-climatic factors
- service availability required

The fade exceeded for a given percentage of an annual year is calculated according to Recommendation ITU-R P.530-9 §2.3 using the planning method (equations 5 and 8).

Values of dN1 are obtained from the ITU-R global database associated with Recommendation ITU-R P.453-8.

3.10.3 Rain fade margin

The rain fade margin for a given availability depends on the path length, frequency, polarisation and geographic location. UK rain rates exceeded for 0.01% of an average year are shown in Annex E at the centre of each 100 km grid square.

The rain fade is derived using the higher of the rain rates exceeded for 0.01% of the time at the two terminals of each link, $R_{0.01}$ mm/hr.

The specific attenuation, γ_R, for the rain intensity $R_{0.01}$ is calculated for the required frequency and polarisation using ITU-R Recommendation P.838-1.Values of the regression coefficients k and α are given in Table 3 below for both horizontal (H) and

vertical (V) polarisations. These have been derived using ITU-R Recommendation P.838-1, for the highest frequency in the band:

Frequency	k_H	k_V	α_H	α_V
31.4 GHz	0.187	0.167	1.021	1.0

Table 3: Regression coefficients

The path reduction term and attenuation are determined using ITU-R Recommendation P.530.

3.10.4 Equivalent isotropically radiated power calculation

The licence schedule will detail the assigned EIRP for each transmitting station. This is based on the following calculation:

> EIRP = Rx median signal level + Rx station feeder losses - Rx antenna gain + Median Path loss

The Rx (Receiver) median signal level is as defined in Table 2. The maximum co-polar gain figure for the receiving antenna is used.

Section 4

Interference Assessment

4.1 General

The link to be assigned is co-ordinated with all other links in the same frequency band. This band is within a co-ordination zone radius of 200 km around each site. The size of the co-ordination zone may be reviewed from time to time as operational experience is gathered. Interference to and from the proposed link is assessed, taking into account the path profile between the two stations. Use is made of antenna radiation patterns to obtain the gain of antennas in the direction of unwanted signals.

The two conditions considered in the evaluation of interference from each single-entry interference source are:

a) the minimum median unwanted signal must equal the wanted to unwanted (W/U) ratio below the faded wanted signal; and

b) the minimum enhanced unwanted signal must equal the W/U ratio below the median wanted signal.

If either of the above two conditions are not met, and an alternative frequency cannot be ascertained, the link will not be assigned.

The procedures followed are in line with ITU-R Recommendation P.452-11 and are outlined in the flow diagram shown in Annex C.

4.2 Interference limits

The interference limit is derived as follows:

Interference limit = Receiver Sensitivity Level (RSL) for the required input level - W/U ratio

4.3 Co- and adjacent channel limits

The maximum co-channel and adjacent channel interference limits, at the receiver input, from a single unwanted source are shown in Table 4 and Table 5. W/U ratios for single-entry interferers relating to mixed capacity digital systems are shown in the matrices in Annex B.

The adjacent channel interference limits given in Table 5 do not apply to links operating on a parallel path over the same hop. Under these circumstances, fading is assumed correlated with interference protection offered by frequency discrimination (and possibly cross-polar antenna discrimination, if applicable). See Section 3.4.

System	W/U ratio (dB)	Interference limit (dBW)
Analogue	30	-131

Table 4: Single-entry co-channel interference limits

System	W/U ratio (dB)	Interference limit (dBW)
Analogue	3	-99

Table 5: Single-entry adjacent channel interference limits

4.4 Multiple interferers

In Table 4 and Table 5 as well as Annex A, the single-entry digital W/U ratios include allowances for multiple interferers. The allowances are 4 dB for co-channel interferers and 6 dB for adjacent channel interferers.

Section 5

National Radio Frequency Channel Plan for the ranges 31.0 to 31.3 GHz paired with 31.5 to 31.8 GHz

In the UK, the 31.0 to 31.8 GHz band is subject to a national channel plan with a 28 MHz raster. Although there are two sub-bands, the adoption of high and low channel pairing (e.g. Ch1 with Ch1') is not compulsory. (Please see section 3.3.)

The channel arrangements are as shown below:

Let: f_o be the reference frequency of 31.402 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.

