
Radiocommunications Assignment and Licensing Instruction

MICROWAVE FIXED SERVICES
FREQUENCY COORDINATION

AUSTRALIAN COMMUNICATIONS AND MEDIA AUTHORITY
SPECTRUM PLANNING & ENGINEERING BRANCH,
SPECTRUM ENGINEERING SECTION
CANBERRA
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RADIOCOMMUNICATIONS ASSIGNMENT AND LICENSING INSTRUCTIONS

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Suggestions for improvements to Radiocommunications Assignment and Licensing Instructions may be addressed to the Manager, Spectrum Engineering, Spectrum Planning Branch, Australian Communications and Media Authority, P.O. Box 78, BELCONNEN ACT 2616.

Amendment Authorisation

The following amendments to RALI FX3 are authorised:

Date of Effect	Page Date*	Description of Amendment
20 June 2023	June 2023	<p>Main Body: New footnote added to 3.3.3 Site Sense, excluding compatibility requirements in the 3.8 GHz band if co-sited parties can reach an agreement. Deleted clause 3.4.2 (Obsolete, 3.4 GHz PTP channel arrangements have not been available since 2000). Preamble: Updated 3.4 GHz spectrum licence band frequencies and removed the 3425-3492.5 MHz band. Included new footnote referencing site sense changes in the 3.8 channel arrangement. Appendix 1: Changes to 3.8 GHz channel arrangement and added coordination with area-wide licences restriction.</p>
28 October 2022	October 2022	Updated channel arrangements for the 7.2 GHz Band
23 September 2019	September 2019	<p>Inclusion of new channel arrangements of 56 and 112 MHz in the 38 GHz band (37.0-39.5 GHz). Retiring the 7 MHz and 14 MHz channels from 38 GHz band. Retiring the whole 28 GHz band (27.5-29.5 GHz) from fixed service.</p>
23 June 2016	June 2016	Inclusion of 10 MHz channels to the 1800 MHz band
24 October 2014	October 2014	Changes as a results of IFC 31/2014 to Appendix 1 channel plans-1.8 GHz, 2.1 GHz, 2.2 GHz, 2.5 GHz (change to spectrum licensing), 6 GHz, 6.7 GHz, 8 GHz, 10 GHz, 11 GHz, 13 GHz, 15 GHz, 22 GHz, new 28 GHz and consequential updates to Appendix 3
18 January 2008	January 2008	<p>The following changers were made to remove references to the 58 GHz Band as this band has been included in FX20 “Millimetre Wave Point to Point (Self-coordinated) Stations”.</p> <p>Main Text – Deleted references to 58 GHz Band. – Deleted reference to MDS.</p> <p>Appendix 1 – Deleted references to 58GHz Band in preamble and deleted 58 GHz Band RF Channel Arrangements. Appendix 10 – Deleted 58 GHz Band Notional Antenna Appendix 11 – Deleted 58 GHz Band Antenna Compliance requirements.</p>
11 August 2006	August 2006	<p>Front pages: amended to reflect current organisational names etc.</p> <p>Main Body: amended to reflect current organisational names, minor editorial changes.</p> <p>Appendix 1 - RF Channel Arrangements and Assignment Instructions amended as follows :</p> <p>Preamble: updated embargo references, reinstated 2.2 GHz band, minor editorial changes.</p> <p>1.8 GHz band: added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS bands, added reference embargo 38 and consequential changes, amended reference embargo 26 and consequential changes, added reference MS 31 and consequential changes, minor editorial changes.</p>

		<p>2.1 GHz band: added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS bands, added reference embargo 26 and consequential changes, added reference embargo 38 and consequential changes, added reference to FX 19 and consequential changes, added reference 2.1 GHz Band Plan and consequential changes, added reference MS 31 and consequential changes, minor editorial changes.</p> <p>2.2 GHz band: reverted to April 2004 version, added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS band, added need to coordinate with 2.1 GHz services, added references embargoes 23/26 and consequential changes, added reference to MSS band plan, added reference MS 31 and consequential changes, minor editorial changes.</p> <p>2.5 GHz band: added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS band, added reference embargo 43 and consequential changes, minor editorial changes.</p> <p>3.8 GHz band: added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS band, added reference embargo 42 and consequential changes, added need to coordinate 4 GHz fixed services / FSS / radiolocation, amended ITU-R recommendation to latest revision, minor editorial changes.</p> <p>5 GHz band: added reference "Strategies for WAS" paper, added requirement for Advisory Note BL in candidate WAS band, amended ITU-R recommendation to latest revision, minor editorial changes.</p>
6 September 2005	September 2005	<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Revision of assignment instructions in 2.1 GHz band and removal of assignment instructions in 2.2 GHz band due to Embargo 23.</p> <p>Removal of MDS A band plan and references to MDS A within 2.1 and 2.2 GHz bands.</p>
8 April 2005	April 2005	<p>Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Summary table amended to remove MDS A band and to reflect changed frequency range of 2.5 GHz ENG band.</p> <p>1.5 GHz and 1.5 GHz DRCS bands - updated notes concerning point-to-multipoint systems in defined rural and remote areas. Requirement to apply Advisory Note BL to all assignments in the 1452-1492 and 1518-1535 MHz frequency ranges</p> <p>2.5 GHz ENG band –pre- 7 March 2005 channel arrangements removed.</p> <p>8.3 GHz band – modified to reflect inclusion of channel 2 within ABC TOBN licence.</p> <p>13 GHz band – clarified application of no interference, no protection condition on TOB assignments</p> <p>18 GHz band - Removal of Notes allowing assignments under</p>

		the previous channel arrangements that were superseded in 1996. Note relating to Embargo 25 has been revised and Note about Advisory Note BL has been revised. Minimum path length requirements have been revised.
7 April 2004	April 2004	<p>The following changes were required as a result of the introduction of the antenna compliance regime based on front-to-back ratio and cross-polar discrimination:</p> <p>Main text Sections 3.1.4, 3.2.4 and 4.2.2 were updated.</p> <p>Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Introductory text updated to reflect change from notional antenna regime to antenna requirements under Appendix 11.</p> <p>Notional antenna pattern envelopes removed from all band modules, as necessary, and placed in Appendix 10 Annex A.</p> <p>Appendix 6 updated to remove case studies referring to notional antennas.</p> <p>Appendix 10 (including Annex A) added detailing notional antennas regime and consolidating radiation pattern envelopes.</p> <p>Appendix 11 added detailing antenna compliance requirements.</p> <p>Consequential update to Table of Contents (Appendices) to reflect addition of Appendix 10 and 11.</p> <p>Also a number of minor changes and editorials were made throughout the document.</p>
16 September 2003	September 2003	<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Group A MDS band updated to reflect revised dates in “<i>2.1 GHz Band Frequency Band Plan 2002</i>”;</p> <p>2.1 GHz Band updated to reflect revised dates in “<i>2.1 GHz Band Frequency Band Plan 2002</i>”;</p> <p>2.2 GHz Band updated to reflect revised dates in “<i>2.1 GHz Band Frequency Band Plan 2002</i>” and some simplifications due to removal of text that described transitional arrangements that are now in place.</p> <p>Other parts have also been updated as follows: Summary table of Microwave Fixed Service Bands – Typical Utilisation Parameters.</p>
17 December 2002	December 2002	<p>Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Changes to the 1.8 GHz Band to introduce coordination requirements with 2 GHz spectrum licences, remove reference to coordination with private CTS, add reference to coordination with FWA services and remove Advisory Notes F4, BL and BN.</p>
23 August 2002	August 2002	Section 3.2.2 - text added to reflect output power restrictions to FS operating in the band 18.6-18.8 GHz as specified in Article 21.5A

		<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>18 GHz band - updated to include note on power restriction above.</p> <p>2.5 GHz ENG band – revised start date for new channelling arrangements and inclusion of a note concerning no protection from spread spectrum devices in the band 2463-2483.5 MHz.</p>
3 June 2002	<p>June 2002</p> <p>June 2002</p> <p>June 2002</p> <p>June 2002</p> <p>June 2002</p>	<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Group B MDS band deleted (now spectrum licensed – no apparatus licensing in this band);</p> <p>Group A MDS band updated to reflect introduction of “<i>2.1 GHz Band Frequency Band Plan 2002</i>”;</p> <p>2.1 GHz Band updated to reflect the introduction of the “<i>2.1 GHz Band Frequency Band Plan 2002</i>” and the “<i>Mobile-Satellite Service (2 GHz) Frequency Band Plan 2002</i>”;</p> <p>2.2 GHz Band updated to reflect the introduction of the “<i>2.1 GHz Band Frequency Band Plan 2002</i>”.</p> <p>Other parts have also been updated as follows:</p> <p>Summary table of Microwave Fixed Service Bands – Typical Utilisation Parameters.</p>
15 January 2002	<p>January 2002</p>	<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Change to the 38 GHz Band notional antenna radiation pattern envelope (RPE). The RPE was altered between 0 to 5.5 degrees.</p>
13 December 2001	<p>December 2001</p>	<p>Appendix 1 – RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Change ABC designated channels (channels 4, 7, 15 and 18) to S (shared) channels and change arrangements for access between 7250 and 7375 MHz by non-Defence licensees.</p>
19 October 2001	<p>October 2001</p> <p>October 2001</p> <p>October 2001</p> <p>October 2001</p> <p>July 2001</p> <p>June 2001</p>	<p>Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:</p> <p>Remove reference to Manager, Radiocommunications Licensing Policy Team on the first page.</p> <p>Add 2.2 GHz entry to table "Microwave Fixed Service Bands - Typical Utilisation Parameters".</p> <p>Remove Advisory Notes F4, BL and BN in the 2.1 GHz Band.</p> <p>Remove Advisory Notes BN and BL and reference to Embargo 23 in the 2.2 GHz Band.</p> <p>Correct page date error for RPE [Page Date August 1998] and reinstate correct version of protection ratio correction factors graph [Page Date October 1999] in 7.5 GHz Band.</p> <p>Correct page date error on page 2 [Page Date June 2001], correct page date error for RPE and protection ratio tables [Page Date August 1998] and reinstate correct version of protection ratio correction factors graph [Page Date October 1999] in the</p>

		13 GHz Band. Other parts have been updated as follows: October 2001 Consequential update to Table of Contents (Appendices) to reflect Appendix 7 title change. October 2001 Consequential update to Part 4.2.5 to reflect Appendix 7 title change. October 2001 Additions to References due to 2.1 and 2.2 GHz Band references. October 2001 Correction to unwanted signal power formula in Part 4.2.3. October 2001 Change "Amendment History" to "Amendment Authorisation".
28 September 2001	September 2001 September 2001 September 2001	Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows: Changes to the 2.1 GHz Band to accommodate the new 2.2 GHz Band, introduce coordination requirements with 2 GHz and 2.3 GHz spectrum licences, update coordination requirements with MDS A services, introduce coordination requirements with Defence aeronautical mobile telemetry systems, update protection ratio tables, and update channel availability. Add the 2.2 GHz Band. Appendix 7 updated to incorporate advice for coordination of fixed services in the 2.1 and 2.2 GHz Bands with 2 GHz spectrum licences.
21 August 2001	June 2001 June 2001 June 2001 June 2001 July 2001 June 2001 June 2001	Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows: Change to the 2.5 GHz Band method of channel designation from centre frequency and channel width to lower and upper frequency bounds. Change to the 7.2 GHz Band method of channel designation from centre frequency and channel width to lower and upper frequency bounds. Change to the 8.3 GHz Band method of channel designation from centre frequency and channel width to lower and upper frequency bounds. Change to the 13 GHz Band method of channel designation from centre frequency and channel width to lower and upper frequency bounds for TOB. 7.5 GHz Band updated to accommodate higher demand for wider bandwidth channels - channel raster and protection ratio tables. Annex A updated to accommodate ITU-R Recommendation P.837-3. Table "Microwave fixed services bands - typical utilisation parameters" updated. Table "Index of RF Channel Arrangements" deleted.
22 January 2001		Appendix 1- RF Channel Arrangements and Assignment Instructions updated as follows:

	January 2001	Table "Microwave fixed services bands - typical utilisation parameters" updated to reflect spectrum licensing in the 3.4 GHz Band and the Group B MDS Band.
	January 2001	Channel arrangements for the 3.4 GHz Band updated.
29 May 2000		Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:
	May 2000	Corrections to Notes text and addition of Advisory Notes in 1.8 GHz Band.
	May 2000	Correction to Reference 8 title and addition of Advisory Notes in 2.1 GHz Band.
	May 2000	Addition of text to reflect new band plan and Embargo 23 in the Group A MDS Band.
	May 2000	Addition of text to reflect spectrum licensing and Embargo 26 in the Group B MDS Band.
20 April 2000	March 2000	Appendix 3 updated to include interim guidelines for digital fixed services, based on ETSI and FCC emission criteria.
14 February 2000	February 2000	Part 4 - 'Frequency Coordination' page 29 amendment of the net effective antenna gain equation and page 31 amendment of the summation of individual interference entries equation.
January 2000		Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:
	January 2000	The 1.8 GHz Band amended to take account of additional spectrum allocated for spectrum licensing.
	January 2000	The 7.2 GHz Band amended to include a reference to Embargo 30.
	January 2000	Appendix 7 amended to take account of additional spectrum allocated for spectrum licensing.
29 October 1999		Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows:
	October 1999	Protection ratio correction factor curves updated for the 1.5, 1.5 DRCS, 1.8, 2.1, 3.8, 6, 6.7, 7.5, 8, 10, 11, 13, 15, 18, 22, 38 and 50 GHz Bands.
	October 1999	Antenna RPEs for the 18 and 38 GHz Band redefined.
	October 1999	Appendix 6 references to MS 28 replaced by reference to the information paper "Principles for Decision Making".
	October 1999	Part 1 references to MS 28 replaced by reference to the information paper "Principles for Decision Making".
	October 1999	References updated to include the information paper "Principles for Decision Making".
	October 1999	Correction to text in section 2.1 of Appendix 5 (117.5°E changed to 171.5°E).
	October 1999	Appendix 9 'Adaptive Transmit Power Control' and Annex A to Appendix 9 'ATPC Example Calculations' added.

	October 1999	Consequential amendments to the Table of Contents, sections 3.2.2 and 4.2.2 due to the introduction of Adaptive Transmit Power Control.
31 May 1999	May 1999	Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows: The 1.8 GHz Band and the 2.1 GHz Band updated regarding tenure of new and renewed fixed service licences in the bands.
	May 1999	The 58 GHz Band added.
	May 1999	Consequential amendments to the References list.
12 January 1999	December 1998	Appendix 8 'Coordination of DRCS Outstations with Point-to-Point Links' and Annex A to Appendix 8 '1.5 GHz DRCS Outstation Characteristics' added.
	December 1998	Consequential amendments to Part 3.4.1.
	December 1998	RALI AC1 removed from Reference list.
	December 1998	Minor amendment to text in Part 3.1.7, clarifying analogue versus digital protection criteria.
13 October 1998	October 1998	Appendix 1 - RF Channel Arrangements and Assignment Instructions updated as follows: New assignment note added to the 3.4, 3.8 and 11 GHz Bands.
	October 1998	New interleaved channel pattern added to the 11 GHz Band.
	October 1998	New protection ratio correction factor graphs added to the 3.8, 6.7 and 11 GHz Bands.
	October 1998	3.4 GHz Band updated reference to FX 14.
	October 1998	Part 3.4.3 updated reference to FX 14.
	October 1998	Reference list added reference to FX 14.
	October 1998	Appendix 4 amended.
	October 1998	Annex A to Appendix 6 amended.

* The Page Date appears at the bottom of each page and indicates the date that the page was last updated.

AMENDMENT AUTHORISATION:

Approved 16/06/2023

Chris Worley

Manager

Spectrum Engineering

Spectrum Planning & Engineering Branch

Australian Communications & Media Authority

File: ACMA2005/350

Update History - pre August 1998

SECTION	DATE	COMMENTS
RALI	16/12/97	Sequence Number 125 (96) (12), RALI pages preceding Section 1 were updated.
	23/01/97	Sequence Number 96 (12), RALI updated.
	02/10/92	Sequence Number 12, New RALI.
1 RF Channel Arrangements (previously Channel Arrangements)	10/02/98	Attachment added relating to 1.8 GHz coordination with spectrum licences. The Introduction and 1.8 GHz RF Channel Arrangements and Assignment Instructions have also been updated to reference the new attachment.
	12/12/97	18 GHz Band - Notes 3 and 4 were added to the Assignment Instructions.
	24/09/97	2.1 GHz Band updated.
	15/09/97	1.8 GHz Band updated.
	04/08/97	18 GHz Band updated. 22 GHz Band updated.
	January 1997	8.3 GHz Band updated.
	November 1996	Complete update of Section 1.
	14/11/1996	New RF channel arrangements for the 18 GHz Band.
	09/10/1995	New RF channel arrangements for the 31 GHz Band.
	12/09/1995	New Section 1.
	28/07/1995	New channel arrangement for the 8.3 GHz band.
	28/07/1995	New channel arrangement for the 7.2 GHz band.
	10/10/1994	New interim channel arrangement for the 49 GHz band.
	05/08/1994	New channel arrangement for the 5 GHz band.
	03/05/1993	New attachment to the 13 GHz band channel arrangement.
	30/11/1992	New channel arrangement for the 7.5 GHz band.
	08/10/1992	New channel arrangement for the 15 GHz band.
2 Standard Method of Frequency Coordination		
3 Rules for System Planning and Frequency Coordination	05/08/1994	New notional antenna pattern for the 5 GHz band.
	30/11/1992	New notional antenna pattern for the 7.5 GHz band.
4 Interference Criteria	30/11/1992	New 15 GHz protection ratios.
	08/10/1982	New 15 GHz protection ratios.

TABLE OF CONTENTS

1.	INTRODUCTION.....	1
1.1	PURPOSE	1
1.2	SCOPE	1
1.3	OUTLINE	2
2.	BACKGROUND	3
2.1	MICROWAVE FIXED SERVICE.....	3
2.1.1	<i>Applications.....</i>	3
2.1.2	<i>Spectrum Suitability.....</i>	3
2.1.3	<i>Allocations, Band Planning and Channel Arrangements</i>	4
2.1.4	<i>Equipment Standards.....</i>	5
2.1.5	<i>Licensing</i>	5
3.	COORDINATION AND SYSTEM PLANNING RULES.....	6
3.1	ASSIGNMENT INSTRUCTIONS.....	6
3.1.1	<i>Typical Use.....</i>	6
3.1.2	<i>Assignment Priority.....</i>	7
3.1.3	<i>Minimum Path Length.....</i>	7
3.1.4	<i>Antenna Requirements.....</i>	7
3.1.5	<i>Notes and Special Assignment Instructions.....</i>	8
3.1.6	<i>References</i>	8
3.1.7	<i>Protection Ratios and Interference Criteria.....</i>	8
3.1.8	<i>Protection Ratio (path length) correction factors</i>	9
3.2	RADIO EQUIPMENT CONSIDERATIONS.....	9
3.2.1	<i>Spectrum Efficiency.....</i>	10
3.2.2	<i>Transmit Power and Adaptive Transmit Power Control (ATPC).....</i>	10
3.2.3	<i>Emission Criteria</i>	10
3.2.4	<i>Antennas.....</i>	11
3.3	RADIOCOMMUNICATION SITE AND SYSTEM PLANNING CONSIDERATIONS.....	12
3.3.1	<i>Geographic Coordinates</i>	12
3.3.2	<i>High Spectrum Demand Areas (HSDA)</i>	12
3.3.3	<i>Compatibility (Site Sense)</i>	14
3.3.4	<i>Link Diversity Options.....</i>	16
3.3.5	<i>Passive and “RF” repeaters</i>	16
3.4	POINT-MULTIPOINT FIXED SERVICES.....	19
3.4.1	<i>Rural telephony (1.5 GHz DRCS) systems</i>	19
3.4.2	<i>3.4 GHz Fixed Point-to-Multipoint services.....</i>	Error! Bookmark not defined.
4.	FREQUENCY COORDINATION	21
4.1	AN OVERVIEW OF THE COORDINATION PROCESS	21
4.2	BASIC METHOD OF FREQUENCY COORDINATION FOR TERRESTRIAL FIXED SERVICES.....	22
4.2.1	<i>Identifying potentially affected services</i>	24
4.2.2	<i>Calculating received signal levels.....</i>	26
4.2.3	<i>Assessing received signal levels against interference management criteria</i>	29
4.2.4	<i>Compliance with assignment instructions and planning rules</i>	30
4.2.5	<i>Coordination with other types of radiocommunication services</i>	30
4.3	CONSIDERATIONS WHICH MAY FACILITATE SUCCESSFUL COORDINATION	32
4.3.1	<i>Detailed Interference Analyses.....</i>	32
4.3.2	<i>Interference Countermeasures</i>	33

RALI AUTHORISATION

GLOSSARY

REFERENCES

Appendices:

- 1. RF Channel Arrangements and Assignment Instructions**
Annex A - Propagation Related Statistical Information
- 2. Interference Mechanisms and Performance Criteria**
- 3. Fixed Service Emission Criteria**
- 4. Fixed Service Propagation Modelling**
Propagation models applicable to the fixed service
Equations for calculating fixed link path losses
- 5. Geostationary Satellite Orbit Avoidance**
Annex A - Microwave Fixed Service Bands Sharing with GSO Space Services
- 6. Application of Assignment Policy Rules**
Annex A - Examples in support of Appendix 6
- 7. Coordination of Apparatus Licences with Spectrum Licences: 1.8, 2.1 and 2.2 GHz Band Fixed Services**
- 8. Coordination of DRCS Outstations with Point-to-Point Links**
Annex A - 1.5 GHz DRCS Outstation Characteristics
- 9. Adaptive Transmit Power Control**
Annex A - ATPC Example Calculations
- 10. Notional Antennas**
Annex A –Notional Antenna Radiation Pattern Envelopes (NARPE)
- 11. Antenna Compliance Requirements**

1. INTRODUCTION

1.1 PURPOSE

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) FX 3 “*Microwave Fixed Services Frequency Coordination*” document is to describe procedures for the frequency coordination of terrestrial microwave fixed services and to specify key technical radiocommunication policy requirements applicable to these services within the general spectrum management context.

The document is primarily intended for use by Australian Communications and Media Authority (ACMA) and Accredited¹ frequency assigners engaged in the assignment of frequencies for microwave fixed services. As the RALI document specifies important planning rules, recommendations and useful information for the coordination and licensing of microwave fixed services, it will also be of particular interest to telecommunication network operators, system planners and equipment manufacturers/importers.

This RALI replaces RALI FX 3, sequence number 125, dated 16 December 1997.

The information in this document reflects the Australian Communications and Media Authority’s statement of current policy in relation to the frequency coordination of microwave fixed services. Users of RALI FX 3 are advised that, recognising that the ITU-R continues to study and make recommendations regarding radiocommunications and associated regulatory and spectrum management issues, this document is subject to ongoing revision. In the application of the policy, ACMA and accredited assigners are required to take all relevant matters into account and to decide each case on its merits². Any consistent anomalies or cases where relevant issues are considered inadequately addressed within the scope of the RALI, should be brought to the attention of the Manager, Spectrum Engineering Section, Spectrum Planning Branch, Australian Communications and Media Authority, PO Box 78 BELCONNEN ACT 2616.

1.2 SCOPE

Microwave fixed services include point-to-point and point-to-multipoint radio systems utilised for the transmission of voice, video and data information. The definition and nature of microwave fixed service systems is further described under Part 2 “*Background*”. The scope of the RALI is generally limited to the coordination of homogeneous line-of-sight fixed services operating in specified frequency bands (Refer to Appendix 1), although some of the criteria and methodology may also be useful for the coordination of other types of fixed services.

In general, the coordination of microwave fixed services with other types of radiocommunication services (including Multipoint Distribution Systems (MDS),

¹ Refer to RALI AC 1 “*Requirements for Accredited Frequency Assigners - Assigning Fixed Point-to-Point Microwave Services*”.

² In accordance with ACA Information Paper “*Principles for Decision Making*”.

special types of fixed service systems and inter-service coordination³) is detailed in other documents, as identified in the References section of the RALI. However, specific guidance is provided to facilitate the protection of geostationary space services operating within bands shared with fixed terrestrial services, as required under the International Telecommunication Union (ITU) Radio Regulations. Detailed guidance is also provided with respect to the coordination of apparatus licensed fixed services with spectrum licensed radiocommunication services operating within particular frequency bands.

Although the RALI specifies a number of important rules and guidelines which need to be taken into account as part of the system planning process, it is not intended to serve as a link planning document as such. The scope of the specified planning rules and coordination guidelines is limited to the matters considered necessary for the efficient utilisation of the radiofrequency spectrum, management of interference and compliance with relevant domestic and international radiocommunications regulatory requirements. For general link planning purposes, reference should be made to other relevant publications, such as the “*ITU-R Handbook on Digital Radio-Relay Systems*”, Geneva 1996 which provides detailed guidance on most aspects of fixed service link planning.

1.3 OUTLINE

The document comprises four main parts:

- Part 1 - (this part) the introduction, detailing the purpose and scope of the RALI;
- Part 2 - provides background information and a brief overview of the general regulatory and technical planning environment for microwave fixed services;
- Part 3 - details specific coordination and system planning rules, necessary for the optimisation of spectrum usage and the management of interference; and
- Part 4 - outlines a basic method of frequency coordination for terrestrial microwave fixed services.

Appendix 1 “*RF Channel Arrangements and Assignment Instructions*” details criteria specific to each of the fixed link frequency bands currently supported in Australia. Further appendices and annexes provide additional supporting material, including some of the more detailed frequency coordination methodologies, interference protection and emission criteria.

The arrangements detailed in this document are based on relevant ITU-R work, studies conducted by the ACMA (and its predecessors) and accepted Australian industry practices. References to the appropriate ITU-R recommendations, RALIs and other documents are incorporated throughout the document and are consolidated in the Reference section of the document.

³eg. Cordless Telecommunication Services (CTS), satellite services and Spectrum Licensed services.

2. BACKGROUND

This part of the RALI FX 3 provides background information and a brief overview of the general regulatory and technical planning environment for microwave fixed services.

2.1 MICROWAVE FIXED SERVICE

In accordance with the “*Australian Radiofrequency Spectrum Plan*” (the Spectrum Plan) a “fixed service” is defined simply as “a radiocommunication service between particular fixed points⁴”. Thus the basic definition potentially encompasses a very broad range of point-to-point and point-to-multipoint radiocommunication services. The terms “microwave fixed service” and “fixed links”, although not formal, are adopted in this document in order to distinguish the types of wideband systems operating in the “microwave” frequency range (about 1 to 60 GHz) from the generic service definition. Other terms, such as “radio-relay systems” are also commonly utilised to denote particular sub-types of microwave fixed services, as outlined in the next sub-part.

2.1.1 Applications

Currently supported microwave fixed service applications may be classified into a number of sub-types, usually defined by their operational application and typically falling into the following main categories:

- trunk radio-relay systems - supporting high speed common carrier networks;
- local network access links - usually small to medium capacity, typically used for serving regional, rural and remote areas;
- thin route networks - typically small to medium capacity and often used by public and private utility operators and mobile telecommunication operators;
- customer links - typically small capacity providing mainly in-house voice and data communications, usually over relatively short distances; and
- studio-to-transmitter and outside broadcast links - as typically used by the network broadcasters.

An ever increasing proportion of the above described fixed services support digital communication requirements, with data rates from a few hundred kilobits per second for some local access and telemetry systems and customer links to a current maximum of 155 Mbit/s in support of broadband applications. Analogue microwave fixed services are generally limited to the outside broadcast and limited numbers of older television distribution applications but even in those applications moves are being made toward digital operation.

2.1.2 Spectrum Suitability

Given the basic transmission capacity requirements of modern communication networks and the nature of the radiofrequency spectrum, wideband (≥ 512 kbit/s) fixed

⁴ This definition is also consistent with that given in the ITU Radio Regulations.

service links are generally operated in the microwave region of the spectrum between about 1 to 60 GHz. The spectrum below about 1 GHz is rarely used for such links because of the bandwidth demand imposed by the transmission requirement and in any case this spectrum is already devoted to use by various other radiocommunication services, in particular the broadcasting and mobile services. The upper bound for fixed links is currently considered to be about 60 GHz, due to inherent propagation limitations and cost factors associated with millimetrewave radio technology.

The lower microwave bands, between about 1 to 10 GHz, have traditionally been preferred for long haul radio-relay applications due to their favourable propagation characteristics. Consequently, these bands are well utilised and congested at many locations, including the major telecommunication trunk routes and the larger metropolitan population centres. These lower microwave bands also accommodate the bulk of the population of the older analogue links still in service. Additionally, the 1-3 GHz bands are subject to increasing pressure to accommodate new terrestrial and satellite based mobile telecommunication and broadcasting services.

The bands above about 10 GHz are subject to increasing attenuation and link availability constraints due to rain intensity related outage events. In practice, this equates to decreasing achievable hop lengths. However, these bands offer capacity to support short hop high density applications such as mobile network backbones, customer megalinks and other urban network applications. Re-use distances are significantly smaller and available antenna isolation greater in these higher bands, thus optimising their utility in the high-density urban environment.

2.1.3 Allocations, Band Planning and Channel Arrangements

Australian fixed service frequency allocations are specified in the Spectrum Plan and generally conform to the ITU Radio Regulations fixed service allocations for Region 3.

As outlined in the Spectrum Plan, all of the fixed service allocations between 1 GHz and 60 GHz are also allocated to one or more other services. Not all fixed allocation arrangement options are able to be implemented in all countries, nor would this be sensible. National policies generally determine the use to which each band is put; some bands are reserved for the exclusive use of one service allocation whilst others may be available on a shared basis to one or more of the allocated services. The specific utilisation of each band is subject to particular implementation arrangements, including relevant intra-service and inter-service sharing and coordination considerations, normally derived from ITU agreed criteria. Fixed service microwave bands are generally planned to align with well defined ITU recommendations or other recognised regional standards and to accommodate readily available products. Accordingly, most of the Australian Radio Frequency (RF) Channel Arrangements (as detailed in Appendix 1) are closely aligned with the appropriate ITU-R recommendations.

Internationally, fixed service recommendations are developed by ITU-R Study Group 9, which is tasked with the study of the technical and operational aspects of fixed services. Australian participation in the work of Study Group 9 is coordinated by the ACMA, on advice from the Australian Radiocommunication Study Group 9 (ARSG9). ARSG9 meets regularly to consider international fixed service developments and proposals and contribute to the work of the ITU

Radiocommunication Sector. Membership is open to all parties interested in the fixed services; members include private and public sector organisations (eg. the telecommunication carriers, the ACMA and other major fixed link users including defence and broadcasters, equipment manufacturers and other industry bodies).

2.1.4 Equipment Standards

No definitive Australian radiocommunication standards or regulatory type approval procedures are in place, or seen as necessary, for microwave fixed service radiocommunication equipment. However, it is expected that such equipment:

- comply with the arrangements detailed in this document (with particular reference to Part 3.2 “*Radio Equipment Considerations*”);
- are operated in compliance with the technical conditions specified in the relevant ACMA licence; and
- be manufactured to conform with the requirements of the International Radio Regulations, relevant ITU Recommendations and/or other recognised world-wide or regional standards.

2.1.5 Licensing

Microwave fixed services are normally licensed, under Part 3.3 of the *Radiocommunications Act 1992*, as Apparatus Licences of the Fixed Licence type⁵. Fixed link licences are also subject to the requirements of the “*Radiocommunications Licence Conditions (Fixed) Licence Determination No.1 of 1997*”.

A summary of the applicable Apparatus Licence fees is provided in the ACMA document “*Radiocommunications Apparatus Licence Fees and Charges*”, which also incorporates an overview of the Apparatus Licence Fee Framework and the available licence types.

⁵ Where necessary, special Apparatus Licence arrangements may be invoked, such as in the case of the Multipoint Distribution Stations and Television Outside Broadcast stations. However, in particular cases other licensing categories may apply, eg. in some circumstances fixed link operation may be covered under a relevant Class Licence or Spectrum Licence.

3. COORDINATION AND SYSTEM PLANNING RULES

This part of the RALI details assignment instructions, coordination and general system planning rules considered necessary for the management of interference and the optimisation of spectrum usage for microwave fixed services. The rules are established as a reasonable balance between the cost of implementing services, unnecessary spectrum denial and the likelihood of interference, with particular relevance to identified (see Part 3.3.2) High Spectrum Demand Areas (HSDA).

In considering the application of assignment instructions and planning rules, assigners are reminded of the need for consistency and transparency, with particular reference to applications seeking exceptions to, or the relaxation of, specific assignment policy requirements. Overall guidance regarding such considerations is provided in Appendix 6 “*Application of Assignment Policy Rules*”.

3.1 ASSIGNMENT INSTRUCTIONS

Assignment instructions, as detailed in Appendix 1 for each microwave fixed service band, define particular assignment criteria and address other considerations specific to the utilisation of each band. Instructions and/or advice are normally included for utilisation, (channel) assignment priority, minimum path length and minimum antenna performance requirements, with the object of optimising spectrum utilisation. Specific notes are also provided in the assignment instructions to cover any special requirements (eg. a requirement to apply particular Special Conditions or Advisory Notes) and references relevant to such considerations.

The following sub-parts provide general guidance regarding the purpose and scope of particular assignment instructions.

3.1.1 Typical Use

This specification identifies the types of fixed link applications typically supported in a given frequency band, in terms of technology (analogue/digital) and system capacity.

The choice of an appropriate frequency band and channel raster is important and should ideally match the proposed communication need in terms of achievable path length and system performance objectives (ie. the highest possible frequency band should be utilised), with the link occupied bandwidth optimised against the available channelwidth. Nevertheless, provided that a proposal:

- meets the relevant coordination and licensing criteria;
- complies with the relevant regulatory provisions; and
- does not unreasonably impact on spectrum availability for other users

the prospective licensee is at liberty to choose the appropriate frequency band that meets their operational requirement.

3.1.2 Assignment Priority

The assignment priority defines the order in which the available channels in a particular channel raster should be assigned, with a view to optimising⁶ the loading of radiofrequency channels in a given frequency band.

Where an initial choice of a channel in the assignment priority is precluded through unsuccessful coordination, the next channel in the priority sequence is to be attempted. In general, optimum spectrum utilisation is achieved by maximising the re-use of channels in the order of the assignment priority sequence and is often referred to as the vertical loading (of radiofrequency channels) principle. In practice this means assigning the first channel in the specified priority which passes the coordination criteria.

3.1.3 Minimum Path Length

The minimum path length defines the smallest end-to-end distance for a single-hop link which may be supported in a particular frequency band.

At the lower end of the microwave spectrum, line-of-sight path lengths of the order of 60 -100 km are achievable, depending upon system gain and link performance objectives. As mentioned in Part 2 of this RALI, the available path length decreases with increasing frequency and propagation losses. For radio-relay systems a decrease in available path length equates to additional infrastructure and system costs in the form of additional repeaters. Accordingly, the lower microwave frequency bands should be assigned primarily to systems requiring the use of long link paths, where fade margins are often critical. For microwave fixed services with link paths shorter than the specified minimum path length, higher frequency bands should to be utilised.

Note: The minimum path length requirement will not normally be relaxed within designated HSDA locations.

3.1.4 Antenna Requirements

Antenna requirements specify the minimum allowed antenna performance for antennas used in the fixed service bands.

As outlined in Part 4.2.2, wanted and unwanted signal levels are directly dependent upon antenna performance. The antenna may be considered to be the single most important component of a fixed service system in terms of frequency coordination and in determining the overall extent of spectrum denial to other services. Generally, antennas with higher levels of discrimination to off-axis signals facilitate more opportunity for frequency re-use.

The antenna requirements detailed in Appendix 11 have been developed to provide simple, unambiguous criteria against which antenna compliance can be easily determined. This method removes elements of subjective judgement and facilitates a transparent and light touch approach to antenna assessment.

The criteria outlined in Appendix 11 were developed following studies on antenna manufacturer data, analysis of antenna usage within individual frequency bands and

⁶ Sometimes other reasons (eg. interservice considerations) may dictate a particular priority.

locations, and extensive statistical analysis of antenna performance correlations. Appendix 11 sets performance requirements that may allow the use of smaller antennas (as opposed to Appendix 10 criteria which tended to imply a minimum aperture size), as long as the overall performance of the chosen antenna meets specified front-to-back ratio and cross-polar discrimination requirements. This approach ensures that a required level of frequency re-use (i.e. spectrum efficiency) is maintained, while providing licensees with greater flexibility in terms of antenna selection.

Table 1 in Appendix 11 generally allows for the use of standard, non shrouded antennas in non-HSDA areas, and imposes a requirement for the use of high performance, shrouded antennas in the HSDA. Certain frequency bands (3.8, 6.0, 6.7 & 8.0 GHz) are important trunk bands. Accordingly, the Appendix 11 Table 1 criteria have been chosen to facilitate a high level of spectrum re-use in these bands.

Note: The antenna compliance arrangements described in Appendix 11 represent a change from the previous practice of assessing candidate antennas against a defined “notional antenna RPE”. To allow a transition period for the introduction of the Appendix 11 arrangements, over the period 31 March 2004 and 31 March 2005, antennas may be assessed against either the Appendix 11 arrangements or the earlier arrangements (for convenience those notional antenna arrangements have been consolidated in Appendix 10).

3.1.5 Notes and Special Assignment Instructions

The notes provided with the Assignment Instructions given in Appendix 1, specify particular (band specific) criteria and provide important advice regarding any special requirements. References may be made to legal instruments (e.g. the Spectrum Plan, formal Band Plans) or other RALIs (e.g. to relevant spectrum embargo notices or coordination guidelines).

The onus is on the frequency assigner to take account of and comply with the relevant requirements specified in the reference documents.

3.1.6 References

Usually the source ITU-R recommendation (or other recognised standard) for the RF Channel Arrangement adopted for the implementation of the particular band is given. In addition, the full titles of any specific reference documents identified in the Assignment Instructions are also detailed in Appendix 1.

Note: ITU recommendations for RF channel arrangements often specify different (sometimes numerous) channelling options. Accordingly, although based on the same source recommendations, there can be significant differences between the Australian arrangements detailed in Appendix 1 and those adopted by other countries.

3.1.7 Protection Ratios and Interference Criteria

Protection ratios, as defined in Appendix 1 and applied under the basic method of frequency coordination detailed in Part 4, specify the default interference criteria for systems operating in each microwave fixed service frequency band⁷. The discrete protection ratio criteria are to be used when more detailed information on system protection requirements is not available. In essence:

⁷ Excepting certain bands/channel rasters designated for TOB or other itinerant use applications.

- co-channel and adjacent channel protection ratios are defined for digital and, for the bands supporting significant populations of FM video and FDM telephony links, analogue fixed service systems; however,
- in the bands for which analogue system protection ratios are not explicitly defined, the protection ratios and correction factors specified for digital systems shall apply irrespective of the modulation type employed. In effect, no additional protection will be afforded to analogue systems operating within these bands.

Given that these protection ratios address the requirements of a broad range of fixed service systems, situations may arise where an overly conservative coordination result is obtained using these criteria. In these cases, a more detailed approach, taking account of system specific interference criteria, may be appropriate. In general, a coordination approach based on the direct application of threshold degradation and/or noise interference criteria⁸ is potentially more efficient in terms of optimising channel loading and overall spectrum productivity.

In cases where an RF channel arrangement is overlaid with a pre-existing arrangement or other overlaid arrangements for which no specific protection ratios are defined:

- Where the potential interfering and victim spectra overlap, the relevant co-channel criteria should be applied;
- In the case of non-overlapping but adjacent spectra, the relevant adjacent channel criteria should be applied; or
- Where sufficient detailed information regarding the potentially interfering emission and the victim service characteristics is available, the FDR⁹ criteria outlined in Spectrum Planning Report SPP 4/95 “*Frequency Dependent Rejection (FDR) Software*” may be used as the basis for a more detailed analysis.

3.1.8 Protection Ratio (path length) correction factors

The protection ratios specified for digital systems (in Appendix 1) for each fixed service band are normalised for a particular path length and geoclimatic zone. Accordingly, appropriate corrections must be applied to the tabulated protection ratio values in order to account for the victim system actual path length and geographic location. In the absence of more detailed statistical data for local worst month multipath fading and/or rainfall intensity, the geoclimatic contour maps provided in Annex A to Appendix 1 may be used.

3.2 RADIO EQUIPMENT CONSIDERATIONS

Although the ACA does not mandate regulatory type approval procedures for microwave fixed service radiocommunication equipment, it is expected that such equipment be manufactured to conform with the requirements of the International Radio Regulations, relevant ITU recommendations and/or other credible recognised world-wide or regional standards. More specifically, in order to meet the minimum

⁸ Interference mechanisms and performance criteria are the subject of ongoing ACA work, the results of which will be included in Appendix 2.

⁹ Frequency Dependent Rejection, which takes into account the victim receiver selectivity response.

requirements for licensing, microwave fixed service equipment must comply with the arrangements detailed in this document, including the following regulatory criteria for spectral efficiency, transmit power limits, emission criteria and antennas.

3.2.1 Spectrum Efficiency

Microwave fixed service equipment supporting a digital baseband signal (i.e. digital systems) intended for operation in Australia in the bands below 19.7 GHz are required to comply with a minimum spectrum efficiency criteria of 1 bit per second per Hertz (1 bit/s/Hz). No explicit spectral efficiency criterion applies to analogue FDM or FM video systems.

3.2.2 Transmit Power and Adaptive Transmit Power Control (ATPC)

In accordance with International Radio Regulation 21.5(3) and ITU-R Recommendation SF.406 “*Maximum Equivalent Isotropically Radiated Power of Radio-Relay System Transmitters Operating in the Frequency Bands Shared with the Fixed-satellite Service*”, the power delivered by a transmitter measured at the antenna connection¹⁰ of a station in the fixed service shall not exceed:

- +43 dBm (20 Watts) in the bands between 1 GHz and 10 GHz; and,
- +40 dBm (10 Watts) in the frequency bands above 10 GHz, except in the band 18.6-18.8 GHz where the limit is +27 dBm (0.5 Watts) in accordance with International Radio Regulation 21.5A.

It should be noted that in the band 18.6-18.8 GHz, multiple transmitters, operating on different RF carrier frequencies, individually respecting the above output power limit can be connected to a single antenna of a fixed service.

Microwave fixed services operated in Australia must conform with the above power limits and the EIRP limit criteria detailed in Appendix 5 “*Geostationary Satellite Orbit Avoidance*”.

In general, transmit power levels should be adjusted to ensure that radiated power levels do not significantly exceed that necessary for compliance with link availability and performance objectives. Transmit power levels may be controlled through the judicious application of fixed attenuators or, with the emerging generation of fixed service radio equipment, direct programming and Adaptive Transmit Power Control (ATPC).

ATPC is a desirable equipment feature of digital systems with significant benefits¹¹ for the system operator and spectrum manager. In essence, ATPC allows transmitter operation at less than maximum power for most of the time, with increased power applied only (for short percentages of time) during periods of fading. The rules and conditions governing the operation of microwave fixed service systems fitted with ATPC is detailed in Appendix 9 “*Adaptive Transmit Power Control*”.

3.2.3 Emission Criteria

In general, the relative power spectral density of a given radiofrequency emission¹² is determined by the baseband information rate, the modulation technique employed and

¹⁰ ie. At the actual waveguide flange or coaxial connection point of the antenna itself.

¹¹ As outlined in Chapter 4.3.4.2 of ITU-R “*Handbook on Digital Radio Relay Systems*”, Geneva 1996.

¹² Defined in the ITU Radio Regulations as the radiation produced by a radio transmitting station.

system implementation (eg. DSP techniques and filtering). Such emissions may be defined as consisting of two components

- the major “wanted signal” portion of the transmitted spectra, normally defined as the necessary bandwidth¹³. The necessary bandwidth is a key parameter in frequency coordination and its value is recorded in the ACA's RADCOM database as part of the emission designator field used to characterise the nature of a given radiocommunication service; and
- a remainder (unwanted emissions), falling outside of the necessary bandwidth. Unwanted emissions include out-of-band and spurious emissions, as defined in the International Radio Regulations.

In general, it is expected that the necessary bandwidth of a fixed service emission is wholly contained within the RF channel limits of the relevant Appendix 1 channel arrangement. However, for high capacity digital systems operating in specific bands (3.8, 6.7 and 11 GHz), the necessary bandwidth is permitted to exceed the relevant RF channel limits by up to 20%.

Wanted and unwanted emission criteria for microwave fixed services are subject to review. Pending development of Appendix 3, enquiries regarding this matter should be directed to the Spectrum Engineering Section, Spectrum Planning Branch.

3.2.4 Antennas

Minimum antenna performance requirements for Australian microwave fixed services are specified in Appendix 11 for each frequency band and are further discussed under Part 3.1.4 “*Antenna Requirements*”. Antennas are a critical component within the overall interference environment and their characteristics play a large part in determining overall frequency re-use for fixed services. Accordingly, it is essential that licensees should furnish detailed radiation pattern envelope (RPE) data for their (discrete and equipment integral) antenna products that are to be used in proposed assignments. Parameters should include an antenna’s physical diameter and on-axis gain as well as the antenna 360° radiation pattern envelope for both co-polar and cross-polar orientation, in order to facilitate their use in detailed frequency coordination and sharing studies.

In order to promote standardisation and electronic working methods (and in the absence of relevant ITU criteria), the “*Standard Format for Electronic Transfer of Terrestrial Antenna Pattern Data*” file data format developed by the National Spectrum Managers Association (NSMA¹⁴) may be utilised, with a view to facilitating simple, accurate and expedient transfer of coordination data between manufacturers, frequency assigners and users. Although not a formal standard, the format is recognised and supported by most major antenna manufacturers.

¹³ Necessary bandwidth is defined in the International Radio Regulations as “*the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions*”.

¹⁴ NSMA (USA) Working Group 16, refer to <http://www.nisma.org>.

3.3 RADIOCOMMUNICATION SITE AND SYSTEM PLANNING CONSIDERATIONS

Site selection and detailed radiocommunication system engineering issues are normally matters within the jurisdiction of the system planner and prospective licensee. Nevertheless, a number of geographic and other link planning considerations are of concern from a regulatory perspective and require detailed treatment due to their potential impact on the overall interference environment.

Accordingly, in order to facilitate timely system commissioning and to avoid potentially costly redesign work, the matters discussed in the following sub-parts need to be considered and taken into account within the early phases of link planning.

3.3.1 Geographic Coordinates

As outlined under Part 4.2.2, the coordination of microwave fixed services is predicated upon the accurate determination of the relative spatial (distance and azimuth) relationships between potential victim and interfering services.

Since the reliability of predicted signal levels will be affected by the uncertainty of the geographic coordinates used, it is important that the link end-point location coordinates are derived and recorded accurately. The endpoints in the context of microwave fixed services are defined as the coordinates at the centre or main axis of the antenna support structure (ie. pole or tower). In the case of particularly large support structures (ie. where the radius distance from the antenna to the axis is greater than 10 metres) the coordinates of the actual antenna are to be recorded, consistent with the specified (see below) level of accuracy of coordinate data.

Geographic coordinates for radiocommunication sites are recorded in the Australian Map Grid (AMG) format, a Universal Transverse Mercator projection of latitudes and longitudes on the Australian Geodetic Datum (AGD). Conversion algorithms between latitude and longitude and AMG coordinates are detailed in “*The Australian Geodetic Datum Technical Manual (National Mapping Council 1986)*”.

The ACMA's “*Site Entry Rules*” Business Operating Procedure (BOP) document provides guidance regarding the derivation and recording of radiocommunication site data and specifies that site data entered into the ACMA's RRL database should aim for an accuracy of +/- 10 metres (equivalent to approximately 0.3 of a second of latitude). However, this may be relaxed to +/- 100 metres in rural and remote areas in cases where better data may be unobtainable.

3.3.2 High Spectrum Demand Areas (HSDA)

Spectrum demand and high usage density typically coincide with population centres and the trunk route corridors between such centres. Designated High Spectrum Demand Areas (HSDA) define geographic boundaries within which the overall link density is high and where demand mandates a tightly managed assignment strategy, including strict compliance with the spectrum productivity related assignment and system planning rules specified in this document.

Metropolitan HSDAs are circular areas defined by radii centred on the town or city GPO coordinates, as specified in Table 3.1 and shown in Figure 3.1.

Location	Location AMG coordinates	HSDA radius (km)
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	Zone	Easting	Northing	$f < 10$ GHz	$f \geq 10$ GHz
Sydney	56	334100	6250900	140	95
Melbourne	55	320630	5812740	140	95
Brisbane	56	502810	6961540	130	85
Adelaide	54	280575	6132250	70	45
Perth	50	392022	6464195	100	65
Canberra	55	693400	6093700	90	60
Newcastle	56	384696	6355416	130	85

Table 3.1. Designated High Spectrum Demand Areas (HSDA)

Although HSDAs are not explicitly defined for the major trunk routes, coordination and planning rule criteria should also be closely observed along the intercapital trunk and other routes making extensive use of the bands below 10 GHz.

Note: The Table 3.1 microwave fixed service HSDA definitions are not the same as, and are not necessarily intended to be consistent with, the definitions given in the ACA's "*Radiocommunications Apparatus Licence Fees and Charges*" document.

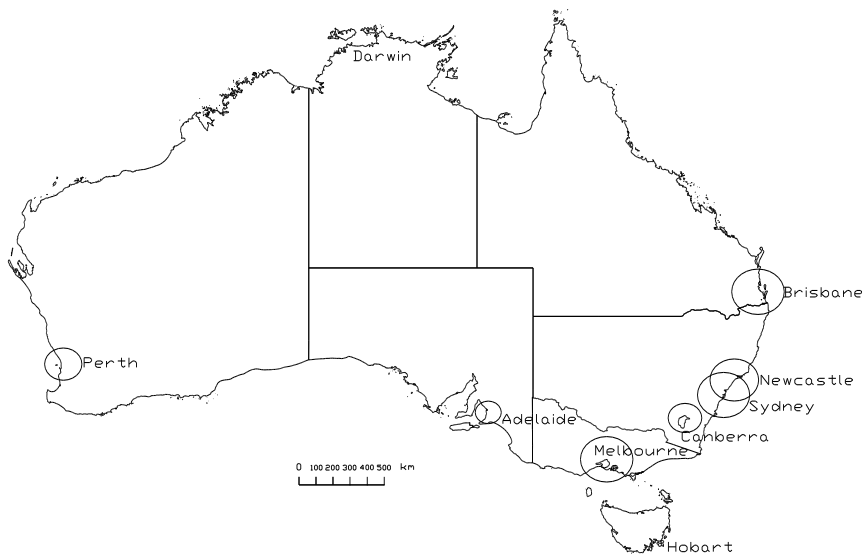


Figure 3.1. Designated HSDA for microwave fixed service bands below 10 GHz.

3.3.3 Compatibility (Site Sense)¹⁵

The majority of microwave fixed services are bidirectional and for this reason radiofrequency channel arrangements are defined in paired blocks of “go” and “return” channels (i.e. designated 1/1', 2/2' ...), separated in frequency by a fixed “transmit/receive duplex spacing”, in accordance with the principles defined in ITU-R Recommendation F.746 “Radio-frequency Channel Arrangements for Radio-Relay Systems”.

In order to maximise the isolation between collocated transmitters and receivers operating in the same band, at any given site, frequencies are assigned from either the lower (site sense “low”) or the higher (site sense “high”) frequency block.

Accordingly, where a given site has been designated as “transmit high” then all transmit frequencies at that site will be in the upper frequency block and the corresponding paired duplex receive frequencies in the lower “receive low” block. Figure 3.2 provides a simple (arbitrary) example of a network with consistent site sense allocation.

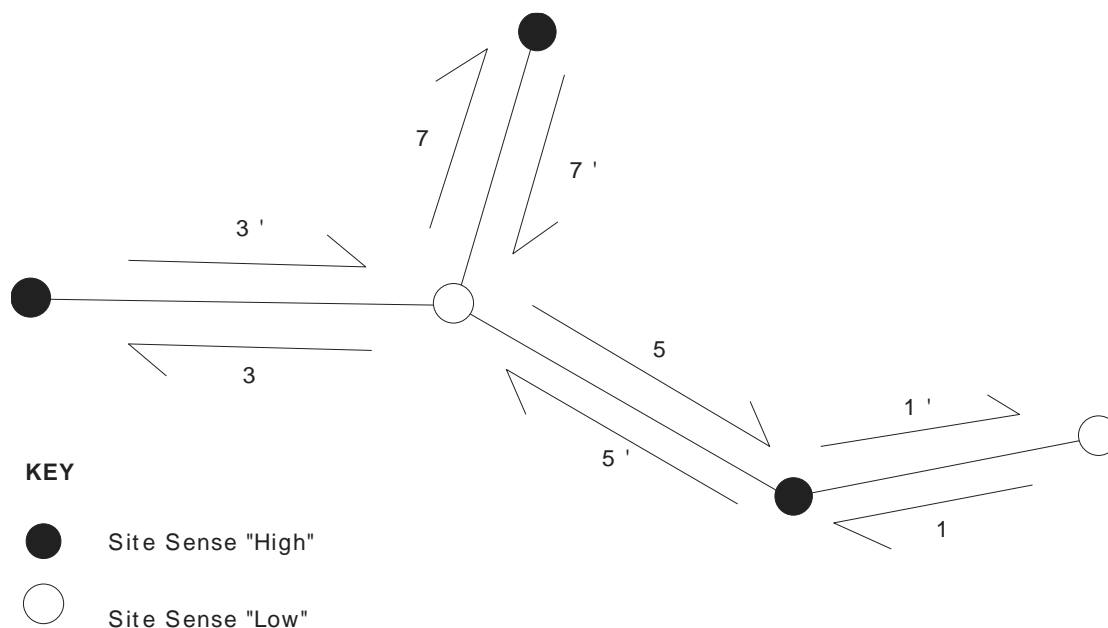


Figure 3.2. An arbitrary example of a site sense consistent network.

The collocation of transmitters and receivers using the same frequency block must be avoided, since the high levels of adjacent channel energy are highly likely to cause receiver desensitisation¹⁶. The extent of desensitisation depends upon the absolute frequency separation between a transmitter and the victim receiver and its effect may range from a small reduction in available system fade margin through increasing baseband noise to severe blocking where the receiver becomes essentially inoperative.

¹⁵ In the 3.8 GHz band site sense compatibility is not required if co-sited parties can reach an agreement.

¹⁶ ie. results in a reduction in the dynamic range of the receiver.

The following cases outline the site sense considerations most often encountered in practice:

- for an isolated single-hop link, the choice of relative transmit/receive site sense is not usually of particular importance;
- in the case of a radio-relay trunk route or any multi-hop system, site sense alternates at each hop, with the initial choice of upper or lower frequency block selection typically influenced by any sites where the new route interconnects with existing systems for which a site sense has already been established; and
- network node sites, or “prime” sites where multiple systems converge. Consistent application of site sense is particularly important at node sites, since conflicts invariably preclude the use of otherwise available radiofrequency channels.

In addition, the harmonic relationships between co-sited equipment operating in different frequency bands must be taken into account, i.e. multiples of the transmit frequencies from a lower band falling within the receive frequency block of a higher band represent a particularly severe source of interference.

Incorrectly applied site sense may lead to extensive and unreasonable spectrum denial, particularly at high demand prime radiocommunication sites which are often shared between a number of operators. Accordingly, appropriate consideration at the route/network planning stage is vital in ensuring that potential problems of this nature are avoided. Nevertheless, in certain circumstances it may not be possible to maintain site sense when making a new frequency assignment (eg. when a new link connects existing sites with identical pre-established site sense). In this case and other situations where individual circumstances warrant the violation of normal site sense practice, the proposed assignment strategy should be carefully examined with a view to minimising the adverse impact of such an assignment. In many cases, through judicious site sense planning and choice of assigned channels, a site sense violation can be effectively “transferred” to a part of the network (site) where the potential impact on other existing and future systems may be minimised.

If a mixed site sense is proposed at a shared radiocommunication facility (or adjacent facilities), it is the licence applicant’s responsibility to advise and to negotiate with any potentially affected parties, including the site owner(s) or their designated representative(s). In cases where operators are unable to reach agreement, the site owner(s) may choose to arbitrate or to impose an outcome. In the event of an unresolved disagreement between respective site owners, the parties involved may seek the advice of the ACMA.

Other on-site interference and compatibility issues (intermodulation, broadband noise) are outside the scope of this frequency coordination document and fall under the scope of individual site engineering practice. For guidance regarding such site engineering related matters, reference may be made to Australian Standard AS 3516.2 “*Siting of radiocommunications facilities - Part 2 Guidelines for fixed, mobile and broadcasting facilities at frequencies above 30 MHz*” and general radio and telecommunication engineering references.

3.3.4 Link Diversity Options

Link diversity arrangements and other measures are utilised to improve system performance, typically to combat the effects of multi-path fading and to expand the application of link arrangements over hops with difficult propagation conditions. As outlined in ITU-R Recommendation F.752 “*Diversity Techniques for Radio-Relay Systems*”, the traditional microwave fixed service diversity techniques are generically described as frequency diversity and space diversity:

- frequency diversity, employing two or more frequencies to send identical information over the same propagation path. The frequency separation¹⁷ must be large enough to ensure that the effects of multipath fading on the two discrete signals are sufficiently de-correlated; and
- space diversity, usually implemented with two or more receiving antennas with a vertical separation large enough to provide separate signal paths in which the impairments due to multi-path fading are sufficiently de-correlated.