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

a) For vertically polarised systems with a carrier spacing of 28 MHz:

lower half of the band: $f_n = (f_o - 406 + 28n)$ MHz

upper half of the band: $f_{n'} = (f_o + 94.5 + 28n)$ MHz where n = 1,2,3,... 10

c) For horizontally polarised systems with a carrier spacing of 28 MHz:

lower half of the band: $f_n = (f_o - 392 + 28n)$ MHz

upper half of the band: $f_{n'} = (f_o + 108.5 + 28n)$ MHz where n = 1,2,3,... 9

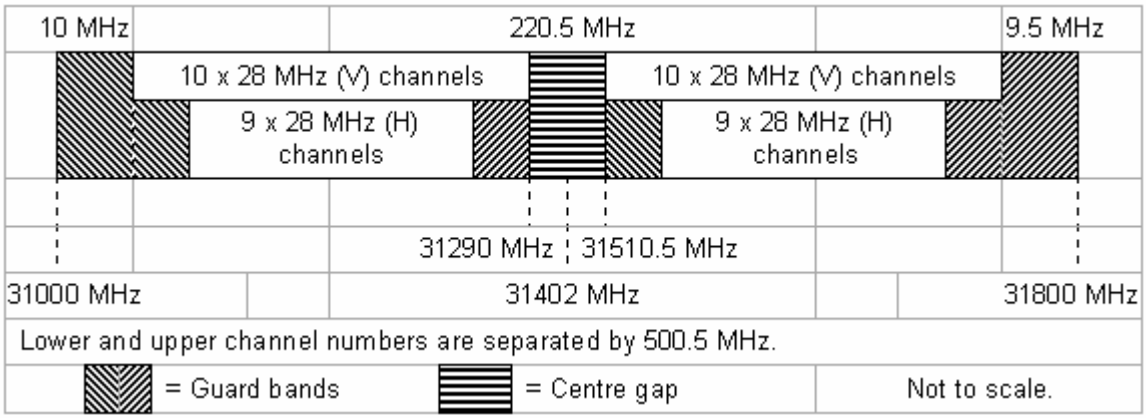


Figure 1: National channel plan arrangement for the 31.0 to 31.8 GHz frequency band

Annex A: Wanted to Unwanted Levels

Table A1 gives the W/U ratios, in dB, for all licensable channel bandwidths up to three times the mean value of the sum of the wanted and unwanted channel spacing (3 XS).

The figures in the Annex A tables have been derived on the following basis:

Co-channel and adjacent channel W/U ratios for like-with-like systems have been linked to Table 4 and Table 5 and therefore to the appropriate equipment standard. W/U ratios for all other combinations have been derived using the ETSI TR 101 854 methodology for calculating Net Filter Discrimination.

The values shown in the step 0 column are associated with interference where the interfering signal carrier is at zero offset from the wanted carrier.

Step 1 is an offset between wanted and unwanted signals equal to 1 x the bandwidth of like-to-like systems or 1 x the narrower bandwidth of like-to-unlike systems.

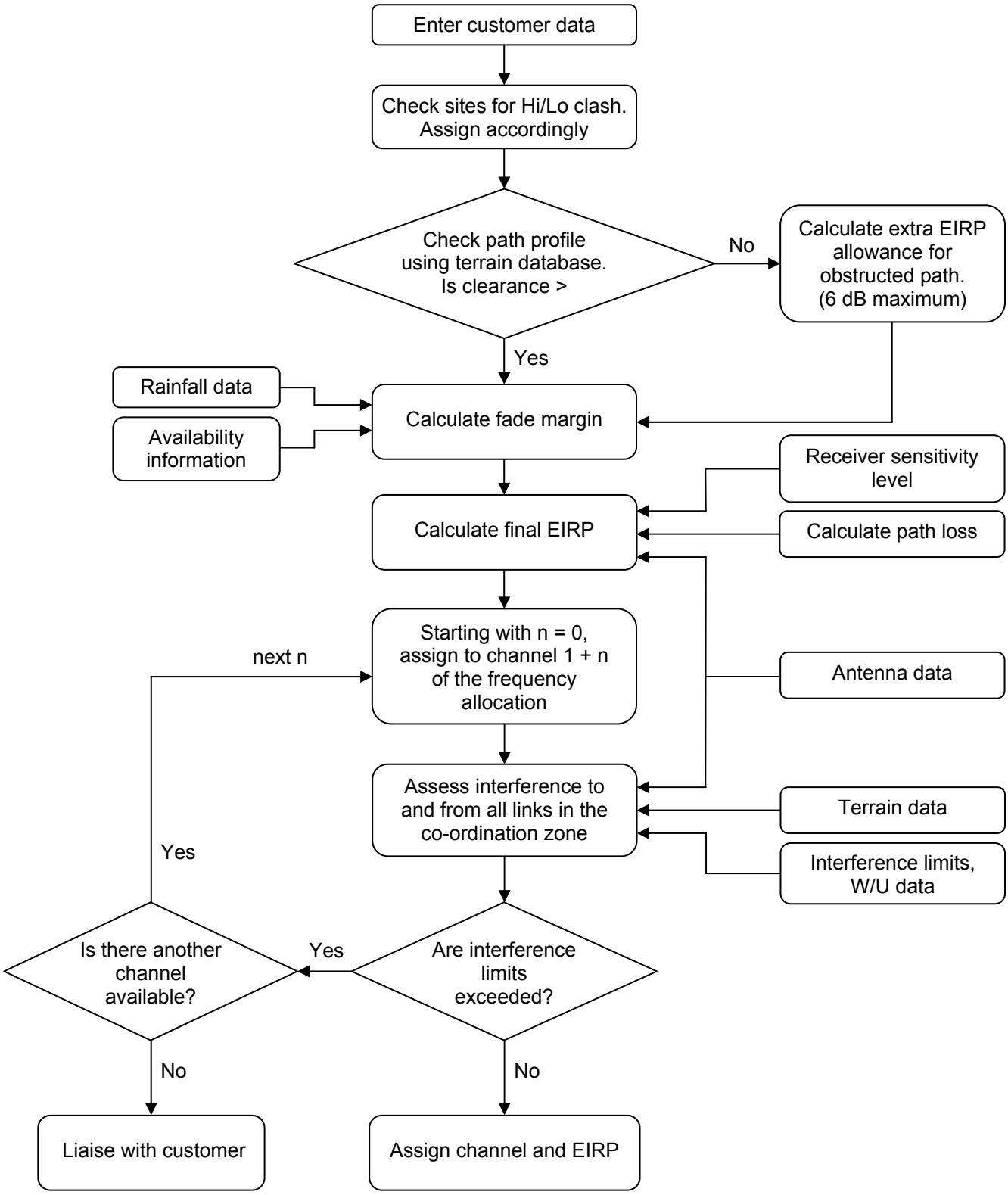
When the wanted and unwanted channels of digital systems are not equal, Step 1 in the W/U tables is equal to ½ the narrowest bandwidth. Thereafter the step sizes are equivalent to the narrowest bandwidth. When the unwanted channels are the same size, all step sizes are equal to the channel width of these systems. Shaded steps indicate W/U ratio of -40 dB.

Table A1: Wanted system – analogue in 28 MHz

Unwanted System	Wanted/Unwanted Ratio (dB) versus Step Number (See page 13) All W/U ratios in the shaded areas are equal to -40 dB															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Co-polar[1]	38	3	-24	-40												
Cross-polar	-	32	-22	-27	-40											