In addition to the above recommendation, Chapter 4.3 of the ITU-R “*Handbook on Digital Radio Relay Systems*” provides useful guidance regarding the various diversity options and countermeasures available to the system planner, including an extensive listing of relevant references.

From a spectrum utilisation perspective, the use of frequency diversity represents an inefficient use of a limited spectrum resource, especially at locations where spectrum availability is a concern and where other viable diversity options are available.

As discussed in Annex 1 to ITU-R Recommendation F.1093 “*Effects of Multipath Propagation on the Design and Operation of Line-of-Sight Digital Radio-Relay Systems*”, space diversity is one of the most effective methods of combating multipath fading and improvements in path reliability offered by space diversity are at least equivalent to that of frequency diversity. Accordingly, from a spectrum utilisation perspective, the application of space diversity techniques should be considered in preference to frequency diversity.

In view of the above considerations, the use of frequency diversity is permitted only in situations where individual circumstances warrant the application of hybrid/multiple diversity methods (eg. extended hops over water or remote areas where spectrum demand is low) or where systems employ more than one active channel over a single path (i.e. one standby channel can be used for N active channels, where $N > 1$).

Note: The limitation on the application of frequency diversity will not normally be relaxed within designated HSDA locations.

3.3.5 Passive and “RF” repeaters

For the system planner, passive repeaters are sometimes a useful option in cases where the direct propagation path is severely obstructed (typically near end), but where another site, with path clearance to both ends of the wanted communication

¹⁷ Typically 3 to 5 % of the RF operating frequency.

link, can be used to direct sufficient signal energy around the obstacle to satisfy the overall system gain requirement. The most common types of passive repeaters include “back-to-back” antennas and “billboard” reflectors. A typical back-to-back configuration is demonstrated in Figure 3.3, where antennas with different azimuths are simply coupled together.

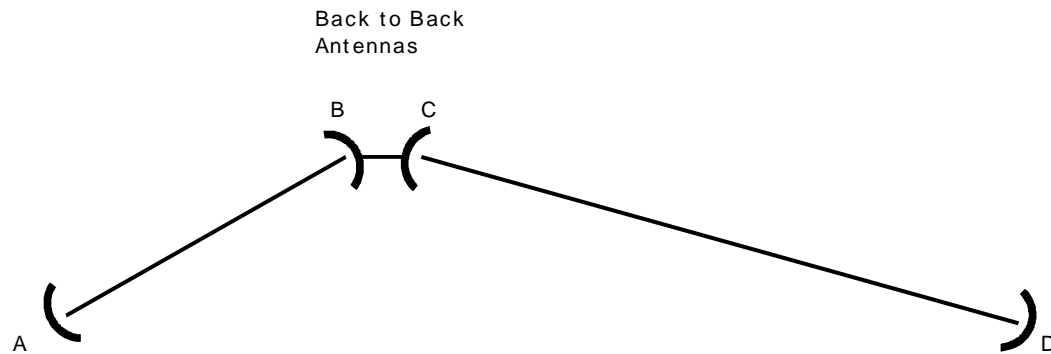


Fig 3.3 Passive repeater employing back-to-back antennas.

The total path losses via the repeater are calculated as the sum of losses (in dB) of the two individual hops. The transmit signal level (at the antenna connector) of the second hop is equal to the received signal level (at the antenna connector) of the first hop, less the attenuation (typically around 0.5 dB) of the intermediate feeder and connectors. The unwanted signal is the sum of the interferences received via each receiving antenna. For each potential interference source, separate calculations are required for each antenna involving separate discrimination angles. In order to reduce coupling to the direct (potentially interfering) propagation path, the antennas of the two radio paths are always orthogonally polarised.

Figure 3.4 demonstrates a passive repeater configuration implemented by the installation of a flat “billboard” reflector of a size commensurate with practical dimensional constraints and the need to obtain a reasonable system fade margin.

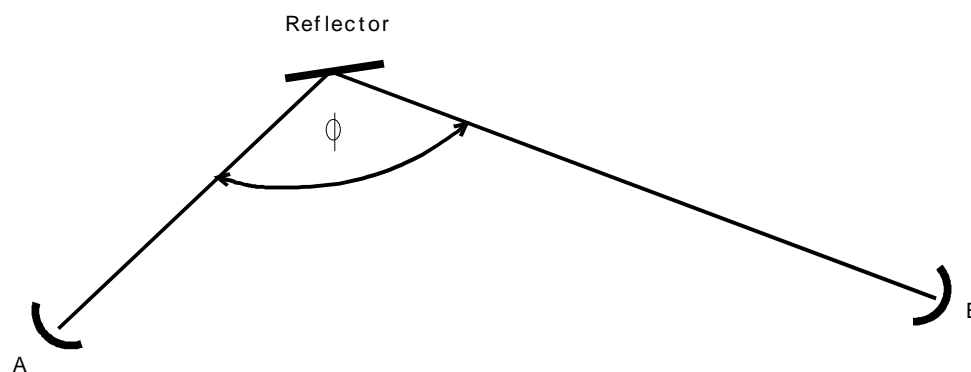


Fig 3.4 “Billboard” reflector passive repeater.

As with the back-to-back antenna case, path losses are calculated separately for each hop and interference can occur via the direct paths and the reflector. The gain of the reflector is given¹⁸ by:

$$G = 21.45 + 20 \log(f) + 10 \log \left[A \cos\left(\frac{\phi}{2}\right) \right] \quad (\text{dB})$$

where:

f - frequency in GHz

A - actual area of the reflector in m²; and

ϕ - angle between the incident and reflected beams

Passive repeaters offer practical and economic communication solutions in many situations. Nevertheless, their application is typically constrained by path geometry and terrain considerations. In addition to the need to obtain adequate system gain under normal operating conditions, the planner must ensure that the direct path signal (ie. an unwanted signal) remains well below the system threshold during periods of abnormal propagation.

RF repeaters are sometimes utilised to improve overall system gain of the otherwise “passive” or non-frequency translating repeater. The typical RF repeater consists of a class A linear amplifier inserted between the antenna ports of the intermediate repeater. Bidirectional RF amplification with a single amplifier block may be achieved using appropriate passband filtering, circulators and careful design, ensuring that sufficient isolation exists between “go/return” directions for stable operation.

From a spectrum utilisation and interference management perspective, passive and RF repeaters exhibit several potentially undesirable characteristics:

- Given the constraints on system gain (high overall path loss), systems utilising passive repeaters operate with characteristically low margins, necessitating significantly more stringent interference protection levels than other links;
- Such systems are susceptible to (cumulative) interference entering at multiple locations and azimuths;
- Since passive repeaters are “non-frequency translating”, significant problems can arise with respect to established network “site sense” criteria (see Part 3.3.3), particularly in situations where the passive repeater itself is collocated with other radiocommunication services operating within the same band; and
- RF repeaters will amplify any signal above the noise floor within the passband of its filters, including unwanted signals from other systems.

¹⁸ In accordance with “*Economic and Technical Aspects of the Choice of Transmission Systems*”, Appendix to Section B IV3 of the Handbook, ITU Geneva 1971.

All of these factors contribute (in varying degrees) to spectrum denial. Accordingly, the ACMA will not normally support the use of passive or RF repeaters within designated HSDA, at prime¹⁹ radiocommunication sites or other locations where their use may unreasonably impact upon the availability of spectrum to other users.

3.4 POINT-MULTIPOINT FIXED SERVICES

Several Australian fixed service allocations are designated for use by point-to-multipoint fixed services:

- The 1.5 GHz (1427-1535 MHz) Point-to-Multipoint Services band, supporting rural and remote area public telecommunication services²⁰; and
- The 3.4 GHz (3425-3492.5 MHz) band, supporting Wireless Local Loop (WLL) services.

3.4.1 Rural telephony (1.5 GHz DRCS) systems

DRCS point-to-multipoint systems are extensively deployed in rural and remote areas of Australia, facilitating the delivery of basic telecommunication services to locations where other service delivery mechanisms are impractical or too costly to implement. Australian rural telephony systems principally utilise the 1.5 GHz (1427-1535 MHz) DRCS band, although in some areas 500 MHz and “hybrid” 500/1500 MHz systems also operate. Spectrum within the band 1427-1535 MHz is shared between DRCS and regular point-to-point fixed services and, in accordance with the RF Channel Arrangements detailed in Appendix 1, separate but overlaid arrangements are specified for point-to-point and multipoint systems. As noted in Appendix 1, the operation of DRCS and other 1.5 GHz radiocommunication services is subject to the provisions of the “1.5 GHz Band Plan”, December 1996.

Given the inherent spectrum denial of DRCS hub stations (due to their omnidirectional antennas) and the unmanageable nature of potential interference between point-to-point links and uncoordinated DRCS outstations, the deployment of 1.5 GHz point-to-multipoint systems is not normally permitted within designated HSDA and operation in other areas with high point-to-point link densities should be avoided. All applications seeking point-to-multipoint operation within the band 1427-1535 MHz and which encroach upon designated HSDA must be referred to the Manager, Spectrum Planning and Engineering Team, Radiofrequency Planning Group for policy advice.

Specific guidance regarding the coordination of DRCS point-to-multipoint outstations with point-to-point links is provided in Appendix 8 “*Coordination of DRCS Outstations with Point-to-Point Links*”.

¹⁹ ie. Main trunk route or other shared use radiocommunication sites.

²⁰ Digital Radio Concentrator System (DRCS).

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4. FREQUENCY COORDINATION

This part of the RALI FX 3 provides an overview of the coordination process, outlines a basic method of frequency coordination for homogeneous microwave fixed services and suggests more detailed approaches which may facilitate successful coordination and improved spectrum utility. Guidance is also provided for the coordination of microwave fixed services with other types of radiocommunication services.

The basic method and other approaches outlined in this part seek to identify the key technical considerations which need to be taken into account as part of the coordination process. Other than the requirement of compliance with any mandatory assignment instructions²¹, spectrum management related planning requirements and good engineering practice, the coordination methodology outlined is not intended to be prescriptive. It is accepted that there will be some variation in the implementation of coordination methods, which in some instances may be manual but more often are reliant on the application of integrated database tools, additional information and computer based modelling techniques.

4.1 AN OVERVIEW OF THE COORDINATION PROCESS

The purpose of the microwave fixed service frequency coordination process is to determine the compatibility of a proposed new fixed link service with existing services operating on a particular channel frequency in a given geographical area. Depending upon individual circumstances, coordination may be required for a single new link or a complete network/radio-relay route. For the purposes of description, the coordination of multiple fixed links may be considered as simply an extension of the principles given for a single fixed microwave service.

Accurate information regarding the technical and operational characteristics of the proposed new system and any potentially affected services must be available before the coordination process can be properly invoked. Data for existing licensed services may be obtained from the ACMA's RRL database. The technical details of any proposed new link will normally be provided by the prospective licensee as part of a licence application. Typically, the following should be considered as the minimum data set necessary to initiate the most basic level of coordination:

- the applicant's preferred frequency band;
- geographic coordinates (location) of the transmit and receive sites;
- system type/capacity/emission details;
- nominal mean (coordinated) transmit power; and
- antenna type and characteristics.

²¹ As specified in Appendix 1 for each fixed link frequency band.

The accuracy of the coordination data should be consistent with the level of confidence necessary for a proper assessment against the applicable interference management criteria. In cases where the available information falls short of the necessary level of confidence to constitute a valid assessment, further advice should be sought from the licence applicant. However, it is recognised that it is often difficult to obtain timely detailed information and under some circumstances it may be acceptable, depending upon the level of spectrum utility sought, to make conservative assumptions regarding specific coordination parameters.

The following sub-parts outline the basic method of frequency coordination.

4.2 BASIC METHOD OF FREQUENCY COORDINATION FOR TERRESTRIAL FIXED SERVICES

The basic method of frequency coordination applicable to proposed new terrestrial fixed service systems is outlined as follows:

1. Identify all homogeneous microwave fixed services operating within the coordination area of the proposed new service that may affect or be affected by the deployment of the proposed new service;
2. Calculate the wanted signal and interference levels to/from the proposed new service and the existing services within the coordination area;
3. Evaluate the compatibility of the proposed new link by comparing the calculated levels of interference against the relevant interference management criteria;
4. Check the compliance of the proposed assignment against the relevant specific assignment instructions and general spectrum policy requirements; and
5. Consider any relevant inter-service and non-homogeneous fixed service coordination requirements, including geostationary orbit protection in the bands shared with space radiocommunication services.

An overview of the basic method of frequency coordination is given in the flowchart in Figure 4.1. A detailed discussion of the method and related considerations is provided in the following sub-parts.

In addition to the coordination methodologies and requirements discussed in this part of the RALI, the user is also reminded of the need to consider and take account of the general radiocommunication policy requirements detailed in Part 3 “*Coordination and System Planning Rules*”.

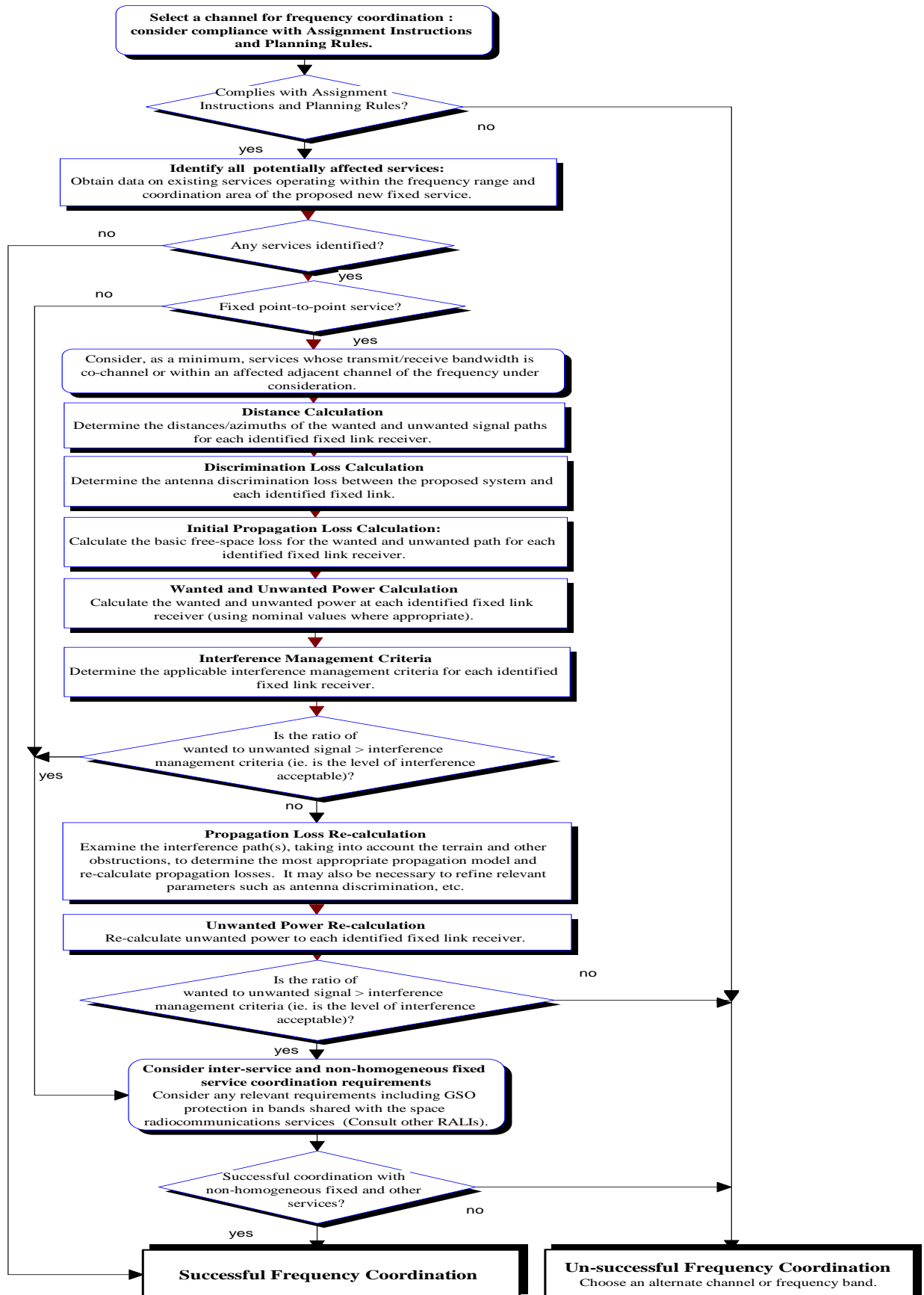


Figure 4.1. An overview of the basic method of frequency coordination.

4.2.1 Identifying potentially affected services

In order to effectively identify existing microwave fixed services which may affect, or be affected by, the deployment of a proposed new service it is necessary to establish:

- the frequency limits applicable to the coordination - normally being at least one full channelwidth²² on either side of the channel centre frequency being coordinated (ie. co-channel and the first adjacent channel, with channelwidth as defined in the relevant RF Channel Arrangement); and
- a coordination area, geographically defining the extent of necessary coordination.

The purpose of identifying a coordination area is to facilitate a reduction in the size of the dataset of services to be coordinated, by excluding from further consideration the services located outside of a defined coordination area and for which detailed interference studies should be unnecessary. A coordination area is defined by a radius distance, centred upon the respective sites of the proposed new link (i.e. a separate coordination area is defined for each end of the link). Recommended minimum coordination radius distances for the 1.5 to 50 GHz bands are given in Table 4.1.

f (GHz)	Coordination Radius (km)
$1.5 \leq f < 10$	200
$10 \leq f < 20$	150
$20 \leq f$	100

Table 4.1 Recommended minimum coordination distances.

In practice, the generic distances in Table 4.1 should be adequate for most cases. However, the given coordination radii represent a necessary compromise between the need to identify significant potential interference sources/victims and the burden of unnecessary coordination²³. Thus, a small but finite probability exists that a proposed new fixed link may interfere with or receive interference from a station located beyond the above defined coordination distance. Clearly, that risk is greater in situations where high (victim and/or interferer) site elevations are involved. In such cases, it is appropriate to extend the coordination area in the direction of the boresight azimuth of the proposed new service.

No universal coordination area model exists which can be confidently used under all circumstances and variations in approach may be necessary to account for local factors such as band specific equipment, terrain and geoclimatic statistics. In some cases, where these factors are known and well defined, it may be useful to develop a detailed coordination area model adapted for, and taking account of, local topography and propagation conditions. An example of such an approach is described in ITU-R Recommendation F.1095 “A Procedure for Determining Coordination Area Between

²² Also taking account of any overlap with superseded or overlaid existing channel arrangements.

²³ Note: This is not necessarily of great concern, eg. if computer based coordination methods are used then doubling the coordination radius distance may only result in a marginal increase in overall processing time.

Radio-Relay Stations of the Fixed Services". The majority of microwave fixed services are bidirectional, utilising separate go/return channels as defined in the relevant RF Channel Arrangements. Accordingly, the interference scenario is unique for each direction of transmission and interference to/from the proposed new system needs to be evaluated separately for each operating frequency.

A typical example of a potential interference scenario (for one direction of transmission, ie. a single frequency) is presented in Figure 4.2, where link 'AB' designates an existing service and link 'CD' is a proposed new service. The potential interference paths (AD & CB), with the corresponding transmit and receive antenna discrimination angles (θ and ϕ respectively) relative to the respective antenna "boresight" azimuths are also shown. Since fixed links predominantly employ directional antennas, the relative azimuths of the interference source and the victim antennas are a key factor in establishing the relationship between interference and the wanted signal.

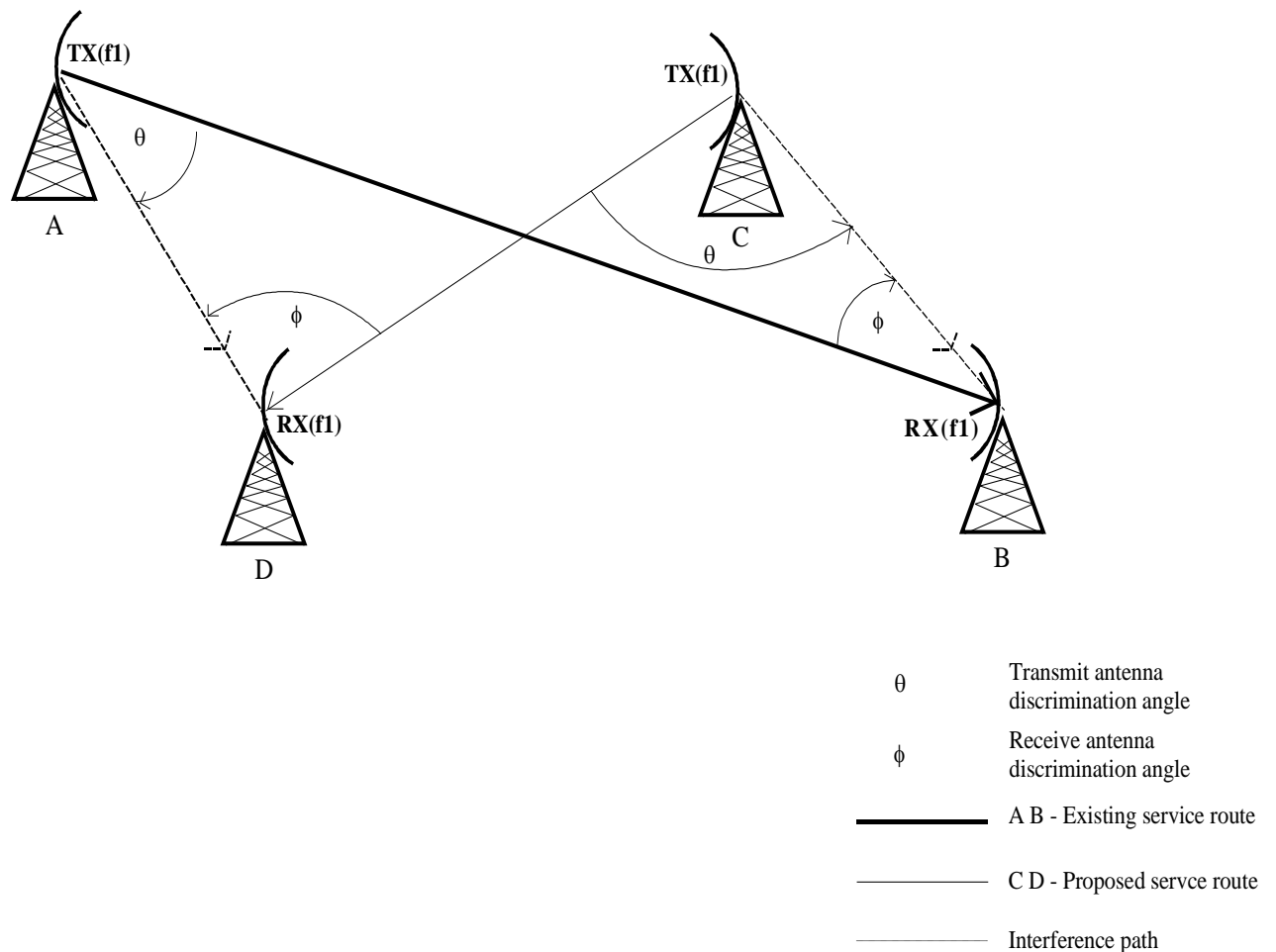


Figure 4.2. Example of wanted signal (AB, CD) and interference paths (AD, CB)

In practice, the typical coordination scenario is much more complicated than the simple example shown and care needs to be taken to ensure that all potentially significant interference source paths are adequately identified and assessed. The effective interference power level at any potential victim receiver is equal to the sum of the individual interference entries (see Part 4.2.3). However, unless two or more entries are of a similar order (i.e. of equivalent power), the worst case interferer will typically emerge as the dominant element of the coordination.

Note: Calculation algorithms for path distance, antenna azimuths and other relevant coordinate geometry related information are detailed in the “*Australian Geodetic Datum Technical Manual*”, National Mapping Council 1986. Input data into such calculations should take account of the considerations outlined in Part 3.3.1 “*Geographic Coordinates*”.

4.2.2 Calculating received signal levels

The received (wanted or unwanted) signal power can be expressed as:

$$P_r = P_t + G_t - L_t - L_b + G_r - L_r$$

where :

- P_r - RF signal power at the input to the receiver (dBm);
- P_t - RF signal power at the output of the transmitter (dBm);
- G_t - gain of the transmitting antenna in the azimuth of the receiver (dBi);
- L_t - feeder and branching losses associated with the transmitter (dB);
- L_b - total transmission loss between the transmit and receive antennas (dB);
- G_r - gain of the receiving antenna in the azimuth of the transmitter (dBi);
- L_r - feeder and branching losses associated with the receiver (dB).

The above parameters are discussed in detail in the following sub-parts.

Transmit power (P_t)

The transmit power²⁴ is the nominal mean (coordinated) power level to which the transmitter is set during system commissioning. The level is measured at the transmitter output port, but the actual power level thus obtained must be reduced by an amount equal to any fixed attenuator fitted between the output port and the antenna feed system. Note that for fixed systems operating with ATPC, the coordinated transmit power may be significantly less than the system maximum transmit power – refer to Appendix 9 “*Adaptive Transmit Power Control*” for details.

²⁴ Hard limits apply in respect to the maximum power that may be delivered to the antenna of a fixed service system (refer to Part 3.2.2).

Net fixed losses (L_t and L_r)

Includes transmission line and any branching losses associated with combiners, connectors and any special antenna feed system configuration (eg. hot standby) arrangements. These fixed losses may be considered insignificant and disregarded in the case of terminals with integral antennas.

However, for systems utilising separate feeder/antenna arrangements, transmission line and branching losses are significant and their magnitude can potentially determine the success or failure of individual instances of coordination. Waveguide is normally associated with microwave fixed services, but air and foam dielectric coaxial feeders are also common in the lower bands.

The end-to-end attenuation of a transmission line is dependent upon the frequency of operation, the length of the line and the actual type of line used. Accordingly, transmission line attenuation should be calculated using the manufacturers loss per unit length (normally dB/metre) specification for the actual waveguide/coaxial feedline used, at the frequency of operation. Thus fixed losses may be calculated as:

$$L = \alpha d + B \quad (\text{dB})$$

where:

- L = net fixed loss (dB) at the transmit (L_t) or receive (L_r) end of a link;
- α = specific attenuation (per metre) of the feeder, as per manufacturers data;
- d = length of the feeder run (metres); and
- B = Total branching losses (dB), as per manufacturers specification.

If the length of the feeder run (from the antenna flange to the equipment) is not already established, then a reasonable estimate may be obtained using:

$$d = h_a - h_g + l_1 + l_2 \quad (\text{metres})$$

where:

- h_a = height of the antenna on the tower;
- h_g = height of the feeder gantry above the base of the tower;
- l_1 = length of the feeder gantry from the tower to the hut; and
- l_2 = length of the feeder tail to the waveguide flange/coaxial connection.

Note: The ACMA's current RRL assignment database does not record such fixed losses. Accordingly, under the basic method of coordination and pending the incorporation of such information into the database, the assumption must be made that wanted and unwanted signals are attenuated to the same degree (ie. the same C/I ratio is maintained) and accounted for through reciprocity.

Antenna parameters (G_t , G_r)

Microwave fixed services normally utilise linearly polarised parabolic antennas with a circularly symmetric response about their main axis of radiation (boresight azimuth). Antenna response is typically described in terms of a Radiation Pattern Envelope (RPE), providing an estimate of antenna gain relative to its on-axis gain (G_o), for the full (360°) range of azimuths and for the two orthogonally polarised components of the radiated signal.

In evaluating a system link budget (ie. the wanted signal level), only the on-axis gains (G_o) of the co-polar transmit and receive antennas need to be considered since reciprocal azimuths are involved, ie. the net effective link antenna gain (transmit + receive) is simply the sum $G_t + G_r$. The value of G_o may or may not be the same in each case, depending upon the actual antennas used at each end of a link.

However, in the case of an interference path, the effective gains of the interfering and victim antennas in the direction of the interference path may be expressed in terms of the on-axis gain (G_{ot} and G_{or} for the transmitter and receiver respectively) and a reduction factor proportional to a discrimination angle:

$$G_t = G_{ot} - G_\theta \quad (\text{at the transmitter}); \text{ and}$$

$$G_r = G_{or} - G_\phi \quad (\text{at the victim receiver}).$$

Here the parameters θ and ϕ refer to the difference between the respective boresight and interference path azimuths, as shown in the example in Figure 4.2. The actual discrimination (dB) value for a given angle is obtained using the antenna RPE.

In cases where the interference source and victim antennas are cross-polarised, both of the orthogonal components of antenna gain need to be considered, corresponding to:

- the cross-polar response of the victim receive antenna to the component of signal radiated on the intended polarity by the transmitting antenna; and
- the co-polar response of the victim receive antenna to the component of signal radiated on the unintended polarity by the transmitting antenna.

Thus in the cross-polar case, it is necessary to evaluate the co-polar and cross-polar components of the transmit and receive angles at their respective discrimination angles. The net effective antenna gain (transmit + receive) in the direction of the interference path is given by:

$$(G_t + G_r) = 10 \log \left(10^{\frac{(G_{tH} + G_{rH})}{10}} + 10^{\frac{(G_{tV} + G_{rV})}{10}} \right) \quad (\text{dB})$$

where the terms G_{tH} , G_{rH} and G_{tV} , G_{rV} are parameters for the respective horizontally (H) and vertically (V) polarised components of the transmit and receive antenna gain in the interference path azimuth.

Calculating transmission loss (L_b)

The total transmission loss (L_b) between two ideal antennas, can be summarised²⁵ as consisting of two principal components:

- a (time invariant) basic free space loss (L_{bf}); and
- additional attenuation due to terrain, atmospheric absorption and other physical attributes associated with a particular propagation path (L_m).

The total transmission loss is then given by:

$$L_b = L_{bf} + L_m \quad (\text{dB})$$

For the basic method, path clearance over the wanted signal path is assumed and for an initial assessment, often only the free-space loss (coupled with antenna discrimination) over the wanted and unwanted signal paths needs to be considered. If the corresponding level of interference complies with the specified interference management criteria, then more complex propagation analyses involving the L_m component need not be initiated. The free-space loss may be calculated using the formula:

$$L_{bf} = 32.4 + 20\log f + 20\log d \quad (\text{dB})$$

where: f - frequency (MHz); and
 d - distance (km).

In cases where the levels calculated with the free-space model exceed the relevant interference management criteria, detailed propagation models characterising the nature of the L_m component may be invoked. Application of the appropriate propagation model/s is important in obtaining an accurate representation of this component of transmission loss. Fixed service propagation models based on relevant ITU-R recommendations are outlined in Appendix 4 “*Fixed service propagation modelling*”

4.2.3 Assessing received signal levels against interference management criteria

For the basic method of frequency coordination, a generic interference management methodology and criteria based on the concept of a Protection Ratio (PR) is adopted. The PR defines a minimum ratio of the relative levels of wanted and unwanted (interference) signals at the input port of the (potential) victim receiver. The protection ratios required for the coordination of analogue and digital systems are defined in Appendix 1 for each microwave frequency band.

The wanted-to-unwanted signal power ratio at the input of a potential victim receiver is given by:

$$\frac{W}{U} \text{ (dB)} = \text{Wanted signal power (dBm)} - \text{Unwanted signal power (dBm)}$$

²⁵As outlined in ITU-R Recommendation P.341-4 “*The concept of Transmission Loss for Radio Links*”.

The unwanted signal power represents an aggregate interference level the value of which is obtained through the summation of individual interference entries:

$$U = 10 \log \left(\sum_1^k 10^{\frac{U_k}{10}} \right) \quad (\text{dBm})$$

where $k=1$ defines the case where a single source is deemed dominant.

The wanted to unwanted signal ratio is then compared against the relevant protection ratios defined in Appendix 1. For a successful coordination, this ratio must be greater than the protection ratio, ie. the following relation must be satisfied:

$$\frac{W}{U} \geq *PR$$

* NOTE: For digital systems, appropriate corrections must be applied to the normalised (for a specific path length) PR values given in the Appendix 1 tables, using the correction factor graphs also provided in Appendix 1 for each frequency band. The correction takes account of the victim system's actual path length and its geographic location in terms of the relevant worst month multipath fading statistics P_L (%) and/or rainfall intensity rate R (mm/hr), as determined using the geoclimatic contour maps²⁶ provided in Annex A to Appendix 1.

4.2.4 Compliance with assignment instructions and planning rules

In addition to the assessment of interference levels and interference management criteria, it is necessary to ensure that the proposed new fixed link service complies with the relevant assignment instructions (including any special notes) specified in Appendix 1 and the planning rules detailed in Part 3 (eg. "site sense", diversity options). Where specific references are included as part of an assignment instruction (eg. to other administrative instructions or statutory instruments, which includes embargoes and legally binding band plans), then the requirements of such documents must also be taken into account, unless clearly of an advisory nature (eg. RF channel arrangement source recommendations).

A discussion of the application of Assignment Instructions and other relevant spectrum management and fixed service engineering policy matters is provided under Part 3 "*Coordination and System Planning Rules*". Additionally, circumstances under which variations in the (RALI) specified fixed service policy may be supported, are discussed in Appendix 6 "*Application of Assignment Policy Rules*".

4.2.5 Coordination with other types of radiocommunication services

Most of the spectrum allocations utilised by microwave fixed services are shared with various other (fixed and non-fixed) types of radiocommunication services²⁷. Accordingly, in addition to the specific coordination procedures and criteria defined

²⁶ As reproduced from ITU-R Recommendations P.453-5 "*The Radio Refractive Index: its formula and Refractivity Data*" and P.837 "*Characteristics of Precipitation for Propagation Modelling*".

²⁷ As detailed in the "*Australian Radiofrequency Spectrum Plan*".

in this document for the homogeneous fixed microwave service, it is also necessary to consider:

- the potential for interference to/from other types of radiocommunication services (ie. inter-service coordination and/or coordination with other types of non-homogenous fixed services²⁸); and
- the potential for interference to/from space radiocommunication services operating in the Geostationary Orbit (GSO) and compliance with the relevant provisions of Article 21 of the ITU Radio Regulations (on “orbit avoidance”).

Non-homogenous fixed and inter-service coordination

Specific RALIs exist to address some instances of the coordination of microwave fixed services with non-homogenous fixed or other radiocommunication services, eg. RALI MS 26 “*Coordination of Microwave Fixed Services with Earth Stations*”. References to relevant RALI documents are incorporated within the assignment instructions for each (Appendix 1) microwave fixed service band and a consolidated list of such RALIs is included in the Reference section of this document. In addition to the protection of the GSO (see Appendix 5) specific guidance on two particular cases of coordination between the fixed service and non-homogenous fixed/other services, is provided in the following appendices:

- Appendix 7 “*Coordination of Apparatus Licences with Spectrum Licences: 1.8, 2.1 and 2.2 GHz Fixed Services*”; and
- Appendix 8 “*Coordination of DRCS Outstations with Point-to-Point Links*”. Refer also to Part 3.4.1 “*Rural Telephony (1.5 GHz DRCS) Systems*”.

²⁸ For example, Multipoint Distribution Systems (MDS).

Due to the diversity and complexity of sharing situations which may arise, it is not possible to provide rigorous and explicit procedures covering all coordination requirements. In these cases, coordination defaults to the identification of all non-homogeneous services in the band in question, followed by a manual assessment of their impact on the interference environment.

Criteria defining the protection requirements of microwave fixed services are provided in relevant ITU-R recommendations. In particular, ITU-R Recommendation F.758 “*Considerations in the development of criteria for sharing between the terrestrial fixed service and other services*” provides some useful generic guidance in this regard. Guidance regarding the protection requirements of other radiocommunication services may be obtained from the recommendations specific to that service, such as the SF Series of recommendations which address sharing issues between the fixed service and the fixed-satellite service.

Geostationary Satellite Orbit avoidance

Fixed services operating in the same frequency band/s as satellites in the geostationary orbit are required to ensure that (fixed service) emissions do not cause harmful interference to sensitive satellite receivers. Additionally, fixed service receivers may suffer interference from space station emissions, depending upon the fixed service receiver antenna azimuth/elevation and the power flux density (pfd) of the space station emission at the location under consideration. Appendix 5 “*Geostationary Satellite Orbit Avoidance*” describes the restrictions on fixed service azimuth and EIRP for all frequency bands in general, as well as for particular frequency bands within which tighter restrictions apply. Additionally, a methodology is described which facilitates a basic assessment of the long-term interference to the fixed service which may be caused by emissions from satellites operating in the GSO.

4.3 CONSIDERATIONS WHICH MAY FACILITATE SUCCESSFUL COORDINATION

An unfavourable comparison of the wanted-to-unwanted signal power ratio against the applicable protection ratio would indicate that coordination is not possible under the given set of circumstances. In this case, the only available course of action may be to attempt coordination within another channel or frequency band. However, it must be remembered that the basic method of frequency coordination represents a generic approach, intended to accommodate the criteria consolidated from a wide range of fixed service systems. Accordingly, in many cases where an initial assessment results in only a marginal failure against the relevant protection ratio, a successful coordination may be facilitated through the application of measures such as those described in the following paragraphs.

4.3.1 Detailed Interference Analyses

Detailed interference analyses may incorporate:

- a re-calculation of the transmission losses attributed to the interference path, based on detailed terrain (ie. path profile) analyses and the application of relevant propagation models, in accordance with the principles outlined in Appendix 4;

- a more rigorous interference management criteria assessment based on the specific characteristics and protection requirements of the individual victim system undergoing coordination;
- consideration of the relationship of the victim and interfering system power spectral density functions, with consequent FDR (as outlined in Spectrum Planning Report SPP 4/95); and
- a careful reconsideration/refinement of the other assumptions and factors used as part of the initial assessment (eg. antenna angular and cross-polar discrimination, fixed losses and other factors relevant to a particular case).

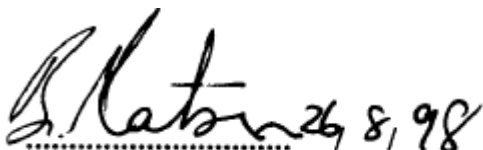
4.3.2 Interference Countermeasures

The incorporation of appropriate countermeasures as part of the detailed link planning process may provide a critical contribution towards facilitating a successful coordination. For example, such countermeasures may be implemented at the interference source (transmit) and/or at the victim (receive) locations by:

- ensuring that full advantage is taken of antenna cross-polar discrimination, if not already taken into account;
- increasing the system gain of the victim service, typically by installing antennas with higher on-axis gain (ie. larger diameter parabolic dishes);
- increasing antenna discrimination in the azimuth of the interference path, for example through the utilisation of higher performance antennas and/or by deliberately exploiting near end path clearance to advantage (ie. antenna location shielding); and
- reducing transmit power at the interfering system transmitter (i.e. by placing a fixed attenuator between the transmitter output port and the antenna feed/branching network), in cases where significant excess fade margin is available over the wanted signal path (of the interfering system) or through the use of ATPC.

Of course the viability of the above (and other) countermeasures will depend upon individual circumstances and should be considered in conjunction with the system planner as part of the overall detailed link design.

RALI Authorisation



Barry Matson
Executive Manager
Spectrum Planning and Standards Group
Australian Communications Authority

GLOSSARY

BER - Bit Error Rate

CTS - Cordless Telecommunications Services

DRCS - Digital Radio Concentrator System

DSP - Digital Signal Processing

EIRP - Effective Isotropic Radiated Power

ENG - Electronic News Gathering

FDM/FM - Frequency Division Multiplex/Frequency Modulation

FDR - Frequency Dependant Rejection

GSO - Geostationary Orbit

HSDA - High Spectrum Demand Areas

LOS - Line of Sight

MDS - Multipoint Distribution Station

PDH - Plesiochronous Digital Hierarchy

RADCOM - The ACMA Radiocommunications licensing database

RPE - Radiation Pattern Envelope

SDH - Synchronous Digital Hierarchy

STL - Studio-to-Transmitter Link

TDM - Time Division Multiplex

TDMA - Time Division Multiple Access

TOB - Television Outside Broadcast

WLL - Wireless Local Loop

REFERENCES

This section consolidates the references incorporated as part of the RALI FX 3 “*Microwave Fixed Services Frequency Coordination*” document, including detailed Appendices. The following listing incorporates references to ACMA statutory and administrative instruments, ITU Radio Regulations, relevant recommendations and other standards. Further references and information resources are also provided for material which may have been used during the development of the RALI and/or which may be considered otherwise useful in the fixed service coordination context.

ACMA

“*Radiocommunications Act 1992*”.

“*Australian Radiofrequency Spectrum Plan*”.

“*Radiocommunications Licence Conditions (Fixed) Licence Determination No.1 of 1997*”.

“*1.5GHz Band Plan*”, December 1996.

“*1.9 GHz Band Plan*”, 14 March 1996.

“*2.1 GHz Band Frequency Band Plan 2002*”, 17 September 2003.

“*Mobile Satellite Service (2GHz) Frequency Band Plan 2002*”, 23 April 2002.

“*Radiocommunications Apparatus Licence Fees and Charges*”.

Spectrum Re-allocation Declaration No. 3 of 1997.

Spectrum Re-allocation Declaration No. 4 of 1997.

Information Paper “*Principles for Decision Making*”.

“*Radiocommunications (Spectrum Re-allocation) Declaration No. 2 of 2000*.”

“*Radiocommunications (Spectrum Designation) Notice No.1 of 2000*” [January 2000].

ACMA RALIs

FX 9 “*Frequency Coordination of Fixed Links with Regional MDS Services*”.

FX 14 “*Point to Multipoint Fixed Services in Specified Parts of the 3.4-3.59 GHz Band*”.

FX 18 “*Frequency Coordination and Licensing Procedures for Fixed Wireless Access Services Sharing the 1.9 GHz Band with Fixed Links*”.

MS 3 “*Spectrum Embargoes*”.

MS 11 “*Licence Text in RADCOM (Incorporating Special Conditions and Advisory Notes)*”.

MS 24 “*Apparatus Licence Periods*”.

MS 25 “*Frequency Coordination and Licensing Procedures for Cordless Telecommunications Services Sharing the 1.9 GHz Band with Fixed Links*”.

MS 26 “*Coordination of Microwave Fixed Services with Earth Stations*”.

ACMA SPECTRUM PLANNING POLICY DOCUMENTS

SP 1/90, “*Spectrum and Licensing Arrangements for Outside Broadcast Television Services*” March 1990.

SP 5/90, “*Notional Antenna Radiation Patterns*”, Department of Transport and Communications, July 1990.

SPP 3/95, “*Television Outside Broadcast (TOB) Service - 7.2 GHz and 8.3 GHz RF Channel Arrangements*”, July 1995.

SPP 4/95, “*Frequency Dependent Rejection (FDR) Software*”, May 1995.

SPP 4/96, “*Interim Channel Arrangements for the 18 GHz Band - A Discussion Paper*”, September 1996, and Addendum 1 to that paper, “*New Interim Arrangements in the 18 GHz Band*”.

SP 10/01, “*Coordination Information for Defence Aeronautical Mobile Telemetry Systems Operating in the 2200 to 2300 MHz Frequency Range*”.

SP 08/01, “*Microwave fixed services: Survey of commercially manufactured (1.5-58 GHz) parabolic antennas*” June 2001

SP05/03, “*Proposal for Spectrum Efficient Antenna Performance Regulatory Criteria for use in the Fixed Service Microwave Bands*”, June 2003

SP 04/04, “*Spectrum Efficient Antenna Performance Regulatory Criteria Proposal - Summary and Discussion of Responses*”, April 2004

ITU DOCUMENTS

ITU Radio Regulations.

“ITU-R Handbook on Digital Radio-Relay Systems”, Geneva 1996.

“Economic and Technical Aspects of the Choice of Transmission Systems”, Appendix to Section B IV3 of the Handbook, ITU Geneva 1971.

ITU-R F-Series (Fixed Service) Recommendations

F.283-5 *“Radio-frequency channel arrangements for low and medium capacity analogue or digital radio-relay systems operating in the 2 GHz band”*.

F.382-6 *“Radio-frequency channel arrangements for radio-relay systems operating in the 2 and 4 GHz bands”*.

F.383-5 *“Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band”*.

F.384-5 *“Radio-frequency channel arrangements for medium and high capacity analogue or high capacity digital radio-relay systems operating in the upper 6 GHz band”*.

F.385-6 *“Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band”*.

F.386-4 *“Radio-frequency channel arrangements for radio-relay systems operating in the 8 GHz band”*.

F.387-6 *“Radio-frequency channel arrangements for radio-relay systems operating in the 11 GHz band”*.

F.497-4 *“Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band”*.

F.595-4 *“Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band”*.

F.635-2 *“Radio-frequency channel arrangements based on a homogeneous pattern for radio-relay systems operating in the 4 GHz band”*.

F.636-3 *“Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band”*.

F.637-2 *“Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band”*.

F.701 *“Radio-frequency channel arrangements for analogue and digital point-to-multipoint radio systems operating in frequency bands in the range 1.427 to 2.690 GHz (1.5, 1.8, 2.0, 2.2, 2.4 and 2.6 GHz)”*.

F.746 *“Radio-frequency Channel Arrangements for Radio-Relay Systems”*.

F.747 “Radio-frequency channel arrangements for radio-relay systems operating in the 10 GHz band”.

F.749-1 “Radio-frequency channel arrangements for radio-relay systems operating in the 38 GHz band”.

F.752 “Diversity Techniques for Radio-Relay System”.

F.758 “Considerations in the development of criteria for sharing between the terrestrial fixed service and other services”.

F.1099 “Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4400-5000 MHz) band”.

F.1093 “Effects of Multipath Propagation on the Design and Operation of Line-of-Sight Digital Radio-Relay Systems”.

F.1095 “A procedure for determining coordination area between radio-relay stations of the fixed service”.

F.1098-1, “Radio-frequency channel arrangements for radio-relay systems operating in the 1 900 - 2 300 MHz Band”.

F.1100 “Radio-Frequency Channel Arrangements for Radio-Relay Systems Operating in the 55 GHz band”.

F.1247 “Technical and operational characteristics of systems in the Fixed Service to facilitate sharing with the Space Research, Space Operation and Earth-Exploration Satellite Services operating in the bands 2025-2110MHz and 2200-2290 MHz”.

F.1249 “Maximum Equivalent Isotropically Radiated Power of transmitting stations in the Fixed Service operating in the frequency band 25.25-27.5 GHz shared with the Inter-Satellite Service”.

ITU-R P-Series (Propagation) Recommendations

P.310-9 “Definitions of terms relating to propagation in non-ionised media”.

P.341-4 “The concept of Transmission Loss for Radio Links”.

P.452-7 “Prediction Procedure for the Evaluation of Microwave Interference between stations on the Surface of the Earth at frequencies above about 0.7 GHz”.

P.453-5 “The Radio Refractive Index: its formula and Refractivity Data”.

P.526-4 “Propagation by diffraction”.

P.530-6 “Propagation data and Prediction Methods required for the design of Terrestrial Line-of-Sight Systems”.

P.581-2 “The concept of Worst Month”.

P.676 “Attenuation by atmospheric gases”.

P.834 “*Effects of tropospheric refraction on radiowave propagation*”.

P.837 “*Characteristics of Precipitation for Propagation Modelling*”.

P.838 “*Specific Attenuation Model for Rain for use in Prediction Methods*”.

P.841 “*Conversion of annual statistics to worst-month statistics*”.

ITU-R SF-Series (FS/FSS Frequency Sharing) Recommendations

SF.406 “*Maximum Equivalent Isotropically Radiated Power of Radio-Relay System Transmitters Operating in the Frequency Bands Shared with the Fixed-satellite Service*”.

SF.765 “*Intersection of Radio-Relay Antenna beams with orbits used by Space Stations in the Fixed-Satellite Service*”.

SF.766 “*Methods for determining the effects of interference on the performance and the availability of terrestrial radio-relay systems and systems in the fixed-satellite service*”.

SF.1004 “*Maximum equivalent isotropically radiated power transmitted towards the horizon by earth stations of the fixed satellite service sharing frequency bands with the fixed service*”.

SF.1005 “*Sharing between the fixed service and the fixed-satellite service with bidirectional usage in bands above 10 GHz currently unidirectionally allocated*”.

SF.1006 “*Determination of the interference potential between earth stations of the fixed-satellite service and stations in the fixed service*”.

SF.1193 “*Carrier-to-interference calculations between earth stations in the fixed-satellite service and radio-relay systems*”.

Other

“*Spectrum Management Issues Relevant to Telecommunications*”, Spectrum Management Agency, August 1996.

“*The Australian Geodetic Datum Technical Manual (National Mapping Council 1986)*”.

Australian Standard AS 3516.2 “*Siting of radiocommunications facilities - Part 2 Guidelines for fixed, mobile and broadcasting facilities at frequencies above 30 MHz*”.

“*Frequency Coordination Procedures for Microwave Communication Services*”, W. Yates and P. Hilly, August 1990.

Part 101 “*Fixed Microwave Services*” of the FCC Rules, Pike & Fischers Communication Regulations.

“*Catalogue of Software for Radio Spectrum Management*”, ITU Radiocommunication Bureau, Geneva 1997.

“*Analysing antenna performance in microwave radio interference environment*”, E.S. Lensson, A. Kerans, G. French, IEEE Asia Pacific Conference (Sydney 3-6 December 2000)

Useful Web Links

<i>http://www.acma.gov.au</i>	Australian Communications and Media Authority.
<i>http://www.ga.gov.au</i>	Geoscience Australia, Department of Industry, Tourism and Resources.
<i>http://www.itu.int</i>	International Telecommunication Union.
<i>http://www.nsma.org</i>	National Spectrum Managers Association (USA).
<i>http://www.fcc.gov</i>	Federal Communications Commission (USA).
<i>http://www.ntia.doc.gov</i>	National Telecommunications and Information Administration (USA).
<i>http://www.ero.dk</i>	European Radiocommunications Office

APPENDIX 1: RF Channel Arrangements and Assignment Instructions

This appendix to the RALI FX 3 “*Microwave Fixed Services Frequency Co-ordination*” specifies radio frequency channel arrangements and important assignment instructions for the fixed service microwave frequency bands currently supported in Australia. The interpretation and application of the information provided in this appendix is subject to the provisions of the relevant parts (Parts 2, 3 and 4) of RALI FX 3. The arrangements are based mainly upon ITU-R Recommendations and have been implemented by ACMA and its predecessors through a process of progressive development over many years.

For ease of reference and in order to facilitate the ongoing maintenance of the document, the arrangements are provided in a modular format for each band. Each individual band module incorporates the applicable RF channel arrangements, assignment instructions and other band specific coordination criteria in the form of antenna requirements, protection ratios and protection ratio correction factors, as described in the coordination methodology detailed in Part 4 of this RALI. Relevant ITU-R recommendations, complementary RALIs and other supporting documents are also referenced. In each module, specific assignment instructions are provided for the following assignment criteria :

- Typical Use;
- Assignment Priority;
- Minimum Path Length;
- Antenna Requirements; and
- Notes covering special arrangements, such as restrictions.

Every microwave fixed service assignment application should be routinely checked for compliance against all relevant RALI specified assignment criteria. Detailed guidance regarding the above assignment instructions and their application is provided in Part 3.1 of the RALI and Appendix 6 “*Application of Assignment Policy Rules*”. Where a specific assignment instruction refers to another document, eg. another RALI or a Band Plan, then the user must take steps to ensure that any resulting action also complies with the relevant provisions given in the referenced document.

Any consistent anomalies resulting from the application of the assignment instructions or where clarification of the scope and/or application of a specific assignment instruction is considered necessary, policy advice should be sought from the Manager, Spectrum Engineering Section, Spectrum Planning Branch, ACMA.

A short form summary of the currently supported Australian microwave fixed service bands is provided in the following pages and is intended as a guide only. Specific information should be checked against the relevant detailed frequency band module(s).

MICROWAVE FIXED SERVICE BANDS - TYPICAL UTILISATION PARAMETERS

Band (GHz)	Frequency Range (MHz)	Designated Use	Typical Use	Typical Capacity	Min Path Length (km)	Channel Width(s) (MHz)	RF Channel Arrangement
1.5	1427 - 1535 ¹	Low & Med. Capacity P-P	Radio Relay	2 Mbit/s	20	4	-
1.5 DRCS	1427 - 1535 ¹	Fixed Radio Access	Rural & Remote area (USO) services	0.7 – 2 Mbit/s	-	2	ITU-R Rec. F.701
1.8	1700 - 1900 ³	Low & Med. Capacity P-P	Radio Relay	8/17 Mbit/s	20	14	ITU-R Rec. F.283-5
1.8	1710 - 1880 ²	<i>Spectrum Licensed Band⁵ (typically GSM/GPRS Mobile services)</i>					
2.1	1900 – 2170 ²	<i>Spectrum Licensed Band⁵ (typically 3G Mobile services)</i>					
2.1	1900 - 2300 ²	Low & Med. Capacity P-P	Radio Relay, FM Video	34 Mbit/s	20	29	ITU-R Rec. F.382-6
2.2	2025 - 2285 ^{2,3}	Medium Capacity P-P	Radio Relay	34 Mbit/s	20	14	ITU-R Rec. F.1098-1
2.3	2302 - 2400 ²	<i>Spectrum Licensed Band (typically FWA subscriber-access services)</i>					
2.5	2500 - 2690 ²	<i>Spectrum Licensed Band</i>					
3.4	3400 - 3700	<i>Spectrum Licensed Band</i>					
3.8	3580 – 4200 ⁴	High Capacity	Long Haul (Intercapital) Radio Relay	140/155 Mbit/s	20	40	ITU-R Rec. F.635-2
5	4400 - 5000	<i>Defence Use</i>					
6	5925 - 6425	Med. & High Capacity P-P	Medium Haul Radio Relay	34/197 Mbit/s	20	29.65/59.3	ITU-R Rec. F.383-5
6.7	6425 - 7110	High Capacity	Long Haul (Intercapital) Radio Relay	140/155/298 Mbit/s	20	40/80	ITU-R Rec. F.384-5
7.2	7100 - 7425	Television Outside Broadcast (TOB)	Itinerant use TOB video links	FM Video	-	8	-
7.5	7425 - 7725	Low & Med. Capacity P-P	Medium Haul Radio Relay	2 – 17 Mbit/s	20	14/7/3.5/1.75	ITU-R Rec. F.385-6
8	7725 - 8275	Med. & High Capacity P-P	Medium Haul Radio Relay	34/197 Mbit/s	10	29.65/59.3	ITU-R Rec. F.386-4
8.3	8275 - 8400	TOB	Itinerant use TOB video links	FM Video	-	28	-
10	10.55 - 10.68	Low & Med. Capacity P-P	Urban Networks	2-34 Mbit/s & FM Video	5	14/7	ITU-R Rec. F.747
11	10.7 - 11.7	High Capacity	Medium Haul Radio Relay & Urban Networks	155/298 Mbit/s	5	40/80	ITU-R Rec. F.387-6

(...continued on following page)

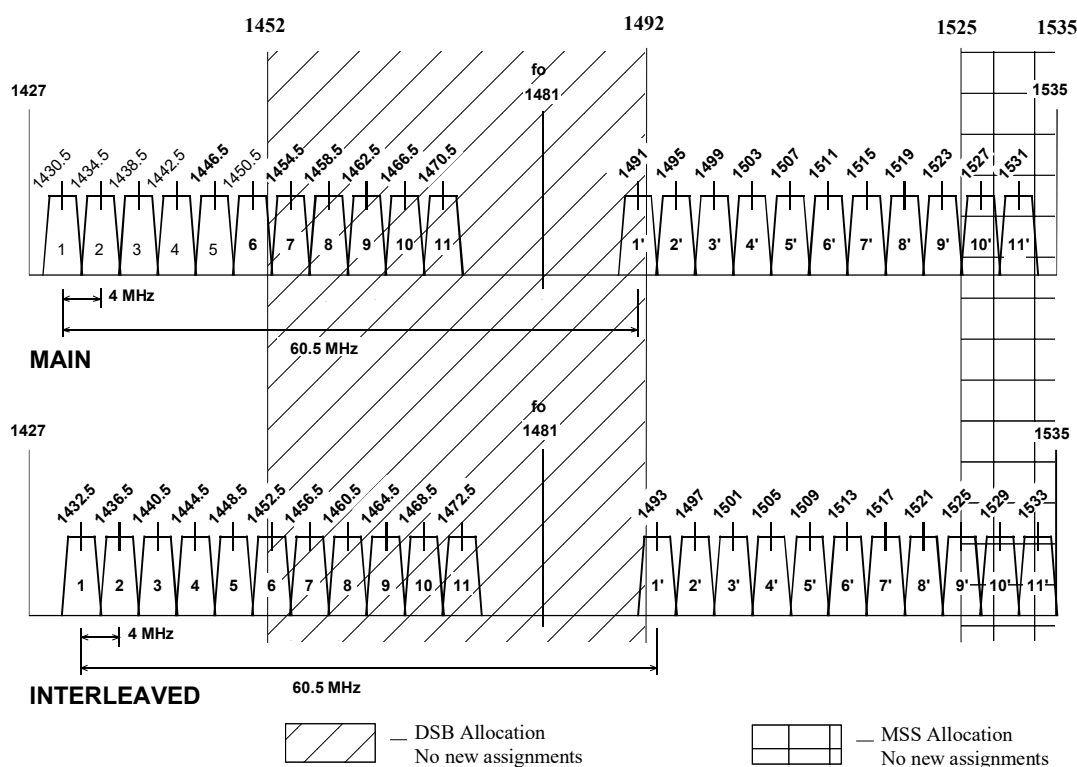
Microwave Fixed Service Bands - Typical Utilisation Parameters (...continued from previous page)

Band (GHz)	Frequency Range (GHz)	Designated Use	Typical Use	Typical Capacity	Min Path Length (km)	Channel Width(s) (MHz)	RF Channel Arrangement
13	12.75 - 13.25	Med. Capacity P-P & TOB	Video links in urban areas	FM Video & 34/68 Mbit/s	-	28	ITU-R Rec. F.497-4
15	14.5 - 15.35	Low & Med. Capacity P-P	Urban Networks	2-68 Mbit/s	5	28/14/7	ITU-R Rec. F.636-3
18	17.7 - 19.7 ²	Low to High Capacity P-P	Urban Networks	2-155 Mbit/s	2	55/27.5/13.75/7.5	ITU-R Rec. F.595-4
22	21.2 - 23.6	Low & Med. Capacity P-P & TOB	Urban networks & itinerant TOB video links	2-34 Mbit/s, FM video	-	56/50/28/14/7	ITU-R Rec. F.637-2
27	26.5 – 27.5 ²	<i>Spectrum Licensed Band⁵ (typically FWA/LMDS services)</i>					
28	27.5 – 29.5	High Capacity P-P	Urban & MTS backhaul	155-310 Mbit/s	-	28/56/112	ITU-R Rec. F.749-1
38	37 - 39.5	Low & Med. Capacity P-P	Urban & MTS backhaul	2-34 Mbit/s	-	28/14/7	ITU-R Rec. F.749-1
49	49.2 - 49.95	Itinerant P-P	Temporary Links	-	-	40	-
50	50.4 - 51.15	Low Capacity P-P	Urban Networks	-	-	40	

1. Use of the 1.5 GHz (1427-1535 MHz) band is subject to the provisions of the “1.5GHz Band Plan”, December 1996.
2. These bands are subject to a spectrum embargo, as specified in RALI MS 3 “*Spectrum Embargoes*”.
3. Only parts of the 1.8, 2.1 and 2.2 GHz bands are available for use by apparatus licensed microwave fixed services due to spectrum licensing in the band. Refer to the relevant Assignment Restrictions for the affected frequency ranges and areas. Methods for coordination with the spectrum licensed bands and areas are set out in the 1.8, 2.1 and 2.2 GHz Channel Arrangements, Assignment Instructions and Assignment restrictions and also Appendix 7.
4. ITU-R Rec. F.635-2 specifies the channel arrangement for this band, but channels 1-6 are no longer available for assignment. Refer to the 3.8 band details in Appendix 1.

THE 1.5 GHz BAND (1427-1535 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by low capacity fixed point-to-point links.

- Typical Use** : 2 Mbit/s data
- Assignment Priority** : not specified, See Note 1.
- Minimum Path Length** : 20 km
- Antenna Requirements** : refer to Appendix 11

Notes:

1. The use of this band is subject to the provisions of Reference 1, constraining the availability of some channels for new fixed services.
2. The spectrum 1427 to 1535 MHz is also used by 1.5 GHz DRCS services in rural and remote areas.
3. All assignments that have emissions in the 1452 – 1492 or 1518-1535 MHz ranges shall be endorsed with Advisory Note BL that states “This frequency band is currently under review to accommodate changes in technology. This review may lead to a requirement to change frequency or cease transmissions”.

Reference

1. The “*1.5 GHz Band Plan*”, December 1996.

THE 1.5 GHz BAND (1427-1535 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on 2 and 4 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	2 MHz → 2 MHz	2 MHz → 4 MHz	4 MHz → 2 MHz	4 MHz → 4 MHz
0	60	60	60	60
2	30	55	47	55
4		27	20	30
6				8

2. Protection ratios required by digital systems operating on 2 and 4 MHz channels against interference from analogue systems operating on 2 and 4 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Analogue Interferer Tx → Digital Victim Rx			
	2 MHz → 2 MHz	2 MHz → 4 MHz	4 MHz → 2 MHz	4 MHz → 4 MHz
0	60	60	60	60
2		30	30	60
4				20

3. Protection ratios required by analogue systems operating on 2 and 4 MHz channels against interference from digital systems operating on 2 and 4 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Analogue Victim Rx			
	2 MHz → 2 MHz	2 MHz → 4 MHz	4 MHz → 2 MHz	4 MHz → 4 MHz
0	60	60	60	60
2	10	10	10	30

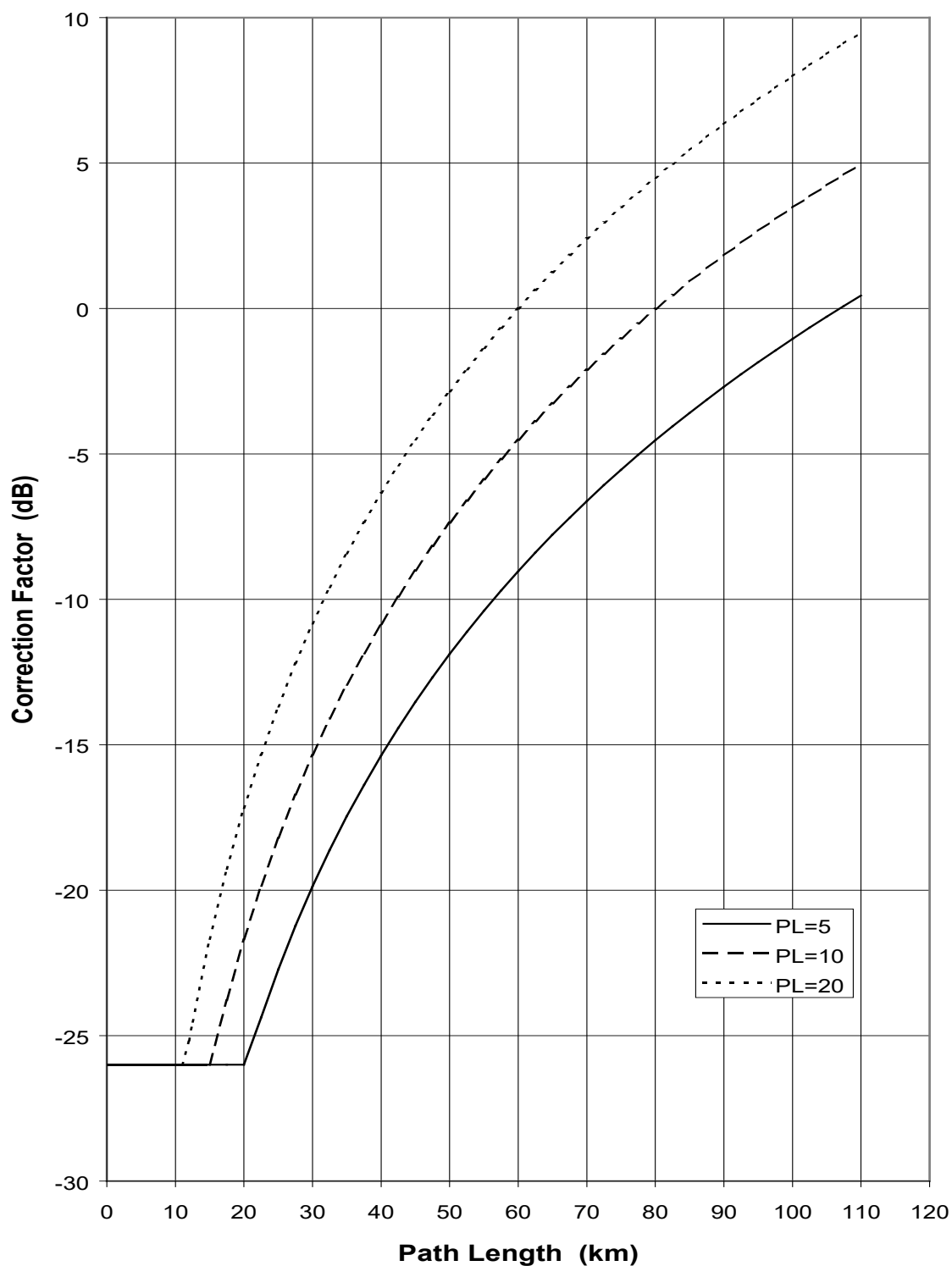
Notes:

1. Protection ratio for digital systems are based on a 60 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.

THE 1.5 GHz BAND (1427-1535 MHz)

PROTECTION RATIO CORRECTION FACTORS

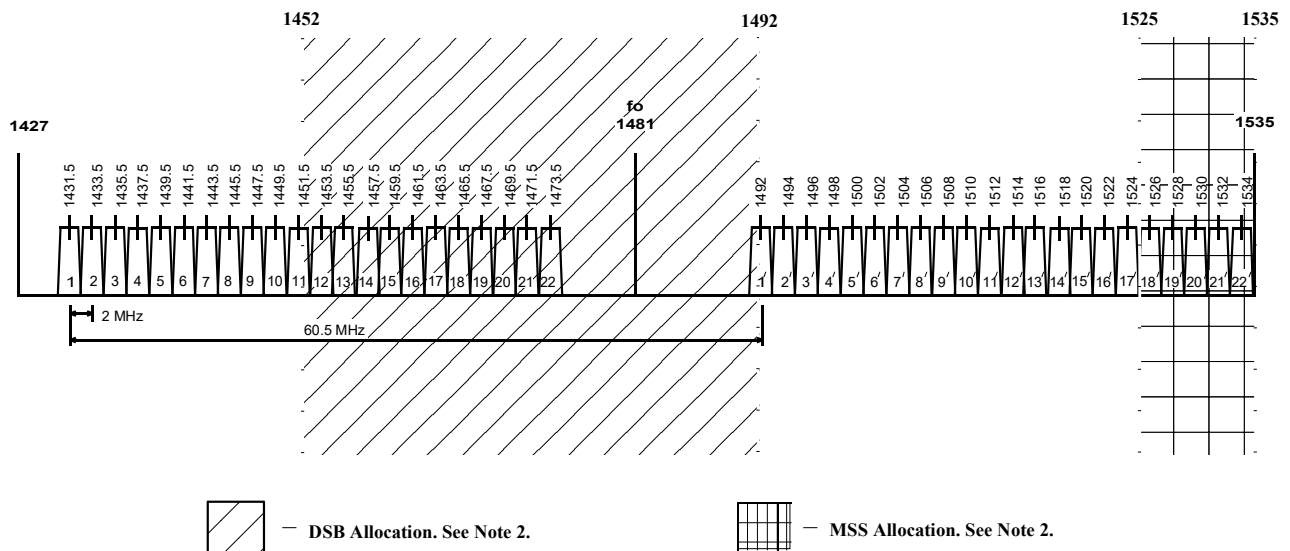
MULTI PATH



P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

**THE 1.5 GHz DRCS BAND (1427-1535 MHz)
(Point-to-Multipoint Services)
RF CHANNEL ARRANGEMENTS**



ASSIGNMENT INSTRUCTIONS

This band is designated for use by point-to-point and point-to-multipoint fixed links used for the delivery of public telecommunications services in rural and remote areas (see Reference 1).

Typical Use	: Digital Radio Concentrator Systems (DRCS).
Assignment Priority	: See Notes 2b and 3a
Minimum Path Length	: not applicable
Antenna Requirements	: not specified

Note:

1. The use of these arrangements is restricted to rural and remote areas.
- 2a. Assignments for DRCS systems (or upgrades to DRCS systems) may not be made in parts of Australia that are less than 200 km from the GPOs any of the following locations: Sydney, Melbourne, Brisbane, Adelaide, Perth, Hobart, Canberra, Albury, Horsham and Port Macquarie.
- 2b. Channel assignment restrictions apply. No further point-to-multipoint assignments may be made on channels 20/20', 21/21' or 22/22' and new point-to-multipoint assignments on channels 11 to 19 and channel 1', 18' and 19' are restricted to cases where interference considerations preclude the use of other channels in the band. In such cases an "assign lowest channel first" rule applies.
- 2c. All assignments that have emissions in the 1452 – 1492 or 1518-1535 MHz ranges shall be endorsed with Advisory Note BL that states: "This frequency band is currently under review to accommodate changes in technology. This review may lead to a requirement to change frequency or cease transmissions".
- 3a. Assignments for broadband wireless access (BWA) systems may in some circumstances be made in parts of this band. Assignments for BWA services may

not be made in high or medium density areas (see Schedule 1 of Reference 3). Assignments for BWA systems may only be made on channels 2/2' to 10/10' and, pending the future revision of Reference 1, shall be subject to case-by-case consideration by the Manager, Spectrum Planning and Engineering.

- 3b. Assignments for broadband wireless access (BWA) systems shall be endorsed with the following Special Condition and Advisory Note:

Special Condition:

“The transmitting equipment authorised by this licence shall employ automatic transmit power control (ATPC).”

Advisory Note

“Note:

- (a) remote station receivers will be afforded protection from harmful interference only from services provided that they: operate within 15 km of their associated base station; have an antenna with a height above sea level no greater than that of their associated base station antenna; and, have an antenna gain no greater than 11 dBi.*
- (b) remote station transmitters must not cause interference to other services beyond the levels that would be caused if they: were located within 15 km of their associated base station; have an antenna with a height above sea level no greater than that of their associated base station antenna; operate with a transmitter power of no more than 30 dBm; and, have an antenna gain no greater than 11 dBi”.*

References

1. The “1.5 GHz Band Plan”, December 1996.
2. Rec. ITU-R F.701, “Radio-frequency channel arrangements for analogue and digital point-to-multipoint radio systems operating in frequency bands in the range 1.427 to 2.690 GHz (1.5, 1.8, 2.0, 2.2, 2.4 and 2.6 GHz)”.
3. Radiocommunications (Transmitter Licence Tax) Determination 2003 No.2

THE 1.5 GHz DRCS BAND (1427-1535 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on 2 and 4 MHz channels.

Frequency Offset MHz	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	2 → 2 MHz	2 → 4 MHz	4 → 2 MHz	4 → 4 MHz
0	60	60	60	60
2	30	55	47	55
4		27	20	30
6				8

2. Protection ratios required by digital systems operating on 2 and 4 MHz channels against interference from analogue systems operating on 2 and 4 MHz channels.

Frequency Offset MHz	PROTECTION RATIO (dB)			
	Analogue Interferer Tx → Digital Victim Rx			
	2 → 2 MHz	2 → 4 MHz	4 → 2 MHz	4 → 4 MHz
0	60	60	60	60
2		30	30	60
4				20

3. Protection ratios required by analogue systems operating on 2 and 4 MHz channels against interference from digital systems operating on 2 and 4 MHz channels.

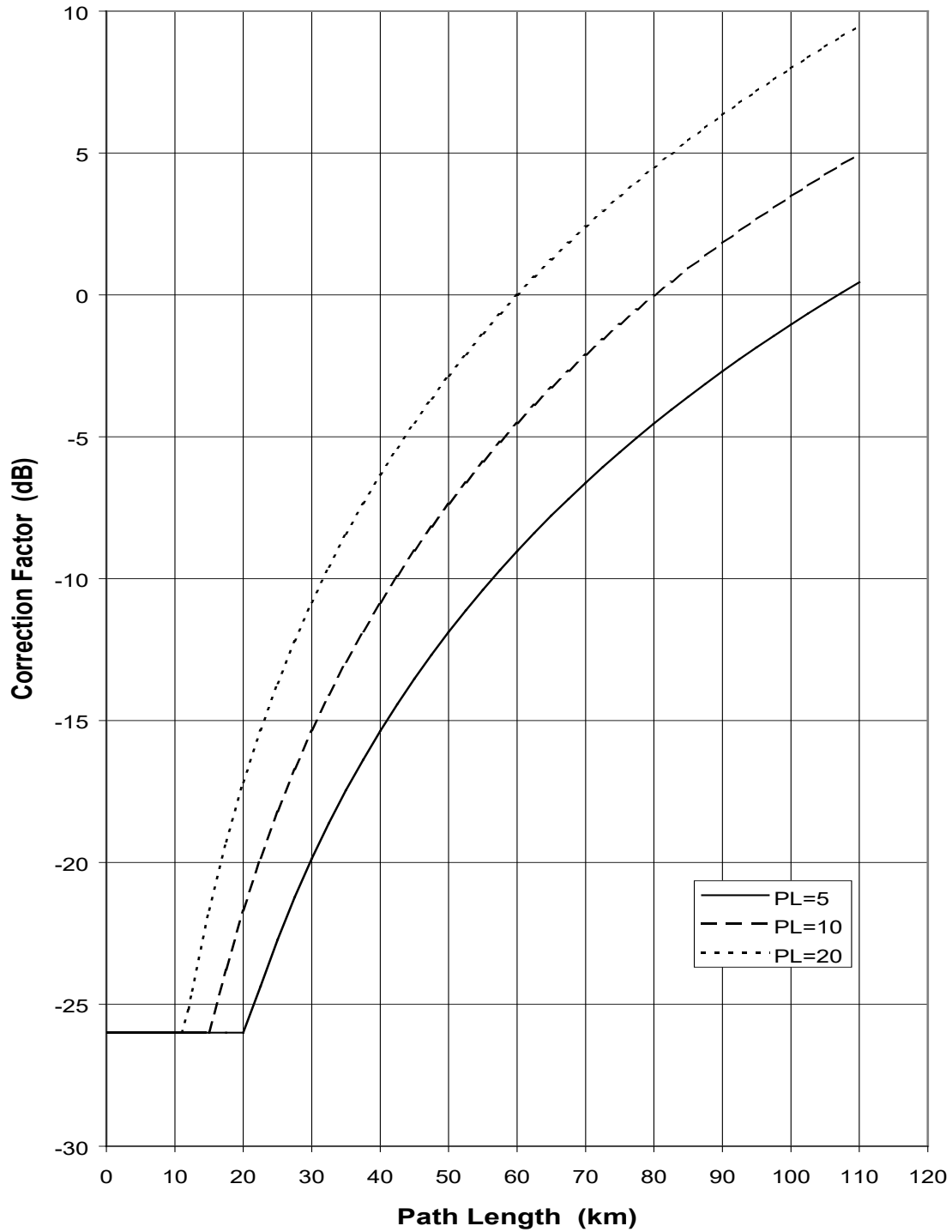
Frequency Offset MHz	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Analogue Victim Rx			
	2 → 2 MHz	2 → 4 MHz	4 → 2 MHz	4 → 4 MHz
0	60	60	60	60
2	10	10	10	30

Note: Protection ratio for digital systems are based on a 60 km path length and $P_L=20$. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.

THE 1.5 GHz DRCS BAND (1427-1535 MHz)

PROTECTION RATIO CORRECTION FACTORS

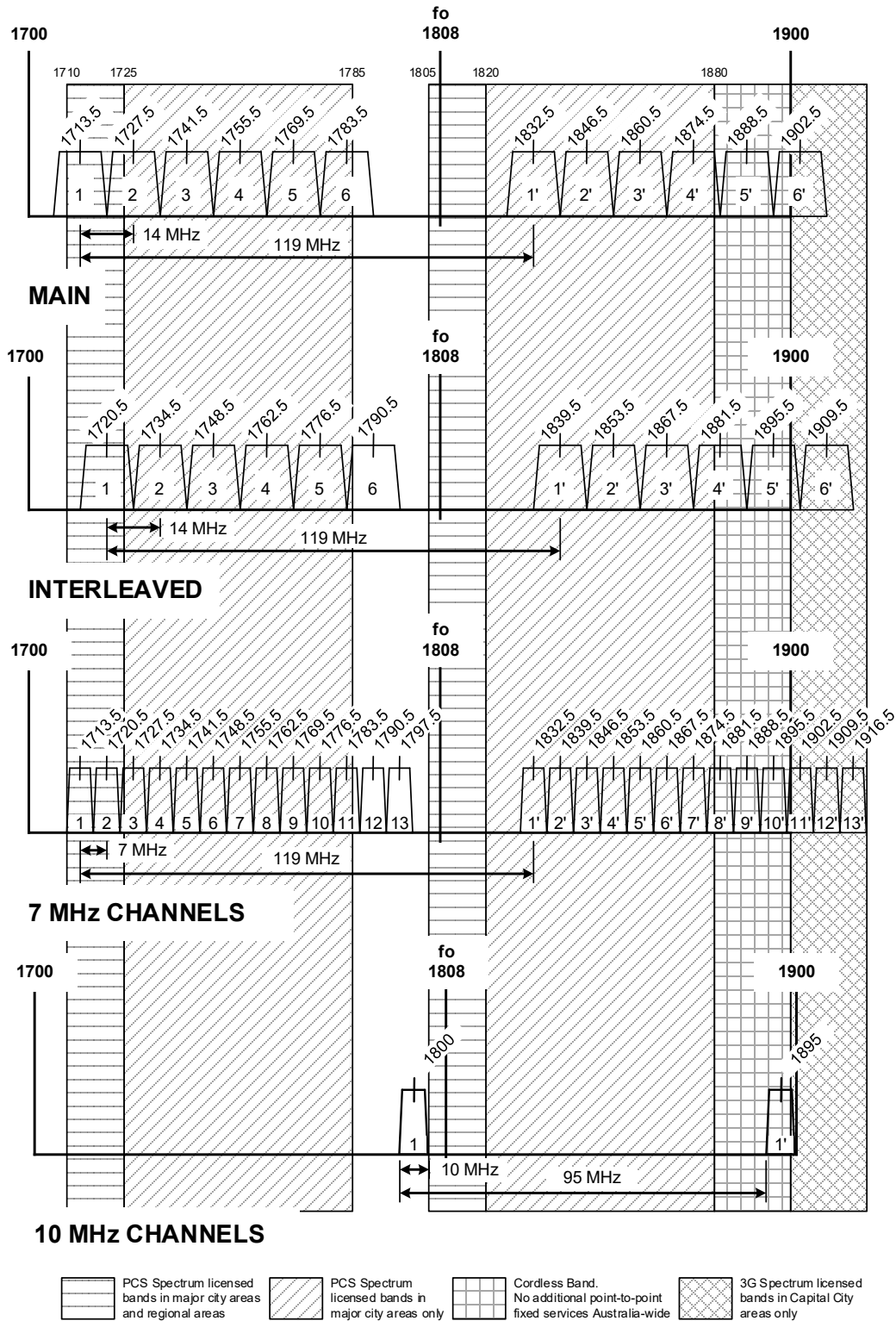
MULTIPATH



PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

THE 1.8 GHz BAND (1700 - 1900 MHz)



ASSIGNMENT INSTRUCTIONS

This band is designated for use by low and medium capacity fixed point-to-point links.

Typical Use	: 8/17 Mbit/s data
Assignment Priority	: not specified
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

THE 1.8 GHz BAND (1700 - 1900 MHz)

Notes:

1. Some channels are not available for assignment (Assignment Restrictions 1).
2. Proposed fixed link assignments must be coordinated with spectrum licences operating in 1800 MHz (1710-1785 MHz and 1805-1880 MHz) and 2 GHz (1900-1980 MHz) bands (Assignment Restrictions 2 and ref. 5).
3. Note potential for interference to/from fixed services operating in the upper channels of the 1.8 GHz band to/from adjacent 2.1 GHz band fixed services.
4. Note potential for interference to adjacent Met-Sat services near 1.7 GHz from channel 1 of the 14 MHz channel main raster and channels 1 and 2 of the 7 MHz channel raster.
5. DELETED
6. New and existing apparatus licensed assignments in all areas and with emissions in the frequency range 1710 -1880 MHz shall be endorsed with Advisory Note BL.
7. DELETED
8. New apparatus licensed assignments in spectrum license space and with emissions in the frequency ranges 1710-1785 MHz and 1805-1880 MHz are embargoed (ref. 5).
9. Prospective new apparatus licensed assignments within specified zones around specified radio astronomy facilities and with emission bandwidths in the frequency range 1250-1780 MHz must be notified to CSIRO (ref. 12).
10. The 7 MHz channel raster is to support migration of existing assignments with an emission bandwidth of 7 MHz or less from the 14 MHz raster. No new services are to be assigned on the 7 MHz raster.
11. The 10 MHz channels have been defined to support the migration of existing assignments with an emission bandwidth of 10 MHz or less from the 14 MHz channel raster. No new services are to be assigned on the 10 MHz channels. The ACMA intends to review these arrangements before 2019. This review will include consideration of the appropriate long term arrangements and whether new fixed links could be facilitated.
12. All assignments on the 10 MHz channels shall be endorsed with Special Condition C15 and Advisory Note C16 (see Assignment Restriction 6).

References:

1. Rec. ITU-R F.283-5, *"Radio-frequency channel arrangements for low and medium capacity analogue or digital radio-relay systems operating in the 2 GHz band"*.
2. [1.9 GHz Spectrum Arrangements \(1880 - 1900 MHz\)](#)
3. DELETED
4. DELETED
5. RALI MS 3, *"Spectrum Embargoes"*, Embargo 26.
6. DELETED
7. DELETED
8. DELETED
9. DELETED
10. DELETED
11. DELETED
12. RALI MS 31, *"Notification Zones for Apparatus Licensed Services around Radio Astronomy Facilities"*.
13. The *"1900-1920 MHz Frequency Band Plan 2012"*, 26 March 2012

THE 1.8 GHz BAND (1700 - 1900 MHz)

Assignment restrictions:

1. Channels that may NOT be assigned.

1.1 1785-1805 MHz & 1880-1900 MHz In these frequency ranges, no new assignments can be made on any channels that overlap this frequency range (ref .2). However, in line with note 11, existing services can be migrated to the a 10 MHz channel arrangements provided no assignments are made within the *Areas of high mobile use* as defined in Schedule 4 of the *Radiocommunications (Unacceptable Levels of Interference – 1800 MHz Band) Determination 2012*

1.2 Spectrum Licences Apparatus licensing is not permitted in those frequencies and areas subject to spectrum licensing, refer RALI MS 3 Embargo 26 (ref. 5). Therefore, no new assignments are to be made in certain areas in the 1800 MHz bands (1710 to 1785 MHz and 1805 to 1880 MHz) and the 2 GHz band (1900 to 1980 MHz) due to spectrum licensing (refs. 5).

1.3 Affected Channels See Tables 1 and 2 for details on affected channels.

2. Coordination requirements with 1800 MHz and 2 GHz band spectrum licenses.

Proposed fixed link assignments must be coordinated with spectrum licences operating in the 1800 MHz (1710 - 1785 MHz and 1805 - 1880 MHz) and 2 GHz (1900 - 1980 MHz) bands in accordance with Appendix 7 of this RALI. Proposed fixed link assignments planned for co-channel operation with respect to spectrum licences in areas adjacent to spectrum licensed areas must be coordinated with spectrum licences if they are within a threshold distance of 200 km of the spectrum licence boundary. Proposed fixed link assignments planned for adjacent channel operation with respect to spectrum licences inside or adjacent to spectrum licence boundaries must also be coordinated. Tables 1 and 2 detail the affected channels.

Note: The terms ‘remote’, ‘regional’ and ‘major city’ are used to describe areas in the context of 1.8 GHz band spectrum licensing. ‘Major city’ and ‘regional areas’ are those areas that have been re-allocated or designated for spectrum licensing. All other areas are defined as ‘remote’ areas.

3. Coordination requirements with CTS.

The operation of private CTS devices in the 1.9 GHz band are authorised by the *Radiocommunications (Cordless Telecommunications Devices) Class Licence 2014*. Under the class licensing arrangements, CTS devices are not coordinated with other services, as such, existing fixed services in this band are not protected from CTS transmitter interference.

4. Coordination with existing fixed link assignments.

In addition to the coordination requirements stated above, proposed new assignments must be coordinated with existing fixed link assignments in accordance with normal FX-3 assignment procedures.

THE 1.8 GHz BAND (1700 - 1900 MHz)

5. Channels available for assignment.

See Tables 1 and 2 for channels available for assignment.

6. Special condition and Advisory Note for assignments using the 10 MHz channel arrangements

To manage interference into devices operating under an 1800 MHz band spectrum licence, all assignments shall be endorsed with Special Condition C15.

Special Condition C15:

If necessary to facilitate coordination with other services (irrespective of which licence was issued first-in-time), the licensee shall reduce the radiated unwanted emissions of each station authorised by this licence so they do not exceed the levels defined in Schedule 3 of the Radiocommunications Advisory Guidelines (Managing Interference to Spectrum Licensed Receivers – 1800 MHz Band) 2012

1800 MHz band spectrum licensees are not expected to coordinate the operation of transmitters that are exempt from registration (e.g. mobile devices and femtocells) and operating in the 1710-1785 MHz band with fixed links operating on the 10 MHz channel arrangements. Consequently, any such apparatus licensed fixed services are not protected from interference caused by these devices. Advisory Note C16 must be attached to all fixed service licences issued on the 10 MHz channel arrangements to ensure licensees are aware of this.

Advisory Note C16:

Radiocommunications receivers authorised to operate under this licence are not protected from interference caused by radiocommunications transmitters operating under a spectrum licence in the 1710-1785 MHz frequency range.

THE 1.8 GHz BAND (1700 - 1900 MHz)

Table 1: Channel Arrangements (Lower Channel Set) - Channel Availability and Restrictions and Inter-Service Coordination.

Channel Number (14 MHz)	Channel Number (7 MHz)	Channel Number (10 MHz)	Centre (MHz)	Channel Availability and Restrictions			Inter-Service Coordination
				1.8 GHz Major City Areas*	1.8 GHz Regional Areas*		
				Adelaide, Brisbane, Melbourne, Perth, and Sydney	Canberra, Darwin and Hobart	Area A - Eastern Region and Area B Western Region	All Other Areas
1M	1M		1713.5	Not Available (ref. 5)			1.8 GHz Spectrum Licences (within 200 km of a Spectrum Licence boundary).
1I	2M		1720.5				
2M	3M		1727.5				
2I	4M		1734.5				
3M	5M		1741.5				
3I	6M		1748.5				
4M	7M		1755.5				
4I	8M		1762.5				
5M	9M		1769.5				
5I	10M		1776.5				
6M	11M		1783.5				
6I	12M		1790.5				
	13M		1797.5	Not Available (Assignment restriction 1.1)			
		1M	1800	Only available for migration of existing services in 14 MHz channels to 10 MHz channels (Notes 11, Assignment Restrictions 1.1 & 6).			

* See ref. 5 for definition of these areas.

Note: if BW > 11MHz coordination with major city spectrum licences will be required if proposed station is within 200km of the major city spectrum licence boundary.

THE 1.8 GHz BAND (1700 - 1900 MHz)

Table 2: Channel Arrangements (Upper Channel Set) - Channel Availability and Restrictions and Inter-Service Coordination.

Channel Number (14 MHz)	Channel Number (7 MHz)	Channel Number (10 MHz)	Centre (MHz)	Channel Availability and Restrictions			Inter-Service Coordination
				1.8 GHz/2 GHz Major City Areas*	1.8 GHz/ 2GHz Regional Areas*		
				Adelaide, Brisbane, Melbourne, Perth, and Sydney*	Canberra, Darwin and Hobart**	Area A - Eastern Region and Area B Western Region***	All Other Areas
1M'	1M'		1832.5	Not Available (ref. 5)			1.8 GHz Spectrum Licences (within 200 km of a Spectrum Licence boundary).
1I'	2M'		1839.5				
2M'	3M'		1846.5				
2I'	4M'		1853.5				
3M'	5M'		1860.5				
3I'	6M'		1867.5				
4M'	7M'		1874.5				
4I'	8M'		1881.5	Not Available (Assignment Restriction 1.1)			Not Available (Assignment Restriction 1.1)
5M'	9M'		1888.5				
		1M'	1895	Not Available (Assignment Restriction 1.1)			Only available for migration of existing services in 14 MHz channels to 10 MHz channels (Notes 11, Assignment Restrictions 1.1 & 6).
5I'	10M'		1895.5				
6M'	11M'		1902.5	Not Available (ref. 5)			2GHz Spectrum Licences (within 200 km of a Spectrum Licence boundary).
6I'	12M'		1909.5				
	13M'		1916.5				

* See refs. 5 for definition of these areas.

** See refs. 5 for definition of 2 GHz Spectrum Licensed areas. Note: Canberra, Darwin and Hobart form part of the capital city areas for 2 GHz Spectrum Licences.

*** Note: some 2 GHz Spectrum Licence Areas differ to 1.8 GHz Spectrum License areas.

**THE 1.8 GHz BAND (1700 - 1900 MHz)
PROTECTION RATIOS**

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx			
	7 MHz → 7 MHz	7 MHz → 14 MHz	14 MHz → 7 MHz	14 MHz → 14 MHz
0	60	60	60	60
7	30	45	50	53
14		36	27	30
21		6		20

2. Protection ratios required between digital and analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Analogue Interferer Tx ↓ Digital Victim Rx		Digital Interferer Tx ↓ Analogue Victim Rx	
	7 MHz → 7 MHz	14 MHz → 14 MHz	7 MHz → 7 MHz	14 MHz → 14 MHz
0	60	60	60	60
7	30	50	30	50
14		20		20

3. Protection ratios required between analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Analogue Interferer Tx → Analogue Victim Rx 14 MHz → 14 MHz
	0
7	50
14	10

4. Protection ratios required for receivers operating in the 10 MHz channel arrangements.

Frequency Offset*	PROTECTION RATIO (dB) Any Interferer Tx → 10 MHz Victim Rx
Co-channel	60
1 st Adjacent Channel	30
2 nd Adjacent Channel	-**

THE 1.8 GHz BAND (1700 - 1900 MHz) PROTECTION RATIOS

- * In the above table adjacent channels are defined as the maximum of the interfering transmitter and victim receivers channel size. For example, in the case of an interference assessment for a point-to-point transmitter operating in a 14 MHz channel into a point-to-point receiver operating in a 10 MHz channel, the first adjacent channel refers to the 14 MHz channel either side of the victim receiver's licensed channel.
- ** Receivers operating in the 10 MHz channelling arrangements are only provided protection to the first adjacent channel.

5. Protection ratios required from transmitters operating in the 10 MHz channel arrangements.

Frequency Offset*	PROTECTION RATIO (dB) 10 MHz Interferer Tx → Victim Rx
Co-channel	60
1 st Adjacent Channel	30
2 nd Adjacent Channel	0

- * In the above table adjacent channels are defined as the maximum of the interfering transmitter and victim receivers channel size. For example, in the case of an interference assessment for a point-to-point transmitter operating in a 10 MHz channel into a point-to-point receiver operating in a 14 MHz channel, the first adjacent channel refers to the 14 MHz channel either side of the victim receiver's licensed channel. The same logic is used to determine the 2nd adjacent channels.

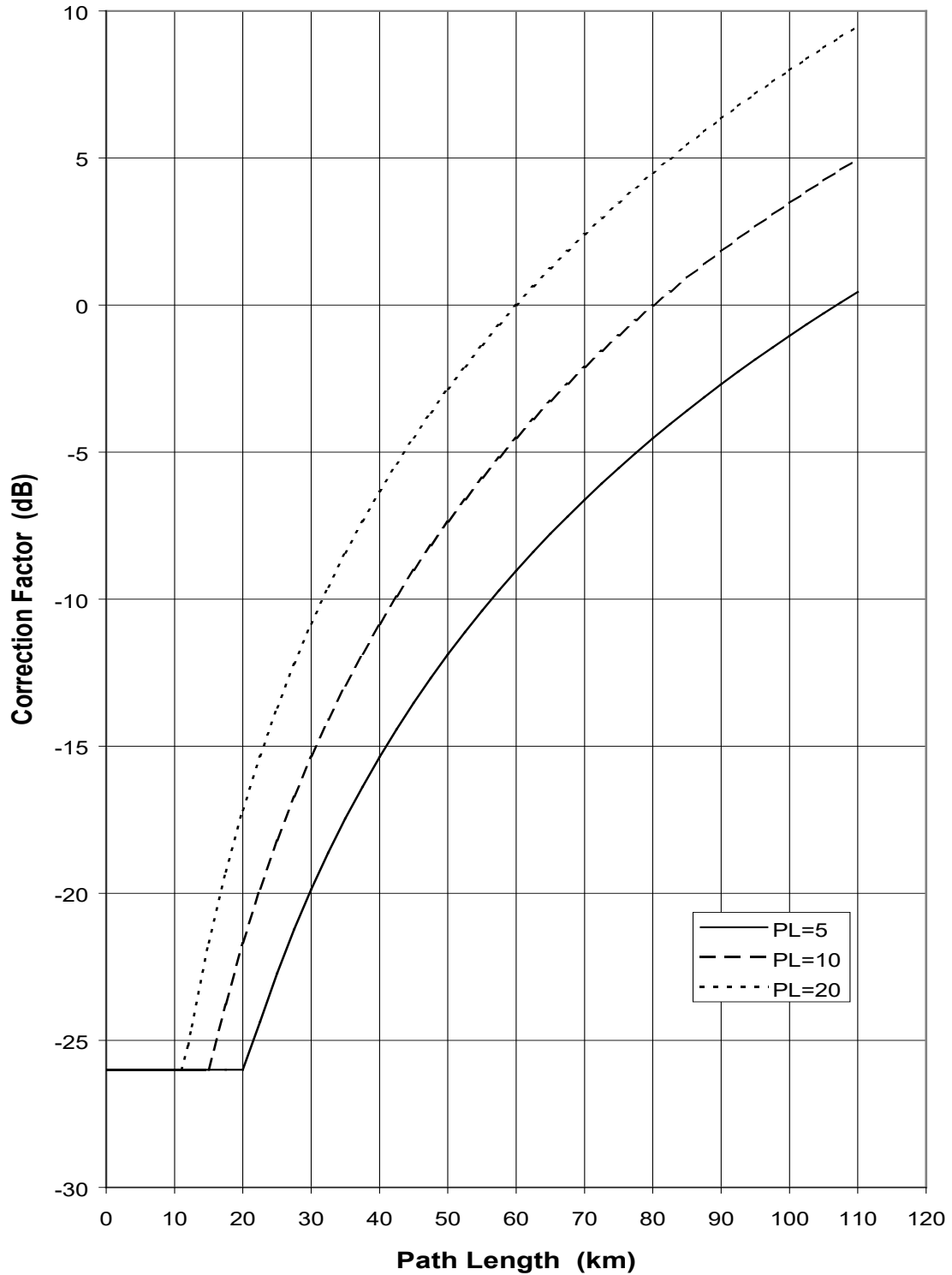
Notes:

1. Protection ratios are based on a 60 km path length and P_L (Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.

THE 1.8 GHz BAND (1700 - 1900 MHz)

PROTECTION RATIO CORRECTION FACTORS

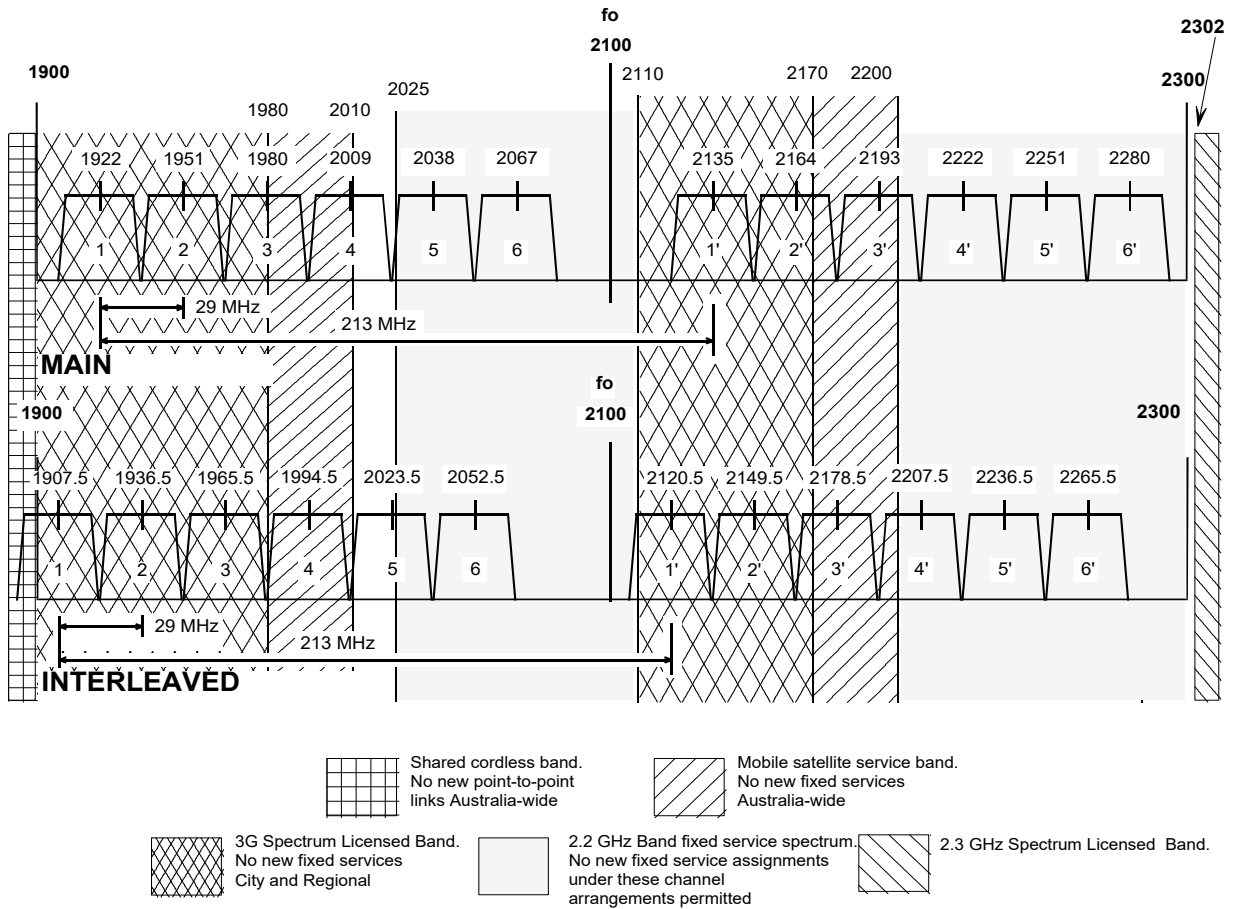
MULTI PATH



PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

THE 2.1 GHz BAND (1900-2300 MHz)



No new assignments are to be made Australia-wide in bands 1980-2010 MHz and 2170-2200 MHz. No new assignments are to be made in channels overlapping the 2.2 GHz channel plan. No new assignments in the bands 2010-2110 MHz and 2200-2300 MHz in the areas identified in Embargo 23 as shown in Figure 2 and 3. Additionally no assignments are to be made in the bands 1900-1980 MHz and 2110-2170 MHz in the areas described in Embargo 26. This band is otherwise designated for use by medium capacity fixed point-to-point links.

Typical Use	: 34 Mb/s data, FM video
Assignment Priority	: not specified
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Notes:

THE 2.1 GHz BAND (1900-2300 MHz)

1. Some channels are not available for assignment (Assignment Restrictions 1 and refs. 2, 3, 9, and 10).
2. Proposed fixed link assignments must be coordinated with spectrum licences operating in 3G bands (Assignment Restrictions 2 and ref. 10).
3. Proposed fixed link assignments must be coordinated with spectrum licences operating in the 2.3 GHz band (Assignment Restrictions 3 and ref. 6).
4. Proposed fixed link assignments must be coordinated with earth stations operating in this band (Assignment Restrictions 4 and ref. 7).
5. Note potential for interference to channel 1 to and from adjacent 1.8 GHz band fixed services.
6. New and existing apparatus licensed assignments in all areas and with emissions in the frequency ranges 1920-1960 MHz and 2110-2150 MHz shall be endorsed with Advisory Note BL (ref. 11).
7. New fixed (and mobile) assignments Australia wide and with emissions in the frequency ranges 1980-2010 MHz or 2170-2200 MHz are embargoed. New Fixed (and mobile) assignments in the frequency ranges 2010-2110 MHz and 2200-2300 MHz are embargoed for specific areas identified in Attachment 1 of Embargo 23, (ref. 3)
8. DELETED
9. DELETED
10. New apparatus licensed assignments in certain spectrum licensed areas and with emissions in the frequency ranges 1900-1980 MHz and 2110-2170 MHz are embargoed (ref. 10).
11. DELETED
12. DELETED
13. DELETED
14. Prospective new apparatus licensed assignments within specified zones around specified radio astronomy facilities and with emission bandwidths in the frequency range 2200-2550 MHz must be notified to CSIRO (ref. 15).
15. Proposed fixed links must be coordinated with fixed TOB collection stations (ref.16).
16. No new assignments within 100km of the Radio Quiet Zone in the bands 1900-2300 MHz (ref. 17).
17. No new assignments within 300km of Mingenew in the bands 2100-2130 MHz and 2280-2310 MHz otherwise 150km for assignments below 12 GHz (ref. 18).

References:

1. Rec. ITU-R F.382-6, *"Radio-frequency channel arrangements for radio-relay systems operating in the 2 and 4 GHz bands"*.

THE 2.1 GHz BAND (1900-2300 MHz)

2. The *"1.9 GHz Band Plan"*, 14 March 1996.
3. RALI MS 3, *"Spectrum Embargoes"*, Embargo No. 23.
4. DELETED
5. DELETED
6. *"Radiocommunications (Spectrum Designation) Notice No.1 of 2000 [January 2000]"*.
7. RALI MS 26, *"Coordination of Microwave Fixed Services with Earth Stations"*.
8. Spectrum Planning Report 2001/10, *"Coordination Information for Defence Aeronautical Mobile Telemetry Systems Operating in the 2200 to 2300 MHz Frequency Range"*.
9. *"Radiocommunications (Spectrum Re-allocation) Declaration No. 1 of 2005"*, 4 April 2005.
10. RALI MS 3, *"Spectrum Embargoes"*, Embargo No. 26.
11. Spectrum Planning Discussion Paper 2006/01, *"Strategies for Wireless Access Services"*.
12. RALI FX 19, *"Frequency Coordination and Licensing Procedures for Apparatus Licensed Broadband Wireless Access Services in the 1900-1920 and 2010-2025 MHz Bands"*.
13. DELETED
14. DELETED.
15. RALI MS 31, *"Notification Zones for Apparatus Licensed Services around Radio Astronomy Facilities"*.
16. RALI FX 21 *"Television Outside Broadcasting Services in the bands 1980-2110 MHz and 2170-2300 MHz"*.
17. RALI MS 3, *"Spectrum Embargoes"*, Embargo No. 41.
18. RALI MS 3, *"Spectrum Embargoes"*, Embargo No. 49.

THE 2.1 GHz BAND (1900 - 2300 MHz)

ASSIGNMENT RESTRICTIONS

1. Channels that may NOT be assigned

1.1 1.9 GHz Band Plan Provisions of the 1.9 GHz Band Plan (ref. 2) which introduced the cordless telecommunications service in the band 1880-1900 MHz do not permit additional (new or re-tuned) fixed stations in this band. This affects channel 1I (1907.5 MHz).

1.2 Spectrum Licences No new assignments are to be made in certain areas in the 3G bands (1900 to 1980 MHz and 2110 to 2170 MHz) due to spectrum licensing (ref. 10).

1.3 Embargo 23 RALI MS 3, Embargo 23 (ref. 3) requires that no new assignments are to be made Australia-wide in bands 1980-2010 MHz and 2170-2200 MHz. No new assignments in frequency ranges that overlaps with the 2.2 GHz band channel arrangements. No new assignments are to be made in the bands 2010-2110 MHz and 2200-2300 MHz in the areas identified in Embargo 23 and show in Figure 2 and 3.

1.4 Affected Channels See Tables 1 and 2 for details on affected channels.

1.5 Embargo 41 RALI MS 3, No new assignments within 100km of the Radio Quiet Zone in the bands 1900-2300 MHz (ref. 17).

1.6 Embargo 49 RALI MS 3, No new assignments within 300km of Mingenew in the bands 2100-2130 MHz and 2280-2310 MHz otherwise no new assignments within 150km of Mingenew for channels below 12 GHz (ref. 18).

2. Coordination requirements with 3G spectrum licences

Proposed fixed link assignments must be coordinated with spectrum licences operating in the 3G bands (1900 to 1980 MHz and 2110 to 2170 MHz) in accordance with Appendix 7 of this RALI. Proposed fixed link assignments planned for co-channel operation with respect to spectrum licences in areas adjacent to spectrum licensed areas must be coordination with spectrum licences if they are within a threshold distance of 200 km of the spectrum licence boundary. Proposed fixed link assignments planned for adjacent channel operation with respect to spectrum licences inside or adjacent to spectrum licence boundaries must also be coordinated. The map at Figure 1 illustrates the geographic boundaries and

[2.1 GHz - Page 4 of 22]

coordination threshold contours for these coordination requirements. Tables 1 and 2 detail the affected channels.

3. Coordination requirements with spectrum licences operating in the 2.3 GHz band

Proposed fixed link assignments with receivers planned for operation in the 2256 to 2300 MHz frequency range or transmitters planned for operation in the 2266 to 2300 MHz frequency range must to be coordinated with spectrum licences operating in the 2.3 GHz spectrum licensed band (2302 to 2400 MHz) (see ref.6).

See Tables 1 and 2 for channels that are subject to coordination as outlined above.

THE 2.1 GHz BAND (1900 - 2300 MHz)

4. Coordination requirements with earth stations

Proposed fixed link assignments must be coordinated with earth stations operating in the 2025 to 2120 MHz and 2200 to 2300 MHz bands. Coordination must be in accordance with the requirements of RALI MS 26 (ref. 7).

See Tables 1 and 2 for channels that are subject to coordination as outlined above.

5. Coordination with existing fixed link assignments

In addition to the coordination requirements stated above, proposed new assignments must be coordinated with existing fixed link assignments in this band and the 2.2 GHz band in accordance with normal FX-3 assignment procedures.

6. Channels available for assignment

See Tables 1 and 2 for channels available for assignment.

7. Coordination with licenced Television Outside Broadcasting (TOB) receivers

Proposed fixed link assignments in the frequency range 2010-2110 MHz and 2200-2300 MHz must be coordinated with existing licensed TOB receivers (collection stations) using the method and parameters outlined in RALI FX 21 (ref. 16).

THE 2.1 GHz BAND (1900 - 2300 MHz)

**Table 1: Channel Arrangements (Lower Channel Set) - Channel Availability and Restrictions
and Inter-Service Coordination**

Channel Number	Centre (MHz)	Channel Availability and Restrictions				Inter-Service Coordination
		Adelaide, Brisbane, Darwin, Hobart, Melbourne, Perth, and Sydney*	Canberra*	Area A - Eastern Region and Area B Western Region*	All Other Areas	
1I	1907.5	Not Available (ref.2 and ref. 7)				
1M	1922	Not Available (ref. 7)	BW < 4 MHz (ref. 7)			3 G Spectrum Licences
2I	1936.5	Not Available (ref. 7)				
2M	1951	Not Available (ref. 7)		BW < 18 MHz (ref. 7)		
3I	1965.5	Not Available (ref. 7)				
3M	1980	Not Available Refer to Embargo 23 (ref. 3)				
4I	1994.5					
4M	2009					
5I	2023.5	Not Available, 2.2 GHz channel plan and Embargo 23 (ref. 3)				TOB licensed receivers

5M	2038		
6I	2052.5		
6M	2067		

* See ref. 7 for definition of these areas and the map at Figure 1

THE 2.1 GHz BAND (1900 - 2300 MHz)

**Table 2: Channel Arrangements (Upper Channel Set) - Channel Availability and Restrictions
and Inter-Service Coordination**

Channel Number	Centre (MHz)	Channel Availability and Restrictions				Inter-Service Coordination	
		Adelaide, Brisbane, Darwin, Hobart, Melbourne, Perth, and Sydney*	Canberra*	Area A - Eastern Region and Area B Western Region*	All Other Areas		
1I'	2120.5	Not Available (ref. 7)	BW < 9 MHz (ref. 7)		BW < 21 MHz (ref. 3 (embargo))	3G Spectrum Licences BW > 1 MHz - Earth Stations BW > 21 MHz - Geostationary Satellite Orbit Avoidance	
1M'	2135	Not Available (ref. 7)				3G Spectrum Licences	
2I'	2149.5	Not Available (ref. 7)		BW < 1 MHz (ref. 7)			
2M'	2164	Not Available (ref. 7)				BW < 12 MHz (ref. 3 (embargo))	3G Spectrum Licences
3I'	2178.5						TOB licensed receiver

[2.1 GHz - Page 9 of 22]

3M'	2193	Not Available 2.2 GHz channel plan and embargo 23 (ref. 3)	Earth Stations
4I'	2207.5		
4M'	2222	Not Available 2.2 GHz channel plan and embargo 23 (ref. 3)	TOB licensed receivers Earth Stations
5I'	2236.5		
5M'	2251		
6I'	2265.5		
6M'	2280		

* See ref. 7 for definition of these areas and the map at Figure 1

THE 2.1 GHz BAND (1900 - 2300 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems applicable when both the Victim and Interferer operate under these channel arrangements only.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	14.5 MHz→ 14.5 MHz	14.5 MHz→ 29 MHz	29 MHz→ 14.5 MHz	29 MHz→ 29 MHz
0	60	60	60	60
14.5	30	45	55	57
29		23	20	30

2. Protection ratios required between digital and analogue systems applicable when both the Victim and Interferer operate under these channel arrangements only.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Analogue Interferer Tx		Digital Interferer Tx	
	↓		↓	
	Digital Victim Rx		Analogue Victim Rx	
	29 MHz → 14.5 MHz	29 MHz → 29 MHz	14.5 MHz→ 29 MHz	29 MHz → 29 MHz
0	60	60	60	60
14.5	42	55	40	58
29		21	0	30

3. Protection ratios between analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Analogue Interferer Tx → Analogue Victim Rx 29 MHz → 29 MHz
0	60
14.5	50
29	20

THE 2.1 GHz BAND (1900 - 2300 MHz)

4. Protection ratios required between digital systems where the Victim operates under the 2.2 GHz band channel arrangements and the Interferer operates under these channel arrangements. See Note 2 below.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14.5 MHz→ 14 MHz	29 MHz→ 14 MHz
0	60	60
14.5	30	55
29		20

5. Protection ratios required between digital systems where the Victim operates under these channel arrangements and the Interferer operates under the 2.2 GHz band channel arrangements. See Note 2 below.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14 MHz→ 14.5 MHz	14 MHz→ 29 MHz
0	60	60
14.5	30	45
29		23

6. Protection ratios required between digital systems operating under the 2.2 GHz band channel arrangements and analogue systems operating under these channel arrangements. See Note 2 below.

Frequency Offset (MHz)	PROTECTION RATIO (dB)

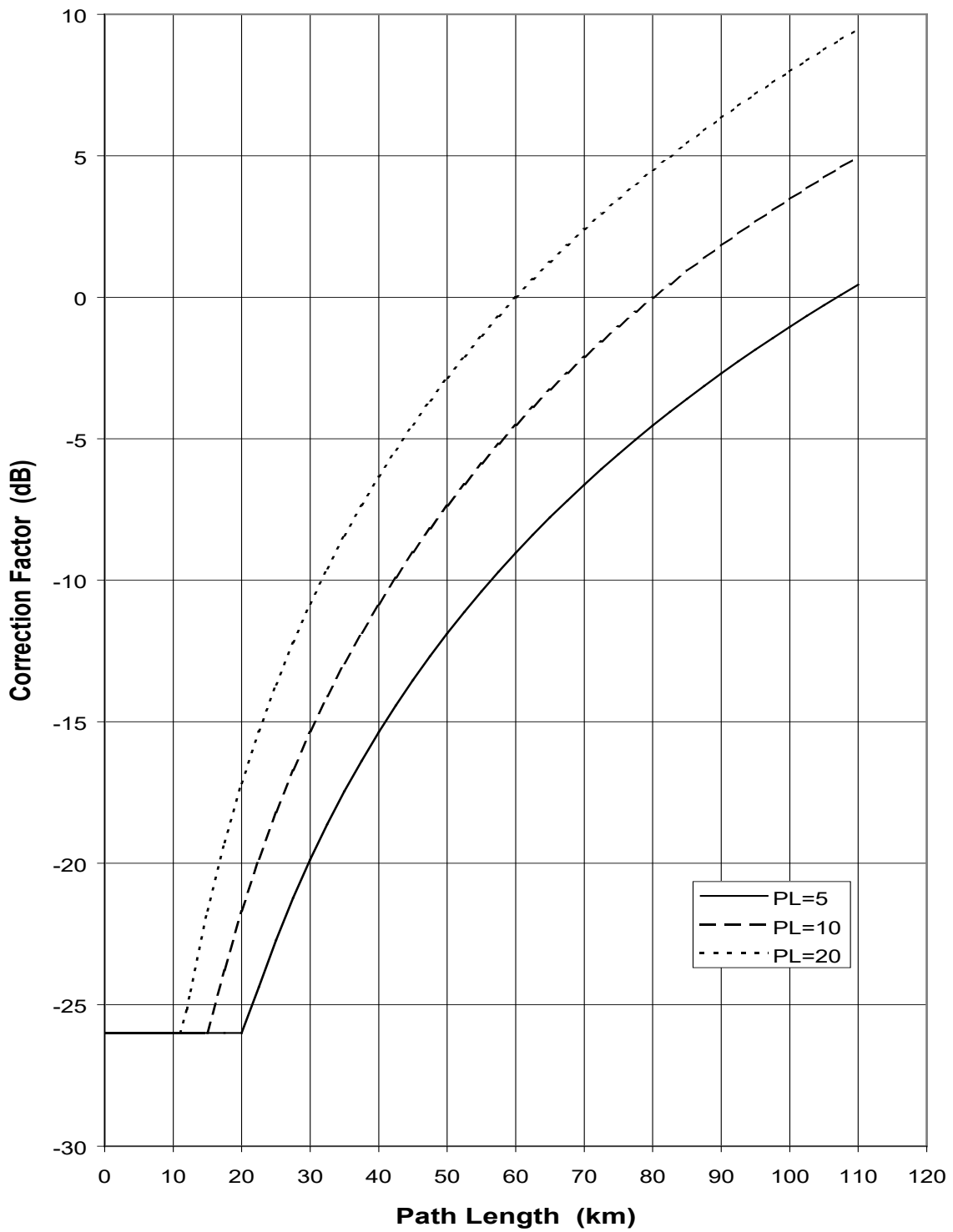
	Analogue Interferer Tx ↓ Digital Victim Rx 29 MHz → 14 MHz	Digital Interferer Tx ↓ Analogue Victim Rx 14 MHz → 29 MHz
0	60	60
14.5	42	40
29		0

Notes:

1. Protection ratios for digital systems are based on a 60 km path length and P_L (Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.
2. Part 3.1.7 "Protection Ratios and Interference Criteria" of this RALI gives guidance on how to apply the protection ratio requirements when RF channel arrangements are overlaid with a pre-existing arrangement or other overlaid arrangements.