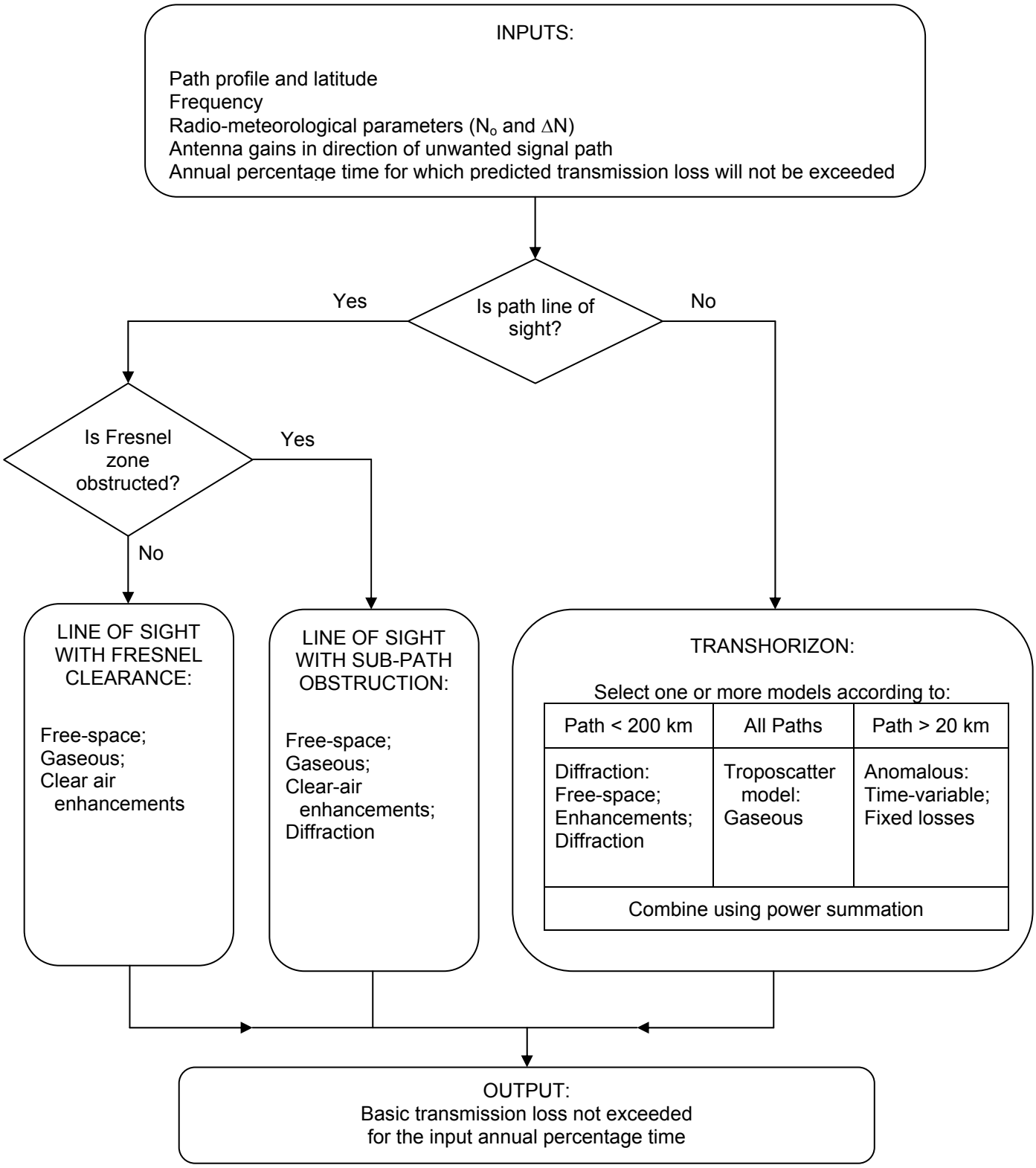
[1] The nine horizontally polarised 28 MHz channels are offset from the vertically polarised channels by 14 MHz (high).

Annex B: Normal Assignment Process Flow Diagram



Annex C: High-Level Flow Diagram for Recommendation ITU-R P.452

Note: the following diagram is based on P.452-11 (1995 P Series Fascicle), but there are no differences between recent versions in the high-level structure of the method.



Annex D: Assigning Passive Repeater Stations

Consider a link from A to D comprising two hops A to B and C to D where B and C are a co-located passive repeater station.

Back to back antenna type

It is necessary to calculate the EIRP from the central repeater station and determine the required signal level to the repeater station. This involves both standard and non standard assignments in the following manner:

1) enter the data for all sites and make the feeder loss at both B and C equal to the loss between the two antennas;

2) perform a standard assignment for the link A to B. From the EIRP and antenna gain at B calculate the required receive level at C. Ignore the direction A to B;

3) carry out a non-standard assignment from C to D using the calculated receive level from step 2) at station C;

4) from the EIRP and antenna gain at C calculate the required receive level at B;

5) repeat the assignment from A to B using the receive level calculated in step 4) at station B.

Step 3) provides the final EIRP at station D and step 5) provides the final EIRP at station A.

It may be useful in some frequency bands to change polarisation at the repeater station.