THE 2.1 GHz BAND (1900 - 2300 MHz)

PROTECTION RATIO CORRECTION FACTORS



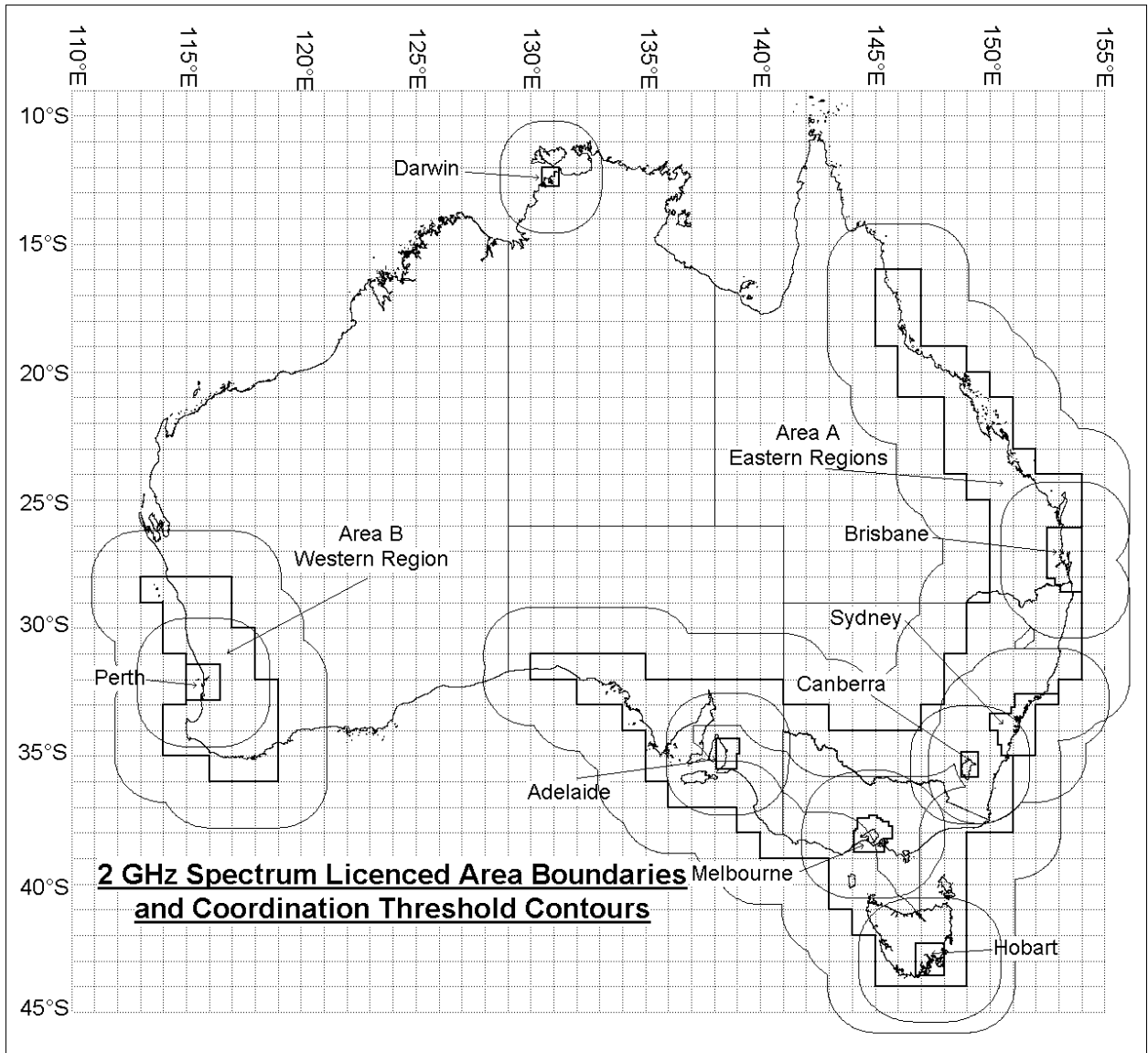
MULTI PATH

PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

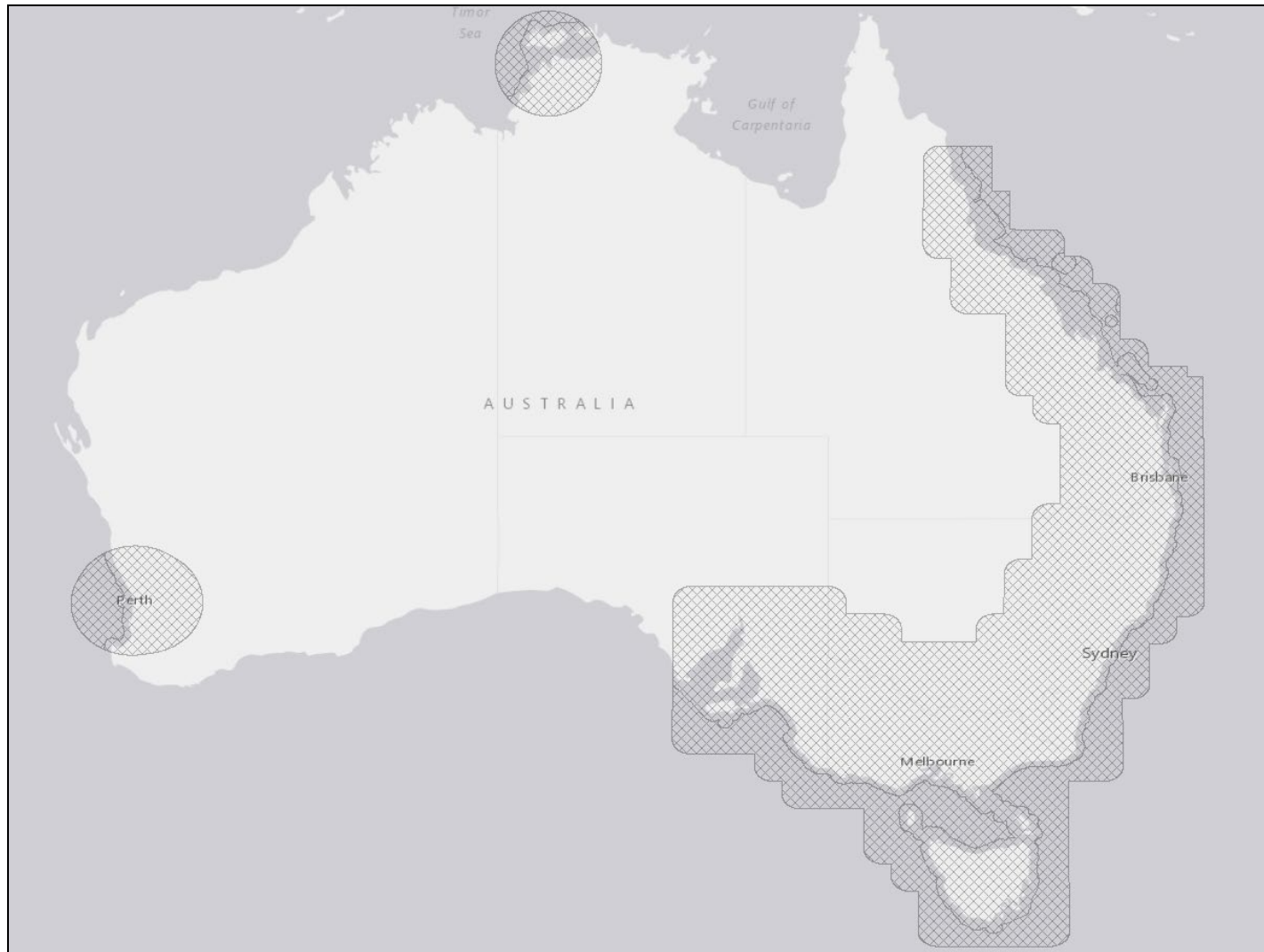
THE 2.1 GHz BAND (1900 - 2300 MHz)

Figure 1: 3G Spectrum Licensed Area Boundaries and Coordination Threshold Contours



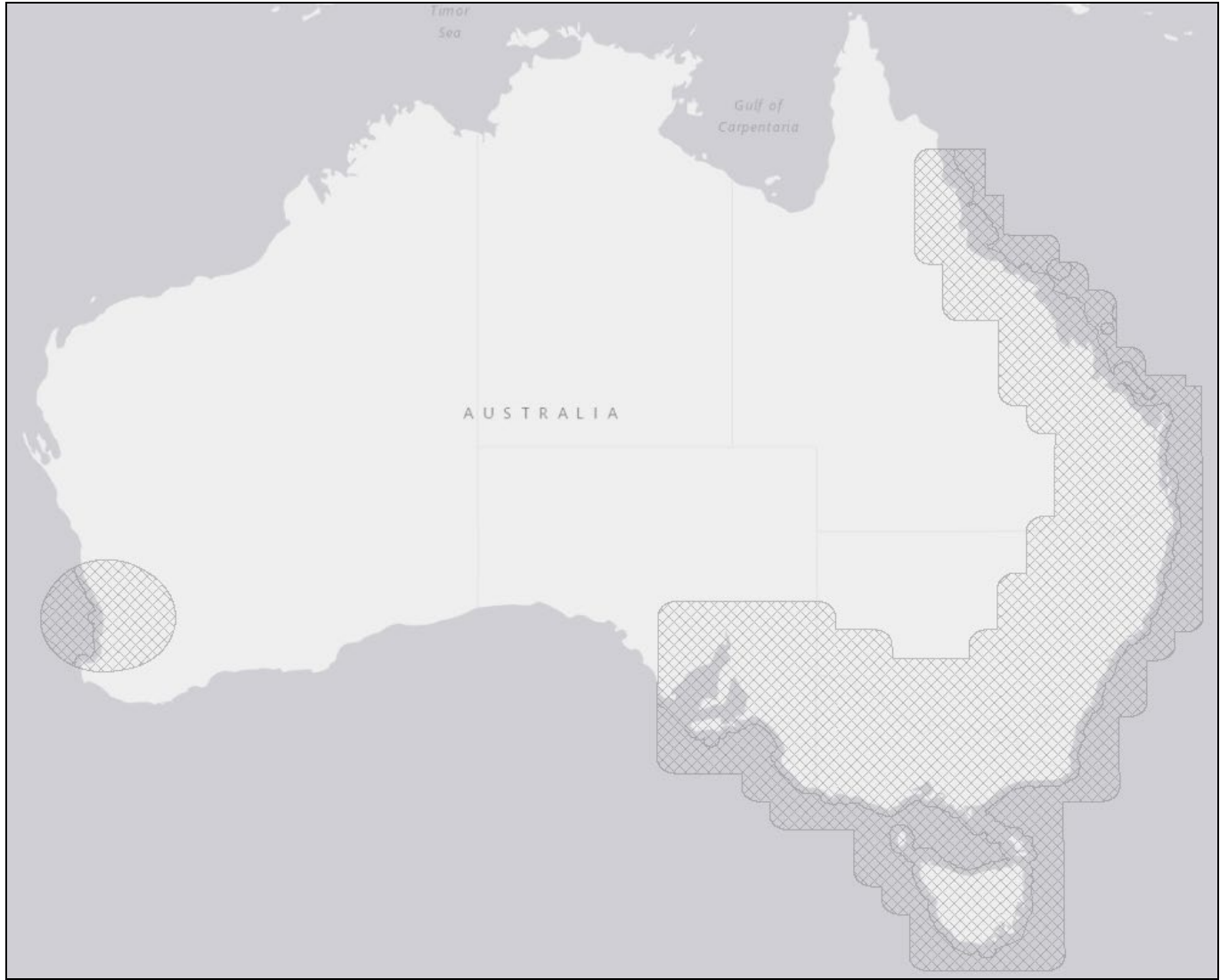
THE 2.1 GHz BAND (1900 - 2300 MHz)

Figure 2: Fixed link embargo areas in the bands 2010-2100 MHz



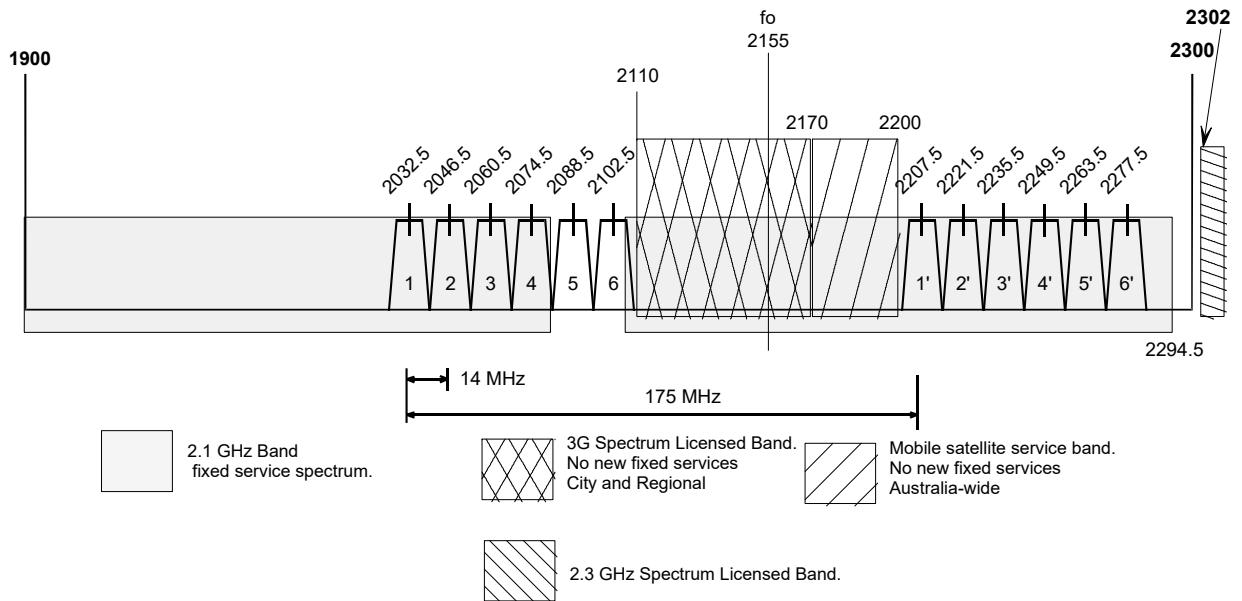
THE 2.1 GHz BAND (1900 - 2300 MHz)

Figure 3: Fixed link embargo areas in the bands 2200-2300 MHz



THE 2.2 GHz BAND (2025 - 2285 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

No new assignments are to be made in the bands 2010-2110 MHz and 2200-2300 MHz in the areas identified in Embargo 23 and show in Figure 2 and 3. This band is otherwise designated for use by medium capacity fixed point-to-point links.

Typical Use	: 34 Mbit/s data
Assignment Priority	: not specified
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Notes:

1. Proposed fixed links must be coordinated with spectrum licences operating in the 3G band (Assignment Restrictions 1 and ref. 9).
2. DELETED.
3. Proposed fixed links must be coordinated with spectrum licences operating in the 2.3 GHz band (Assignment Restrictions 3 and ref. 4).

4. Proposed fixed links must be coordinated with earth stations operating in this band (Assignment Restrictions 4 and ref. 6).
5. Proposed fixed links must take account of the requirements for geostationary satellite orbit avoidance (Assignment Restrictions 5).
6. Proposed fixed links must be coordinated with fixed receivers supporting aeronautical mobile telemetry systems (Assignment Restrictions 6 and ref. 7).
7. There is potential for interference to fixed links on some channels due to the operation of aeronautical mobile telemetry transmitters (Assignment Restrictions 7 and ref. 7).
8. DELETED
9. There is potential for interference to and from 2.1 GHz band fixed services sharing the same spectrum (Assignment Restrictions 8).
10. New Fixed (and mobile) assignments in the frequency ranges 2010-2110 MHz and 2200-2300 MHz are embargoed for specific areas identified in Attachment 1 of Embargo 23, (ref. 8, Figure 2 and 3)
11. DELETED
12. DELETED
13. DELETED
14. DELETED.
15. Prospective new apparatus licensed assignments within specified zones around specified radio astronomy facilities and with emission bandwidths in the frequency range 2200-2550 MHz must be notified to CSIRO (ref. 12).
16. Proposed fixed links must be coordinated with fixed TOB collection stations (Assignment Restrictions 10 ref.13).
17. No new assignments within 100km of the Radio Quiet Zone in the bands 1900-2300 MHz (ref. 14).
18. No new assignments within 300km of Mingenew in the bands 2100-2130 MHz and 2280-2310 MHz otherwise 150km for assignments below 12 GHz (ref. 15).

References:

1. Rec. ITU-R F.1098-1, *"Radio-frequency channel arrangements for radio-relay systems operating in the 1900 - 2300 MHz Band"*.
2. DELETED
3. DELETED
4. *"Radiocommunications (Spectrum Designation) Notice No.1 of 2000 [January 2000]"*.
5. DELETED.
6. RALI MS 26, *"Coordination of Microwave Fixed Services with Earth Stations"*.

7. Spectrum Planning Report 2001/10, "*Coordination Information for Defence Aeronautical Mobile Telemetry Systems Operating in the 2200 to 2300 MHz Frequency Range*".
8. RALI MS 3, "*Spectrum Embargoes*", Embargo 23.
9. RALI MS 3, "*Spectrum Embargoes*", Embargo 26.
10. Spectrum Planning Discussion Paper 2006/01, "*Strategies for Wireless Access Services*".
11. DELETED
12. RALI MS 31, "*Notification Zones for Apparatus Licensed Services around Radio Astronomy Facilities*".
13. RALI FX 21 "*Television Outside Broadcasting Services in the bands 1980-2110 MHz and 2170-2300 MHz*".
14. RALI MS 3, "*Spectrum Embargoes*", Embargo 41
15. RALI MS 3, "*Spectrum Embargoes*", Embargo 49

THE 2.2 GHz BAND (2025 - 2285 MHz)
ASSIGNMENT RESTRICTIONS

1. Coordination requirements with 3G spectrum licences

New assignments on channels 5 and 6 planned for operation within or adjacent to the capital city boundaries (Figure 1) are subject to coordination with spectrum licensed devices operating in the 2110 to 2170 MHz frequency range in accordance with Appendix 7 of this RALI.

2. DELETED

3. Coordination requirements with spectrum licences operating in the 2.3 GHz band

Proposed fixed link assignments receiving in the 2256 to 2285 MHz frequency range or transmitting in the 2266 to 2285 MHz frequency range must to be coordinated with spectrum licences operating in the 2.3 GHz spectrum licensed band (2302 to 2400 MHz) (see ref. 4).

See Table 1 for channels that are subject to coordination with as outlined above.

4. Coordination requirements with earth stations

Proposed fixed link assignments must be coordinated with earth stations operating in the 2025 to 2120 MHz and 2200 to 2300 MHz bands. Coordination must be in accordance with the requirements of RALI MS 26 (ref. 6).

See Table 1 for channels that are subject to coordination as outlined above.

5. Geostationary satellite orbit avoidance requirements

Proposed fixed link assignments planned for operation in the 2025 to 2110 MHz and 2200 to 2290 MHz bands must take account of the requirements for geostationary satellite orbit avoidance at Appendix 5 to this RALI.

See Table 1 for affected channels.

THE 2.2 GHz BAND (2025 - 2285 MHz)

6. Coordination requirements with aeronautical mobile telemetry receivers

Aeronautical mobile telemetry (AMT) receivers operate in the 2200 to 2300 MHz frequency range in certain locations in Australia. New assignments for fixed links must be coordinated with the AMT receivers identified in ref. 7. Reference 7 provides the necessary location and coordination parameters.

Note: Assigners should note that the information contained in ref. 7 is of an interim nature pending finalisation of sharing issues. Contact the Manager, Spectrum Engineering Section, Spectrum Planning and Engineering Branch for information on progress on finalisation.

See Table 1 for affected channels.

7. Potential for interference from aeronautical mobile telemetry transmitters

Aeronautical mobile telemetry (AMT) transmitters operate in the 2200 to 2300 MHz frequency range in certain areas of Australia. New assignments for fixed links will not be afforded protection from AMT transmitters operated in the areas described in ref. 7.

Note: Assigners should note that the information contained in ref. 7 is of an interim nature pending further studies on sharing issues. Contact the Manager, Spectrum Engineering Section, Spectrum Planning Branch for information on the progress of these studies.

AMT transmitters operate in the geographic areas and with the technical parameters described in ref. 7. New assignments for links in these frequency ranges should note the potential for interference from AMT transmitters. Advisory Note FF shall be applied to new assignments for fixed link receivers operating in the 2200 to 2300 MHz frequency range within 350 km of the areas defined in ref. 7.

Advisory Note FF reads:

"No protection from interference caused by the operation of Defence aeronautical mobile telemetry transmitters is afforded to this licence"

See Table 1 for affected channels.

8. Coordination with existing fixed link assignments

In addition to the coordination requirements stated above, proposed new assignments must be coordinated with existing fixed link assignments in this band and in the 2.1 GHz band in accordance with normal FX-3 assignment procedures.

THE 2.2 GHz BAND (2025 - 2285 MHz)

9. Channels available for assignment

See Table 1 for a summary table of channels detailing channel availability and interservice coordination requirements.

10. Coordination with licenced Television Outside Broadcasting (TOB) receivers

Proposed fixed link assignments in the frequency range 2010-2110 MHz and 2200-2300 MHz must be coordinated with existing licensed TOB receivers (collection stations) using the method and parameters outlined in RALI FX 21 (ref. 14).

11. Channels that may NOT be assigned

11.1 Embargo 23 RALI MS 3, Embargo 23 (ref. 3) requires that no new assignments are to be made in the bands 2010-2110 MHz and 2200-2300 MHz in the areas identified in Embargo 23 and show in Figure 2. These frequency ranges represent spectrum that overlaps with the 2.2 GHz band channel arrangements.

11.2 Embargo 41 RALI MS 3, No new assignments within 100km of the Radio Quiet Zone in the bands 1900-2300 MHz (ref. 14).

11.3 Embargo 49 RALI MS 3, No new assignments within 300km of Mingenew in the bands 2100-2130 MHz and 2280-2310 MHz otherwise no new assignments within 150km of Mingenew for channels below 12 GHz (ref. 15).

THE 2.2 GHz BAND (2025 - 2285 MHz)

Table 1: Channel Arrangements - Channel Availability and Inter-Service Coordination

Channel Number	Centre (MHz)	Channel Availability	Inter-Service Coordination
1	2032.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance
2	2046.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance
3	2060.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance
4	2074.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance
5	2088.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance 3G Spectrum Licences
6	2102.5	Refer to Embargo 23 and 26 for channel availability (ref. 8, 9)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance 3G Spectrum Licences
1'	2207.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance Aeronautical Mobile Telemetry
2'	2221.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance Aeronautical Mobile Telemetry

3'	2235.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance Aeronautical Mobile Telemetry
4'	2249.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance Aeronautical Mobile Telemetry and 2.3 GHz Spectrum Licences
5'	2263.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance, Aeronautical Mobile Telemetry and 2.3 GHz Spectrum Licences
6'	2277.5	Refer to Embargo 23 for channel availability (ref. 8)	TOB, Earth Stations and Geostationary Satellite Orbital Avoidance Aeronautical Mobile Telemetry and 2.3 GHz Spectrum Licences

THE 2.2 GHz BAND (2025 - 2285 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems applicable when both the Victim and Interferer operate under these channel arrangements only.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14 MHz→ 14 MHz	
0	60	
14	30	

2. Protection ratios required between digital systems where the Victim operates under these channel arrangements and the Interferer operates under the 2.1 GHz band channel arrangements. See Note 2 below.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14.5 MHz→ 14 MHz	29 MHz→ 14 MHz
0	60	60
14.5	30	55
29		20

3. Protection ratios required between digital systems where the Victim operates under the 2.1 GHz band channel arrangements and the Interferer operates under these channel arrangements. See Note 2 below.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14 MHz→ 14.5 MHz	14 MHz→ 29 MHz
0	60	60
14.5	30	45
29		23

THE 2.2 GHz BAND (2025 - 2285 MHz)

4. Protection ratios required between digital systems operating under these channel arrangements and analogue systems operating under the 2.1 GHz band channel arrangements. See Note 2 below.

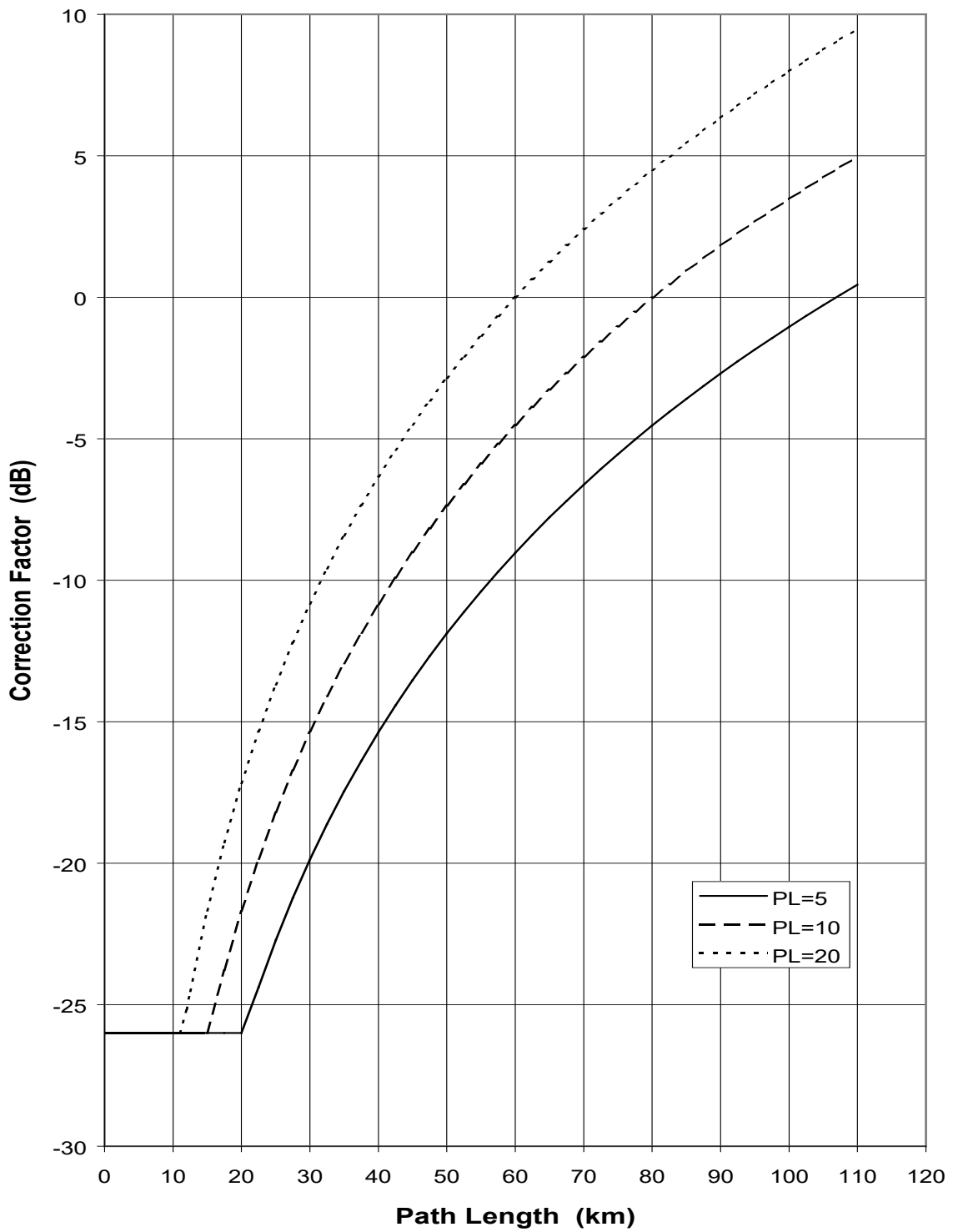
Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Analogue Interferer Tx	Digital Interferer Tx
	↓	↓
	Digital Victim Rx	Analogue Victim Rx
	29 MHz → 14 MHz	14 MHz → 29 MHz
0	60	60
14.5	42	40
29		0

Notes:

- Protection ratios for digital systems are based on a 60 km path length and P_L (Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.
- Part 3.1.7 "*Protection Ratios and Interference Criteria*" of this RALI gives guidance on how to apply the protection ratio requirements when RF channel arrangements are overlaid with a pre-existing arrangement or other overlaid arrangements.

THE 2.2 GHz BAND (2025 - 2285 MHz)

PROTECTION RATIO CORRECTION FACTORS



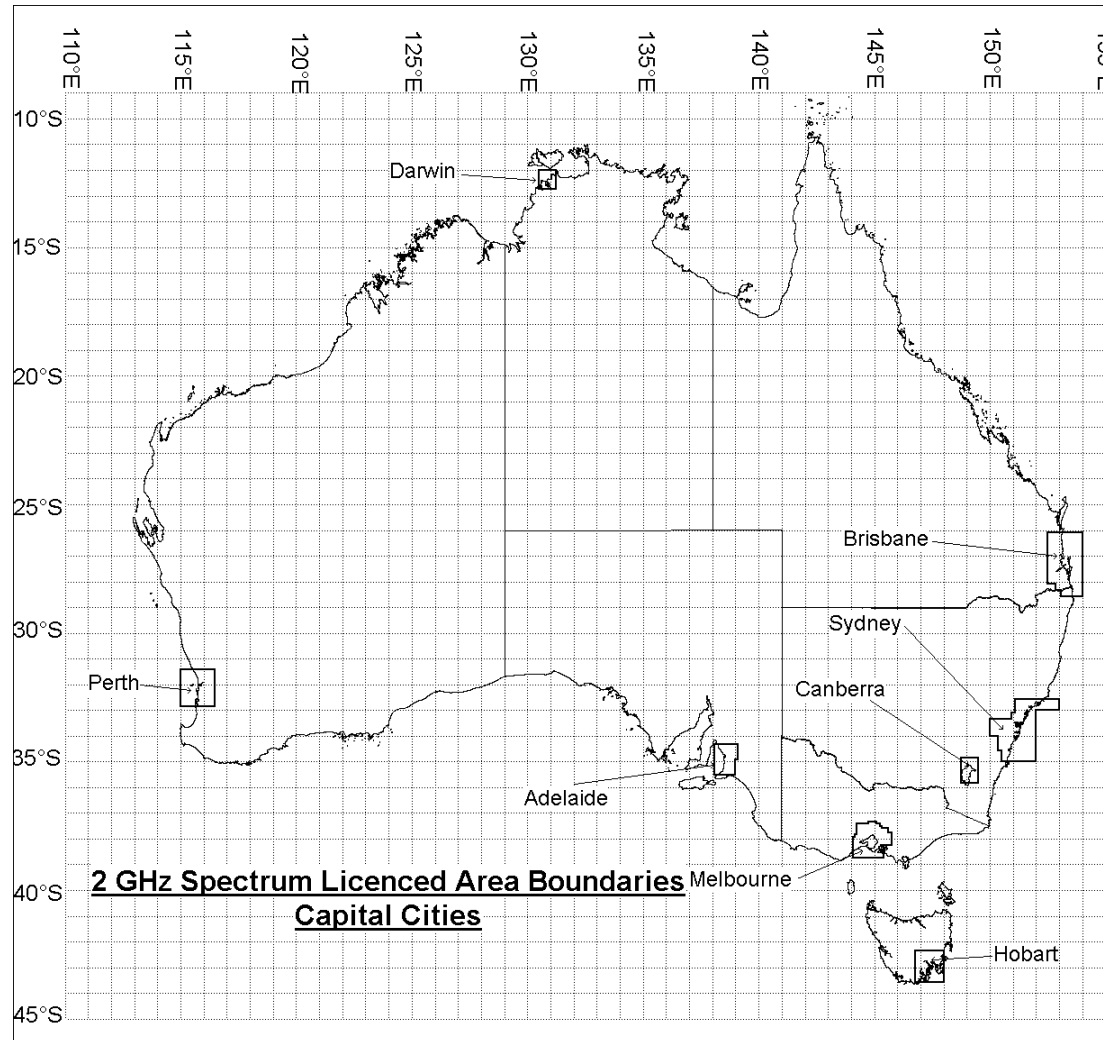
MULTI PATH

PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

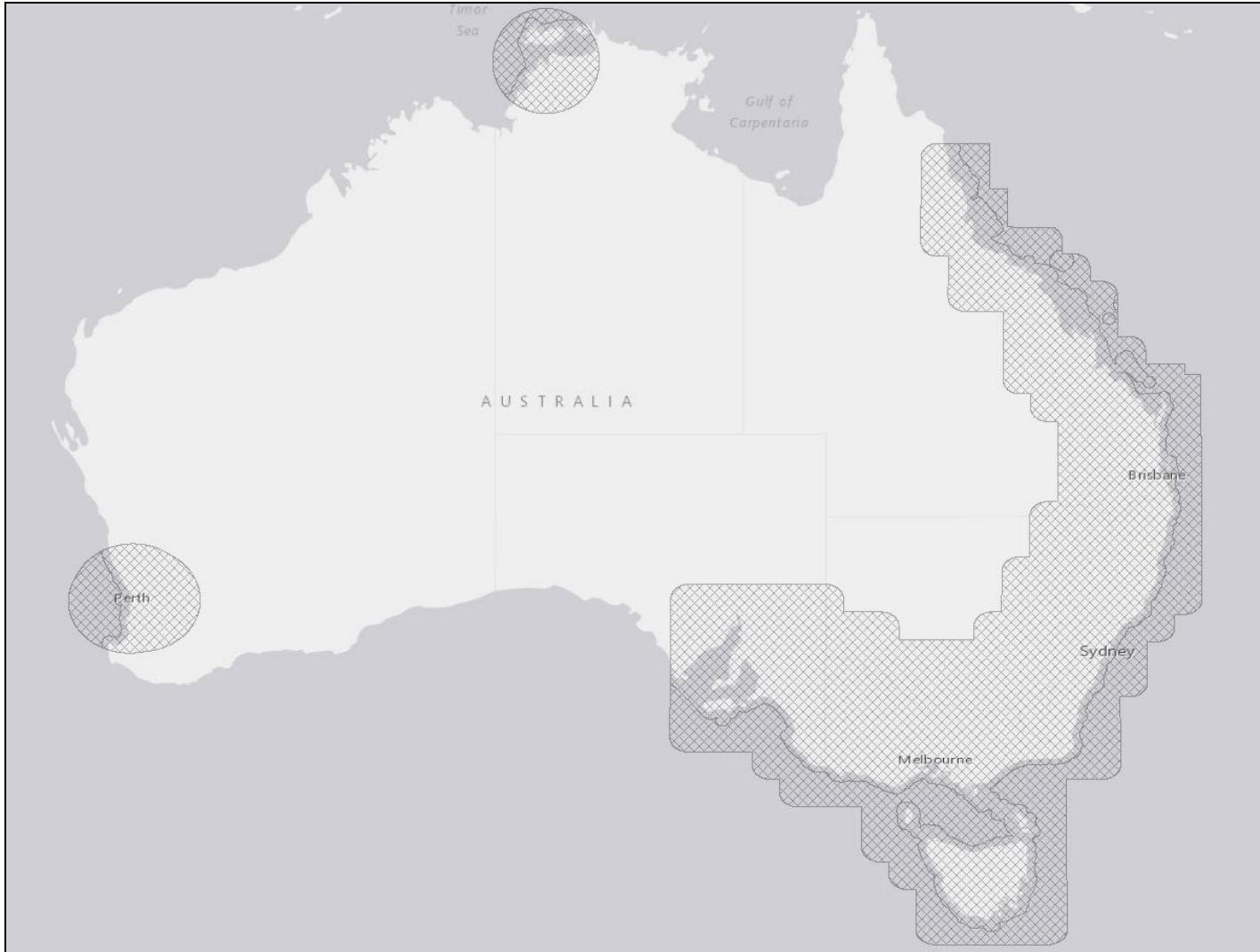
THE 2.2 GHz BAND (2025 - 2285 MHz)

Figure 1: 3G Spectrum Licensed Area Boundaries - Capital Cities



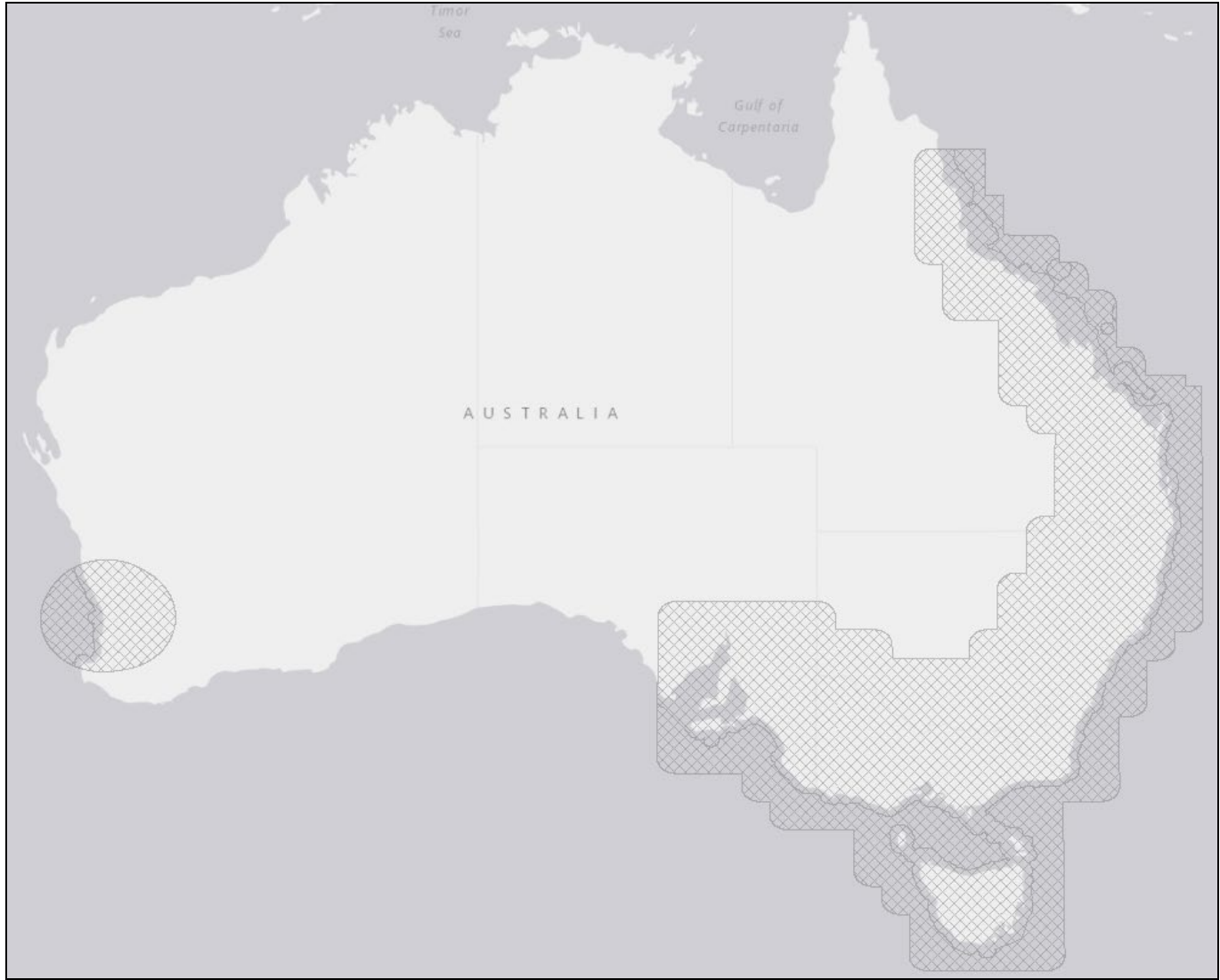
THE 2.2 GHz BAND (2025 - 2285 MHz)

Figure 2: Fixed link embargo areas in the bands 2010-2100 MHz

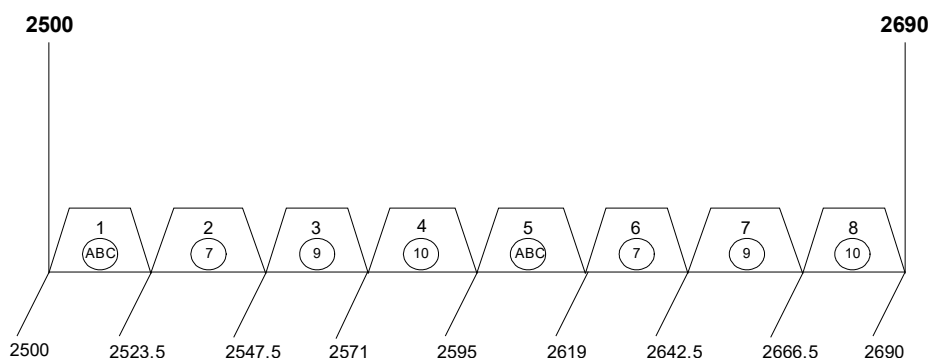


THE 2.2 GHz BAND (2025 - 2285 MHz)

Figure 3: Fixed link embargo areas in the bands 2200-2300 MHz



THE 2.5 GHz ENG BAND (2500 - 2690 MHz) ASSIGNMENT RESTRICTIONS



TOB Network Licences: (7)=Seven Network, (9)=Nine Network, (10)=Ten Network, (ABC)=ABC Network.

ASSIGNMENT INSTRUCTIONS

This band is no longer available for apparatus licensing as the band has been spectrum licenced. See Embargo 26. The text below has been retained for historical reference only.

This band is identified primarily for use by Television Outside Broadcast (TOB) services particularly Electronic News Gathering (ENG) applications.

Typical Use : temporary video links to provide live coverage of events

Assignment Priority : not applicable

Minimum Path Length : not specified

Antenna Requirements : 0.6 m standard parabolic dish

Notes:

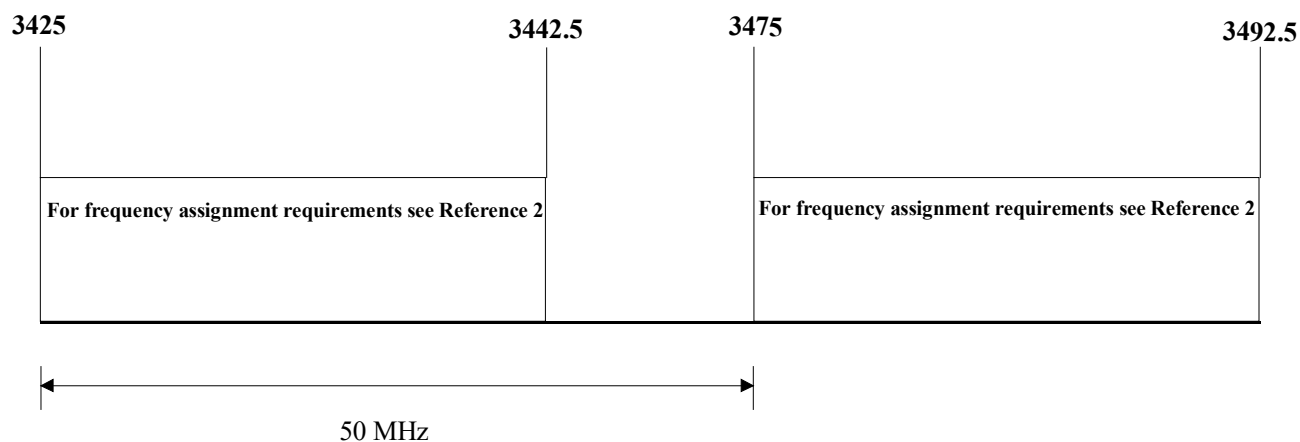
1. Designated channel allocations for the major television networks on an Australia-wide basis are shown above. New assignments will not normally be made on these channels, see also notes 3 and 4.
2. The channelling arrangements shown above came into effect on 7 March 2005.
3. New and existing apparatus licensed assignments in all areas and with emissions in the frequency range 2500-2690 MHz shall be endorsed with Advisory Note BL, but see also notes 1 and 4 (Assignment Restrictions 1 and ref. 2).
4. New assignments of all types and in all areas and with emissions in the frequency range 2500-2690 MHz are embargoed (ref. 1).

References:

1. RALI MS 3, "Spectrum Embargoes", Embargo 26.
2. Spectrum Planning Discussion Paper 2006/01, "Strategies for Wireless Access Services".

THE 3.4 GHz BAND (3425-3492.5 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

These bands were originally designated for use by fixed point-to-multipoint services (in particular, Wireless Local Loop (WLL) systems) Australia wide under apparatus licensing arrangements. During 2000, these bands along with other spectrum in the 3.4 to 3.6 GHz range were re-allocated for spectrum licensing in some areas of Australia, including all capital cities (see Reference 1). The remaining areas are still available for apparatus licensing in accordance with Reference 2.

Note:

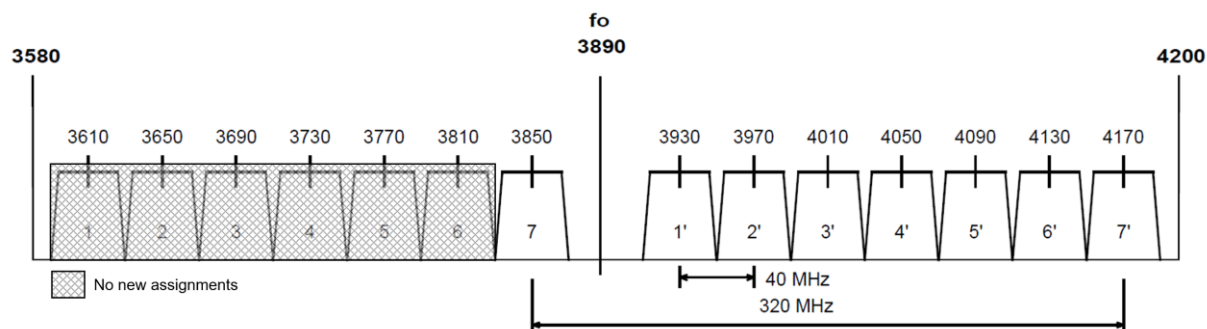
1. Specific requirements for apparatus licensing this band are given in Reference 2.
2. New assignments within this band are subject to limitations - see Reference 3.
3. Requests for assignments within 150 km of the GPOs of Darwin (NT) or Geraldton (WA) are to be referred to the Manager, Customer Services Coordination Team, Customer Services Group, Canberra Central Office, ACA, for preliminary coordination consultation¹.

References

1. Radiocommunications (Spectrum Re-allocation) Declaration 2000
2. RALI FX 14 “*Point to Multipoint Fixed Services in Specified Parts of the 3.4 - 3.59 GHz Band*”.
3. RALI MS 3 “*Spectrum Embargoes*”, Embargo No. 26.

¹ ACA file F89-207, held by Manager, Spectrum Planning and Engineering Team, Radiofrequency Planning Group, refers.

THE 3.8 GHz BAND (3580 - 4200 MHz) RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by digital high capacity fixed point-to-point links.

Typical Use	: 140 Mbit/s data
Assignment Priority	: not specified
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Notes:

1. Proposed fixed links need to be coordinated with licensed earth stations operating in this band.
2. Requests for assignments within 150 km of the GPOs of Darwin (NT) or Geraldton (WA) are to be referred to the Manager, Spectrum Engineering Section, Spectrum Planning Branch for preliminary coordination consultation. ACMA file F1989/207, held by Manager, Spectrum Engineering Section, Spectrum Planning Branch, refers.
3. Some channels are not available for new assignments (Assignment Restrictions 1).
4. There is potential for interference to and from former 4.0 GHz band fixed services (Assignment Restrictions 2).
5. Proposed fixed links must be co-ordinated with fixed satellite services in this band (Assignment Restrictions 3).
6. Proposed fixed links must be co-ordinated with radiolocation services in this band (Assignment Restrictions 4).
7. Proposed fixed links must be co-ordinated with area-wide licence services in this band and cannot be licensed within an existing area-wide licence service spectrum space unless agreed to by the licensee (Assignment Restrictions 5).
8. Site sense compatibility (refer to section 3.3.3) and paired channel use does not apply in this band, if co-sited parties can reach an agreement.

THE 3.8 GHz BAND (3580 - 4200 MHz)

References:

1. Rec. ITU-R F.635-6, *"Radio-frequency channel arrangements based on a homogeneous pattern for radio-relay systems operating in the 4 GHz band"*.
2. Spectrum Planning Discussion Paper 2006/01, *"Strategies for Wireless Access Services"*.

THE 3.8 GHz BAND (3580 - 4200 MHz) ASSIGNMENT RESTRICTIONS

1. Channels that may not be assigned

Channels 1, 2, 3, 4, 5, and 6 are not available for assignment Australia-wide due to spectrum licensing in metro and regional areas, and to support the deployment of wireless broadband services in remote areas.

2. Coordination with existing fixed link assignments

Proposed new assignments must be coordinated with existing fixed link assignments in this band.

3. Coordination with fixed satellite service

The Australian Radiofrequency Spectrum Plan allocates the band 3600-4200 MHz to the fixed satellite service on a primary basis and the band is utilised by earth station receive services. Proposed new assignments are to be coordinated with these services.

4. Coordination with radio-location service

The Australian Radiofrequency Spectrum Plan allocates the band 3400-3600 MHz to the radiolocation service on a primary basis. Proposed new assignments are to be coordinated with these services.

5. Coordination with area-wide licence services

Proposed fixed links must be co-ordinated with services authorised under area-wide licences in this band as required in RALI MS 47 and cannot be licensed within an existing area-wide licence spectrum space unless agreed to by the licensee.

THE 3.8 GHz BAND (3580 - 4200 MHz)

PROTECTION RATIOS

Protection ratios for digital services are:

Co-channel	60 dB
First adjacent channel	30 dB
Second adjacent channel	0 dB

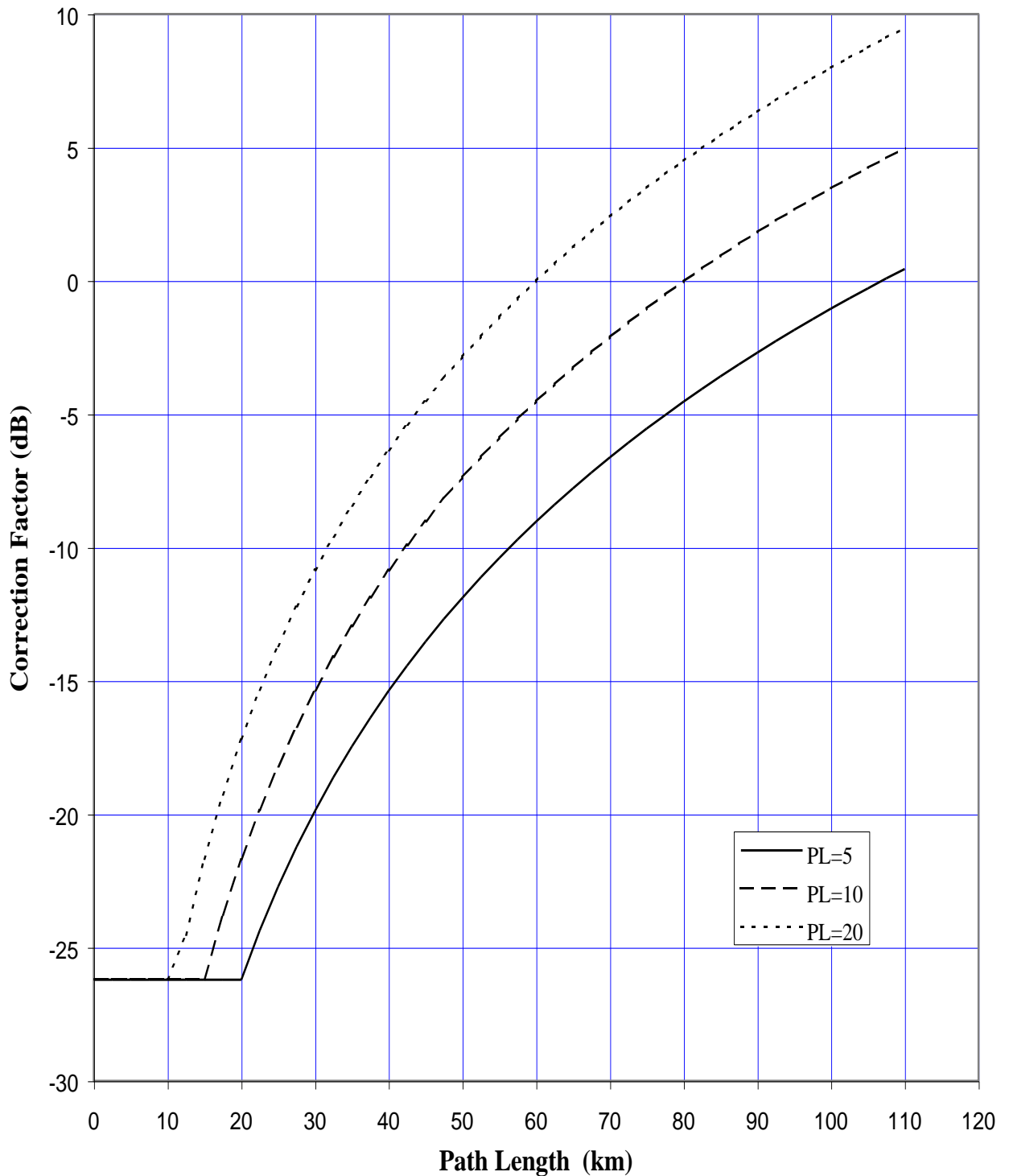
Note:

1. Protection ratios for digital systems are based on a 60 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths and P_L values refer to the protection ratio correction factors graph on the following page.

THE 3.8 GHz BAND (3580 - 4200 MHz)

PROTECTION RATIO CORRECTION FACTORS

MULTI PATH

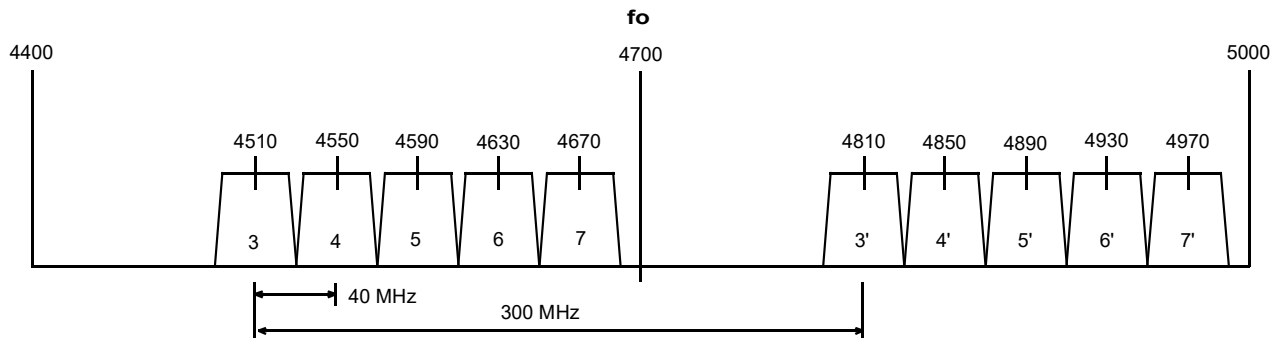


P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

THE 5 GHz BAND (4400 - 5000 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

Effective July 1998, this band is only available for Defence assignments.