Planar Reflector

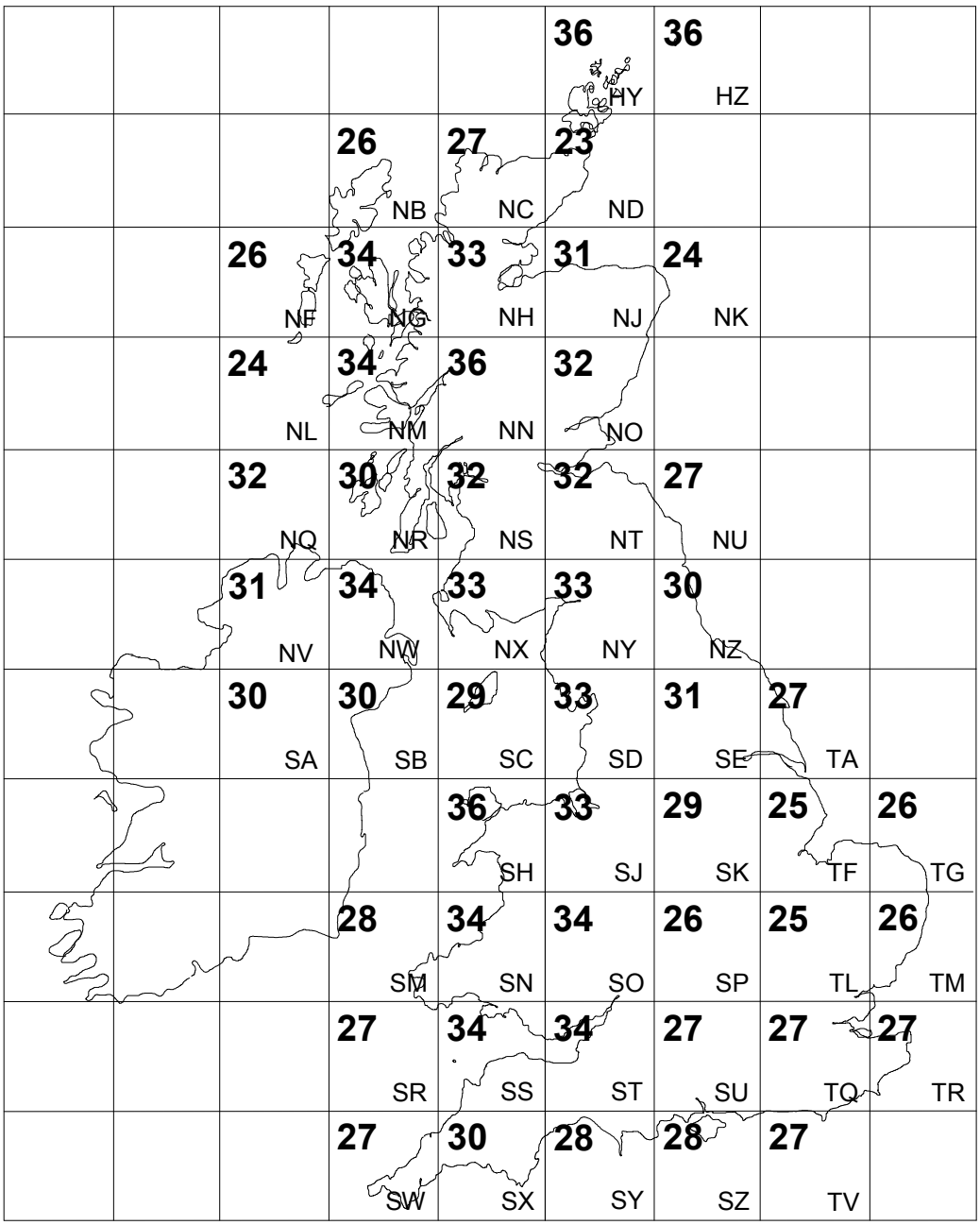
The procedure for these types of passive repeater is the same as steps 2) to 5) above except that B is the same point as C and the gain of the reflector needs to be calculated from the following expression:

$$Grep = 20 \cdot \log\left(139.5 \cdot f^2 \cdot a \cdot \cos\left(\frac{angle}{2}\right)\right)$$

Where: f = frequency in GHz;
a = area of the reflector; and
$angle$ = the angle at the reflection point in degrees.

The antenna gain for point B should be half the value $Grep$, for each hop A to B(C) and C(B) to D. Interference at the reflector needs to be considered only if it arrives from the same direction as the wanted signal.

Annex E: UK Rain Rates in mm/hr for 99.99% Availability by National Grid Square



Additionally:

Channel Islands: 28 mm/hr. Derived from ITU rain zone data.

Shetland Islands: 30 mm/hr. Derived from ITU rain zone data.

Document History

Version	Published Date	Comments