Reference 1 designates this band as primarily for the purposes of Defence (refer to Reference 1 footnotes AUS 1 and AUS 11 for precise provisions). Effective July 1998, no further applications for non-Defence fixed link service use of the band may be accepted. Existing non-Defence fixed digital high capacity point-to-point links may continue operation under the provisions of current licences, which may be renewed subject to continuing endorsement of Special Condition 41 (Note 1).

Typical Use	: 155 Mbit/s (STM-1)
Assignment Priority	: no new assignments
Minimum Path Length	: 20 km
Minimum Transmission Capacity	: 68 Mbit/s
Antenna Requirements	: 3.0 m high performance parabolic dish

Notes:

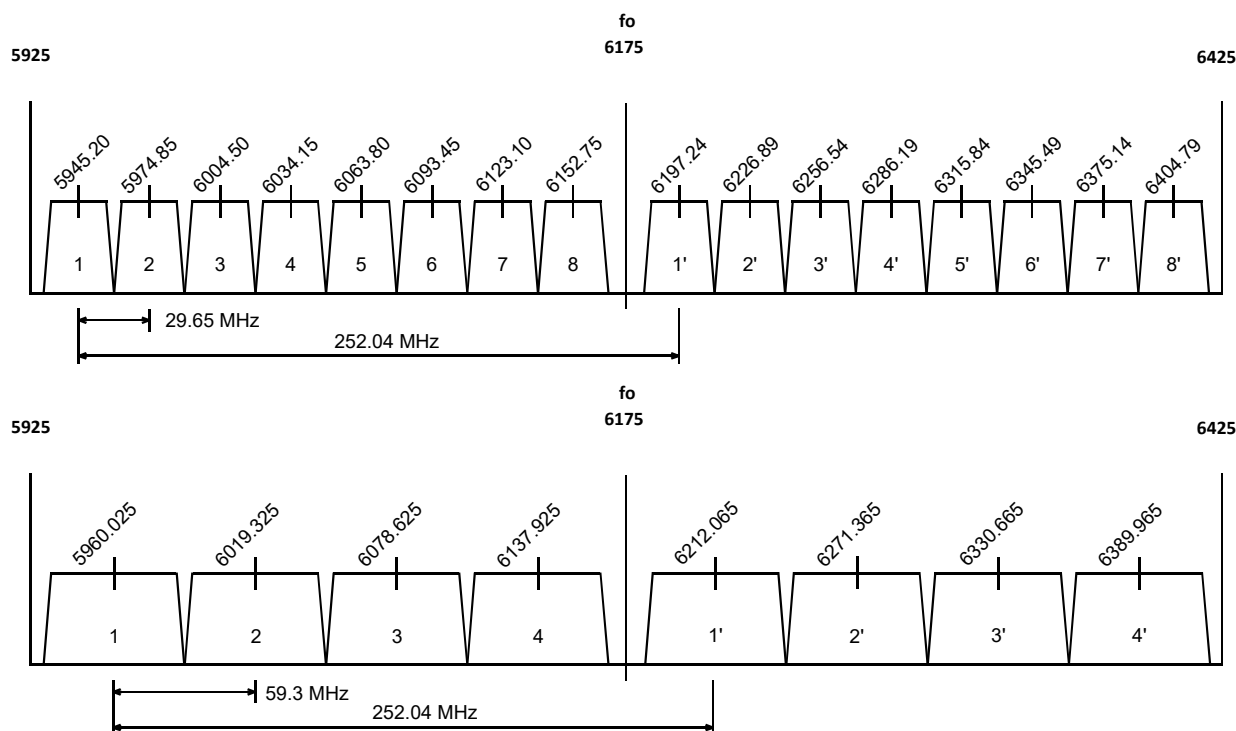
1. Non-Defence fixed link services shall not interfere with Defence radiocommunications services and no protection from Defence services shall be afforded to non-Defence services (refer to Special Condition 41).
2. Effective July 1998, this band is only available for Defence assignments.
3. All non-Defence assignments that have emissions in the 4940-4990 MHz range shall be endorsed with Advisory Note BL, but see also note 2 (ref. 3).

References:

1. "Australian Radiofrequency Spectrum Plan".
2. Rec. ITU-R F.1099-3, "Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4400-5000 MHz) band", 1999.
3. Spectrum Planning Discussion Paper 2006/01, "Strategies for Wireless Access Services".

THE 6 GHz BAND (5925 - 6425 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by medium and high capacity fixed point-to-point links.

Typical Use	: 29.65 MHz channels - 34 Mbit/s data, FM Video : 59.3 MHz channels - 197 Mbit/s data
Assignment Priority	: 59.3 MHz channels - from lowest channel upwards
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Note:

1. Proposed links need to be coordinated with licensed earth stations operating in this band.
2. The channel raster known previously as the interleaved raster is grandfathered. No new assignments are to be made; existing services may continue to operate.
3. Potential for interference to and from adjacent 6.7 GHz band fixed services.

Reference

1. Rec. ITU-R F.383-5, "Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band".

THE 6 GHz BAND (5925 - 6425 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	29.65 MHz ↓ 29.65 MHz	29.65 MHz ↓ 59.3 MHz	59.3 MHz ↓ 29.65 MHz	59.3 MHz ↓ 59.3 MHz
0	60			68
14.825	57	67	56	
29.65	30			
44.475		36	25	
59.3				34
74.125		13	13	
103.775		7	3	
118.6				13

2. Protection ratios required between digital and analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Analogue Interferer Tx ↓ Digital Victim Rx	Digital Interferer Tx ↓ Analogue Victim Rx
	29.65 MHz ↓ 29.65 MHz	29.65 MHz ↓ 29.65 MHz
	0	60
14.825	55	58
29.65	21	30

3. Protection ratios between analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)
	Analogue Interferer Tx → Analogue Victim Rx 29.65 MHz → 29.65 MHz
0	60
14.825	50
29.65	20

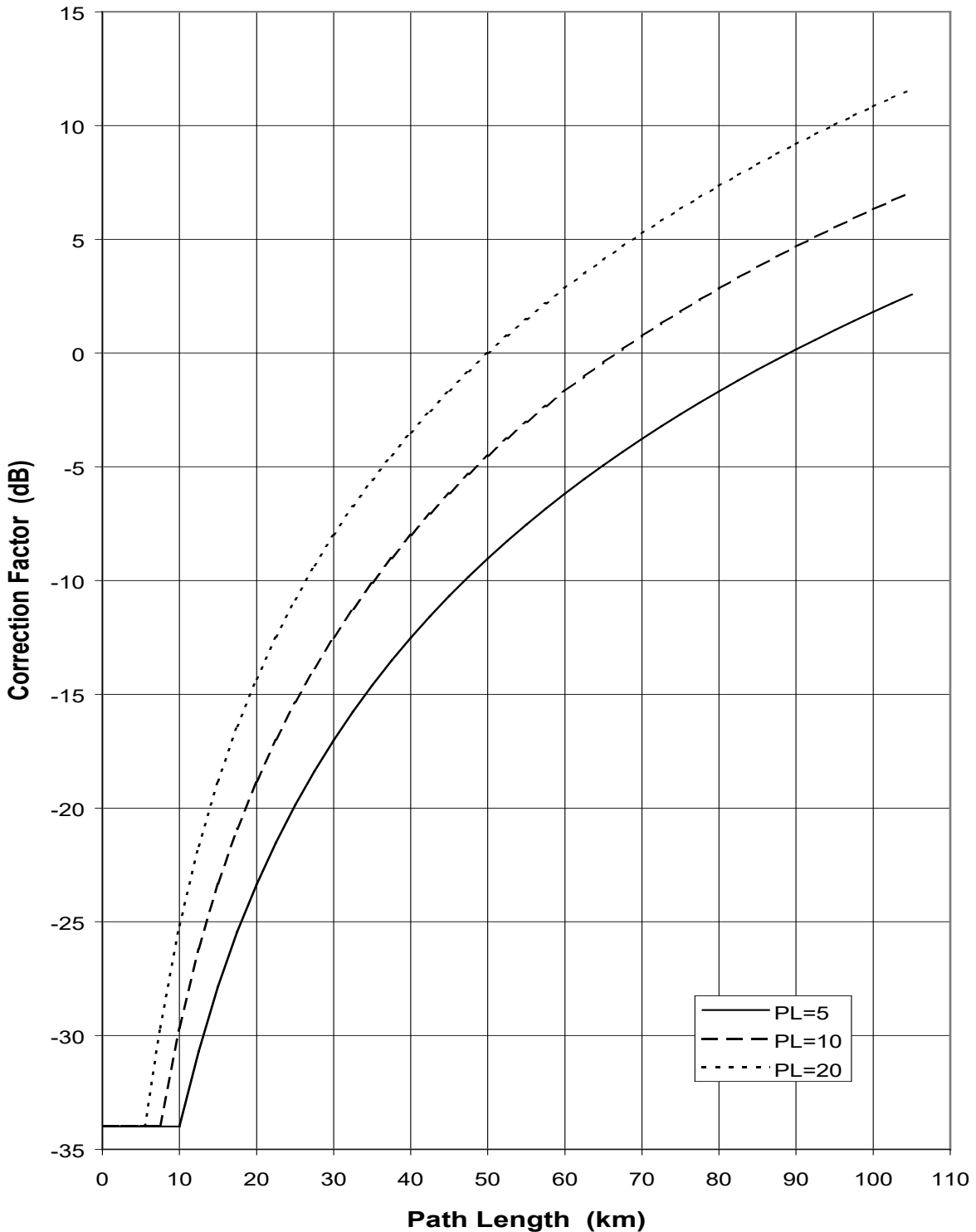
4. Protection ratios required between digital systems in the adjacent 6.7 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	29.65 MHz ↓ 40 MHz	29.65 MHz ↓ 80 MHz	59.3 MHz ↓ 40 MHz	59.3 MHz ↓ 80 MHz
55.21	10.5			
70.035			16	
75.21		19.5		
90.035				25
110.035			4	
170.035				10

Notes:

1. Protection ratio for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.

THE 6 GHz BAND (5925 - 6425 MHz)
PROTECTION RATIO CORRECTION FACTORS
MULTI PATH

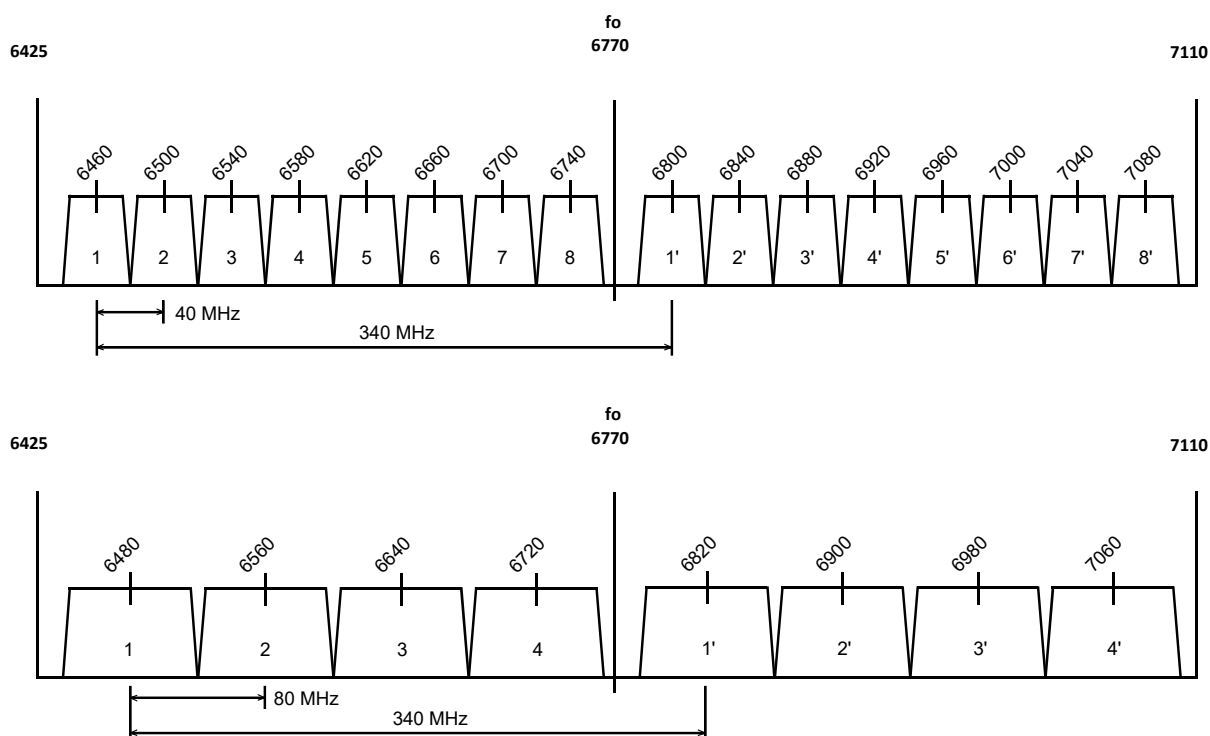


PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

THE 6.7 GHz BAND (6425 - 7110 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by digital high capacity fixed point-to-point links.

Typical Use	: 40 MHz channels - 140 Mbit/s data : 80 MHz channels - 298 Mbit/s data
Assignment Priority	: 80 MHz channels - from highest channel downwards
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Note:

1. Proposed links need to be coordinated with licensed earth stations operating in this band.
2. The channel raster known previously as the interleaved raster has been removed. No new assignments are to be made.
3. Potential for interference to and from adjacent 6 GHz band fixed services.

Reference

1. Rec. ITU-R F.384-5, "Radio-frequency channel arrangements for medium and high capacity analogue or high capacity digital radio-relay systems operating in the upper 6 GHz band".

THE 6.7 GHz BAND (6425 - 7110 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Interferer Tx → Victim Rx			
	40 MHz ↓ 40 MHz	40 MHz ↓ 80 MHz	80 MHz ↓ 40 MHz	80 MHz ↓ 80 MHz
0	60			69
20		68	56	
40	30			
60		50	35	
80	0			46
100		15	12	
140		8	4	
160				15

2. Protection ratios required between digital systems in the adjacent 6 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	40 MHz ↓ 29.65 MHz	40 MHz ↓ 59.3 MHz	80 MHz ↓ 29.65 MHz	80 MHz ↓ 59.3 MHz
55.21	12			
70.035		20		
75.21			15	
84.86	1.5			
90.035				24
104.86			10	

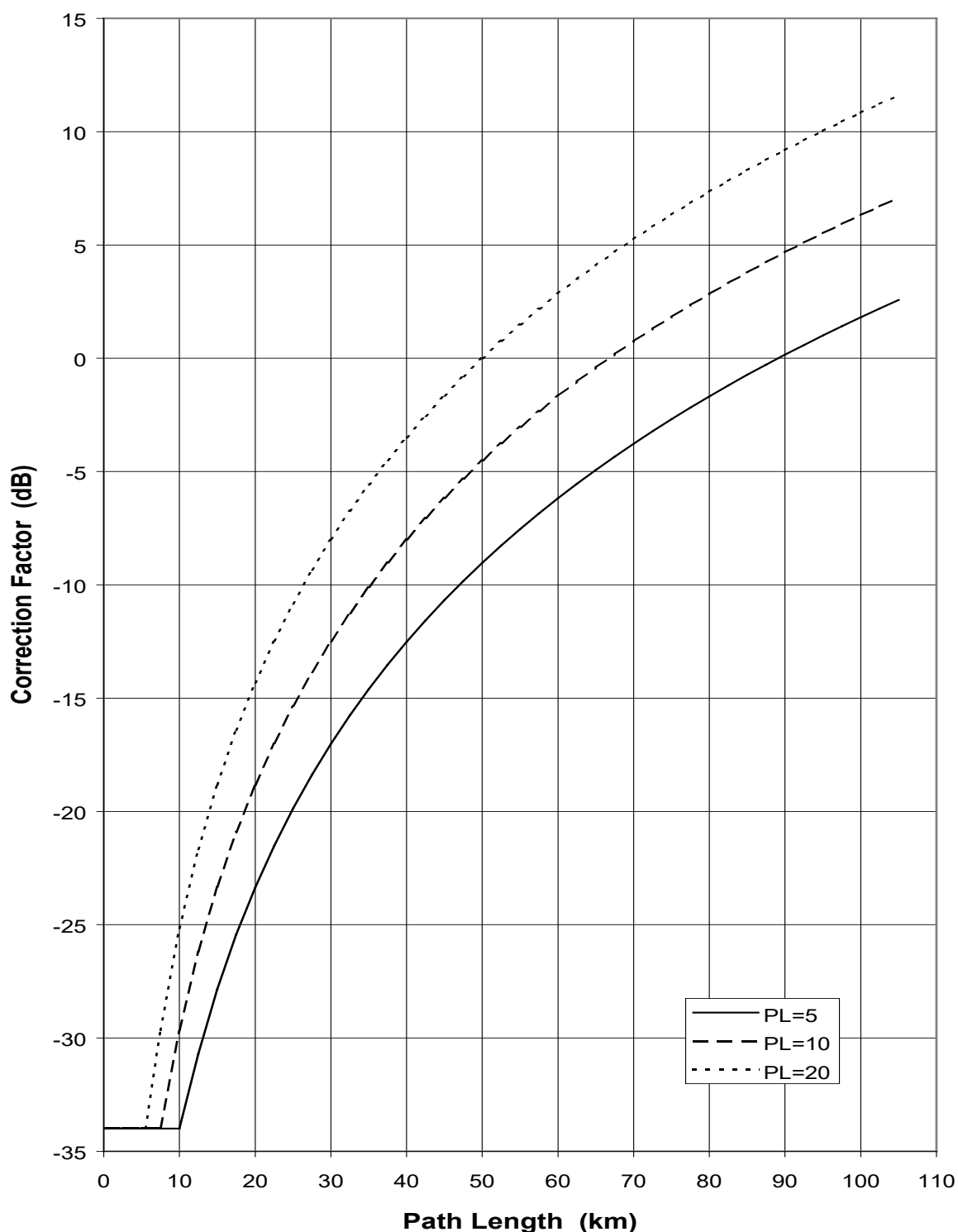
Note:

1. Protection ratios for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths and P_L values refer to the protection ratio correction factors graph on the following page.

THE 6.7 GHz BAND (6425 - 7110 MHz)

PROTECTION RATIO CORRECTION FACTORS

MULTI PATH

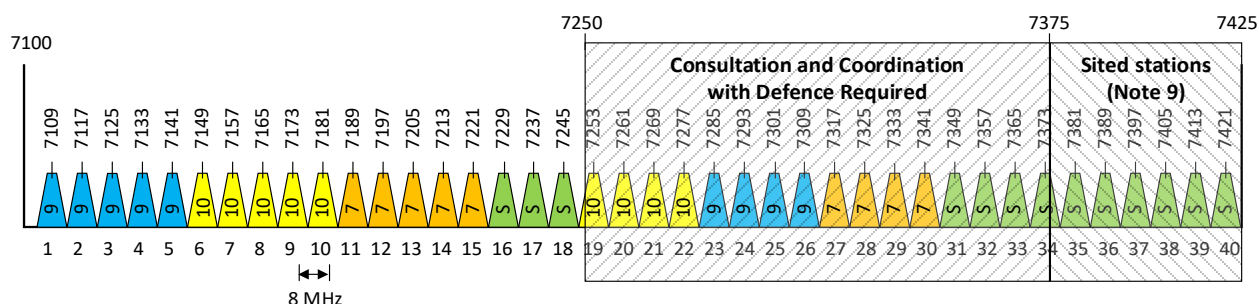


PL: Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

For further details refer to Annex A to Appendix 1.

THE 7.2 GHz BAND (7100 - 7425 MHz)

RF CHANNEL ARRANGEMENTS



7	Seven Network (7)
9	Nine Network (9)
10	Network Ten (10)
S	Shared General (S)

Frequency limits (MHz)	Channel bandwidth (MHz)	Channel centre frequency formula (MHz)	Range of integer values for variable 'n'	First channel–last channel centre frequency (MHz)
7105– 7425	8	7101 + n (8)	1 to 40	7109–7421

Channel allocation	Channel number	Consultation and coordination with defence required?	Coordination with licensed earth station receivers required?
Shared (S)	16–18	No	No
	31–34	Yes	Yes
	35–40	No	Yes
Seven Network (7)	11–15	No	No
	27–30	Yes	Yes
Nine Network (9)	1–5	No	No
	23–26	Yes	Yes
Network Ten (10)	6–10	No	No

ASSIGNMENT INSTRUCTIONS

This band is designated for use by Television Outside Broadcast (TOB) services.

Typical use	: temporary video links providing live coverage of events
Assignment Priority	: not applicable
Minimum Path Length	: not specified
Antenna Requirements	: 0.6 m standard parabolic dish

Previous channel arrangements

Previous channel arrangements which provided were replaced these channel arrangements on 28 October 2022. No new assignments are to be made to the old channel arrangements. Existing services are to transition to the new arrangements. For new shared channels 16,17 &18 note there are existing licences issued before the commence of these arrangements and these should be consider under Assignment restriction 4 (that is consider whether operations will be in the same area).

Notes:

1. All TOB transmitters in the bands 7100 to 7425 MHz operate subject to the condition that they do not cause interference to other services (see Reference 1). The coordination criteria outlined in this RALI will be used in the consideration of any interference.
2. Deleted.
3. Channels designated 'S' are for shared general use and can be licensed by any entity for TOB use.
4. Defence must be consulted when a non-Defence licence applicant requests an assignment in the frequency range 7250 to 7375 MHz (see assignment restriction 1).
5. The channel raster known previously as the interleaved raster has been removed. No new assignments are to be made in accordance with that raster.
6. Earth transmit stations in the space research (Earth-space) service operate at New Norcia and Tidbinbilla in the bands 7145 to 7235 MHz. Services that operate in and adjacent to this earth station transmit band do so on the basis that they are not afforded protection from interference from earth station transmitters at the New Norcia and Tidbinbilla facilities.
7. Channels marked with 7, 9 or 10 are for exclusive use by the Seven Network, Nine Network Australia and Network Ten respectively.
8. Earth receive stations and TOB services in the band 7375 to 7425 MHz need to be coordinated as detailed in assignment restriction 3.
9. Shared channels with [area-wide access areas](#) are not afforded protection from other services. To increase visibility to other licensees, commonly used sites can be recorded as special conditions on assignments with area-wide access areas.
10. The potential for interference between TOB services is to be managed in accordance with assignment restriction 4.
11. Chanel bandwidth are notional and larger bandwidths can be assigned provided the assignment is within the segment limits. For example, assignments for shared channels can have bandwidths greater than 8 MHz, provided the bandwidth only overlaps channels allocated for shared usage.

References:

1. [Radiocommunications Licence Conditions \(Fixed Licence\) Determination 2015.](#)
2. [Australian Radiofrequency Spectrum Plan 2021](#), May 2021.
3. [RALI MS 03](#), *Spectrum Embargoes* – embargos 47, 49 and 59.
4. [Recommendation SF.1006](#): ‘Determination of the interference potential between earth stations of the fixed-satellite service and stations in the fixed service’.
5. [Recommendation ITU-R S.465](#): ‘Reference radiation pattern of earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz’.
6. [Recommendation ITU-R P.452](#): ‘Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz’ using 20% time percentage.

THE 7.2 GHz BAND (7100 - 7425 MHz)

ASSIGNMENT RESTRICTION

1. Non-Defence assignments between 7250 and 7375 MHz

The frequency range 7250 to 7375 MHz (channels 19 to 34) is subject to footnote AUS100 in reference 2. In accordance with this footnote, assignments to non-Defence licence applicants must not be made in this frequency range unless Defence has been consulted and the licence applicant agrees to coordinate with Defence prior to each transmission being undertaken.

Licence applicants are to consult with Defence before applying for a licence and send details of agreed coordination arrangements to Manager, Spectrum Planning Section via freqplan@acma.gov.au.

Special Condition FH must be applied to all the licences in this band. Special Condition FH reads:

The licensee must coordinate any proposed transmissions in the frequency range 7250 MHz to 7375 MHz with the Department of Defence before commencing such transmissions.

2. TOB exclusion zones

There are a number of embargoes that restrict TOB assignments. Refer to RALI MS 03 to confirm current restrictions. Currently (at the time this channel plan was prepared) TOB assignments are not permitted in the areas and frequencies as listed in RALI MS 03 Embargos 47, 49 and 59 (reference 3):

- Embargo 47: 7250–7425 MHz near Geraldton WA
- Embargo 49: 7135–7245 MHz and 7250–7425 MHz near Mingenew WA
- Embargo 59: 7250–7425 MHz near Kapooka NSW.

3. Coordination requirements with earth station receivers in the 7375–7425 MHz band

To facilitate the use of shared TOB channels, the coordination requirements in the 7375–7425 MHz band have been designed to support handheld-like TOB cameras (with a maximum EIRP of 26 dBm and a notional antenna height of 1.5 m). Coordination of proposed TOB services consistent with these parameters is not required beyond a distance of 75 km from a licensed earth station receiver that has overlapping frequencies and operates in the 7375–7425 MHz band.

Sited TOB services that operate above these parameters will be considered on a case-by-case basis, provided it can be demonstrated that the protection requirements for earth station receivers are achieved.

Coordination between a proposed TOB transmitter and earth station receiver is deemed completed if the received power from the TOB transmitter at the earth station receiver is less than -158.6 dBW/MHz (derived from Recommendation SF.1006 – see reference 4).

The antenna pattern of the earth station antenna should be used if known. Otherwise, the latest version of Recommendation ITU-R S.465 should be used (see reference 5).

When calculating interference levels, propagation model P.452 using 20% time percentage should be used with Digital Elevation Model of 3 seconds or better (see reference 6).

Note: Proposed earth station receivers are required to be coordinated with existing licensed sited TOB stations.

4. Coordination requirements between TOB services

Shared channels and airborne transmitters

To facilitate sharing, airborne TOB transmitters (e.g., aboard helicopters) are not intended to be supported on shared channels. Usage will be considered on a case-by-case basis.

Coordination of shared channels

There are no coordination requirements between TOB services on shared channels. Shared channels are to be self-managed within the TOB industry to manage interference. TOB licensees are encouraged to coordinate usage of shared channels with other TOB licensees.

Adjacent channel coordination

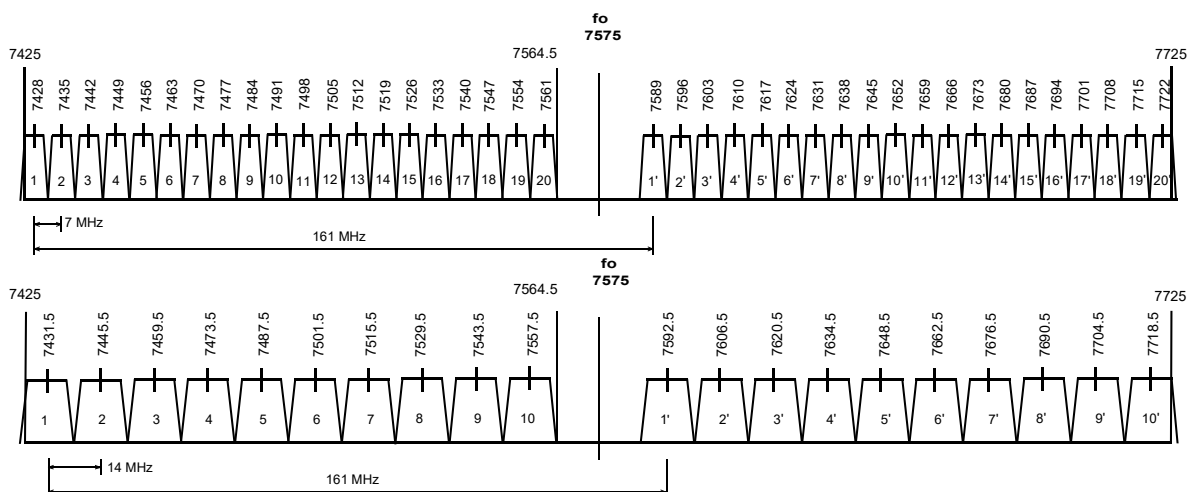
TOB licensees are to self-coordinate adjacent channel use with other TOB licensees.

5. Coordination requirements with space research services

Space research services transmit in the 7145 to 7235 MHz band from New Norcia (WA) and Tidbinbilla (ACT), and TOB services are not afforded protection from these services.

THE 7.5 GHz BAND (7425 - 7725 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by low-medium capacity fixed point-to-point links.

Typical Use	: 2-17 Mbit/s data
Assignment Priority	: See Note 1.
Minimum Path Length	: 20 km
Antenna Requirements	: refer to Appendix 11

Notes:

1. Assignment priorities are defined as follows:
 - 14 MHz channels - from the highest channel downward;
 - 7 MHz channels - from the lowest channel upward.
2. Co-ordination with Defence is required for assignments in Canberra. All Defence co-ordination requirements should be addressed through ACA Central Office.
3. Assignments should not be made on the 7 MHz Ch1 to avoid band edge interference.
4. Potential for interference to and from adjacent 8 GHz band fixed services.

References

1. Rec. ITU-R F.385-6, "Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band".

THE 7.5 GHz BAND (7425 - 7725 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on the same channel raster.

Co Channel:	60 dB
1st Adjacent Channel	30 dB
2nd Adjacent Channel	0 dB

2. Protection ratios between systems using 3.5 MHz channels and systems using either 7 MHz or 14 MHz channels - see note 2.

Frequency Offset (MHz)	PROTECTION RATIO (dB)					
	3.5 MHz*	7 MHz	3.5 MHz*	14 MHz	3.5 MHz*	18 MHz*
	↓ 7 MHz	↓ 3.5 MHz*	↓ 14 MHz	↓ 3.5 MHz*	↓ 18 MHz*	↓ 3.5 MHz*
1.75	60	60	60	60	60	60
5.25	55	48	60	55	60	60
8.75	18	20	55	40	60	55
12.25			30	30	55	40
15.75				10	30	30

3. Protection ratios between systems using either 7 MHz or 14 MHz channels and systems using 18 MHz channels - see note 3.

Frequency Offset (MHz)	PROTECTION RATIO (dB)					
	7 MHz	14 MHz	7 MHz	18 MHz*	14 MHz	18 MHz*
	↓ 14 MHz	↓ 7 MHz	↓ 18 MHz*	↓ 7 MHz	↓ 18 MHz*	↓ 14 MHz
0	60	60	60	60	60	60
7	50	45	60	55	60	60
14	36	27	45	30	55	50
21					30	30

4. Protection ratios required between digital systems in the adjacent 8 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	7 MHz	7 MHz	14 MHz	14 MHz
	↓ 29.65 MHz	↓ 59.3 MHz	↓ 29.65 MHz	↓ 59.3 MHz
10.875	58			
14.375			54.5	
25.7		64		
29.2				61

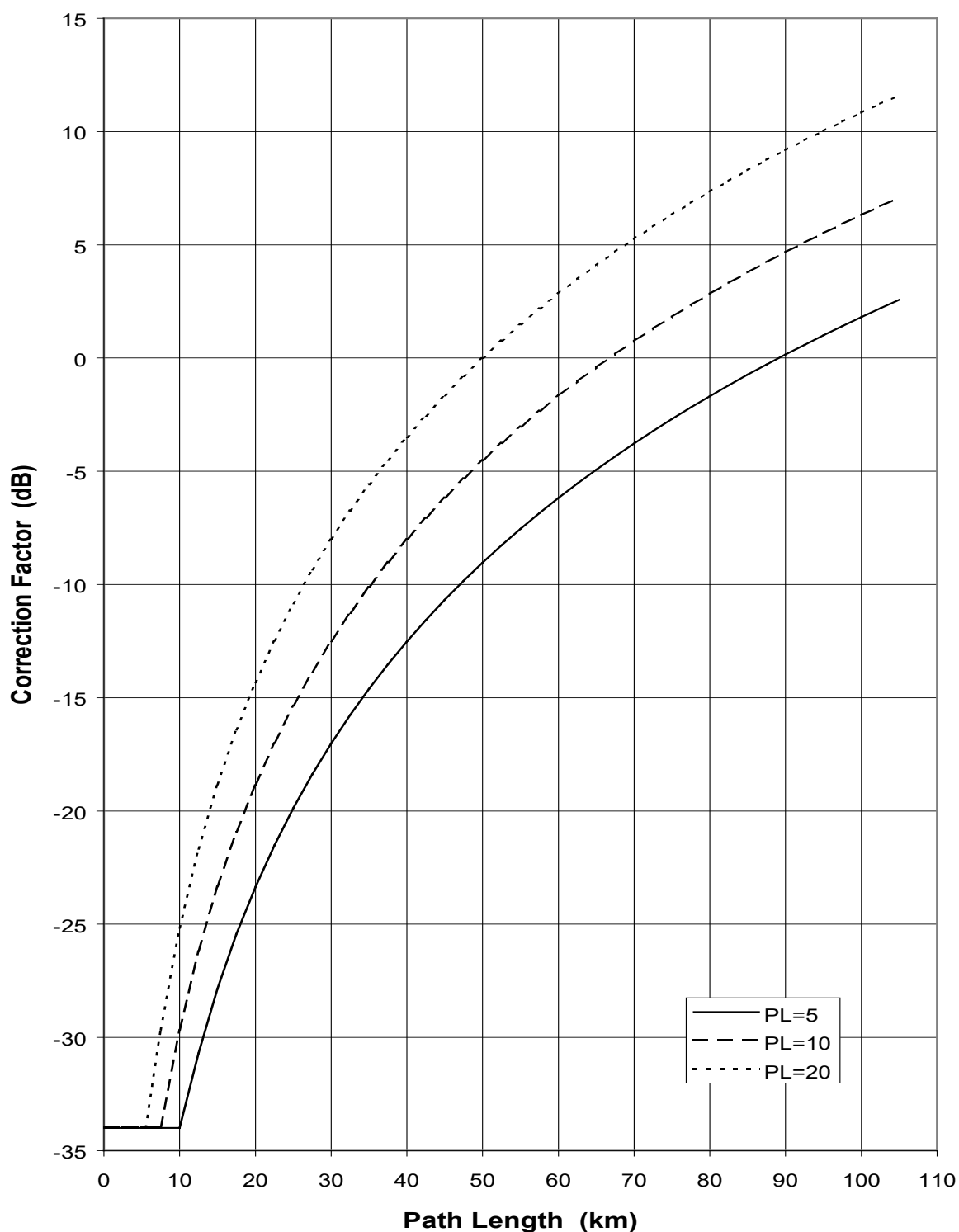
Notes:

1. Protection ratio for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20, for other path lengths and P_L values refer to the appropriate path length correction factors graph on the following page.
2. The 3.5 MHz* table heading denotes systems operating under earlier arrangements which require 3.5 MHz bandwidth, new assignments are to be coordinated around these systems.
3. The 18 MHz* table heading denotes systems operating under earlier arrangements which require 18 MHz bandwidth, new assignments are to be coordinated around these systems.

THE 7.5 GHz BAND (7425 - 7725 MHz)

PROTECTION RATIO CORRECTION FACTORS

MULTI PATH

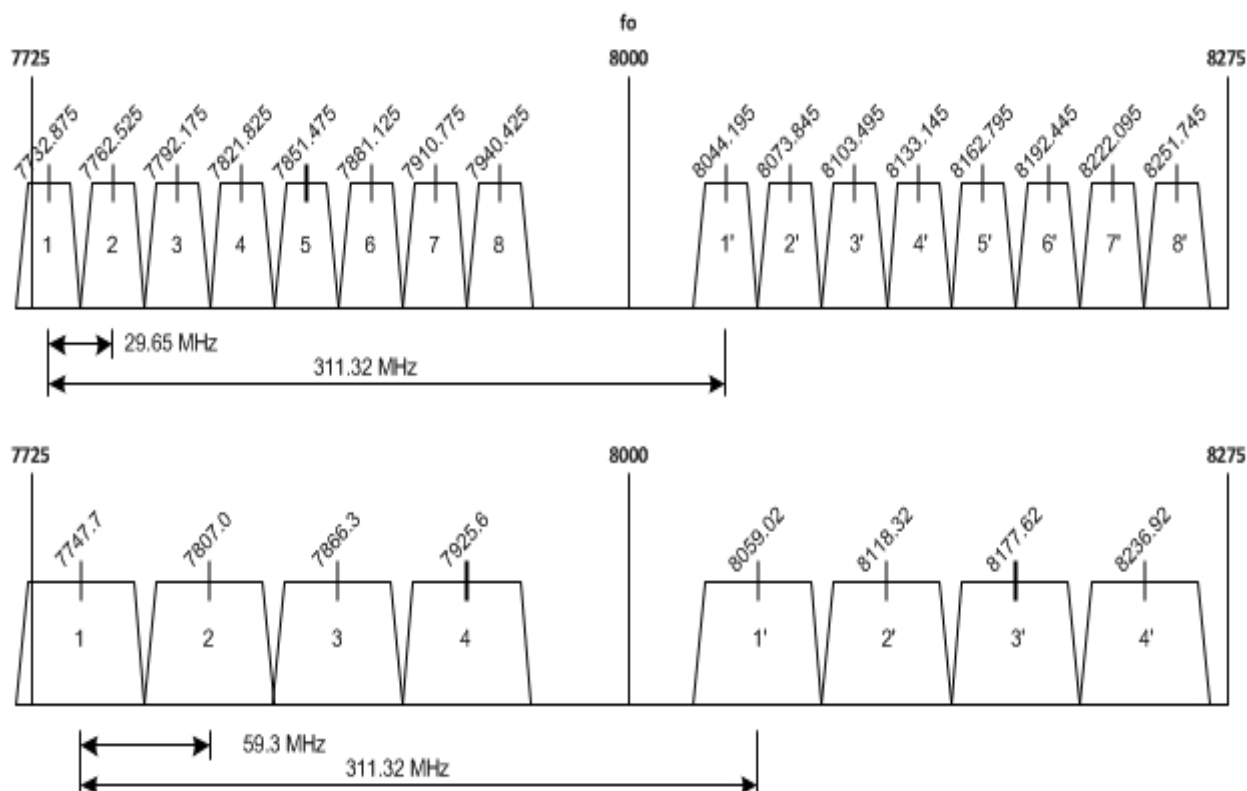


P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to $-100 N$ units/km.

For further details refer to Annex A to Appendix 1.

THE 8 GHz BAND (7725 - 8275 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by medium and high capacity fixed point-to-point links.

Typical Use	: 29.65 MHz channels - 34 Mbit/s data, FM Video : 59.3 MHz channels - 197 Mbit/s data
Assignment Priority	: See Notes 1 & 2.
Minimum Path Length	: 10 km
Antenna Requirements	: refer to Appendix 11

Note:

1. No assignments shall be made on 29.65 MHz channels 7 and 8 (main and interleaf) and 59.3 MHz channel 4, except in cases where the availability of other channels in the band is precluded through unsuccessful coordination.
2. Assignment priorities are defined as follows:

29.65 MHz channels – from the lowest channel upwards
59.3 MHz channels – from channel 3/3' downwards
2. The channel raster known previously as the main raster is grandfathered. No new assignments are to be made; existing services may continue to operate.
3. Potential for interference to and from adjacent 7.5 GHz band fixed services.

Reference

1. Rec. ITU-R F.386-4, “*Radio-frequency channel arrangements for radio-relay systems operating in the 8 GHz band*”.

THE 8 GHz BAND (7725 - 8275 MHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	29.65 MHz ↓ 29.65 MHz	29.65 MHz ↓ 59.3 MHz	59.3 MHz ↓ 29.65 MHz	59.3 MHz ↓ 59.3 MHz
0	60			68
14.825	57	67	56	
29.65	30			
44.475		36	25	
59.3				34
74.125		13	13	
103.775		7	3	
118.6				13

2. Protection ratios required between digital and analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Analogue Interferer Tx ↓ Digital Victim Rx	Digital Interferer Tx ↓ Analogue Victim Rx
	29.65 MHz ↓ 29.65 MHz	29.65 MHz ↓ 29.65 MHz
	0	60
14.825	55	58
29.65	21	30

3. Protection ratios between analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)
	Analogue Interferer Tx → Analogue Victim Rx 29.65 MHz → 29.65 MHz
0	60
14.825	50
29.65	20

4. Protection ratios required between digital systems in the adjacent 7.5 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	29.65 MHz ↓ 7 MHz	29.65 MHz ↓ 14 MHz	59.3 MHz ↓ 7 MHz	59.3 MHz ↓ 14 MHz
10.875	53			
14.375		52.5		
17.875	30			
24.875	19			
25.7			48	
28.375		20		
29.2				47
31.875	14			
32.7			31	
38.875	9			
39.7			14	
42.375		10		
43.2				17
45.875	4			
46.7			13	
53.7			12	
57.2				14
60.7			10	
67.7			9	
71.2				11
74.7			7	
81.7			4	
85.2				6

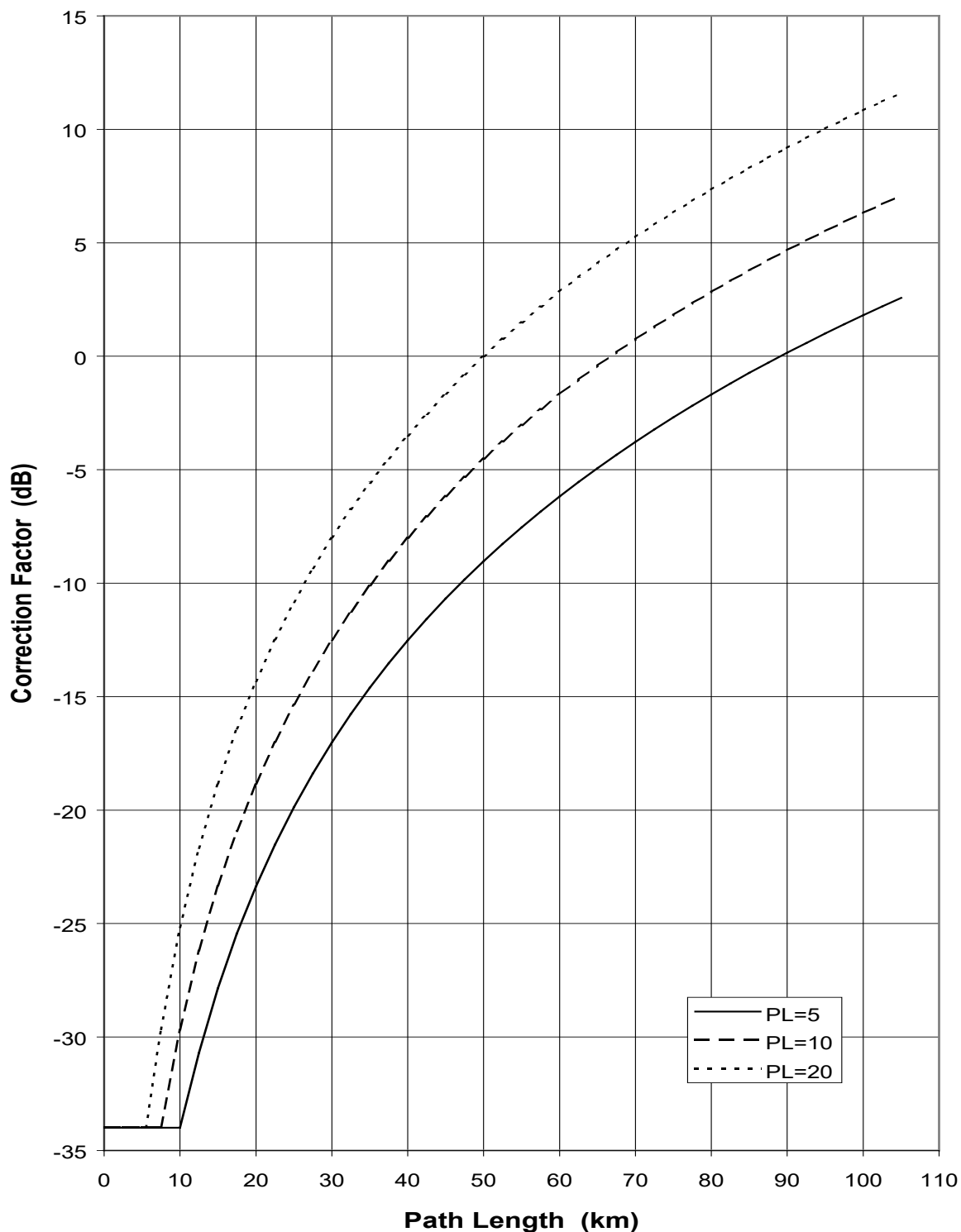
Notes:

1. Protection ratio for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths and P_L values refer to the appropriate protection ratio correction factors graph on the following page.

THE 8 GHz BAND (7725 - 8275 MHz)

PROTECTION RATIO CORRECTION FACTORS

MULTI PATH

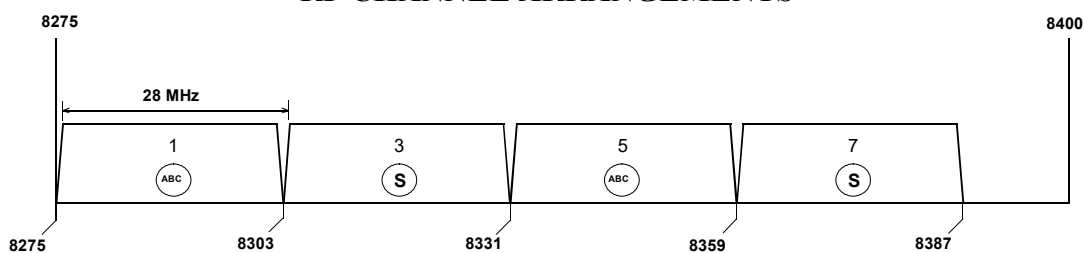


P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

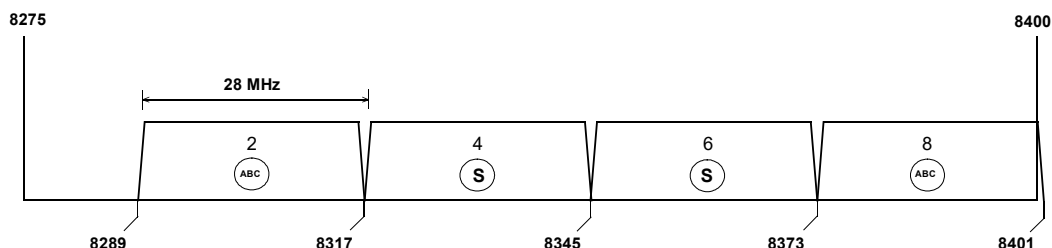
For further details refer to Annex A to Appendix 1.

THE 8.3 GHz BAND (8275-8400 MHz)

RF CHANNEL ARRANGEMENTS



MAIN



INTERLEAVED

TOB Network Licences (ABC) = ABC Network

TOB Provisions (S) = Shared General

ASSIGNMENT INSTRUCTIONS

This band is designated for use by Television Outside Broadcast (TOB) services.

Typical Use	: temporary video links providing live coverage of events
Assignment Priority	: not applicable
Minimum Path Length	: not specified
Antenna Requirements	: 0.6 m standard parabolic dish

Notes:

1. Channels 1, 2, 5 and 8 are reserved for the ABC on an Australia-wide basis.
2. Channels designated 'S' are for general shared use. These channels are not normally available for assignment on an exclusive basis - for special case situations see Reference 1.
3. Main pattern usage has priority over that of the interleaved pattern. Special condition 27 shall be applied to all spectrum accesses relating to TOB operations on interleaved channels.
4. Earth receive stations in the space research (space-to-Earth) service operate at New Norcia in the adjacent 8400-8500 MHz frequency band. Under the Radiocommunications Licence Condition (Fixed Licence) Determination, television outside broadcast stations operate on the condition that harmful interference is not caused to other services. The operation of TOB services on channel 8 is restricted about the New Norcia earth station facility in Western Australia. See Operating Restrictions about the New Norcia Earth Station Facility.

References

1. Spectrum Planning Policy Document SPP3/95, "Television Outside Broadcast (TOB) Service - 7.2 GHz and 8.3 GHz RF Channel Arrangements", July 1995.
2. RALI MS43 JAN 2016

OPERATING RESTRICTIONS ABOUT THE NEW NORCIA EARTH STATION FACILITY

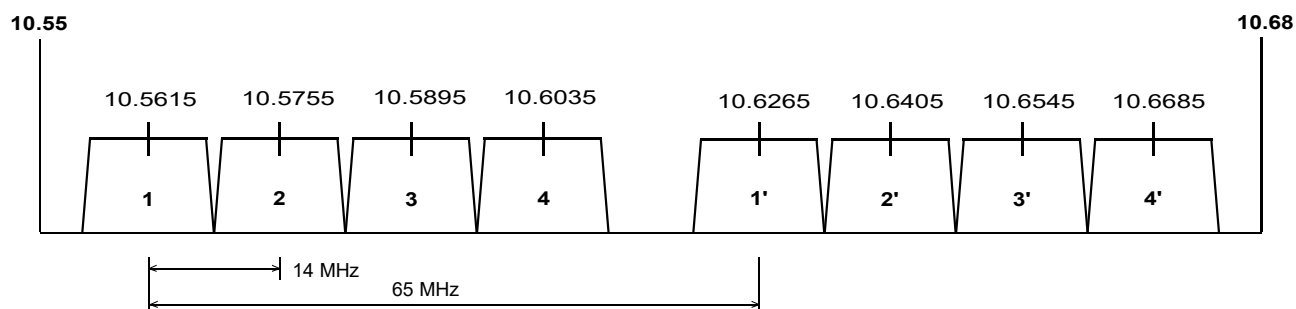
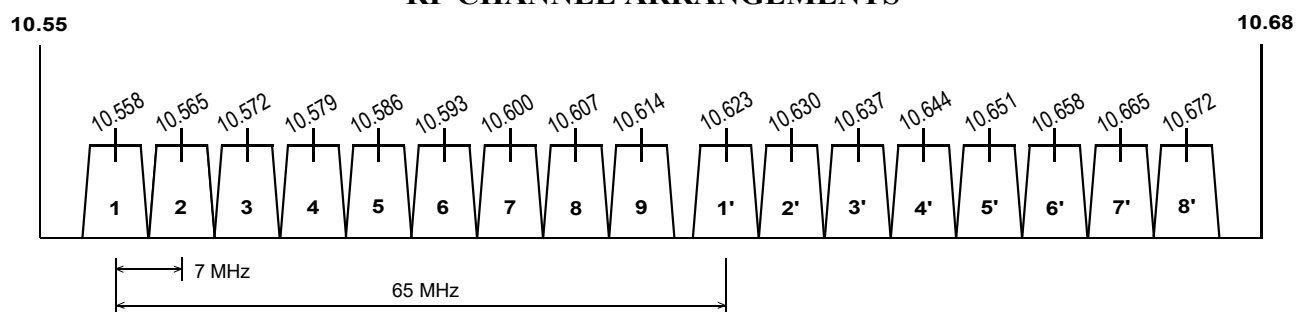
For TOB services operating on channel 8:

- Operation of transmitters is not allowed without the prior approval of the New Norcia earth station licensee within the areas covered by the Hierarchical Cell Identification Scheme (HCIS) cell identifiers BU8I7, BU8I8, BU8I9, BU8J7, BU8J8, BU8M2, BU8M3, BU8N, BU8M5, BU8M6, BU8O4, BU7P9, BU8M7, BU8M8, BU8M9, BV2A1, BV2A2, BV2A3, BV2B1, BV2A6, BV2B4. For a graphical representation of this area, refer to RALI MSXX, Annex D Figure 1 or use the ACMA HCIS converter (<http://www.acma.gov.au/theACMA/convert-hcis-area-description-to-a-placemark>).
- No operations are allowed in the band 8400-8401 within 150km of the New Norcia earth station.
- The level of emissions received at the New Norcia facility in the band 8400-8500 MHz, from transmitters operating on channel 8 is not to exceed the levels specified in RALI MS43.

The New Norcia facility is located at -31.049444°, 116.190000° (ADG66). Refer RALI MS43

THE 10 GHz BAND (10.55 - 10.68 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by low and medium capacity fixed point-to-point links.

Typical Use	: 2 Mbit/s data, narrow-deviation FM video
Assignment Priority	: See Note 1.
Minimum Path Length	: 5 km
Antenna Requirements	: refer to Appendix 11

Notes:

1. Assignment priorities are defined as follows:

- 7 MHz channels - from the lowest channel upward;
- 14 MHz channels - from the highest channel downward; and
- for one-way links using the 7 MHz channels - channel 9 should be utilised first.

2. In accordance with Radio Regulations Resolution 751 (WRC-07), fixed links must meet assignment criteria (Assignment Restrictions 1)

3. Potential for interference to and from adjacent 11 GHz band fixed services

References

1. Rec. ITU-R F.747, "Radio-frequency channel arrangements for radio-relay systems operating in the 10 GHz band".
2. Radio Regulations Resolution 751 (WRC-07), "Sharing criteria in the band 10.6-10.68 GHz"

Assignment Criteria

- In accordance with ITU-R Radio Regulation Resolution 751 (WRC-07), fixed services in the 10.6 – 10.68 GHz band are required to meet the following parameters in order to reduce the interference to EESS from fixed services.

Parameter	Value
Maximum elevation angle	20°
Maximum transmitter power at the antenna port	-15 dBW

THE 10 GHz BAND (10.55 - 10.68 GHz)

PROTECTION RATIOS

- Protection ratios required between systems operating on 7 and 14 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	7 MHz ↓ 7 MHz	7 MHz ↓ 14 MHz	14 MHz ↓ 7 MHz	14 MHz ↓ 14 MHz
0	55	60	55	60
3.5		60	55	
7	30	55	51	60
10.5		50	40	
14	18	25	15	50
17.5		10	0	

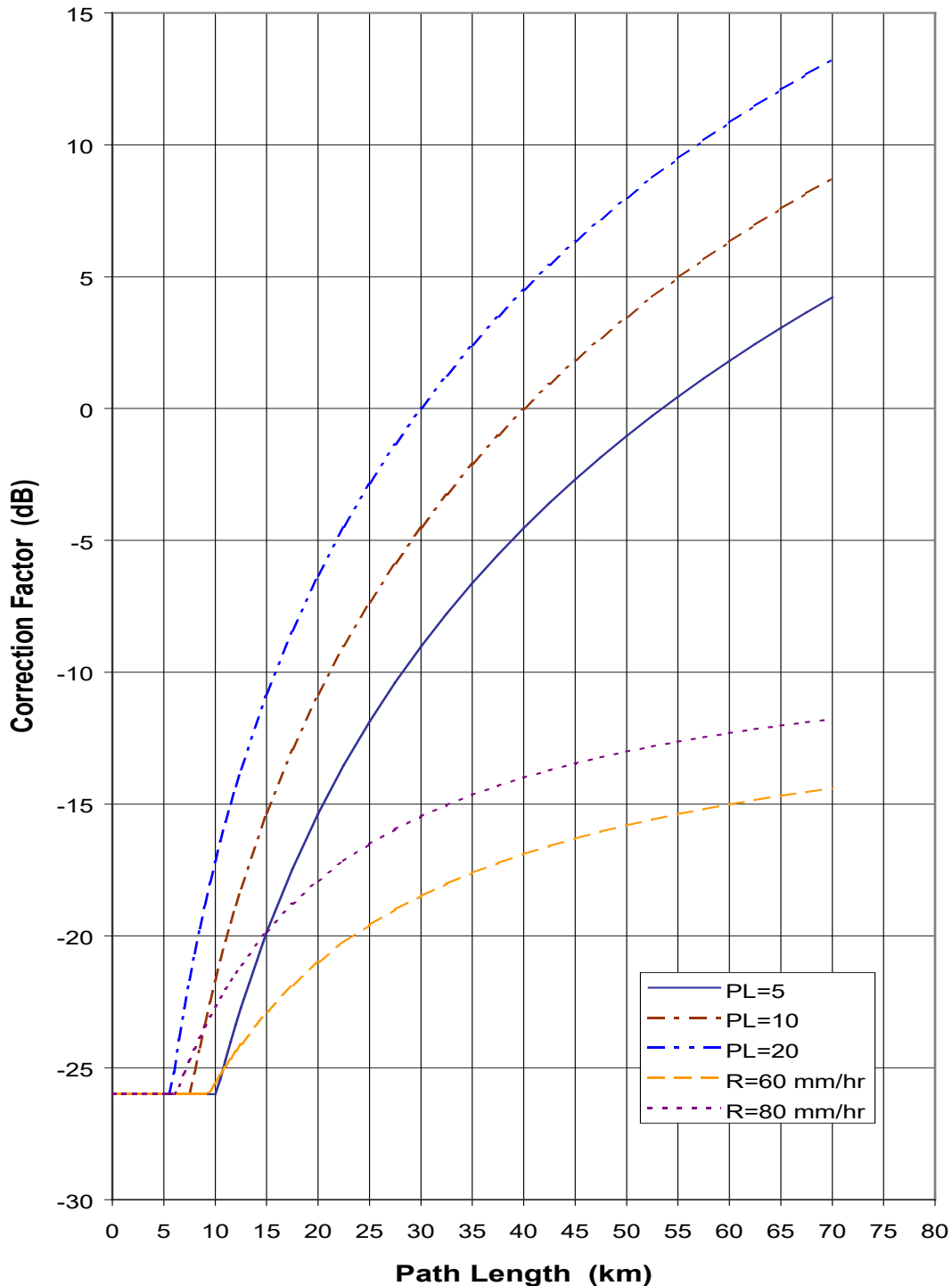
- Protection ratios required between digital systems in the adjacent 11 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	7 MHz ↓ 80 MHz	14 MHz ↓ 80 MHz
83	8	
86.5		8

Notes:

- Protection ratio for digital systems are based on a 30 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. For other path lengths, rainfall rates and P_L values refer to the appropriate propagation path correction factors graph on the following page.

THE 10 GHz BAND (10.55 - 10.68 GHz)
PROTECTION RATIO CORRECTION FACTORS
RAIN AND MULTI PATH



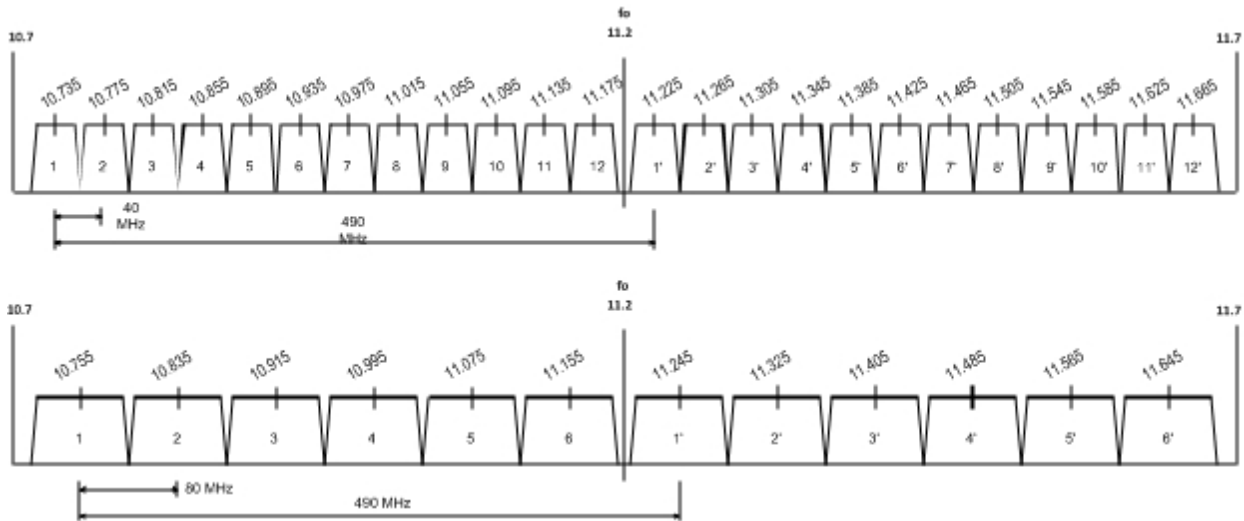
P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

R: Rainfall rate in mm/hr for 0.01% of the worst month.

For further details refer to Annex A to Appendix 1.

11 GHz BAND (10.7 - 11.7 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by digital high capacity fixed point-to-point links (see Notes).

Typical Use	: 40 MHz channels - 140/155 Mbit/s data : 80 MHz channels - 298 Mbit/s data
Assignment Priority	: 80 MHz channels – highest channel downwards
Minimum Path Length	: 5 km
Antenna Requirements	: refer to Appendix 11

Note:

1. Deleted
2. Proposed fixed links need to be coordinated with earth stations operating in this band.
3. Requests for assignments within 150 km of the GPOs of Darwin (NT) or Geraldton (WA) are to be referred to the Manager, Customer Services Coordination Team, Customer Services Group, Canberra Central Office, ACA, for preliminary coordination consultation¹.
4. The channel raster known previously as the interleaved raster has been removed. No new assignments are to be made to that raster.
5. Potential for interference to and from adjacent 10 GHz band fixed services

Reference

1. Rec. ITU-R F.387-6, "Radio-frequency channel arrangements for radio relay systems operating in the 11 GHz band".

¹ ACA file F89-207, held by Manager, Spectrum Planning and Engineering Team, Radiofrequency Planning Group, refers.

11 GHz BAND (10.7 - 11.7 GHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Interferer Tx → Victim Rx			
	40 MHz ↓ 40 MHz	40 MHz ↓ 80 MHz	80 MHz ↓ 40 MHz	80 MHz ↓ 80 MHz
0	60			69
20		68	56	
40	30			
60		50	35	
80	0			46
100		15	12	
140		8	4	
160				15

2. Protection ratios required between digital systems in the adjacent 10 GHz band.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	80 MHz ↓ 7 MHz	80 MHz ↓ 14 MHz
83	7	
86.5		10
90	6	
97	5	
100.5		7
104	3	
111	2	
114.5		5

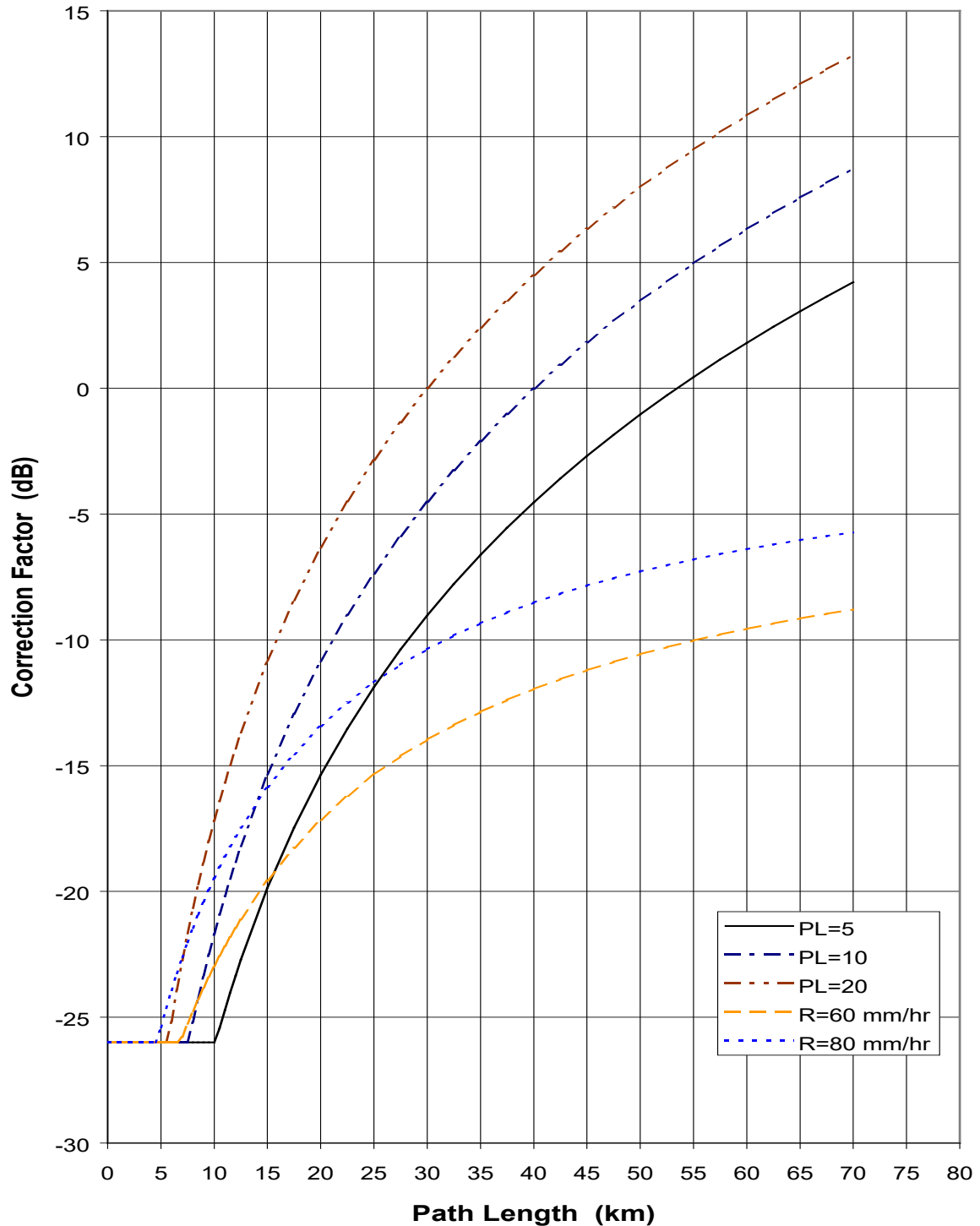
Notes:

1. Protection ratios for digital systems are based on a 30 km path length and P_L (Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km) of 20. For other path lengths, rainfall rates and P_L values refer to the protection ratio correction factors graph on the following page.

11 GHz BAND (10.7 - 11.7 GHz)

PROTECTION RATIO CORRECTION FACTORS

MULTI PATH



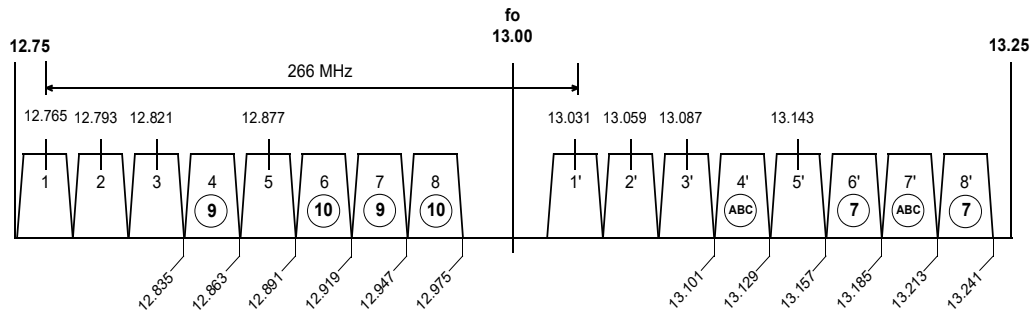
P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

R: Rainfall rate in mm/hr for 0.01% of the worst month.

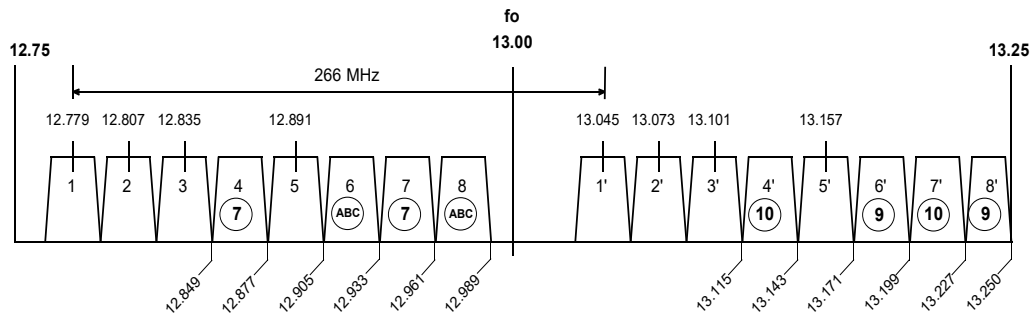
For further details refer to Annex A to Appendix 1.

THE 13 GHz BAND (12.75 - 13.25 GHz)

RF CHANNEL ARRANGEMENTS



MAIN



INTERLEAVED

TOB Network Licences : (7) = Seven Network; (9) = Nine Network; (10) = Ten Network; (ABC) = ABC Network

ASSIGNMENT INSTRUCTIONS

This band is designated for use by medium capacity fixed point-to-point links and Television Outside Broadcast (TOB) services (See Notes 1 to 6).

Typical Use	: FIXED	- 34 Mbit/s data
	TOB	- temporary links for live coverage of events teleconferencing, outside broadcast, etc.
Assignment Priority	: not specified	
Minimum Path Length	: not specified	
Antenna Requirements	: FIXED	- refer to Appendix 11
	TOB	- 0.6 m standard parabolic dish

Notes:

1. With the exception of interleaved channel 8', all channels are 28 MHz wide.
2. Fixed assignments may be made only on main channels 1-1', 2-2', 3-3' and 5-5'. However, assignments for fixed services on channels 5-5' are not permitted within 100 km of a capital city.
3. TOB channel designations for the major television networks are shown above.
4. Non-network TOB operators share channels 5-5'.
5. TOB assignments shall be endorsed with Special Condition 27.
6. TOB sharing arrangements are described in Reference 1.

References

1. Spectrum Planning Document No. SP 1/90, “*Spectrum and Licensing Arrangements for Outside Broadcast Television Services*” March 1990.
2. Rec. ITU-R F.497-4, “*Radio-frequency channel arrangements for radio-relay systems operating in the 13 GHz frequency band*”.

THE 13 GHz BAND (12.75 - 13.25 GHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	14 MHz ↓ 14 MHz	14 MHz ↓ 28 MHz	28 MHz ↓ 14 MHz	28 MHz ↓ 28 MHz
0	50	50	50	50
14	20	35	45	47

2. Protection ratios required between digital and analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Analogue Interferer Tx ↓ Digital Victim Rx		Digital Interferer Tx ↓ Analogue Victim Rx	
	28 MHz ↓ 14 MHz	28 MHz ↓ 28 MHz	14 MHz ↓ 28 MHz	28 MHz ↓ 28 MHz
0	50	50	60	60
14	35	45	40	55

3. Protection ratios between analogue systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)
	Analogue Interferer Tx → Analogue Victim Rx 28 MHz → 28 MHz
0	60
14	50

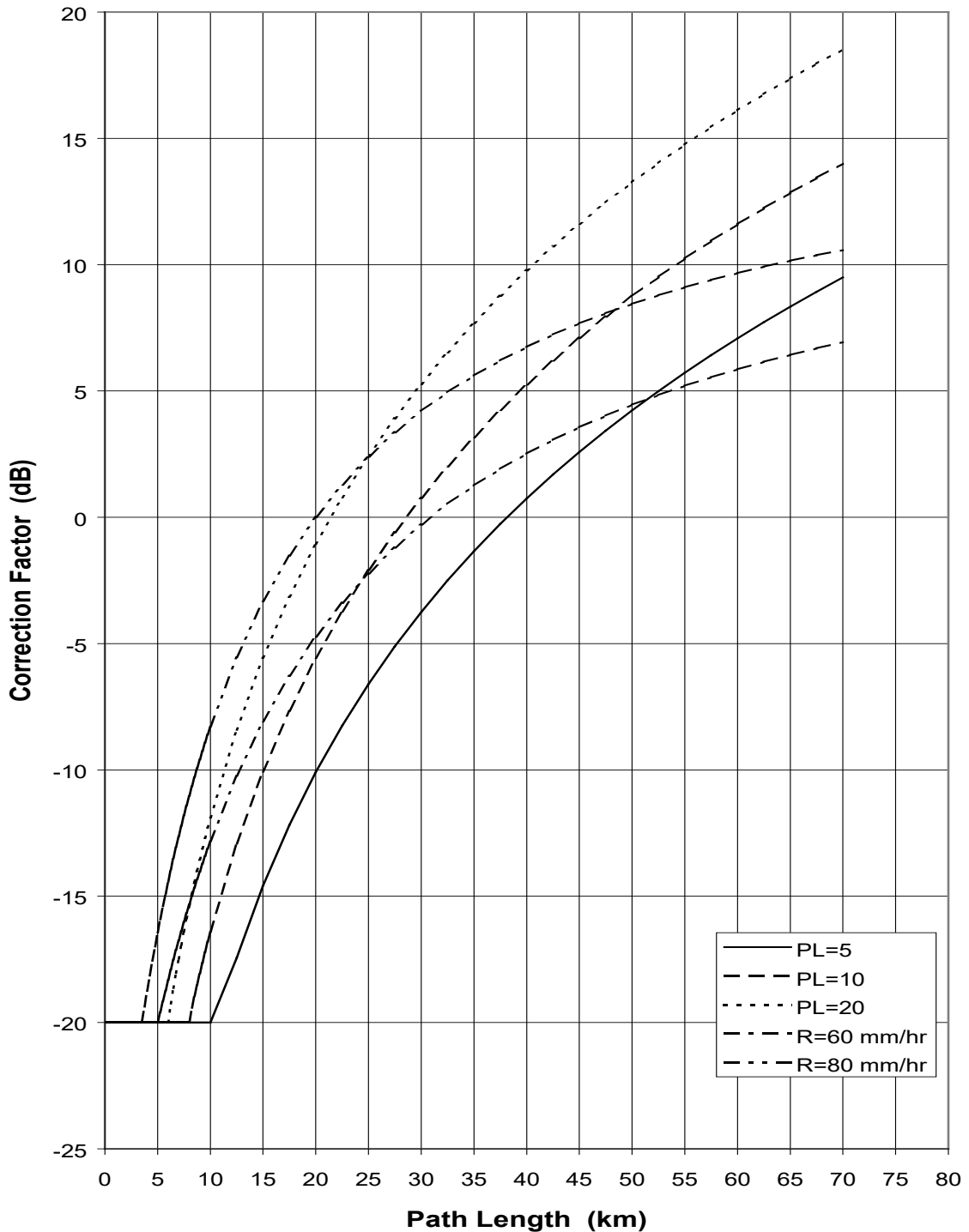
Notes:

1. Protection ratios for digital systems are based on a 20 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr. For other path lengths, rainfall rates and PL (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) values refer to the appropriate protection ratio correction factors graph on the following page.

THE 13 GHz BAND (12.75 - 13.25 GHz)

PROTECTION RATIO CORRECTION FACTORS

RAIN AND MULTI PATH

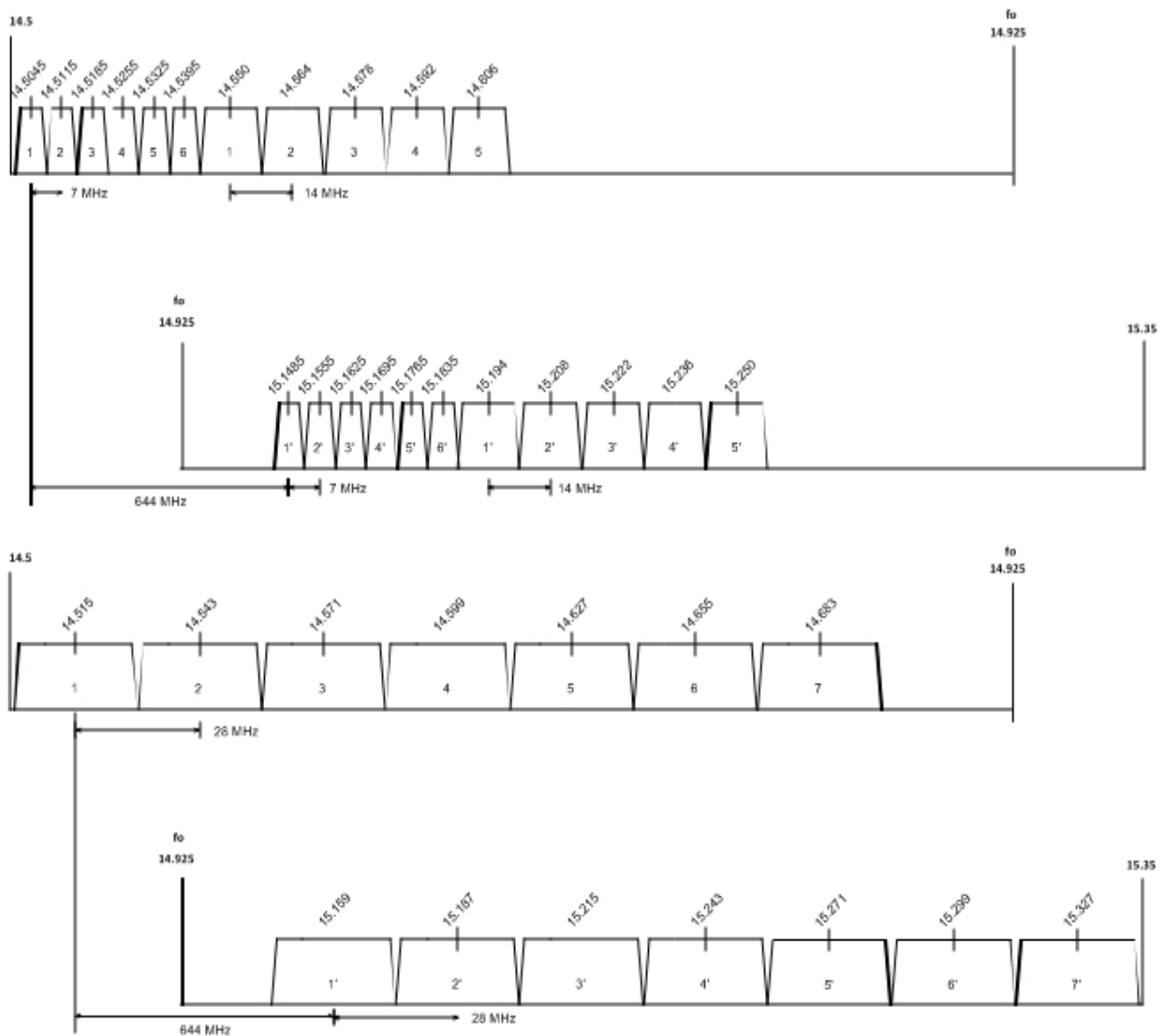


P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

R: Rainfall rate in mm/hr for 0.01% of the worst month. For further details refer to Annex A to Appendix 1.

THE 15 GHz BAND (14.5 - 15.35 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by low and medium capacity fixed point-to-point links.

Typical Use	: low capacity - 2/8 Mbit/s : medium capacity - 34 Mbit/s
Assignment Priority	: See Note 1.
Minimum Path Length	: 5 km
Antenna Requirements	: refer to Appendix 11

Note:

1. Assignment priorities are defined as follows:

28 MHz channels - from channel 6/6' downward;
14 MHz channels - from lowest channel upward; and
7 MHz channels - from lowest channel upward.

2. No assignments shall be made on channel 7/7', except in cases where the availability of other channels in the band is precluded through unsuccessful coordination.

References

1. Rec. ITU-R F.636-3, *“Radio-frequency channel arrangements for radio-relay systems operating in the 15 GHz band”*.

THE 15 GHz BAND (14.5 - 15.35 GHz)

PROTECTION RATIOS

1. Protection ratios between digital systems operating on the same channel arrangements.

Co Channel	60 dB
1st Adjacent Channel	30 dB
2nd Adjacent Channel	0 dB

2. Protection ratios between digital systems requiring 7 and 14 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	7 MHz → 14 MHz	14 MHz → 7 MHz
7	60	59
10.5	58	49
14	44	37
17.5	32	26
21	23	13
24.5	15	

3. Protection ratios between digital systems requiring 7 and 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	7 MHz → 28 MHz	28 MHz → 7 MHz
3.5	60	53
10.5	57	53
17.5	42	33
24.5	13	19
31.5	0	14

4. Protection ratios between digital and analogue systems requiring 14 and 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Tx		Analogue Tx	Digital Tx
	↓		↓	↓
	Digital Rx		Digital Rx	Analogue Rx
	14 MHz	28 MHz	28 MHz	14 MHz
	↓	↓	↓	
	28 MHz	14 MHz	14 MHz	28 MHz
0	60	60	60	60
7	59	56	60	60
21	37	33	30	30
35	7	15		
49	0	5		

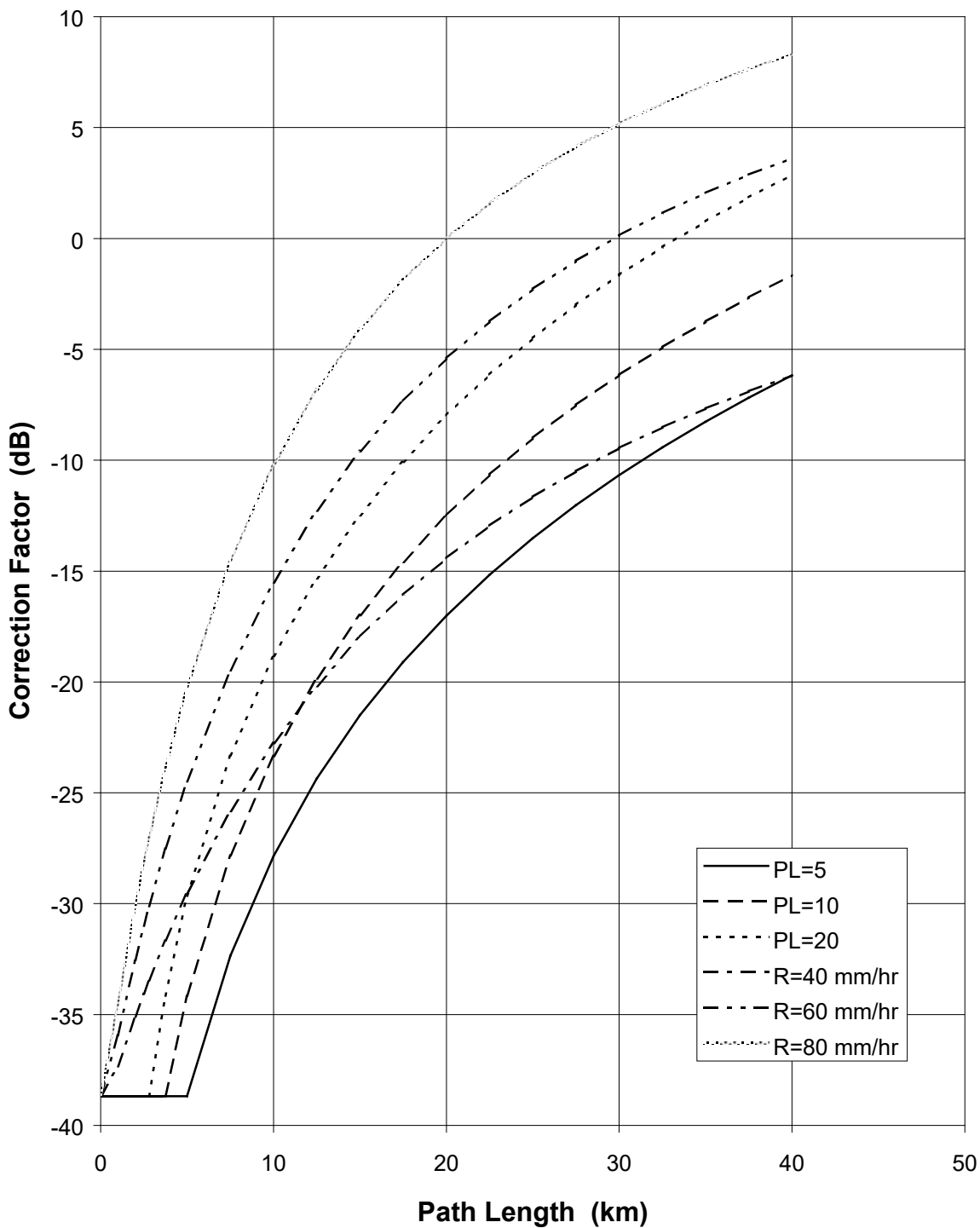
5. Protection ratios between digital and analogue systems requiring 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)		
	Analogue Tx ↓ Analogue Rx	Analogue Tx ↓ Digital Rx	Digital Tx ↓ Analogue Rx
0	60	60	60
28	20	21	30

Notes:

1. Protection ratio for digital systems are based on a 20 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr. For other path lengths and rainfall rates refer to the appropriate protection ratio correction factors graph on the following page.

THE 15 GHz BAND (14.5 - 15.35 GHz)
PROTECTION RATIO CORRECTION FACTORS
RAIN AND MULTI PATH

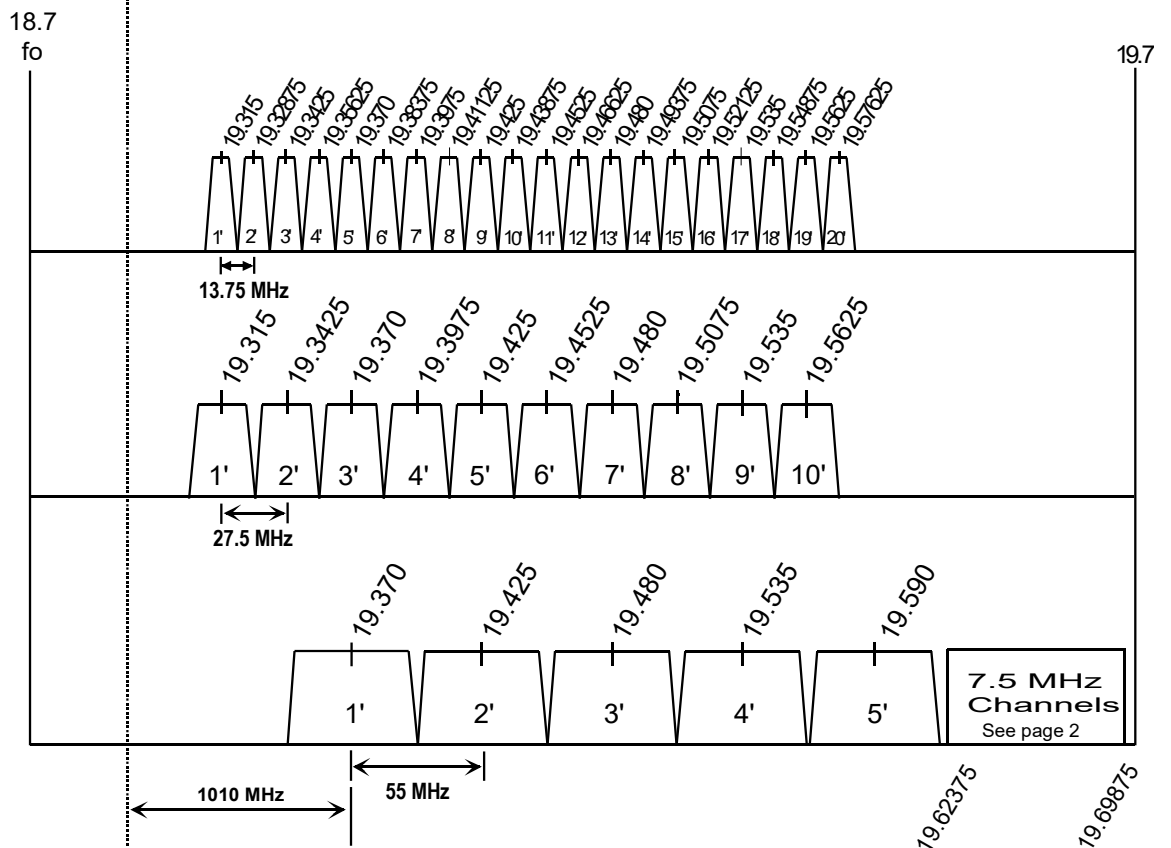
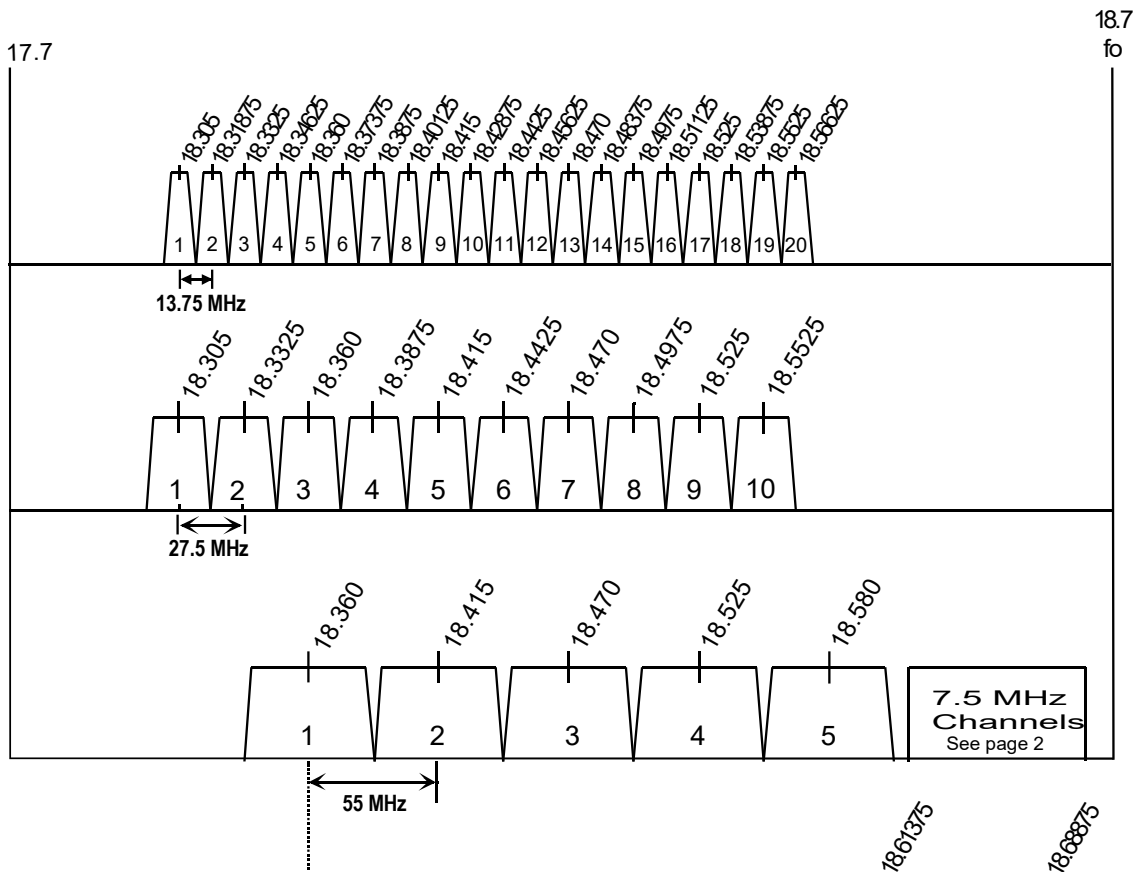


P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

R: Rainfall rate in mm/hr for 0.01% of the worst month. For further details refer to Annex A to Appendix 1.

THE 18 GHz BAND (17.7 - 19.7 GHz)

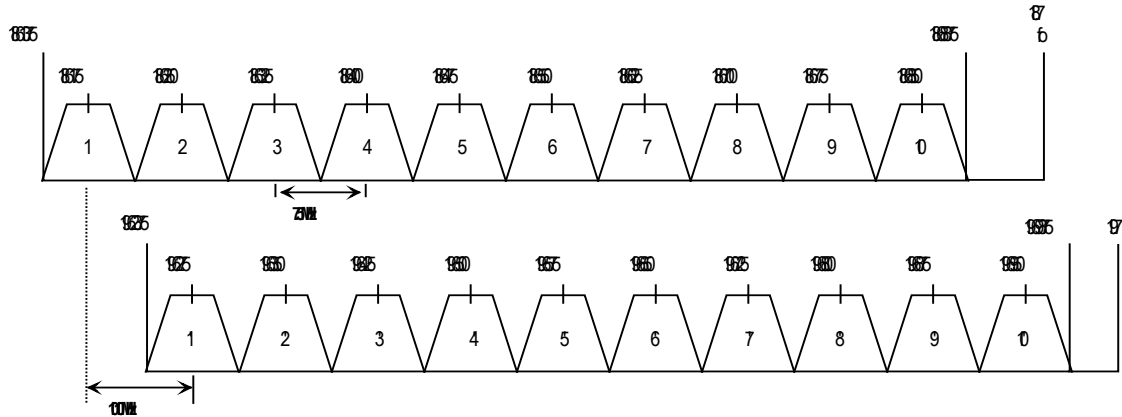
RF CHANNEL ARRANGEMENTS



THE 18 GHz BAND (17.7 - 19.7 GHz)

RF CHANNEL ARRANGEMENTS

Sub-Bands 18.61375 - 18.68875 GHz and 19.62375 - 19.69875 GHz (7.5 MHz Channelling)



ASSIGNMENT INSTRUCTIONS

This band is designated for use by small, medium and high capacity fixed links.

Typical Use

: 8/16/34/155 Mbit/s data

Assignment Priority

: 55 MHz channels - from highest channel downward;
27.5 MHz channels - from lowest channel upward;
13.75 MHz channels - from channel 10/10' downward
then from channel 11/11' upward;
7.5 MHz channels - from highest channel downward.

Minimum Path Length

: 1 km for systems with bandwidths greater than 27 MHz;
1 km for systems operating in high rainfall areas – see
Note 1;
2 km for all other cases.

Antenna Requirements

: refer to Appendix 11

Notes:

1. Minimum Path Length criteria may be relaxed to 1km in areas where the rainfall intensity rate exceeds 80mm/hr for 0.01% of the worst month - see Annex A to Appendix 1 for rainfall intensity rate contour map.
2. No assignments should be made which would overlap the frequency range 18.8 -19.3 GHz - See References 1 and 2.
3. The output power of transmitters (measured at the antenna connection) operating in the band 18.6-18.8 GHz is not to exceed +27 dBm (0.5 Watts). It should be noted that multiple transmitters operating on different RF carrier frequencies individually respecting the above output power limit can be connected to a single antenna. See Reference 4.
4. Advisory Note BL shall be applied to all assignments overlapping the frequency range 18 to 18.4 GHz. The WRC-03 has invited the ITU-R to conduct sharing analysis pertaining to the possible expansion of the geostationary meteorological satellite service allocation in this band. See References 5 and 6.

References

1. Spectrum Planning Policy Document SPP4/96 "*Interim Channel Arrangements for the 18 GHz Band - A Discussion Paper*", September 1996, and Addendum 1 to that paper, "*New Interim Arrangements in the 18 GHz Band*".
2. RALI MS 3 "*Spectrum Embargoes*" (Embargo No. 25).
3. Rec. ITU-R F.595-4, "*Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band*".
4. Article 21.5A, ITU Radio Regulations, Edition of 2001.
5. Resolution 802 (WRC-03) Agenda of the 2007 World Radiocommunication Conference, Agenda item 1.2.
6. Resolution 746 (WRC-03) Issues dealing with allocations to science services.

THE 18 GHz BAND (17.7 - 19.7 GHz)

PROTECTION RATIOS

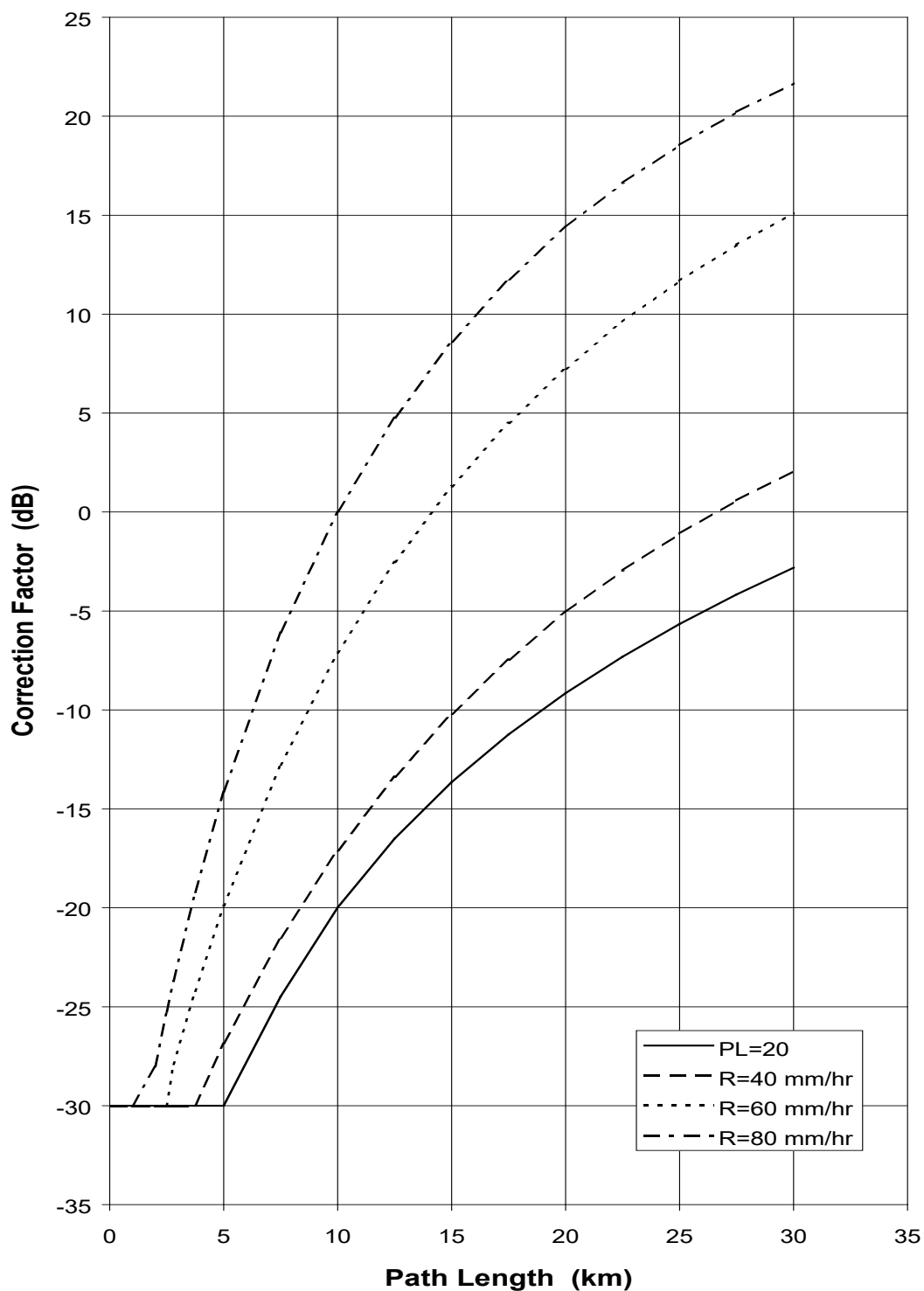
Protection ratios required between systems operating in the 18 GHz band:

Co-channel or overlapping ¹ channels	60dB
1st Adjacent Channel	30dB
2nd Adjacent Channel	0 dB

Notes:

1. The “Co-channel” protection ratio shall apply in cases where any portion of the interfering and victim channels overlap.
2. The “1st Adjacent Channel” protection ratio shall apply in cases where the interfering and victim channels do not actually overlap but are immediately adjacent to each other.
3. Protection ratios for digital systems are based on a 10 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr, for other path lengths and rainfall rates refer to the path length correction factors graph on the following page.

THE 18 GHz BAND (17.7 - 19.7 GHz)
PROTECTION RATIO CORRECTION FACTORS
RAIN AND MULTI PATH

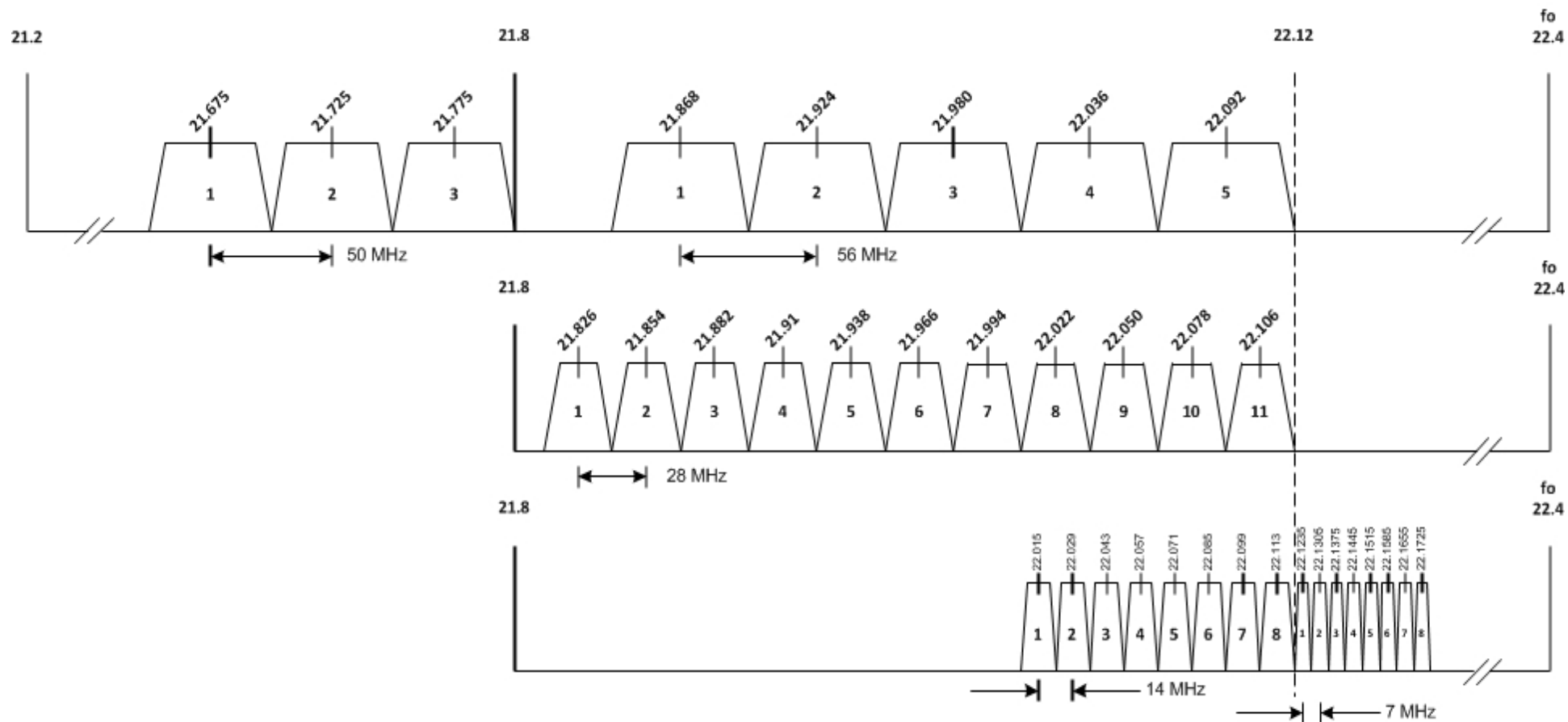


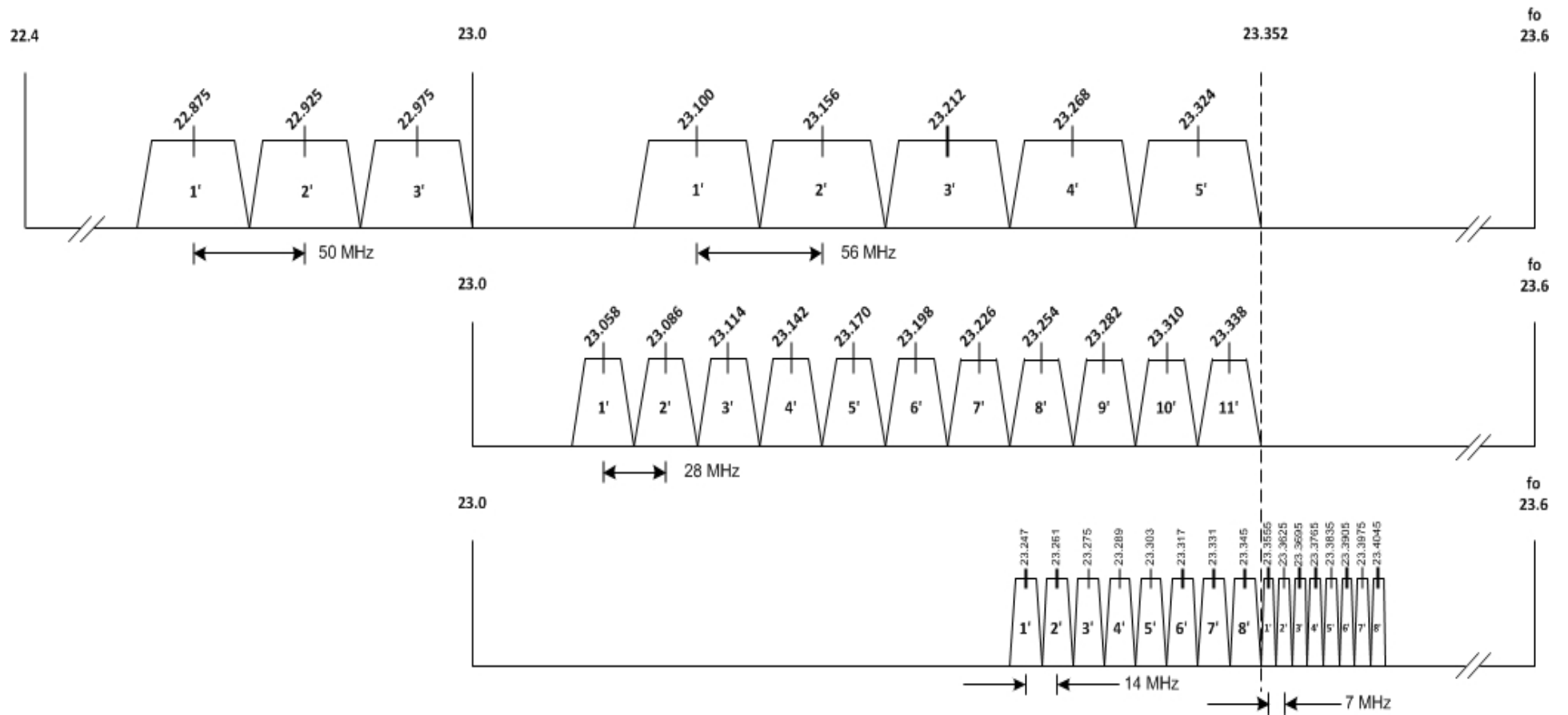
P_L : Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km.

R: Rainfall rate in mm/hr for 0.01% of the worst month. For further details refer to Annex A to Appendix 1.

THE 22 GHz BAND (21.2 - 23.6 GHz)

RF CHANNEL ARRANGEMENTS





CHANNEL CENTRE FREQUENCIES (GHz)											
Channels		56 MHz Channels		50 MHz Channels		28 MHz Channels		14 MHz Channels		7 MHz Channels	
1	1'	21.868	23.100	21.675	22.875	21.826	23.058	22.015	23.247	22.1235	23.3555
2	2'	21.924	23.156	21.725	22.925	21.854	23.086	22.029	23.261	22.1305	23.3625
3	3'	21.980	23.212	21.775	22.975	21.882	23.114	22.043	23.275	22.1375	23.3695
4	4'	22.036	23.268			21.91	23.142	22.057	23.289	22.1445	23.3765
5	5'	22.092	23.324			21.938	23.17	22.071	23.303	22.1515	23.3835
6	6'					21.966	23.198	22.085	23.317	22.1585	23.3905
7	7'					21.994	23.226	22.099	23.331	22.1655	23.3975
8	8'					22.022	23.254	22.113	23.345	22.1725	23.4045
9	9'					22.050	23.282				
10	10'					22.078	23.310				
11	11'					22.106	23.338				

THE 22 GHz BAND (21.2 - 23.6 GHz)

ASSIGNMENT INSTRUCTIONS

This band is designated for use by fixed point-to-point links and Television Outside Broadcast (TOB) services (See Note 1).

Typical Use	: 2/8 Mbit/s data, FM video
Assignment Priority	: See Note 2
Minimum Path Length	: not specified
Antenna Requirements	: refer to Appendix 11

Notes:

1. (a) The 50 MHz channels 1/1'..3/3' are designated for TOB services. Licensed TOB operators may use any of these channels in any area on a co-equal basis with other TOB operators and are expected to coordinate their use among themselves;

(b) Deleted

2. Assignment priorities for point-to-point services are defined as follows:

56 MHz channels - from the lowest channel upward;

28 MHz channels - from the lowest channel upward;

14 MHz channels - from the highest channel downward;

7 MHz channels - from the lowest channel upward;

3. Special Condition BL shall be applied to all licences for operation on the 50 MHz channels 1-3 (21.65-22.00 GHz band). See Reference 1.

References

1. "Australian Radiofrequency Spectrum Plan", (Footnote 530A).

2. Rec. ITU-R F.637-2, "Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band".

THE 22 GHz BAND (21.2 - 23.6 GHz)

PROTECTION RATIOS

- Protection ratios required between digital systems operating on the same channel arrangements, except for 50 MHz and 56 MHz channels (see table 9 and 10 respectively).

Co channel	60 dB
1st Adjacent Channel	30 dB
2nd Adjacent Channel	0 dB

- Protection ratios required between digital systems operating on 3.5 and 7 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	3.5 MHz → 7 MHz	7 MHz → 3.5 MHz
5.25	55	48
8.75	18	20
12.25	0	

- Protection ratios required between digital systems operating on 7 MHz channels and digital systems operating on 14 and 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	7 MHz → 14 MHz	14 MHz → 7 MHz	7 MHz → 28 MHz	28 MHz → 7 MHz
10.5	58	49		
17.5	32	26	45	35
24.5	15		10	20

- Protection ratios required between digital systems operating on 14 and 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	28 MHz → 14 MHz	14 MHz → 28 MHz
7	58	60
21	33	35

5. Protection ratios required between digital systems operating on 7 MHz and 56 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	7 MHz → 56 MHz	56 MHz → 7 MHz
31.5	53	35
38.5	21	15
45.5	11	13
52.5	9	12
59.5	9	10
66.5	9	9

6. Protection ratios required between digital systems operating on 14 MHz and 56 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	14 MHz → 56 MHz	56 MHz → 14 MHz
7	65	53
21	64	53
35	49	34
49	15	16
63	10	13
77	9	9
91	9	4

7. Protection ratios required between digital systems operating on 28 MHz and 56 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	28 MHz → 56 MHz	56 MHz → 28 MHz
14	65	56
42	45	33
70	15	15
98	10	5
126	9	4

8. Protection ratios required between digital systems operating on 28 MHz and 50 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	28 MHz → 50 MHz	50 MHz → 28 MHz
51	17	18
79	7	
83	6	8

107	4	
-----	---	--

9. Protection ratios required between digital systems operating on 50 MHz channel.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx	
	50 MHz → 50 MHz	
0	60	
50	35	
100	9	

10. Protection ratios required between digital systems operating on 56 MHz channel.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx	
	56 MHz → 56 MHz	
0	65	
56	41	
112	15	

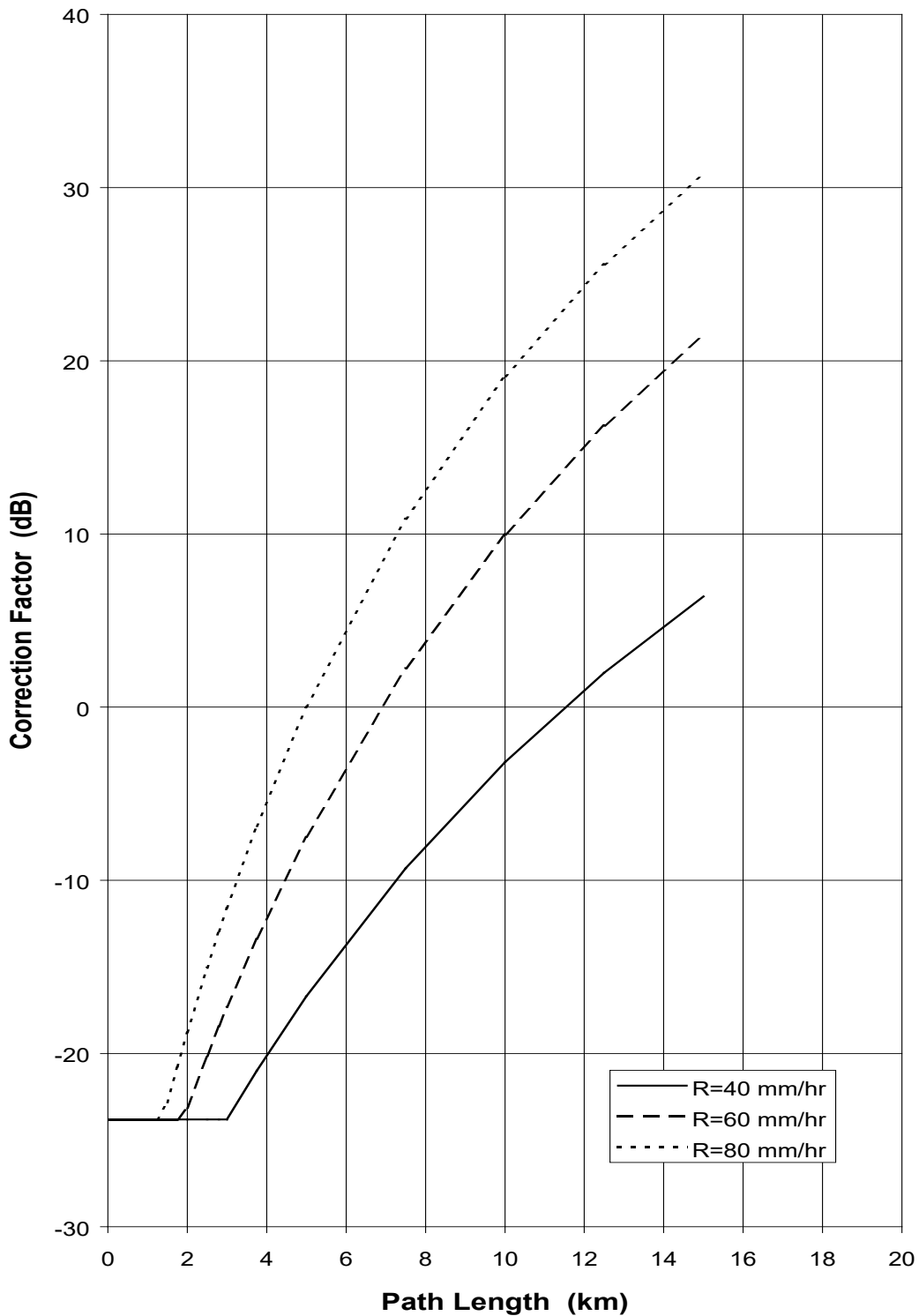
11. Protection ratios required between digital systems operating on 50 MHz and 56 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx	
	50 MHz → 56 MHz	56 MHz → 50 MHz
93	17	12
125	13	8

Notes:

1. Protection ratio for digital systems are based on a 5 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr, for other path lengths and rainfall rates refer to the appropriate path length correction factors graph on the following page.

THE 22 GHz BAND (21.2 - 23.6 GHz)
PROTECTION RATIO CORRECTION FACTORS
RAIN FADE

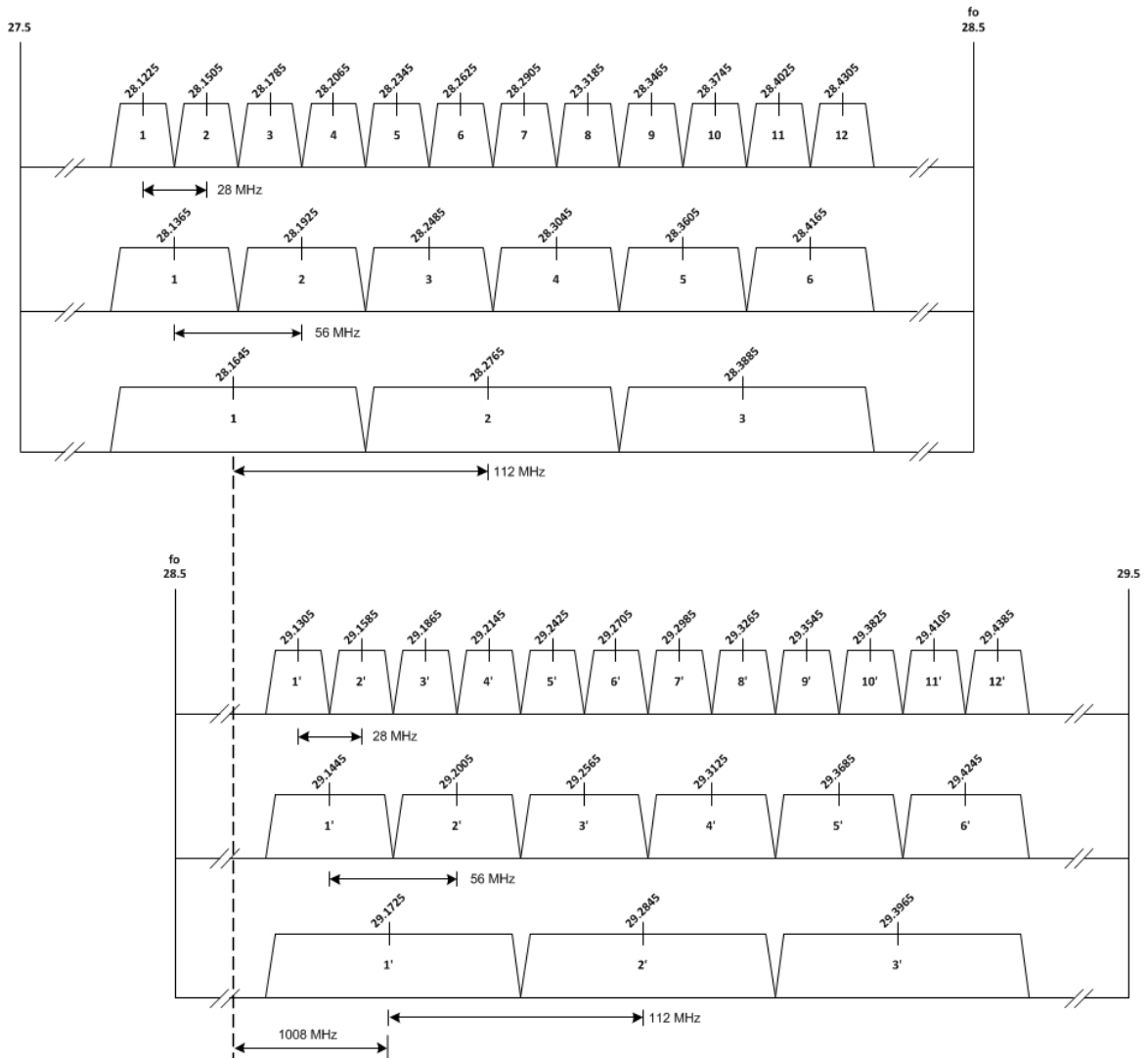


R: Rainfall rate in mm/hr for 0.01% of the worst month.

For further details refer to Annex A to Appendix 1.

THE 28 GHz BAND (27.5 – 29.5 GHz)

RF CHANNEL ARRANGEMENTS



CHANNEL CENTRE FREQUENCIES (GHz)											
28 MHz Channels				56 MHz Channels				112 MHz Channels			
1	1'	28.1225	29.1305	1	1'	28.1365	29.1445	1	1'	28.1645	29.1725
2	2'	28.1505	29.1585	2	2'	28.1925	29.2005				
3	3'	28.1785	29.1865	3	3'	28.2485	29.2565	2	2'	28.2765	29.2845
4	4'	28.2065	29.2145	4	4'	28.3045	29.3125				
5	5'	28.2345	29.2425	5	5'	28.3605	29.3685	3	3'	28.3885	29.3965
6	6'	28.2625	29.2705								
7	7'	28.2905	29.2985								
8	8'	28.3185	29.3265								
9	9'	28.3465	29.3545								
10	10'	28.3745	29.3825								
11	11'	28.4025	29.4105								
12	12'	28.4305	29.4385								

THE 28 GHz BAND (27.5 – 29.5 GHz)

ASSIGNMENT INSTRUCTIONS

Effective 23 September 2019, no new assignments may be made in this band

THE 28 GHz BAND (27.5 – 29.5 GHz)

PROTECTION RATIOS

Protection ratios required between digital systems operating in various channel bandwidths (with offset between centre frequencies Δf) are provided in the tables below

1. Protection ratios required for 28 MHz channels.

Frequency Offset (MHz)	28 MHz → 28 MHz	56 MHz → 28 MHz	112 MHz → 28 MHz
0	64		
14		61	58
28	35		
42		34	57
56	14		
70		17	34
98		10	17
126		9	14
154			12
184			7
210			6

2. Protection ratios required for 56 MHz channels.

Frequency Offset (MHz)	28 MHz → 56 MHz	56 MHz → 56 MHz	112 MHz → 56 MHz
0		64	
14	64		
28			61
42	38		
56		35	
70	14		
84			34
98	9		
112		14	
126	9		
140			17

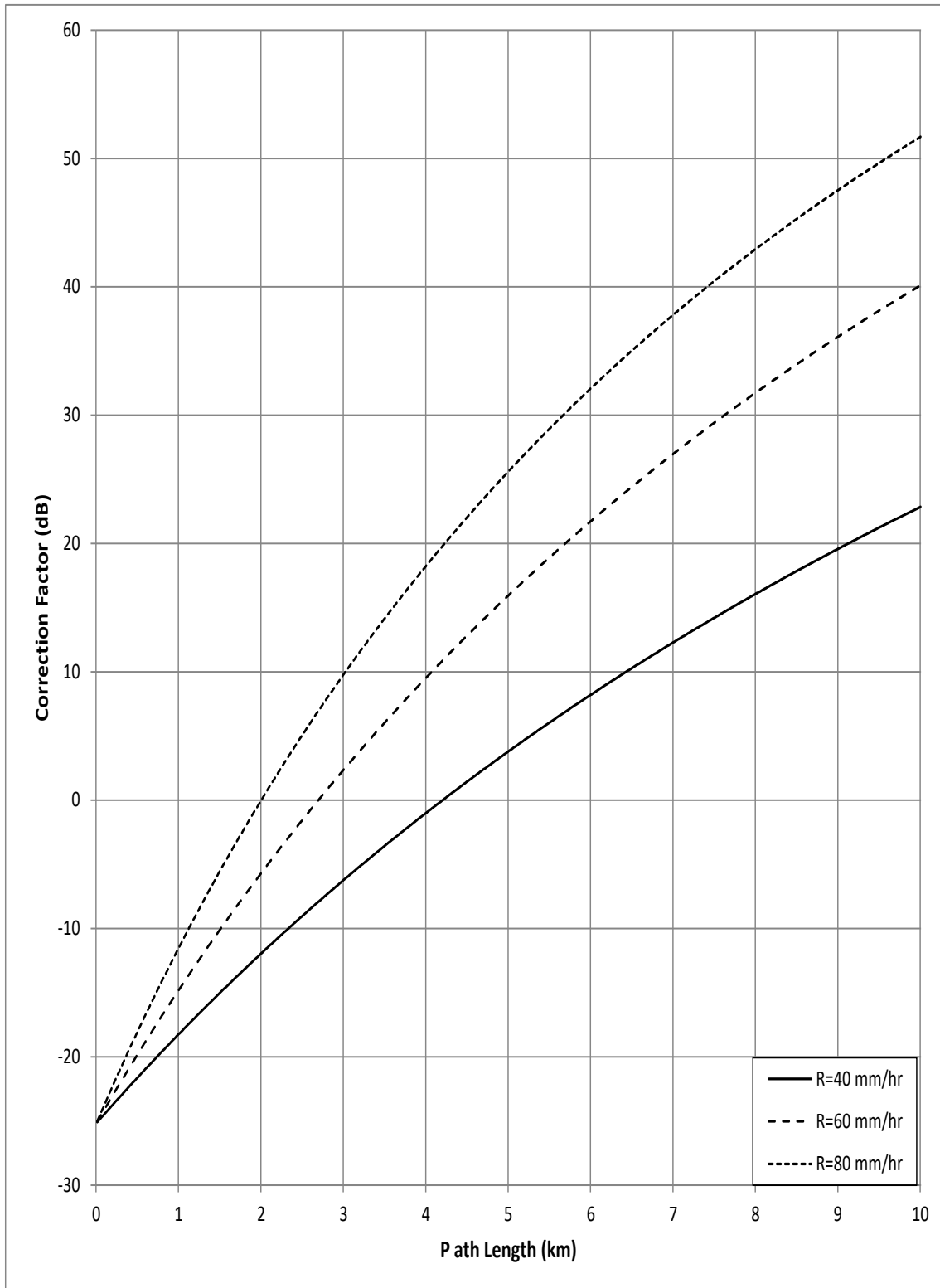
3. Protection ratios required for 112 MHz channels.

Frequency Offset (MHz)	28 MHz → 112 MHz	56 MHz → 112 MHz	112 MHz → 112 MHz
0			64
14	65		
28		64	
42	63		
70	43		
84		38	
98	13		
112			35
126	9		
140		14	
154	9		
196		9	
224			14

Notes:

1. Protection ratio for digital systems are based on a 2 km path length and R (Rainfall rate in mm/hr for 0.01% of the worst month) of 80 mm/hr using Recommendation ITU-R P.530-15, Section 2.4 as outlined in spectrum planning report SPP 2014/07. For other path lengths and rainfall rates refer to the appropriate path length correction factors graph on the following page, these are calculated in accordance with RALI FX 3 Appendix 4, section 4.1.3.

THE 28 GHz BAND (27.5 – 29.5 GHz)
PROTECTION RATIO CORRECTION FACTORS
RAIN FADE

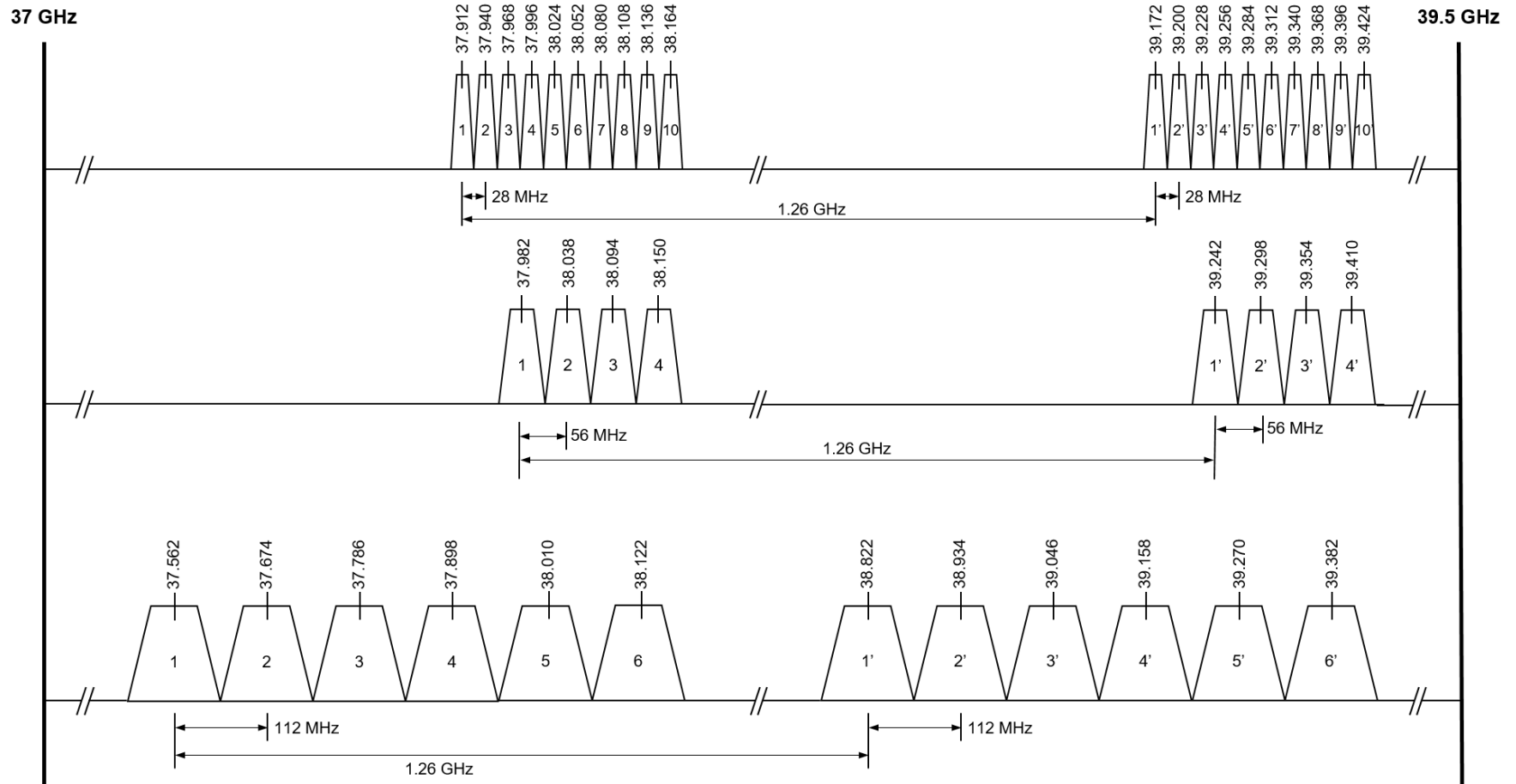


R: Rainfall rate in mm/hr for 0.01% of the worst month.

For further details refer to Annex A to Appendix 1.

THE 38 GHz BAND (37 - 39.5 GHz)

RF CHANNEL ARRANGEMENTS



Channel centre frequencies are listed on the next page.

THE 38 GHz BAND (37 - 39.5 GHz)

CHANNELLING

CHANNEL CENTRE FREQUENCIES (GHz)							
Channels		28 MHz Channels		56 MHz Channels		112 MHz Channels	
1	1'	37.912	39.172	37.982	39.242	37.562	38.822
2	2'	37.940	39.200	38.038	39.298	37.674	38.934
3	3'	37.968	39.228	38.094	39.354	37.786	39.046
4	4'	37.996	39.256	38.150	39.410	37.898	39.158
5	5'	38.024	39.284			38.010	39.270
6	6'	38.052	39.312			38.122	39.382
7	7'	38.080	39.340				
8	8'	38.108	39.368				
9	9'	38.136	39.396				
10	10'	38.164	39.424				

ASSIGNMENT INSTRUCTIONS

This band is designated for use by short haul medium-high capacity fixed point-to-point services.

Typical Use	: not specified
Assignment Priority	: See Notes 1 & 2.
Minimum Path Length	: not specified
Antenna Requirements	: refer to Appendix 11

Note:

1. Assignment priorities are defined as follows:

- 28 MHz channels – from channel 10/10' downwards
- 56 MHz channels – from channel 4/4' downwards
- 112 MHz channels - from the lowest channel upwards

2. 7 MHz and 14 MHz channel raster's have been retired. No new assignments are to be made; existing services may continue to operate and must be afforded protection from proposed new services.

Reference

1. Rec. ITU-R F.749-1, "Radio-frequency channel arrangements for radio-relay systems operating in the 38 GHz band".

THE 38 GHz BAND (37 - 39.5 GHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on the same channel Arrangements (7, 14, 28, 56, 112 MHz).

	7, 14 or 28 MHz channels	56 and 112 MHz channels
Co channel	60 dB	70 dB
1st adjacent channel	30 dB	35 dB
2nd adjacent channel	0 dB	0 dB

2. Protection ratios required between digital systems operating on 7 and 112 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)	
	Digital Interferer Tx → Digital Victim Rx	
	7 MHz → 112 MHz	112 MHz → 7 MHz
3.5	70	49
10.5	70	49
17.5	70	49
24.3	70	49
31.5	69	49
38.5	68	49
45.5	67	49
52.5	64	44
59.5	55	33
66.5	35	15
73.5	35	14
80.5 – 101.5	35	13
108.5 – 143.5	35	12
150.5 – 164.5	35	11

3. Protection ratios from 14 and 28 MHz towards other channel arrangements.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx					
	14 MHz ↓ 28 MHz	14 MHz ↓ 56 MHz	14 MHz ↓ 112 MHz	28 MHz ↓ 14 MHz	28 MHz ↓ 56 MHz	28 MHz ↓ 112 MHz
0						
7			70			
14					69	70
21	36		70	37		
35	15		69	19		
42					45	67
49			66			
63			52			
70					21	49
77			27			
91		24	27			
98					21	24
105		24	27			
119		24	27			
126					21	24
133		24	27			
147			27			
154						24
161			27			

4. Protection ratios from 56 and 112 MHz towards other channel arrangements.

Frequency Offset (MHz)	PROTECTION RATIO (dB) Digital Interferer Tx → Digital Victim Rx					
	56 MHz ↓ 14 MHz	56 MHz ↓ 28 MHz	56 MHz ↓ 112 MHz	112 MHz ↓ 14 MHz	112 MHz ↓ 28 MHz	112 MHz ↓ 56 MHz
0						
7	57			54		
14		60			57	
21				54		
28			69			66
35	33			54		
42		31			56	
49	16			52		
63	14			34		
70		15			32	
77	11			16		
84			42			38
91	11			14		
98		13			16	
105	11			13		
119	11			12		
126		13			14	
133	11			11		
140			25			22
147				9		
154					11	
161				8		

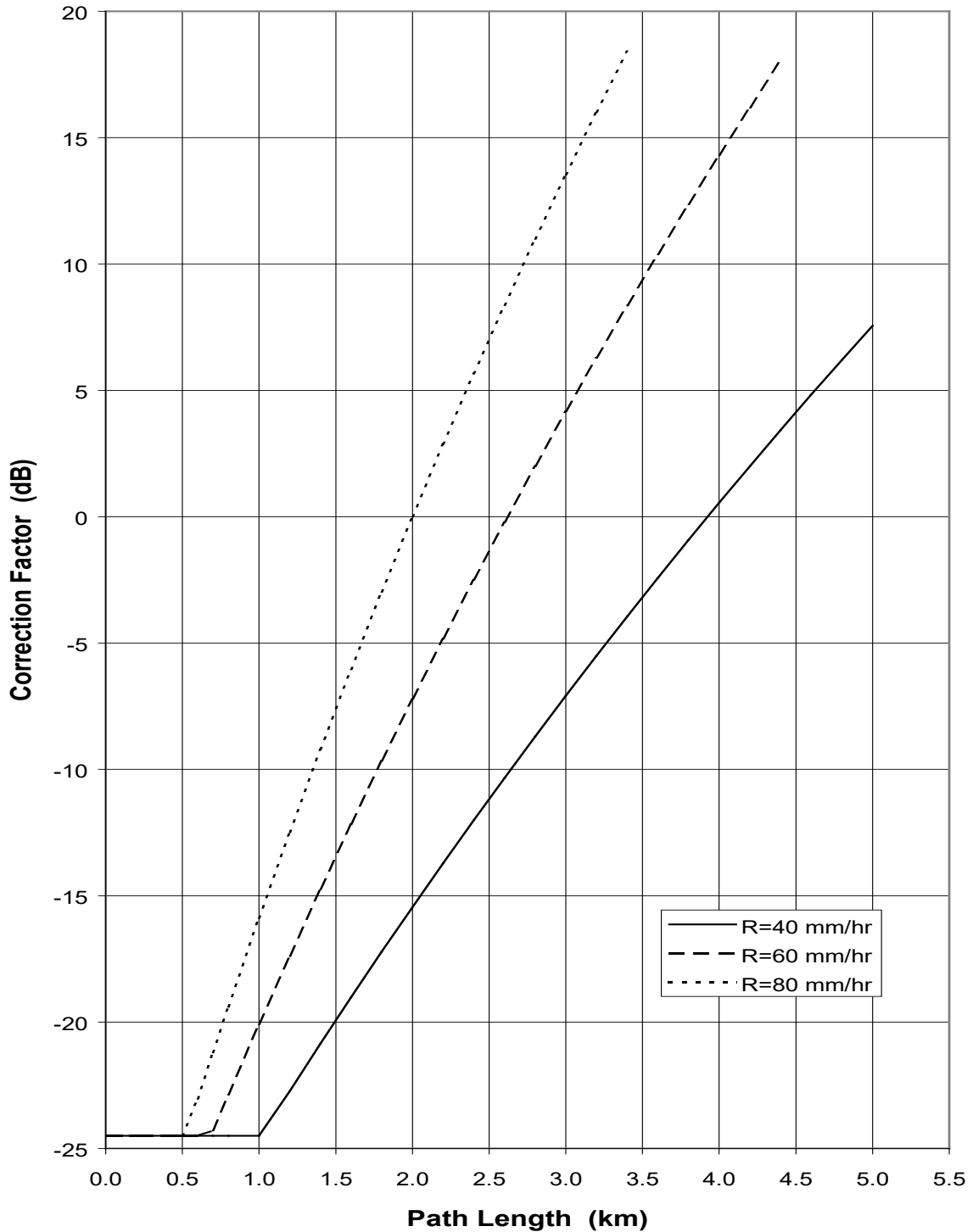
Notes:

1. Protection ratio for digital systems are based on a 2 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr. For other path lengths and rainfall rates refer to the appropriate protection ratio correction factors graph on the following page.

THE 38 GHz BAND (37 -39.5 GHz)

PROTECTION RATIO CORRECTION FACTORS

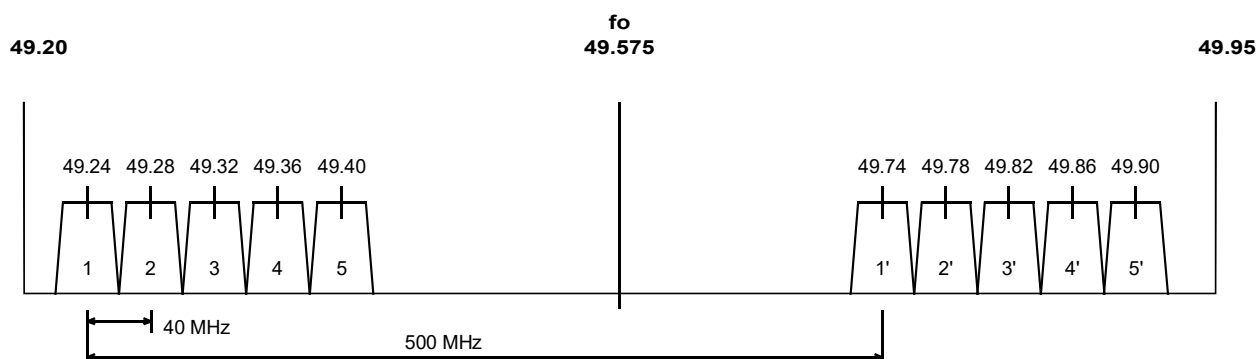
RAIN FADE



R: Rainfall rate in mm/hr for 0.01% of the worst month.
For further details refer to Annex A to Appendix 1.

THE 49 GHz BAND (49.2-49.95 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by temporary microwave links.

Typical Use : temporary digital or video links to provide communications for short term events eg. teleconferencing, outside broadcast, etc.

Assignment Priority : not specified

Minimum Path Length : not specified

Antenna Requirements : 0.3 m standard parabolic dish

Notes:

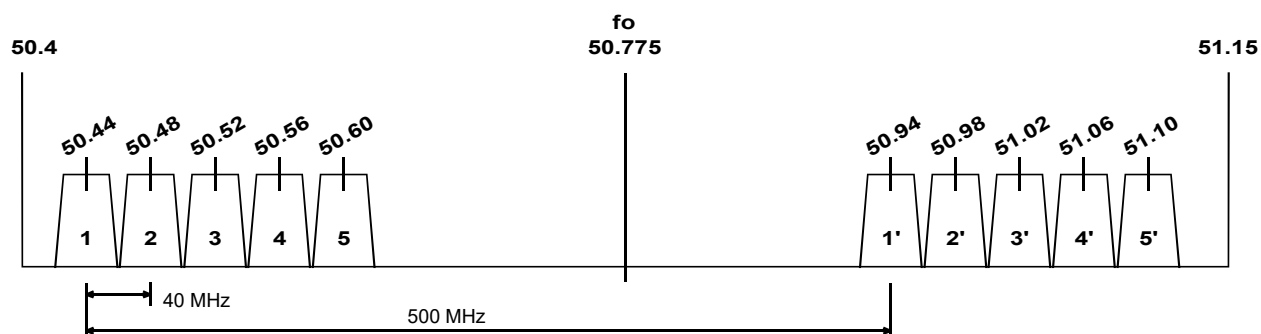
1. Frequency assignments in this band are not exclusive, ie the same channels may be assigned to a number of licensees for use in the same geographic area. Due to the low transmit power, high antenna gain and short transmission paths used there is a low probability of interference between licensees. Where licensees are likely to be co-located, eg. providing video coverage of a particular event, coordination between licensees is recommended. See Reference 1.
2. This is an interim channel arrangement which may be subject to review. Special Condition BL shall be applied to all licences.

Reference

1. ACA File X93-0193, "Frequency Band Usage 49 GHz Band".

THE 50 GHz BAND (50.4 - 51.15 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

This band is designated for use by fixed point-to-point links.

Typical Use	: 2/8 Mbit/s data, FM video.
Assignment Priority	: from lowest upward, unless a specific channel is requested.
Minimum Path Length	: not specified
Antenna Requirements	: refer to Appendix 11

Notes:

1. For allocation of channels see Reference 1.
2. This is an interim channel arrangement which may be subject to review. Special Condition BL shall be applied to all licences.

Reference

1. ACA File R93-1149, "Frequency Band Usage 15 GHz and Above".

THE 50 GHz BAND (50.4 - 51.15 GHz)

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on the same channel arrangements.

Co channel	60 dB
1st Adjacent Channel	0 dB

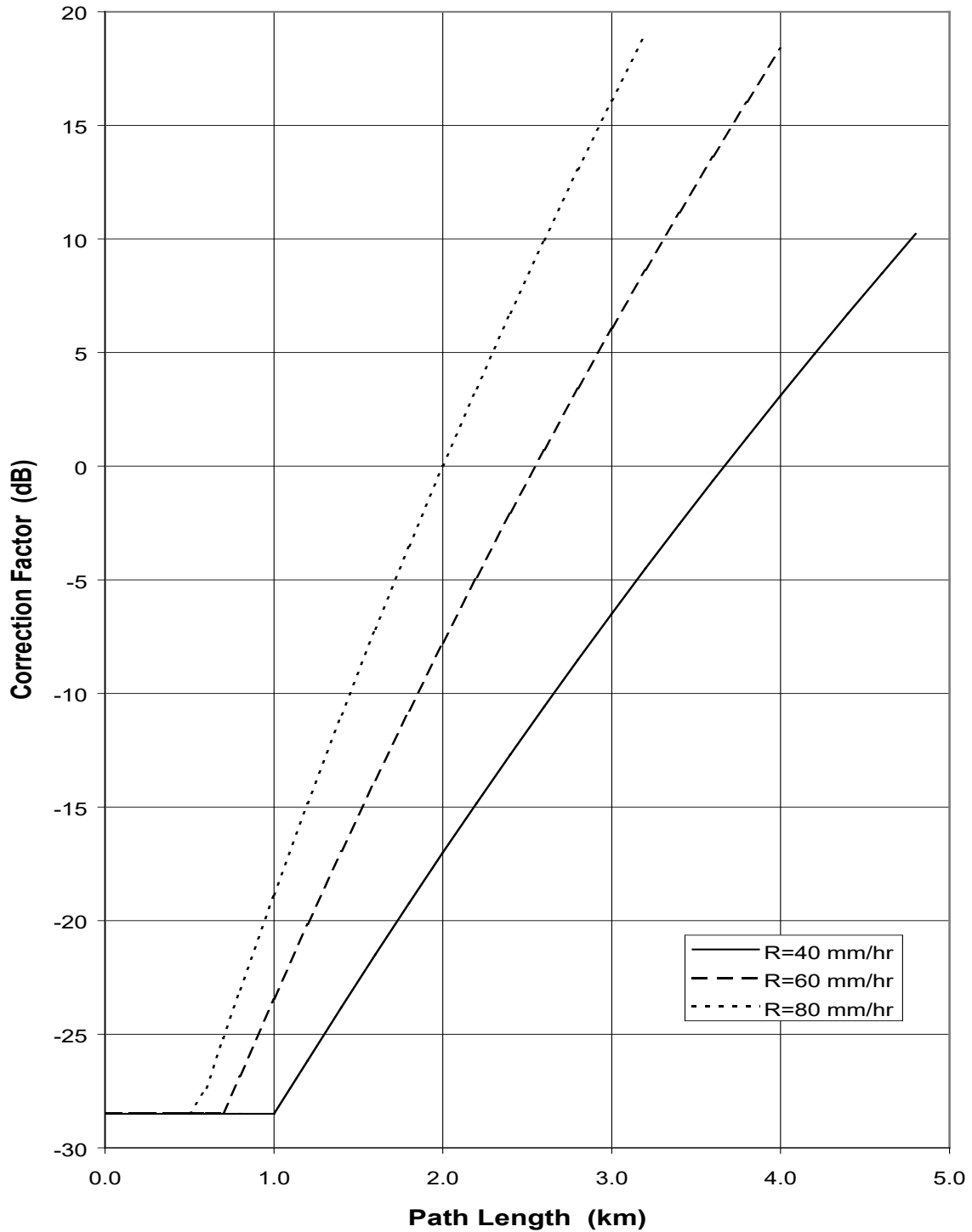
Notes:

1. Protection ratio for digital systems are based on a 2 km path length and R (*Rainfall rate in mm/hr for 0.01% of the worst month*) of 80 mm/hr. For other path lengths and rainfall rates refer to the appropriate protection ratio correction factors graph on the following page.

THE 50 GHz BAND (50.4 - 51.15 GHz)

PROTECTION RATIO CORRECTION FACTORS

RAIN FADE



R: Rainfall rate in mm/hr for 0.01% of the worst month.
For further details refer to Annex A to Appendix 1.

ANNEX A to APPENDIX 1: Propagation Related Statistical Information

Appendix 1 “*RF Channel Arrangements and Assignment Instructions*” specifies protection ratio values, for use under the “*Basic Method of Frequency Coordination*”¹, for each microwave fixed services band. However, in the case of digital systems these protection ratios are normalised for a particular path length and geoclimatic zone.

Accordingly, appropriate corrections must be applied to the (Appendix 1) tabulated protection ratio values in order to account for the victim system actual path length and geographic location, with specific reference to worst month multipath fading (p_L) and average annual rain intensity (R) statistics, where:

- “ p_L ” is the percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than -100 N units/km; and
- “ R ” is the rainfall rate (mm/hr) exceeded for 0.01% of the average year.

Pending the development of more detailed geoclimatic statistical data for frequency coordination purposes, the average year multipath fading and rainfall contour maps provided in this annex are to be used:

- Figure 1 provides contour maps², for estimating p_L values in Australia. The month that has the highest value of p_L (at the fixed service link geographic location) should be chosen from the four seasonally representative months of February, May, August and November; and
- Figure 2 defines a rain intensity (mm/h) map³ for Australia, the value R at the fixed service link geographic location should be selected.

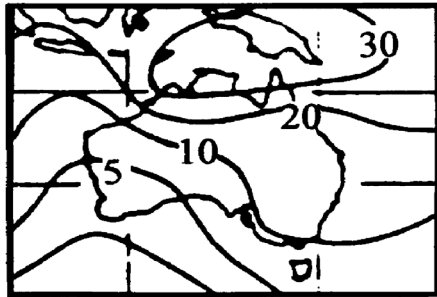
The dominant parameter (ie. either multipath fading or rain attenuation) is then used (together with victim system path length) to determine the appropriate correction values from the relevant (Appendix 1) Protection Ratio Correction Factor graph.

Note: Further guidance regarding propagation prediction methods is detailed in Appendix 4 “*Fixed Service Propagation Modelling*”.

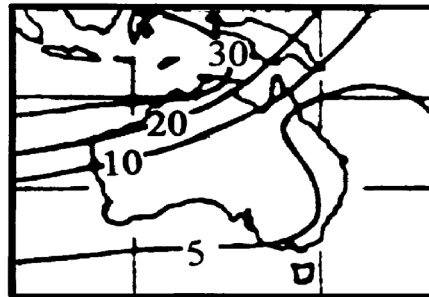
¹ As detailed in Part 4 “*Frequency Coordination*” of RALI FX 3.

² Based on Recommendation P.453 “*The Radio Refractive Index: its formula and Refractivity Data*”

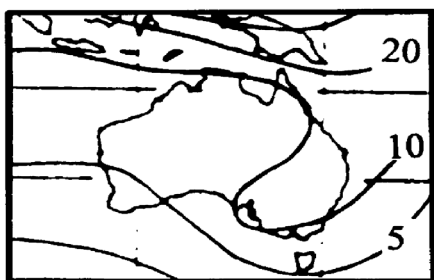
³ Based on Recommendation P.837-3 “*Characteristics of Precipitation for Propagation Modelling*”.



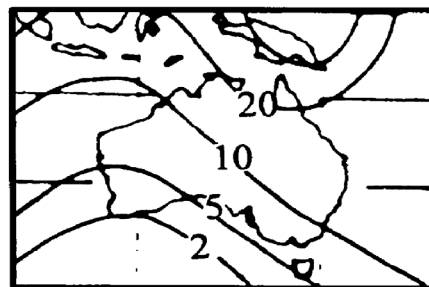
February



May



August



November

Figure 1. Multipath fading (P_L) statistical contour maps

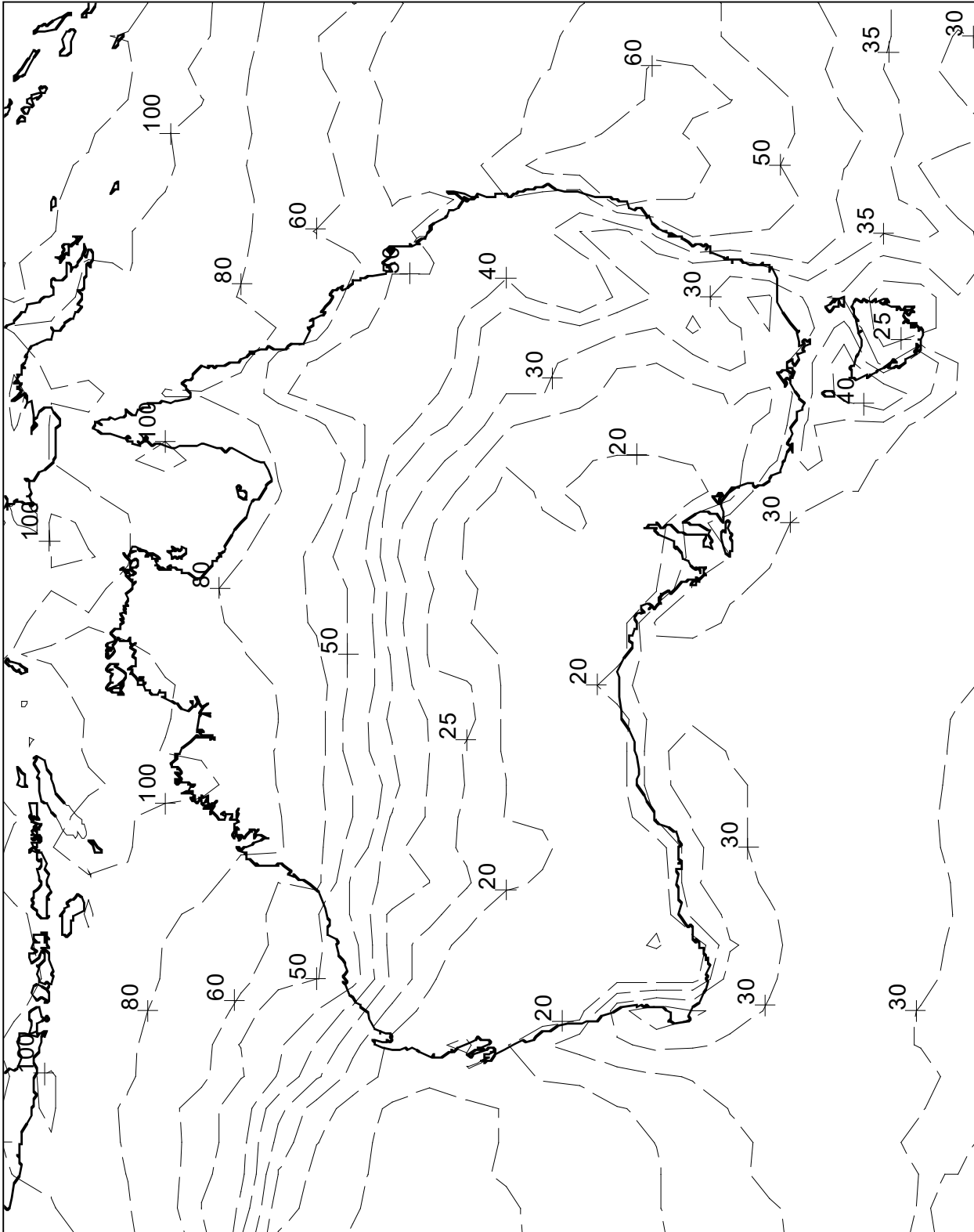


Figure 2. Rain Intensity R (mm/h) exceeded for 0.01% of the average year for Australia

APPENDIX 2: Interference Mechanisms and Performance Criteria

Interference mechanisms and performance criteria for microwave fixed services are under review. In the interim, enquiries related to these matters may be referred to the Spectrum Planning Team, Spectrum Planning and Standards Group, ACA.

APPENDIX 3: Fixed Service Emission Criteria

Introduction

The criteria for fixed service emissions are yet to be reviewed by ACMA, pending the outcome of current ITU-R studies on bandwidth and unwanted emissions for digital fixed services. In the meantime, interim guidelines are provided in Section 2 below. Further inquiries on these matters can be referred to the Spectrum Planning Team, ACMA.

It is anticipated the more detailed criteria may be available towards the end of 2000. These criteria are likely to include:

- guidelines from ITU Recommendation F.1191 for digital fixed services, which remove the need for spectrum masks and simply use the occupied bandwidth (containing 99% of total mean power) as the limiting factor for digital fixed service emissions; and
- guidance on methods for measuring the occupied bandwidth.

Interim Guidelines

Until information from a revised ITU Recommendation F.1191 (and other related ITU Recommendations also under revision) is able to be included in this RALI, the following emission criteria should be used.

Out-of-band Emissions - Digital Fixed Services

Consistent with ITU Rec. F.1191, out-of-band emissions are defined as: "*Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions*".

Transmitter equipment used for Digital Fixed Services should meet either:

- a) emissions criteria in a relevant ETSI¹ standard. See Table 1 for a list of relevant standards;
- b) FCC² emissions criteria, see Part 101.111 of the FCC Rules; or
- c) if a relevant ETSI standard is not available or the FCC criteria is not appropriate, the RF spectrum mask shown in Figure 1 may be used. In some cases this mask may be more stringent than the emission criteria specified by ETSI or the FCC.

Spurious Emissions - All Fixed Services

Consistent with ITU Rec. SM.329, spurious emissions are defined as: "*Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions*".

¹ ETSI is the European Telecommunications Standards Institute (see www.etsi.org)

² FCC is the Federal Communications Commission (USA)

In line with the 'Category A' limits from ITU Recommendation SM.329-7 "Spurious Emissions", the maximum permitted spurious emission level is **-13 dBm** (power supplied to the antenna), which should be measured in a 1 MHz reference bandwidth.

ITU Recommendation SM.329 also provides guidance on measurement methods.

ETSI EN 302 217 provides information on characteristics digital point-to-point equipment and rationalises a large number of previous ETSI standards.³

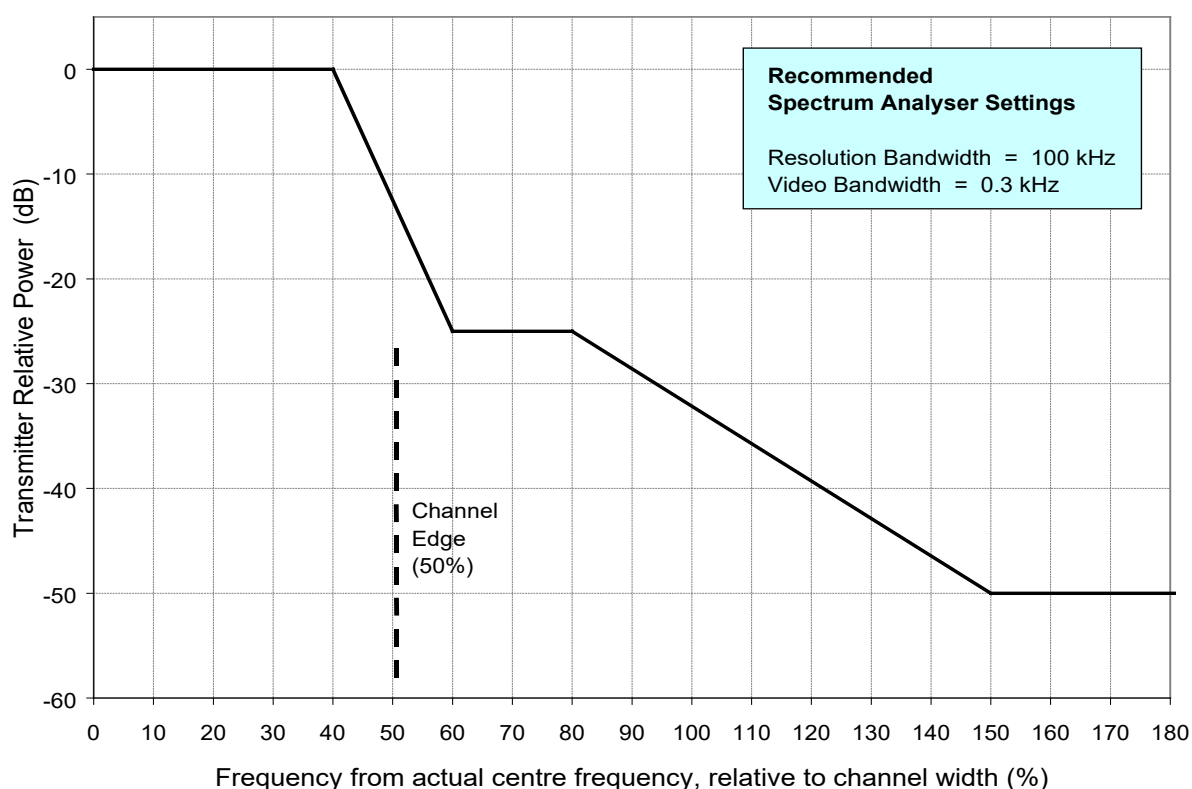


Figure 1: RF Spectrum Mask

- This mask is normalised in frequency to the channel width.
- The 0 dB level shown on the spectrum mask relates to the power spectral density of the actual centre frequency.
- This mask has been developed after consideration of FCC criteria and ETSI criteria (from Table 1). The mask shown is similar to the RF spectrum mask in EN 301 216 (30 MHz chan., class 1)

³ For further information see ETSI EN 302-217-1

Table of Contents

1. INTRODUCTION.....	1
2. CALCULATING THE BASIC TRANSMISSION LOSS (L_{BF})	2
3. MODELLING TERRAIN DEPENDENT LOSSES (L_M)	2
3.1 SMOOTH EARTH	3
3.2 SINGLE KNIFE-EDGE	4
3.3 MULTIPLE OBSTACLES	4
4. DETAILED FIXED SERVICE PROPAGATION PREDICTION MODELS... 5	
4.1 WANTED SIGNAL PATH PROPAGATION MECHANISMS.....	6
4.1.1 <i>Prediction of multi-path fading - initial planning method</i>	7
4.1.2 <i>Prediction of multi-path fading - detailed link design method</i>	8
4.1.3 <i>Prediction of attenuation due to rain</i>	10
4.2 INTERFERENCE PATH PROPAGATION MECHANISMS	11
4.2.1 <i>LOS propagation (including short-term effects)</i>	12
4.2.2 <i>LOS with diffraction losses</i>	12
4.2.3 <i>Clutter losses</i>	13

1. Introduction

The basic method of frequency coordination, detailed under Part 4 of RALI FX 3, requires, in the first instance, the quantification of the basic free-space loss over the wanted and the unwanted signal paths. In order to facilitate a more rigorous assessment of the overall transmission loss, detailed path analysis and the application of appropriate propagation models is often necessary.

This appendix extends the simple transmission loss analysis outlined under the basic method of frequency coordination, through the addition of diffraction models suitable for estimating terrain dependent path losses over the wanted and unwanted signal paths. Guidance is also provided regarding the application of the more commonly used ITU-R terrestrial service propagation prediction methods incorporating statistical analyses based on system specific criteria.

Note: The onus is on the assigner to apply¹ the most appropriate propagation model/s for the given interference environment also noting that the ITU-R prediction models outlined in this document are subject to ongoing development.

¹ All of the fixed service propagation models described in this document may be usefully incorporated as computer program algorithms (integrated with terrain and assignment databases), to facilitate less labour intensive and more efficient frequency assignment practices.

2. Calculating the basic transmission loss (L_{bf})

Recalling that the total transmission loss (L_b) between two ideal antennas, consists of:

- a (time invariant) basic free space loss (L_{bf}); and
- additional attenuation due to terrain, rain and other physical attributes associated with a particular propagation path (L_m).

The total transmission loss is then given by:

$$L_b = L_{bf} + L_m \quad (\text{dB})$$

where:

$$L_{bf} = 32.4 + 20\log f + 20\log d \quad (\text{dB})$$

where: f - frequency (MHz); and
 d - distance (km).

In cases where an initial coordination assessment using the basic free-space attenuation model fails to meet the specified interference management criteria, then more complex propagation analyses may be invoked in order to more accurately characterise the L_m component of the total transmission loss. Subsequent choice of appropriate propagation model/s may be critical in determining the outcome of detailed coordination.

3. Modelling terrain dependent losses (L_m)

A more detailed analysis of the overall transmission loss must include consideration of additional (ie. above free-space) attenuation due to the effects of terrain and diffraction in particular. Thus under the basic method of frequency coordination:

$$L_m \cong L_d$$

where: L_d - attenuation due to diffraction (dB).

The attenuation due to diffraction may be estimated by the propagation models, based on the application of ITU-R Recommendation P.526-4 “*Propagation by diffraction*”, described in the following sub-sections. The models are valid for systems operating above about 1 GHz and consider attenuation due to diffraction over:

- a “smooth-earth” propagation path;
- a single knife-edge obstacle; and
- multiple obstacles.

The selection of the appropriate diffraction model(s) is determined by an analysis of the relevant path profile(s). For an initial analysis and under the basic method of

coordination, critical path clearance over the wanted signal path is normally assumed since no additional interference protection is mandated for fixed service systems operating over obstructed paths. Propagation models used for link planning purposes typically specify results based on a median signal level (ie. the level exceeded for 50% of the time). For interference calculation purposes, more stringent criteria are normally applied and, for the basic method of frequency coordination, long term (20%) and short term (0.01%) criteria are adopted.

Accordingly, for the path profile analysis, the following k-factors² are normally applied:

- $k = 4/3$ under the median link planning “standard atmosphere” criteria (50%);
- $k = 3$ under the long term “annual” interference criteria (20%); and
- $k = 20$ under the short term “worst month³” interference criteria (0.01%)

For terrain modelling and path analyses based on digitised data, an elevation model at least equivalent to or better than the ACA's RadDEM (9 second data) is to be used.

3.1 Smooth Earth

The standard method for calculating the transmission loss due to diffraction over a smooth-earth is defined as follows:

$$L_d = F(X) + G(Y_1) + G(Y_2) \quad (\text{dB})$$

where: X - normalised length of the path;

$$X = 2.2 \sqrt[3]{f} \frac{d}{\sqrt[3]{a_e^2}}$$

Y_1, Y_2 - normalised antenna heights;

$$Y = 0.0096 \sqrt[3]{f^2} \frac{h}{\sqrt[3]{a_e}}$$

a_e - equivalent Earth radius, equal to the product ka

where: a - the actual Earth radius (6370km); and
 k - the applicable k-factor⁴.

h - antenna height (m);

d - path length (km); and

f - frequency (MHz).

the distance term is given by:

² Defined in Recommendation P.310-9 as the ratio of the effective Earth radius to the actual Earth radius and related to the vertical refractivity gradient dn/dh (ΔN , see also Recommendation P.453-5).

³ See Recommendation P.581-2 “*The concept of Worst Month*”.

⁴ Note: As $k \rightarrow \infty$ the spherical earth diffraction model is no longer valid and $L_d = 0$.

$$F(X) = 11 + 10 \log(X) - 17.6X$$

with the height gain term:

$$G(Y) \cong \begin{cases} 17.6\sqrt{Y-1.1} - 5 \log(Y - 1.1) - 8 & \text{for } Y > 2 \\ 20 \log(Y + 0.1Y^3) & \text{for } Y \leq 2 \end{cases}$$

3.2 Single knife-edge

The standard method for calculating the transmission loss due to diffraction over a single knife-edge obstacle is defined as follows:

$$L_d = 6.9 + 20 \log(\sqrt{(v - 0.1)^2 + 1} + v - 0.1) \quad (\text{dB})$$

where:
$$v = h \left(\sqrt{\frac{fd}{150d_1d_2}} \right)$$

h - height (m) of the obstacle relative to a straight line joining the path ends;
d1, d2 - distance (km) of the two ends of the path from the top of the obstacle;
d - path length (km); and
f - frequency (GHz).

3.3 Multiple obstacles

The single obstacle diffraction model may be extended to account for multiple obstacles. Path analysis and calculation of the attenuation due to diffraction over multiple obstacles may be determined using the “stretched string analysis” method detailed in ITU-R Recommendation P.526.

This concludes the outline of basic transmission loss calculation and propagation modelling methodologies intended to be incorporated as part of the basic method of frequency coordination. The following sections provide an overview of the commonly used ITU-R fixed service propagation prediction procedures, which take account of the statistical nature of terrestrial radiowave propagation and which can be applied under particular instances of detailed coordination.

4. Detailed fixed service propagation prediction models

The transmission loss calculation procedures incorporated under the basic method of frequency coordination represent a deterministic approach; free-space loss is constant in time and diffraction loss values are calculated for a particular 'k' value of effective Earth radius. In the real world, the k-factor varies with time and location in accordance with complex physical interactions involving the refractivity gradient (dn/dh) in the lowest part of the atmosphere and other mechanisms, as detailed in the propagation “P series” of ITU Recommendations.

An important objective in planning terrestrial microwave link systems is to ensure that outages resulting from these variations are extremely rare events, thus system fade margins, linked to error performance and availability objectives, of the appropriate order are implemented to assure that this is so. Accordingly, in order to take account of the statistical nature of radiowave propagation, the application of appropriate propagation prediction models is necessary.

Performance prediction (related to propagation effects) principally depends upon the assessment of two main propagation mechanisms; multi-path fading and/or attenuation due to rain. Multi-path fading typically gives rise to short outages and thus has the most impact on error performance. For the purpose of modelling multi-path fading, propagation prediction methods have been derived which estimate the probability of single-frequency fading⁵. Rain attenuation events typically give rise to outage durations greater than 10 seconds, therefore directly influencing availability of systems operating in the bands above about 10 GHz. The prediction of rain outages is possible through application of rainfall intensity statistics to modelling methods for rain attenuation.

The following ITU-R recommendations represent the principal ITU-R models used for fixed service propagation modelling:

- Recommendation P.530-6 “*Propagation data and Prediction Methods required for the design of Terrestrial Line-of-Sight Systems*” as typically utilised for link planning purposes; and
- Recommendation P.452-7 “*Prediction Procedure for the Evaluation of Microwave Interference between stations on the Surface of the Earth at frequencies above about 0.7 GHz*”, provides methodologies specifically intended for use on interference paths.

Although these models address propagation mechanisms for the wanted signal and the interference path independently, the prediction methods are not exclusive to either path type. The use of these particular ITU-R prediction methods is not mandated and, in cases where a departure from these models can be justified, other (relevant) prediction methods may be applied.

An outline of the application of prediction methods based on the above recommendations, for frequency coordination purposes, is provided in the following

⁵ Wideband systems may also suffer frequency selective fading, not addressed in these models.

sections. However, the emphasis in this document is to provide guidance regarding the application of these models in the Australian context, rather than the verbatim reproduction of detailed methodologies. Accordingly, for detailed application, reference must be made to the relevant source recommendations.

4.1 Wanted signal path propagation mechanisms

The wanted signal for microwave fixed services can be modelled using the performance prediction methods presented in ITU-R Recommendation P.530-6, for the following propagation mechanisms:

- diffraction fading due to obstruction or partial obstruction of the path, as already discussed in Section 3 of this Appendix;
- attenuation due to atmospheric gases;
- attenuation due to variation of the angle-of-arrival/launch; and
- fading due to multi-path, beam spreading, scintillation and attenuation due to rain.

For frequency coordination purposes, only the dominant multi-path fading (and related mechanisms) and rain outage mechanisms are considered in this overview. The following subsections outline two methodologies, (Section 4.1.1 “an initial planning method” and Section 4.1.2 “detailed link design method”, as detailed in Recommendation P.530-6) suitable for estimating the effects of multipath fading and statistical algorithms (Section 4.2.3) for evaluating rain fade attenuation.

The prediction of the remaining propagation mechanisms (including multipath enhancement modes) as also detailed in Recommendation P.530-6 are part of the detailed link design process and are not considered here.

Note: The prediction methods presented in Sections 4.1.1 and 4.1.2 model single frequency fading (ie. “flat fade margin”) and do not account for dispersive effects which may be a concern in detailed planning for wideband (ie. 34/140/155 Mb/s) systems. However, the methods may be considered adequate for frequency coordination purposes and are valid for fade depths greater than approximately 15 dB or the value exceeded for 0.1% of the worst month, whichever is the greater.

4.1.1 Prediction of multi-path fading - initial planning method

For the path location in question, estimate the geoclimatic factor K for the average worst month from p_L ⁶ and the following empirical relationships, derived for Australia:

$K = 10^{-6.5} p_L^{1.5}$	Overland links for which the lower of the transmitting and receiving antennas is less than 700 m above mean sea level;
$K = 10^{-7.1} p_L^{1.5}$	Overland links for which the lower of the transmitting and receiving antennas is higher than 700 m above mean sea level;
$K = 10^{-5.9} p_L^{1.5}$	Links over medium-sized bodies of water, coastal areas beside such bodies of water, or regions of many lakes; and
$K = 10^{-5.5} p_L^{1.5}$	Links over large bodies of water, or coastal areas beside such bodies of water.

Whilst in most cases selecting the correct empirical relationship “ K ” is straightforward, any ambiguity can be resolved by referring to the notes included in ITU-R Recommendation P.530-6, which provide further guidance regarding the parameters and terminology used in the above-listed relationship criteria.

If the antenna heights are known, calculate the magnitude of the path inclination ($|\varepsilon_p|$) from:

$$|\varepsilon_p| = \frac{1}{d} |h_r - h_e| \quad (\text{mrad})$$

where: d - path length (km); and

h_e, h_r - transmit and receive antenna height respectively (metres above sea level or some other reference height).

The fade depth (A) that is exceeded for a percentage of time (p_w) in the average worst month is:

$$A = 10 \log(K d^{3.6} f^{0.89} (1 + |\varepsilon_p|)^{-1.4}) - 10 \log p_w \quad (\text{dB})$$

where: f is frequency (GHz).

For the prediction of average year instead of average worst month exceedence percentages, refer to P.530-6 § 2.3.5. and ITU-R Recommendation PN.841⁷.

⁶ p_L (percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than -100 N units/km) refractivity gradient contour maps are provided in Figure 1, Annex A to Appendix 1 of RALI FX 3.

⁷ ITU-R Recommendation P.841 “*Conversion of annual statistics to worst-month statistics*”.

4.1.2 Prediction of multi-path fading - detailed link design method

The detailed link design method is an extension of the initial planning method and it accounts for the path profile. The geoclimatic factor K is estimated using the following empirical relationships:

$K = 10^{-5.4} p_L^{1.5}$	Overland links for which the lower of the transmitting and receiving antennas is less than 700 m above mean sea level;
$K = 10^{-6.0} p_L^{1.5}$	Overland links for which the lower of the transmitting and receiving antennas is higher than 700 m above mean sea level;
$K = 10^{-4.8} p_L^{1.5}$	Links over medium-sized bodies of water, coastal areas beside such bodies of water, or regions of many lakes; and
$K = 10^{-4.4} p_L^{1.5}$	Links over large bodies of water, or coastal areas beside such bodies of water.

The path inclination is calculated as described in the initial planning method. From the profile of the terrain along the path, obtain the terrain heights h at intervals of 1.0 km, beginning 1.0 km from one terminal and ending 1-2 km from the other. Using these heights, carry out a linear regression with the “method of least squares” to obtain the linear equation of the “average” profile:

$$h(x) = a_0 x + a_1$$

where x is the distance along the path. The regression coefficients can be calculated from the relations:

$$a_0 = \frac{\sum_n xh - \left(\sum_n x \sum_n h \right) / n}{\sum_n x^2 - \left(\sum_n x \right)^2 / n}$$

$$a_1 = \left(\sum_n h - a_0 \sum_n x \right) / n$$

where n is the number of profile height samples.

Calculate $h(0)$ and $h(d)$, the heights of the average profile at the ends of the path, and the heights of the antennas above the average path profile:

$$h_1 = h_e - h(0)$$

$$h_2 = h_r - h(d)$$

Calculate the “average” grazing angle φ corresponding to a 4/3 Earth radius model (i.e. $a_e = 8\,500$ km) (Refer to Recommendation ITU-R P.834):

$$\varphi = \frac{h_1 + h_2}{d} \left[1 - m (1 + b^2) \right]$$

where:

$$m = \frac{d^2}{4 a_e (h_1 + h_2)}$$

$$c = |h_1 - h_2| / (h_1 + h_2)$$

$$b = 2 \sqrt{\frac{m+1}{3m}} \cos \left[\frac{\pi}{3} + \frac{1}{3} \arccos \left(\frac{3c}{2} \sqrt{\frac{3m}{(m+1)^3}} \right) \right]$$

In calculation of the coefficients m and c , the variables a_e , d , h_1 and h_2 must be in the same units. The grazing angle φ will be in the desired units of milliradians if h_1 and h_2 are in metres and d in kilometres.

The fade depth (A) that is exceeded for a percentage of time p_w in the average worst month is:

$$A = 10 \log(K d^{3.3} f^{0.93} (1 + |\varepsilon_p|)^{-1.1} \varphi^{-1.2}) - 10 \log p_w \quad (\text{dB})$$

where: f is frequency (GHz).

4.1.3 Prediction of attenuation due to rain

The specific attenuation due to rain, as based on ITU-R Recommendation P.838 “*Specific Attenuation Model for Rain for use in Prediction Methods*” is given by:

$$\gamma_R = kR^\alpha \quad (\text{dB/km})$$

where: R - rainfall intensity⁸ (mm/hr); and
k, α - frequency dependant coefficients.

The coefficients k and α for linear (H - horizontal, V - vertical) and circular polarisation can be calculated from the following equations:

$$k = 0.5 [k_H + k_V + (k_H - k_V) \cos^2\theta \cos(2\tau)]$$

$$\alpha = \frac{1}{2k} [k_H\alpha_H + k_V\alpha_V + (k_H\alpha_H - k_V\alpha_V) \cos^2\theta \cos(2\tau)]$$

where: $k_H, \alpha_H, k_V, \alpha_V$ - regression coefficients (as specified in Table 1) for estimating specific attenuation;

θ - path elevation angle; and

τ - polarisation tilt angle relative to the horizontal ($\tau = 45^\circ$ for circular).

Frequency (GHz)	k_H	k_V	α_H	α_V
1	0.0000387	0.0000352	0.912	0.880
2	0.000154	0.000138	0.963	0.923
4	0.000650	0.000591	1.121	1.075
6	0.00175	0.00155	1.308	1.265
7	0.00301	0.00265	1.332	1.312
8	0.00454	0.00395	1.327	1.310
10	0.0101	0.00887	1.276	1.264
12	0.0188	0.0168	1.217	1.200
15	0.0367	0.0335	1.154	1.128
20	0.0751	0.0691	1.099	1.065
25	0.124	0.113	1.061	1.030
30	0.187	0.167	1.021	1.000
35	0.263	0.233	0.979	0.963
40	0.350	0.310	0.939	0.929
45	0.442	0.393	0.903	0.897
50	0.536	0.479	0.873	0.868

Table 1. Regression coefficients for estimating specific attenuation

⁸ The rainfall intensity for 0.01% of the time can be derived from the rain climate region map in Figure 2, Annex A to Appendix 1, for rainfall intensities at other percentages refer to ITU-R Recommendation P.838.

For any given path the attenuation due to rain is calculated for an effective path length, which accounts for the distribution of the rain intensity rate. The attenuation (A) due to rain, exceeded for 0.01% of the worst month is:

$$A = \gamma_R \left(\frac{d}{1 + \frac{d}{d_0}} \right) \quad (\text{dB})$$

where: d - path length (km); and

$$d_0 = 35e^{(-0.015R_{0.01})}$$

The attenuation (A_p) due to rain, exceeded for $p\%$ ($0.001 < p < 1$) of the worst month is:

$$A_p = 0.12 p^{-(0.546 + 0.043 \log_{10} p)} \quad (\text{dB})$$

4.2 Interference path propagation mechanisms

Interference path transmission losses for microwave fixed service links, including situations where interference levels rise for short periods of time ($p\%$) due to propagation enhancement on the interference path, can be modelled using the prediction models defined in ITU-R Recommendation P.452-7⁹, for the following propagation mechanisms:

- line-of-sight (including multi-path and focussing effects and gaseous absorption);
- line-of-sight with sub-path diffraction;
- diffraction due to clutter;
- tropospheric scatter; and
- ducting and other anomalous propagation modes.

Note: The troposcatter and the above-mentioned “anomalous” mode models are not considered here, as interference contribution through these modes to the homogeneous fixed service are not considered significant. However, they may be of significance when considering interference to particularly sensitive systems such as Earth stations of the space services.

Two basic types of interference path are considered when modelling transmission losses for a terrestrial propagation path. These demonstrate either a first Fresnel zone clearance or intrusion into the first Fresnel zone. For a terrestrial path with first Fresnel zone clearance, line-of-sight and clutter loss are the applicable propagation models. The corresponding predicted transmission loss is:

⁹ Computer programs associated with the prediction procedures described in this Recommendation are available from the ITU.

$$L_b(p) = L_{b0}(p) + A_{ht} + A_{hr} \quad (\text{dB})$$

where: $L_{b0}(p)$ - predicted basic transmission loss not exceeded for $p\%$ of time given by the LOS model; and

A_{ht}, A_{hr} - appropriate additional losses due to height-gain effects in local clutter.

For a terrestrial path with (obstacle) intrusion into the first Fresnel zone, the above-mentioned models apply with the addition of a diffraction model. The predicted transmission loss is then:

$$L_b(p) = L_{b0}(p) + L_{ds}(p) + A_{ht} + A_{hr} \quad (\text{dB})$$

where: $L_{ds}(p)$ - prediction for $p\%$ of the time given by the sub-path diffraction loss element of the diffraction model.

4.2.1 LOS propagation (including short-term effects)

The basic transmission loss $L_{b0}(p)$ not exceeded for time percentage, $p\%$, due to line-of-sight propagation is given by:

$$L_{b0}(p) = 92.5 + 20\log f + 20\log d + E_s(p) + A_g \quad (\text{dB})$$

where: $E_s(p)$ - correction for multipath and focusing effects:

$$E_s(p) = -9.617 (1 - e^{-d/10}) \quad (\text{dB}) \text{ for } 0.01 \% \text{ of the time}$$

$$E_s(p) = -1.035 (1 - e^{-d/10}) \quad (\text{dB}) \text{ for } 20 \% \text{ of the time}$$

Total gaseous (atmospheric) absorption is only considered significant at frequencies above approximately 10 GHz. The total gaseous absorption is:

$$A_g = [\gamma_o + \gamma_w(\rho)] d \quad (\text{dB})$$

where:

$\gamma_o, \gamma_w(\rho)$ - specific attenuation due to dry air and water vapour, respectively, and are found from the equations in Recommendation ITU-R P.676; and

ρ : water vapour density:

$$\rho = 7.5 + 2.5 \omega \quad (\text{g/m}^3)$$

ω : fraction of the total path over water.

4.2.2 LOS with diffraction losses

The excess loss due to diffraction may be calculated using a diffraction methodology¹⁰, assuming the effective Earth radius to be time-dependant due to the

¹⁰ Derived from ITU-R Recommendation P.526-4.

changes in bulk atmospheric radio refractivity lapse rate. ITU-R Recommendation P.452-7 §4.3 describes this time-dependant sub-path refraction loss model.

4.2.3 Clutter losses

The presence of clutter (buildings and vegetation) in the vicinity of the transmit and receive antennas can cause additional transmission losses, A_{ht} and A_{hr} . These losses are dependant upon the height of the clutter. Clutter losses may be calculated using the methodologies described in ITU-R Recommendation P.452-7 §4.6 by a height-gain model which is normalised to the nominal height of the clutter.

Table of Contents

1. INTRODUCTION	1
2. GSO AVOIDANCE NECESSARY TO PROTECT SPACE STATION RECEIVERS.....	1
2.1 ORBIT AVOIDANCE CRITERIA FOR SPECIFIC FREQUENCY BANDS	2
2.2 DEFAULT ORBIT AVOIDANCE CRITERIA.....	3
3. GSO AVOIDANCE NECESSARY TO PROTECT THE FIXED SERVICE	3

1. Introduction

As detailed in the Spectrum Plan¹, most of the frequency bands used by the fixed service (FS) are shared with other radiocommunication services, including geostationary orbit (GSO) space radiocommunication services. Annex A to this appendix provides a summary of fixed service bands which currently share with GSO space services. In order to facilitate spectrum sharing between the terrestrial fixed service and (existing and future) GSO based space radiocommunication services, it is necessary to limit the EIRP of fixed service systems in the direction of the GSO to avoid long term interference to sensitive space station receivers. Conversely, in some situations where the azimuth of a receiving station in the fixed service constitutes a look angle to a co-frequency transmitting station in the GSO, the fixed service may be subject to significant long-term interference, depending upon the sensitivity of the FS receiver and the satellite system power flux density at the receiver location.

2. GSO avoidance necessary to protect space station receivers.

In accordance with International Radio Regulation S21.3, the maximum EIRP of a station in the fixed service shall not exceed 55 dBW. This limit is reduced, in accordance with the criteria outlined in the following tables, for cases where the fixed service antenna main beam illuminates the GSO. Accordingly, for those fixed services employing maximum EIRP in excess of the relevant values, radiocommunication sites should be selected such that the direction of maximum radiation of the antenna is separated from the GSO by at least the specified minimum angular separation.

¹ “*Australian Radiofrequency Spectrum Plan, January 1997*”.

2.1 Orbit Avoidance Criteria for specific frequency bands

Band (GHz)	EIRP limit (dBW)	Minimum Separation Angle (degrees)
2.025-2.110	+8 (<i>Note 1</i>)	2°
2.200-2.290	+8 (<i>Note 1</i>)	2°
25.25-27.50	+24 (<i>Note 1</i>)	1.5°

Table 1. Orbit avoidance for specific frequency bands.

Note 1: The orbit avoidance criteria specified in Table 1 for the bands 2025-2110 MHz, 2200-2290 MHz and 25.25-27.5 GHz, are based on ITU-R Recommendations F.1247² and F.1249³ and are intended to protect Data Relay Satellites (DRS) operating in specific GSO locations from the emissions of terrestrial fixed services which may illuminate these orbital positions. As far as practicable, the fixed service station EIRP in the direction of the given orbital positions should not exceed the values in Table 1. Orbital positions visible from Australian mainland longitudes and identified (in Recommendation ITU-R SA.1276) as requiring protection are located in the GSO at:

47° E, 59° E, 85° E, 90° E, 95° E, 113° E, 121° E, 160° E, 171.5° E,
174° W, 171° W, 170° W, 160° W, 139° W.

Separation angles between these specified GSO locations and terrestrial fixed services may be calculated using the algorithm given in Annex 2 of ITU-R Recommendation F.1249³.

The limits shown in Table 1 for the bands 2025-2110 MHz and 2200-2290 MHz apply to point-to-point systems. For point-to-multipoint systems or point-to-point systems employing Automatic Transmit Power Control (ATPC) other limits may apply (refer to Recommendation F.1247).

² ITU-R Recommendation F.1247 “*Technical and operational characteristics of systems in the Fixed Service to facilitate sharing with the Space Research, Space Operation and Earth-Exploration Satellite Services operating in the bands 2025-2110MHz and 2200-2290 MHz*”.

³ ITU-R Recommendation F.1249 “*Maximum Equivalent Isotropically Radiated Power of transmitting stations in the Fixed Service operating in the frequency band 25.25-27.5 GHz shared with the Inter-Satellite Service*”.

2.2 Default Orbit Avoidance Criteria

For the cases not covered in Table 1 (see section 2.1), the default orbit avoidance criteria specified in Table 2 shall apply.

Band (GHz)	EIRP limit (dBW)	Minimum Separation Angle (<i>Note 2</i>) (degrees)
1-10	+35	2°
10-15	+45	1.5°
>15	+55	Not defined

Table 2. General (default) orbit avoidance criteria⁴.

Note 2: Separation angles need to be calculated for all services whose EIRP exceeds the relevant (Table 2) limits. Separation angles with the GSO may be calculated using the algorithm provided in Annex 2⁵ of ITU-R Recommendation SF.765 “*Intersection of Radio-Relay Antenna beams with orbits used by Space Stations in the Fixed-Satellite Service*”.

3. GSO avoidance necessary to protect the fixed service

Many fixed service band allocations are shared with GSO space radiocommunication services operating in the space-to-Earth direction. Normally the relevant power flux density limits (applicable to the space based service and specified at the surface of the Earth) serve to fully protect the operation of fixed and other terrestrial services. However, in situations where main beam or significant sidelobe coupling occurs between a receiving station of the fixed service and a co-frequency transmitting station within the GSO, severe long term interference may be experienced. The severity of such interference is dependent upon the degree of antenna coupling, pfd levels at the FS receiver location and FS receiver sensitivity.

In the absence of detailed orbit avoidance criteria for the protection of fixed service receivers from the emissions of GSO based space-to-Earth emissions, the following methodology may be used to evaluate potential interference levels on a case-by-case basis:

1. Determine co-frequency pfd levels at the terrestrial fixed service location, as typically provided in ITU-R satellite notices (pfd footprint) or use regulatory limits;
2. Calculate interference noise power (I_r) at the FS receiver input:

$$I_r = pfd + G + 10 \log \left[\frac{\lambda^2}{4\pi} \right] + 10 \log B - L_r \quad (\text{dBW})$$

where:

⁴ Based upon the requirements specified under Article S21 (WRC-95) of the ITU Radio Regulations.

⁵ Includes computer program source code facilitating the calculation of separation angles.

- pdf - power flux density (dB(W/m²/MHz)) at the FS receiver location;
- G - FS receiver antenna gain (dBi) in direction of GSO satellite (Note 2);
- λ - wavelength at operating frequency (m);
- B - FS receiver bandwidth (MHz); and
- Lr - FS receive feeder loss (dB).

The above calculation is based on a 1 MHz reference bandwidth. Where a different reference bandwidth is adopted an appropriate correction will need to be incorporated in the calculation (eg. 4 kHz is traditionally specified for analogue systems); and

3. Compare the calculated interference noise power against the FS system wanted receive signal power and the relevant interference management criteria (ie. ITU-R recommendations, in particular, F.758 and F.1094).

As a general comment, fixed service operators should seek to avoid main beam coupling with the GSO for their own protection at the route/network planning stage. Even where a band may not currently be co-allocated with space radiocommunication services, the world-wide trend is for increased frequency sharing and avoidance of the GSO (where possible) should be taken into account at the planning stage as part of prudent risk management.

ANNEX A to APPENDIX 5 : Microwave Fixed Service Bands Sharing with GSO Space Services

Table 1 provides a summary¹ (current at July 1998) of the microwave fixed service bands within which space services operating in the Geostationary Orbit may need to be considered during fixed service frequency coordination. Fixed service operators should note the trend for increased sharing between fixed and GSO space services. Accordingly, fixed service bands not listed in Table 1 may be the subject of such sharing in the future.

Microwave Fixed Service Band (GHz)	GSO Space Service Allocation
1.5	Space operation, BSS, MSS
2.1	Space operation, MSS
3.8	FSS
6	FSS
6.7	FSS
7.5	FSS
8	FSS, MSS
11	FSS
13	FSS
15	FSS
18	FSS
22	BSS, ISS
38	FSS
49	FSS
50	FSS

Table 1. Microwave fixed service bands within which GSO space services are allocated on a co-primary basis.

¹ Derived from the "Australian Radiofrequency Spectrum Plan, January 1997" and the Report of the RCC Working Group on "Spectrum Demand for New Telecommunications Services", March 1998.

APPENDIX 6: **Application of Assignment Policy Rules**

This appendix to RALI FX 3 provides guidance to frequency assigners regarding the application of assignment instructions and planning rules specified in the RALI and the case-by-case consideration of assignment applications seeking the relaxation of specific assignment policy rules.

As discussed in the introduction to Part 3 of RALI FX 3, assignment instructions, coordination and general system planning rules are necessary for the management of interference and the optimisation of spectrum usage for microwave fixed services. The policy objectives for these assignment and planning rules are to establish a reasonable balance between unnecessary spectrum denial, the likelihood of interference and the cost of implementing services.

Consistency

The consistent application of the rules is particularly important at locations of high spectrum demand, including designated HSDA (see Part 3.3.2), regional centres, radio-relay routes and shared radiocommunication sites.

Consistency is also important for equity reasons as well as from a technical spectrum management perspective and:

- every microwave fixed service assignment application should be routinely checked for compliance against all relevant RALI specified assignment criteria;
- where a proposal fails to meet the relevant assignment criteria, the applicant should be advised of their options with respect to compliance with that criteria;
- if a formal relaxation from the application of an assignment instruction or planning rule is being sought, each proposal must be considered on its individual merits (ie. case-by-case) in accordance with the principles established in the following section “*Case-by-case Consideration*”;
- in cases where, after due consideration of relevant matters, an assignment is made which does not accord with the relevant RALI specified assignment criteria, the assignment record is to be annotated with an outline of the reason or a reference to where such information may be found;
- should uncertainty remain regarding the policy objectives supported by, or the intended scope of, a particular assignment instruction or planning rule, advice may be sought from the Manager, Spectrum Engineering, Spectrum Planning Branch, ACMA.

Case-by-case Consideration

Annex A to this appendix outlines a number of (relatively straightforward) examples of the case-by-case consideration of applications seeking the relaxation of particular assignment or planning rules.

Clearly these simplistic examples represent only a sample of the potentially limitless range of situations likely to be encountered in the process of assigning frequencies for radiocommunication services. However, the common thread in all such cases is the need to consider the circumstances of each situation individually in the light of all relevant factors and with specific reference to the requirements of ACA Information Paper “*Principles for Decision Making*”¹. Accordingly:

- prior to considering the application of an assignment instruction or planning rule, frequency assigners need to ensure that it is intended to be applicable in the particular case. Having decided that it is, a decision should be made about whether the application of the policy rule is appropriate under the circumstances;
- such considerations must take account of the RALI policy objectives supported by the specific assignment criteria under question and the consequences that an anomalous assignment may have on these objectives, balanced against any specific arguments as to why the policy rule should not be applied in the particular circumstances presented by the application; and
- earlier cases where individual consideration may have resulted in an approval must not be construed as automatic grounds for the routine approval of subsequent cases, as each case must be considered on its own merits.

Typically, considerations will revolve around the need to maintain spectrum productivity for the overall fixed service user community, balanced against the legitimate needs of individual spectrum users. A number of questions naturally arise in conjunction with the consideration of unorthodox assignment proposals and the RALI specified assignment policy objectives including (but not limited to) the following:

- is the proposed frequency assignment located within designated HSDA or other relatively high spectrum demand area?
- is the proposed assignment likely to unreasonably impinge on the deployment of radiocommunication services by other (future) users?
- if there is a potential impact on other users, how significant is that impact likely to be, taking into account anticipated spectrum demand?
- does the proposal cover temporary or permanent operation?

¹ With particular reference to section 7 “*Consideration and Flexible Application of Government Policy*” in ACA Information Paper “*Principles for Decision Making*”.

- if the relaxation being sought is of a short term nature (eg. to support temporary operation pending the cutover of another service), what is the proposed duration?

Account also needs to be taken of the relative weighting of individual assignment instructions and planning rules in the context of maintaining spectrum productivity. For example, the application of antenna requirements should be considered as having a much greater weighting than that of say, assignment priority criteria. Naturally, the relative weighting of each such criteria may be moderated by other relevant factors, such as geographic location or that temporary operation is much less likely to compromise the needs of other spectrum users.

In cases where the “temporary” relaxation of assignment policy is being considered, the proposed period will usually need to be explicitly quantified and agreed with the applicant. Where an application is approved under these circumstances, “temporary” operation would normally be for a period of less than twelve months.

In summary, the relaxation of assignment policy requirements should be exceptional rather than routine.

In cases where doubt remains regarding the intent of the policy outlined in this section, advice should be sought from the Manager, Spectrum Engineering, Spectrum Planning Branch, ACMA.

ANNEX A to APPENDIX 6: Examples in support of Appendix 6

This annex provides background information only and is intended to be read in conjunction with Appendix 6 "*Application of Assignment Policy Rules*". It outlines several example cases of the assessment of applications seeking the relaxation of particular RALI assignment or planning rules. The examples are provided in order to demonstrate the application of the general approach outlined in Appendix 6 in considering some of the more exceptional fixed link assignment applications.

Examples of applications seeking the relaxation of individual Assignment Instructions or Planning Rules

CASE I: *A licensee cancels an existing fixed link licence and seeks to re-use the recovered link equipment at another location. However, the operating frequencies of the recovered equipment do not accord with the channels designated by the assignment priority criteria as applicable at the proposed new link location. Although the recovered (older) equipment is in sound working order, it is not readily retuneable and would need to be sent back to the manufacturer for re-alignment.*

As with most of the other RALI coordination and planning rules, assignment priority criteria is intended to facilitate efficient spectrum re-use through the optimisation of overall link densities within a given spectrum space. Accordingly, assigners are expected to practice and encourage the principle of "vertical loading" of radiofrequency channels as a matter of good routine engineering practice. However, it is recognised that some situations (such as outlined above) do arise where a reasonable case can be presented to relax the application of the RALI specified assignment priority. Overall, it can be demonstrated that the relaxation of assignment priority criteria in isolated cases (as outlined above) will not significantly affect spectrum productivity.

CASE II: *An applicant proposes a fixed point-to-point link in the 7.5 GHz band with a necessary channel bandwidth of 14 MHz. However, the proposed path length of 6 km does not meet the minimum path length criteria of 20 km for the band. The proposed link will be located in a high rainfall area close to a designated HSDA.*

The minimum path length requirement is intended to encourage fixed link operators to preserve the lower frequency bands for long link paths. In considering this particular case, it is noted that there are a number of alternative RALI FX 3 arrangements, ie. 10/15/18/22/38 GHz, which provide a 14 MHz channel raster. It is recognised, however, that the higher of these alternative bands may not be suitable for the proposed link, given the location in a high rainfall area. Overall, although the proposed link is not strictly within a designated HSDA, it is considered that the relatively short proposed path length is achievable in other (higher) bands and accordingly, the proposal is not supportable.

Note: The above examples, although based upon (simplified) actual cases, are provided as background information (for Appendix 6) only and must not be interpreted as explicit policy rulings or instant recipes for different fixed link assignment situations.

APPENDIX 7: Coordination of Apparatus Licences with Spectrum Licences: 1.8, 2.1 and 2.2 GHz Band Fixed Services

Table of Contents

1 INTRODUCTION	2
2 BASIC COORDINATION PRINCIPLES.....	3
2.1 COORDINATION ACROSS THE GEOGRAPHIC BOUNDARY	3
2.1.1 Co-channel - Apparatus licence transmitter	3
2.1.2 Co-channel - Apparatus licence receiver.....	4
2.2 COORDINATION ACROSS THE FREQUENCY BOUNDARY	4
2.2.1 Adjacent band - Apparatus licence transmitter	4
2.2.2 Adjacent band - Apparatus licence receiver.....	4
3 COORDINATION THRESHOLD DISTANCE.....	4
4 COORDINATION SCENARIOS - 1.8 GHZ BAND	5
4.1 COORDINATION ACROSS THE GEOGRAPHIC BOUNDARY - 1.8 GHZ BAND.....	5
4.1.1 Co-channel - Apparatus licence <u>transmitter</u> located in the <u>remote area</u> and within 200 km of the regional spectrum licence boundary	5
4.1.2 Co-channel - Apparatus licence <u>receiver</u> located in the <u>remote area</u> and within 200 km of the regional spectrum licence boundary	6
4.1.3 Co-channel - Apparatus licence <u>transmitter</u> located in the <u>regional area</u> and within 200 km of the major city spectrum licence boundary	7
4.1.4 Co-channel - Apparatus licence <u>receiver</u> located in the <u>regional area</u> and within 200 km of the major city spectrum licence boundary	8
4.2 COORDINATION ACROSS THE FREQUENCY BOUNDARY - 1.8 GHZ BAND	9
4.2.1 Adjacent band - Apparatus licence <u>transmitter</u> located in the <u>regional area</u>	9
4.2.2 Adjacent band - Apparatus licence <u>receiver</u> located in the <u>regional area</u>	9
4.2.3 Adjacent band - Apparatus licence <u>transmitter</u> located in a <u>major city area</u>	9
4.2.4 Adjacent band - Apparatus licence <u>receiver</u> located in a <u>major city area</u>	9
5 COORDINATION SCENARIOS - 2.1 AND 2.2 GHZ BANDS.....	9
5.1 COORDINATION ACROSS THE GEOGRAPHIC BOUNDARY - 2.1 GHZ BAND.....	9
5.1.1 Co-channel - Apparatus licence <u>transmitter</u> within 200 km of the spectrum licence boundary.....	10
5.1.2 Co-channel - Apparatus licence <u>receiver</u> within 200 km of the spectrum licence boundary	10
5.2 COORDINATION ACROSS THE FREQUENCY BOUNDARY - 2.1 AND 2.2 GHZ BANDS	12
5.2.1 Adjacent band - Apparatus licence <u>transmitter</u> located in a spectrum licensed area	12
5.2.2 Adjacent band - Apparatus licence <u>receiver</u> located in a spectrum licensed area.....	12
6 ADDITIONAL DEVICE BOUNDARY REQUIREMENT - 2.1 GHZ BAND TRANSMITTERS	12

1 Introduction

This document provides guidance on the approach to be taken in coordinating proposed 1.8, 2.1 and 2.2 GHz apparatus licensed (AL) fixed service links with spectrum licences (SL), across both the geographic and the frequency boundaries of SL's. The spectrum arrangements for AL and SL radiocommunication services are outlined in the 1.8, 2.1 and 2.2 GHz RF Channel Arrangements and Assignment Instructions in Appendix 1 of the RALI FX 3. The following sections set out the principles for such coordination and point to the relevant coordination requirements and criteria contained in other documents for anticipated AL/SL coordination scenarios.

Users of this appendix should familiarise themselves with the relevant spectrum licensing framework (either the 1.8 or 2 GHz band arrangements).

Documents required to undertake the coordination described in this appendix are,

for 1.8 GHz Band coordination:

- Radiocommunications (Unacceptable Levels of Interference-1800 MHz Band) Determination 1999 (referred to as "s145 determination-1800");
- Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers - 1800 MHz Band) 1999 (referred to as "RAG-ALRX-1800");
- Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed and Class-licensed Transmitters - 1800 MHz Band) 1999 (referred to as "RAG-ALTX-1800"); and
- Radiocommunications Advisory Guidelines (Protection of Mobile Base Receivers - 1800 MHz Lower Band) 1999 (referred to as "RAG-BaseRxLower-1800");

and for 2.1 and 2.2 GHz Band¹ coordination:

- Radiocommunications (Unacceptable Levels of Interference-2 GHz Band) Determination 2000 (referred to as "s145 determination-2GHz");
- Radiocommunications Advisory Guidelines (Protection of Apparatus-licensed and Class-licensed Receivers - 2 GHz Band) 2000 (referred to as "RAG-ALRX-2GHz"); and
- Radiocommunications Advisory Guidelines (Managing Interference from Apparatus-licensed and Class-licensed Transmitters - 2 GHz Band) 2000 (referred to as "RAG-ALTX-2GHz").

The above determinations and guidelines form part of the interference management framework for spectrum licences in each of the 1.8 and 2 GHz bands. Spectrum licensees will have acquired their spectrum licences on the basis of that framework. Accordingly, it may be expected that spectrum licensees will anticipate that those determinations and guidelines will normally be followed, and that they (the licensees) will be able to establish services within their spectrum space in accordance with that framework. Nevertheless, in some circumstances it may be possible to depart from the framework, for example with the agreement of relevant spectrum licensees. It should be noted, however, that the position is likely to change when licences are traded. In such an event, either such agreements would need to be re-negotiated, or the operating characteristics of devices would have to be modified, to ensure that the framework is again followed.

¹ Note that the spectrum licensed band overlapping the '2.1 GHz Band' for fixed services, is known as the '2 GHz Band' in context of spectrum licensing arrangements.

2 Basic coordination principles

For every proposed 1.8, 2.1 or 2.2 GHz fixed service AL receiver or transmitter, consideration should be given to whether coordination is required across the geographic boundary and also the frequency boundary of all relevant SL's.

In the context of 1.8 GHz spectrum licensing, the terms "remote", "regional" and "major city" are used in the following text to describe areas. Areas defined in the Spectrum Re-allocation Declarations No. 3 of 1997 for Adelaide, Brisbane, Melbourne, Perth and Sydney constitute "major city" areas. The areas defined in Spectrum Re-allocation Declarations No. 4 of 1997 are referred to as "regional" areas, and the remainder of Australia is referred to as "remote". See also the coordination threshold contours map of the 1.8 GHz band Channel Arrangements and Assignment Instructions in Appendix 1 of RALI FX-3.

In the context of 2 GHz spectrum licensing, terms to group areas are not so relevant to interference management. The term "capital city areas" is used, and all other spectrum licence areas are considered to be "regional". No "remote" areas have been allocated at 2 GHz. Areas are defined in the Spectrum Re-allocation Declaration No. 2 of 2000. See also the coordination threshold contours map of the 2.1 GHz band Channel Arrangements and Assignment Instructions in Appendix 1 of RALI FX-3.

2.1 Coordination across the geographic boundary

AL fixed stations requiring coordination with a SL need to coordinate with a "spectrum space" as opposed to traditional coordination which is undertaken with respect to other radiocommunications devices. Therefore, SL coordination principles need to be utilised for coordination of AL fixed stations with SL's.

To determine whether coordination is required across the geographic boundary, a coordination threshold distance is used. The coordination threshold distances for AL fixed stations are specified in section 3 of this appendix and illustrated in the 1.8 and 2.1 GHz Band Channel Arrangements in Appendix 1 of RALI FX-3. Proposed fixed stations (transmitters or receivers) outside this distance should not require coordination with SL's.

2.1.1 Co-channel - Apparatus licence transmitter

To protect a SL from a proposed (ie new or re-tuned) co-channel² AL transmitter, the AL transmitter should be treated as though it were spectrum licensed. That is, the proposed AL transmitter will be considered to not interfere with the SL if the device boundary (a polygon) of the AL transmitter does not intrude into the co-channel SL area. The device boundary criterion and the method to determine the device boundary polygon are specified in a determination made under Section 145 of the *Radiocommunications Act 1992* (referred to as either *s145 determination-1800* or *s145 determination-2GHz*).

Proposed AL (and SL) transmitters in the 1.8 GHz lower band near "areas of high mobile use", in addition to meeting the device boundary criterion specified in the *s145 determination-1800*, must meet a second device boundary requirement. (Areas of high mobile use are defined in *s145 determination-1800* and include all major city areas plus Canberra.) This additional device boundary requirement is set out in *RAG-BaseRxLower-1800*.

² As SL's are not channelised the term "in-band" is used in spectrum licensing documentation instead of "co-channel". The terms "in-band" or "co-channel" include any AL service with an occupied bandwidth that overlaps the frequency band of the SL considered.

Proposed AL transmitters in the 2 GHz lower band must all meet a second device boundary requirement. This additional device boundary requirement is set out in section 6 of this appendix.

2.1.2 Co-channel - Apparatus licence receiver

As detailed in the relevant RAG-ALRX, proposed (ie. new or re-tuned) AL receivers must accept emissions from devices operated within the SL space up to the maximum levels permitted by the s145 determination and core conditions of the SL. Existing AL receivers are provided with protection as per the RAG-ALRX which points to the protection requirements specified in Appendix 1 to RALI FX 3.

Should a proposed AL receiver fail the standard coordination procedure described in this appendix, the licence applicant may wish to make their own assessment of the risk involved in operating the receiver close to the SL boundary. In doing so they might consider possible locations for SL transmitters such as existing radiocommunications sites or other locations suitable for radiocommunications transmission sites (for example hill or mountain tops) and the probability that a spectrum licensee would deploy systems in the area. If the applicant wishes to proceed with the assignment, such receivers may be proposed for licensing on a “no protection” basis.

2.2 Coordination across the frequency boundary

Coordination across the AL/SL frequency boundary is performed on the basis of potential interference between the proposed device and existing SL devices.

2.2.1 Adjacent band - Apparatus licence transmitter

In coordinating proposed AL transmitters, protection is to be provided to registered SL receivers as per the notional receiver specified in the relevant RAG-ALTX.

2.2.2 Adjacent band - Apparatus licence receiver

AL receivers can expect protection from new SL transmitters to the levels specified in RAG-ALRX which points to the protection requirements specified in Appendix 1 to RALI FX 3. When assigning a new fixed receiver, an assessment of the interference potential of registered SL transmitters should be made.

3 Coordination threshold distance

For fixed service assignments in areas adjacent to SL areas, the coordination threshold distance is specified in Table 3.1.

<i>AL fixed service band</i>	<i>Coordination threshold distance</i>
1.8 GHz Band	200 km
2.1 GHz Band	200 km
2.2 GHz Band	None

Table 3.1

Any proposed fixed station within this distance of a co-channel SL boundary will need to be coordinated with the SL area as described in this appendix. Outside this distance normal microwave fixed services coordination criteria and procedures apply.

In certain scenarios, the coordination threshold distance for transmitters (only) can be reduced. The coordination threshold distance was determined on the basis of protecting an AL fixed service

receiver from SL devices within the spectrum space. As a different interference framework applies to SL receivers compared with AL fixed service receivers, lower power AL fixed service transmitters may use a reduced coordination threshold distance if certain criteria are met. These criteria are shown in Table 3.2.

<i>AL fixed service band</i>	<i>AL fixed transmitter criteria</i>	<i>Reduced Tx coordination threshold distance</i>
1.8 GHz Band	AL transmitter EIRP < 54.5 dBm/30 kHz, AND effective antenna height ³ < 400 m.	50 km
2.1 GHz Band	Any AL transmitter in 2.1 GHz Upper Band: 2100 – 2294.5 MHz	50 km
2.2 GHz Band	All cases	None

Table 3.2

4 Coordination scenarios - 1.8 GHz Band

This section addresses each coordination case possible in the 1.8 GHz fixed services band.

4.1 Coordination across the geographic boundary - 1.8 GHz Band

This section addresses each coordination case for 1.8 GHz AL fixed stations that are co-channel with a SL and are outside the SL area.

4.1.1 Co-channel - Apparatus licence transmitter located in the remote area and within 200 km of the regional spectrum licence boundary

The frequency ranges available for this transmitter are:

Lower Band: 1706 - 1805 MHz

Upper Band: 1805 - 1880 MHz and 1900 - 1917 MHz

If the effective occupied bandwidth of the proposed AL transmitter overlaps the frequency ranges 1710 - 1725 MHz or 1805 - 1820 MHz⁴ then coordination with the regional SL is necessary if the proposed transmitter is within 50 km of the regional SL boundary. Coordination should also be undertaken for transmitters more than 50 km from the SL boundary if the EIRP and effective antenna height of the AL transmitter exceed those specified in section 3 of this appendix.

Note: In some areas, particularly Western Australia, an AL transmitter in the remote area may also be within 200 km of a major city area and must coordinate as per section 4.1.3 of this appendix.

To coordinate: A device boundary polygon should be determined in accordance with *s145 determination*. If the device boundary polygon intrudes into the regional SL area then the assignment is NOT permitted. (If the applicant wishes to pursue the assignment further they could consider ways of reducing the device boundary polygon such as a reduction in power, reducing the effective antenna height, or improved antenna discrimination.)

³ Effective antenna height is defined in Schedule 3 of *s145 determination*.

⁴ 1710 - 1725 MHz and 1805 - 1820 MHz are the frequency ranges of the regional SL's.

4.1.2 Co-channel - Apparatus licence receiver located in the remote area and within 200 km of the regional spectrum licence boundary

Proposed AL receivers located in the remote area must be coordinated with the regional SL if their related transmitter's effective occupied bandwidth overlaps the frequency ranges 1710 - 1725 MHz or 1805 - 1820 MHz, and the proposed AL receiver is within 200 km of the SL boundary.

Note: In some areas, particularly Western Australia, an AL receiver in the remote area may also be within 200 km of a major city area and must coordinate with the major city area as per section 4.1.4 of this appendix.

To coordinate: A number of methodologies are possible for coordination of an AL receiver with an SL as follows:

(a) A device boundary polygon may be calculated for the receiver using a device boundary criterion. The device boundary is calculated in a manner similar to that for a transmitter as described in s145 determination except that the device boundary criterion is replaced by:

$$RLOP - LOP$$

where:

RLOP is the level of protection required by the AL fixed service receiver for normal operation; and

LOP is the level of protection that would be achieved at a particular distance from the SL boundary.

$$RLOP = WL - PR - AD$$

where:

WL = Wanted receive input Level (dBm) of the fixed service receiver;

PR = Protection Ratio as specified in the 1.8 GHz Assignment Instructions in Appendix 1); and

AD = Antenna Discrimination for the particular radial.

$$LOP = 63 - L - LL + 10 * \text{Log}_{10}(N)$$

where:

L = The greater of either FSL or OHL;

LL = Transmission line losses including feeder and combiner losses; and

N = The likely number of 200 kHz bandwidth spectrum licensed transmitters within the receiver bandwidth (suggest N = 4 for coordination with regional boundaries and N= 10 for major city boundaries);

and where:

FSL = free space loss

$$FSL = 32.45 + 20 * \text{Log}_{10}(\text{Freq}) + 20 * \text{Log}_{10}(\text{Dist})$$

OHL = over the horizon loss⁵

$$OHL = 29.73 + 30 * \text{Log}_{10}(\text{Freq}) + 10 * \text{Log}_{10}(\text{Dist}) + 30 * \text{Log}_{10}(\text{Theta}) + 20 * \text{Log}_{10}(5 + (0.27 * \text{Theta} * \text{Dist}) / 4000) + 0.00125 * \text{Theta}^2$$

and where:

$$\text{Theta} = (\text{Dist} - dh) / 8.5 \quad (\text{OHL not valid for } \text{Theta} < 0);$$

⁵ OHL is based on median troposcatter loss for a continental temperate climate (refer to Recommendation P.617-1).

Dist = Distance along each radial to the boundary (in km) plus 48 km;
 Freq = Frequency (in MHz);
 $dh = 4.123 * (he_1(\phi_n)^{0.5} + 19.5)$ (OHL not valid for $dh > Dist$); and
 $he_1(\phi_n)$ = the effective antenna height above average terrain for segment 1 for each bearing ϕ_n (in metres) as defined in s145 determination;

OR

(b) A device boundary polygon may be calculated for the receiver using a device boundary criterion as in (a) except that L is the propagation loss determined in accordance with the general method for estimating diffraction loss described in ITU Recommendation P.526, using a path profile derived from the ACA's digital elevation model RadDEM and an effective earth radius factor of $k=3$, or some other appropriate method.

To calculate L, a notional transmitter is assumed to be located in the geographic area of the SL at a point on each radial 48 km inside the boundary. The notional site height for these transmitters is 350 metres and the notional antenna height above ground is 30 metres.

If coordination fails: If the receiver fails coordination under methods (a) or (b) above, the licence applicant may wish to make their own assessment of the risk involved in operating the receiver close to the SL boundary (refer section 2.1.2 of this appendix). Should the applicant wish to proceed with the assignment **advisory note FA** must be applied to the spectrum access record.

Advisory note FA reads:

"If interference to a station operated under this licence is caused by a radiocommunications device that is authorised to operate under a spectrum licence, the ACA will consider any dispute from the starting point that the spectrum licence has priority over this licence, irrespective of the date that the spectrum licensed device was first operated."

4.1.3 Co-channel - Apparatus licence transmitter located in the regional area and within 200 km of the major city spectrum licence boundary

The frequency ranges available for this transmitter are:

Lower Band: 1725 - 1805 MHz

Upper Band: 1820 - 1880 MHz and 1900 - 1917 MHz

If the effective occupied bandwidth of the proposed AL transmitter overlaps the frequency ranges 1725 - 1785 MHz or 1820 - 1880 MHz⁶ then coordination with the major city SL is necessary if the proposed transmitter is within 200 km of the regional SL boundary.

To coordinate: In this case the coordination process differs depending upon whether the proposed transmitter is within the lower or upper bands as additional requirements are placed on transmitters in the lower band. Step 1 must be satisfied for transmitters in both bands within 50 km⁷ of the SL

⁶ 1710 - 1785 MHz and 1805 - 1880 MHz are the frequency ranges of the major city SL's. The lower 15 MHz of each of these blocks is common to the regional SL licences and cannot be used by AL fixed services in regional areas.

⁷ A coordination threshold distance of 50 km is appropriate only if the EIRP and effective antenna height of the proposed AL transmitter are consistent with that specified in section 3 of this appendix. Transmitters not meeting these requirements must be coordinated when within 200 km of the SL boundary.

boundary. However, Step 2 must also be satisfied for transmitters in the lower band below 1785 MHz that are within 200 km of the major city SL boundary.

Step 1: A device boundary polygon should be determined in accordance with s145 determination. If the device boundary polygon intrudes into the major city SL area then the assignment is NOT permitted. (If the applicant wishes to pursue the assignment further they could consider ways of reducing the device boundary polygon such as a reduction in power, reducing the effective antenna height, or improved antenna discrimination.)

Step 2: If the proposed AL transmitter is in the lower band, below 1785 MHz, then an additional device boundary requirement must also be met as described in clauses 4.2 and 4.3 of RAG-BaseRxLower-1800. An additional device boundary polygon should be calculated in accordance with the additional device boundary criterion set out in schedule 1 of RAG-BaseRxLower-1800 and using the basic methodology set out in s145 determination.

4.1.4 Co-channel - Apparatus licence receiver located in the regional area and within 200 km of the major city spectrum licence boundary

Proposed AL receivers located in the regional area must be coordinated with the major city SL if their related transmitter's effective occupied bandwidth overlaps the frequency ranges 1725 - 1785 MHz or 1820 - 1880 MHz, and the proposed AL receiver is within 200 km of the SL boundary. As SL transmitters in the lower of these bands are restricted to low effective antenna heights (10 m or less), AL receivers in the lower band will be able to be sited closer to the SL boundary than in the upper band.

To coordinate: A number of methodologies to coordinate an AL receiver with an SL are possible:

(a) For receivers operating in either of the above mentioned bands, a device boundary polygon could be calculated using the device boundary criterion set out in section 4.1.2 of this appendix except that for frequency range 1725 - 1785 MHz:

$$\text{Dist} = \text{Distance along the radial in km to the point where the radial crosses the 48 metre elevation contour of RadDEM after entering a (major city) area of high mobile use; and}$$

$$dh = 4.123 * (he_1(\phi_n)^{0.5} + 7.6) - \text{for (major city) areas of high mobile use.}$$

OR

(b) A device boundary polygon may be calculated for the receiver using a device boundary criterion as in (a) except that L is the propagation loss determined in accordance with the general method for estimating diffraction loss described in ITU Recommendation P.526, using a path profile derived from the ACA's digital elevation model RadDEM and an effective earth radius factor of k=3, or some other appropriate method.

To calculate L, a notional transmitter is assumed to be located inside the geographic area of the SL on each radial at the point where the radial crosses the 48 metre elevation contour of RadDEM after entering a (major city) area of high mobile use. The notional antenna height above ground for the transmitter is 10 metres.

If coordination fails: If the receiver fails coordination under methods (a) or (b) above, the licence applicant may wish to make their own assessment of the risk involved in operating the receiver

close to the SL boundary (refer section 2.1.2 of this appendix). Should the applicant wish to proceed with the assignment **advisory note FA** must be applied to the spectrum access record.

Advisory note FA reads:

“If interference to a station operated under this licence is caused by a radiocommunications device that is authorised to operate under a spectrum licence, the ACA will consider any dispute from the starting point that the spectrum licence has priority over this licence, irrespective of the date that the spectrum licensed device was first operated.”

4.2 Coordination across the frequency boundary - 1.8 GHz Band

1.8 GHz AL fixed stations sited within SL areas but outside the SL frequency bands must be coordinated as described in this section. AL fixed stations in close proximity to SL boundaries should also pay regard to protection of and interference from SL devices.

4.2.1 Adjacent band - Apparatus licence transmitter located in the regional area

If an AL transmitter is proposed for operation in a regional area it must be coordinated with all registered SL receivers in the frequency ranges 1710 - 1725 MHz and 1805 - 1820 MHz in accordance with RAG-ALTX. Protection for SL receivers is provided to the levels required by the notional SL receiver specified in schedule 1 of RAG-ALTX. (Refer also to clause 2.5; to part 4; and to schedule 2; of RAG-ALTX). AL transmitters must comply with the emission criteria requirements specified in Part 3.2.3 of RALI FX 3.

4.2.2 Adjacent band - Apparatus licence receiver located in the regional area

If an AL receiver is proposed for operation in a regional area it must be coordinated with registered SL transmitters in the frequency ranges 1710 - 1725 MHz and 1805 - 1820 MHz in accordance with clause 2.5 of RAG-ALRX.

4.2.3 Adjacent band - Apparatus licence transmitter located in a major city area

If an AL transmitter is proposed for operation in a major city area it must be coordinated with all registered SL receivers in the frequency ranges 1710 - 1785 MHz and 1805 - 1880 MHz in accordance with RAG-ALTX. Protection for SL receivers is provided to the levels required by the notional SL receiver specified in schedule 1 of RAG-ALTX. (Refer also to clause 2.5; to part 4; and to schedule 2; of RAG-ALTX). AL transmitters must comply with the emission criteria requirements specified in Part 3.2.3 of RALI FX 3.

4.2.4 Adjacent band - Apparatus licence receiver located in a major city area

If an AL receiver is proposed for operation in a major city area it must be coordinated with all registered SL transmitter in the frequency ranges 1710 - 1785 MHz and 1805 - 1880 MHz in accordance with clause 2.5 of RAG-ALRX.

5 Coordination scenarios - 2.1 and 2.2 GHz Bands

This section addresses each coordination case possible in the 2.1 and 2.2 GHz fixed services bands.

5.1 Coordination across the geographic boundary - 2.1 GHz Band

This section addresses each coordination case for 2.1 GHz AL fixed stations that are co-channel with a SL and are outside the SL area. 2.2 GHz AL fixed stations do not operate co-channel and are therefore not addressed in the following sections.

5.1.1 Co-channel - Apparatus licence transmitter within 200 km of the spectrum licence boundary

The frequency ranges available for this transmitter are:

Lower Band: 1893 - 2100 MHz

Upper Band: 2100 – 2294.5 MHz

If the effective occupied bandwidth of the proposed AL transmitter overlaps the frequency ranges 1900 - 1980 MHz or 2110 - 2170 MHz⁸ then coordination with the major city SL is necessary if the proposed transmitter is within 200 km of the major city SL boundary. If the effective occupied bandwidth of the proposed AL transmitter overlaps the frequency ranges 1960 - 1980 MHz or 2150 - 2170 MHz then coordination with the regional SL is necessary if the proposed transmitter is within 200 km of the regional SL boundary.

To coordinate: In this case the coordination process differs depending upon whether the proposed transmitter is within the lower or upper bands as additional requirements are placed on transmitters in the lower band. Case 1 must be satisfied for transmitters in the Upper Band within 50 km⁹ of the SL boundary. Case 2 must be satisfied for transmitters in the Lower Band below 1980 MHz that are within 200 km of the SL boundary.

Case 1: A device boundary polygon should be determined in accordance with *s145 determination*. If the device boundary polygon intrudes into the SL area then the assignment is NOT permitted. (If the applicant wishes to pursue the assignment further they could consider ways of reducing the device boundary polygon such as a reduction in power, reducing the effective antenna height, or improved antenna discrimination.)

Case 2: If the proposed AL transmitter is in the Lower Band, below 1980 MHz, then the additional device boundary requirement must be met. The additional device boundary polygon should be calculated in accordance with the additional device boundary criterion set out in section 6 "*Additional Device Boundary Requirement -- 2.1 GHz Band transmitters*", which follows the basic methodology set out in *s145 determination*.

5.1.2 Co-channel - Apparatus licence receiver within 200 km of the spectrum licence boundary

If the effective occupied bandwidth of the proposed AL receiver's related transmitter overlaps the frequency ranges 1900 - 1980 MHz or 2110 - 2170 MHz then coordination with the major city SL is necessary if the proposed receiver is within 200 km of the major city SL boundary. If the effective occupied bandwidth of the proposed AL receiver's related transmitter overlaps the frequency ranges 1960 - 1980 MHz or 2150 - 2170 MHz then coordination with the regional SL is necessary if the proposed receiver is within 200 km of the regional SL boundary.

To skip receiver coordination: Instead of following the receiver coordination method below, the licence applicant may wish to make their own assessment of the risk involved in operating the receiver close to the SL boundary (refer section 2.1.2 of this appendix). In this case, **advisory note FA** must be applied to the spectrum access record.

⁸ 1900 - 1980 MHz and 2110 - 2170 MHz are the frequency ranges of the major city SL's. The upper 20 MHz of each of these blocks is common to the regional SL licences and cannot be used by AL fixed services in regional areas.

⁹ This reduction is because coordination is in the 2 GHz SL band typically used for 'mobile Rx' (high site-to-low site).

Advisory note FA reads:

“If interference to a station operated under this licence is caused by a radiocommunications device that is authorised to operate under a spectrum licence, the ACA will consider any dispute from the starting point that the spectrum licence has priority over this licence, irrespective of the date that the spectrum licensed device was first operated.”

To coordinate: The method for coordination of an AL receiver with a SL is:

A device boundary polygon may be calculated for the receiver using a device boundary criterion. The device boundary is calculated in a manner similar to that for a transmitter as described in s145 determination except that the device boundary criterion is replaced by:

$$\text{RLOP} - \text{LOP}$$

where:

RLOP is the level of protection required by the AL fixed service receiver for normal operation; and

LOP is the level of protection that would be achieved at a particular distance from the SL boundary.

$$\text{RLOP} = \text{WL} - \text{PR} - \text{AD}$$

where:

WL = Wanted receive input Level (dBm per 30 kHz¹⁰) of the fixed service receiver;

PR = Protection Ratio as specified in the 2 GHz Assignment Instructions in Appendix 1); and

AD = Antenna Discrimination for the particular radial.

$$\text{LOP} = 55 - \text{L}$$

where:

L = The greater of either FSL or OHL;

and where:

FSL = free space loss

$$\text{FSL} = 32.45 + 20 * \text{Log}_{10}(\text{Freq}) + 20 * \text{Log}_{10}(\text{Dist} + 48)$$

OHL = over the horizon loss¹¹

$$\text{OHL} = 29.73 + 30 * \text{Log}_{10}(\text{Freq}) + 10 * \text{Log}_{10}(\text{Dist} + 48) + 30 * \text{Log}_{10}(\text{Theta}) + 20 * \text{Log}_{10}(5 + (0.27 * \text{Theta} * (\text{Dist} + 48)) / 4000) + 0.00125 * \text{Theta}^2$$

and where:

Theta = (Dist + 48 - dh)/8.5 (OHL not valid for Theta < 0);

Dist = Distance along each radial to the boundary (in km);

Freq = Frequency (in MHz);

dh = 4.123 * (he₁(φ_n)^{0.5} + 7.6) (OHL not valid for dh > Dist+48); and

he₁(φ_n) = the effective antenna height above average terrain for segment 1 for each bearing φ_n (in metres) as defined in s145 determination;

¹⁰ Note bandwidth conversion required here.

¹¹ OHL is based on median troposcatter loss for a continental temperate climate (refer to Recommendation P.617-1).

In this above calculation of L, a notional transmitter is assumed to be located in the geographic area of the SL at a point on each radial 48 km inside the boundary. The notional site height for these transmitters is 350 metres and the notional antenna height above ground is 30 metres.

If coordination fails: If the receiver fails coordination under the method above, the licence applicant may wish to make their own assessment of the risk involved in operating the receiver close to the SL boundary (refer section 2.1.2 of this appendix). Should the applicant wish to proceed with the assignment **advisory note FA** must be applied to the spectrum access record. The text for Advisory Note FA can be found on the previous page of this appendix.

5.2 Coordination across the frequency boundary - 2.1 and 2.2 GHz Bands

2.1 and 2.2 GHz AL fixed stations sited within SL areas but outside the SL frequency bands must be coordinated as described in this section. AL fixed stations in close proximity to SL boundaries should also pay regard to protection of and interference from SL devices.

5.2.1 Adjacent band - Apparatus licence transmitter located in a spectrum licensed area

If an AL transmitter is proposed for operation in a spectrum licensed area it must be coordinated with all registered SL receivers in the frequency ranges shown in Table 5.2, in accordance with RAG-ALTX-2GHz.

Spectrum Licence Area	Frequency range
Adelaide, Brisbane, Darwin, Hobart, Melbourne, Perth and Sydney	1900-1980 and 2110-2170 MHz
Canberra	1900-1920, 1935-1980 and 2125-2170 MHz
Regional areas	1960-1980 and 2150-2170 MHz

Table 5.2: 2 GHz Spectrum Licence frequency ranges

Protection for SL receivers is provided to the levels required by the notional SL receiver specified in schedule 1 of RAG-ALTX-2GHz. (Refer also to clause 2.2; to part 4; and to schedule 2; of RAG-ALTX-2GHz). AL transmitters must comply with the emission criteria requirements specified in Part 3.2.3 and Appendix 3 of RALI FX 3.

5.2.2 Adjacent band - Apparatus licence receiver located in a spectrum licensed area

If an AL receiver is proposed for operation in a spectrum licensed area it must be coordinated with all registered SL transmitters in the frequency ranges shown in Table 5.2, in accordance with clause 2.6 of RAG-ALRX-2GHz.

6 Additional Device Boundary Requirement - 2.1 GHz Band transmitters

The additional device boundary requirement follows a method very similar to that detailed in s145 determination-2GHz, with a replaced device boundary criteria and propagation model. The new propagation model accounts for diffraction and terrain profiles.

The additional device boundary is calculated according to the distance that is necessary to satisfy the following device boundary criterion. This distance is measured along radials of a maximum length of 150 minutes (measured by reference to the Australian National Spheroid) at every 2.5 degrees of arc (beginning at 1.25 degrees from True North) and centred on the transmitter location. However, this additional criterion does not have to be satisfied if:

- (a) the licensee has an agreement with the licensee(s) of a spectrum licence whose geographic area is intersected by the radials and whose frequency band contains the effective occupied bandwidth of the transmitter, to operate transmitters that do not comply with the additional device boundary criterion; or
- (b) in the case of a transmitter operating under an apparatus licence, the licence was issued before the date of issue of the *Radiocommunications Spectrum Marketing Plan (2 GHz Bands) 2000*.

The device boundary criterion is:

$$(\text{HRP} - \text{Lb} - \text{CR}) \leq 0;$$

where HRP = Horizontally Radiated Power; and
 Lb = Propagation Loss; and
 CR = Compatibility Requirement for a notional receiver.

Calculation of Horizontally Radiated Power (HRP)

HRP (dBm EIRP per 30 kHz) is the horizontally radiated power for each radial. Note that there is a cap on HRP of 55 dBm EIRP per 30 kHz for transmitters operating under spectrum licences.

High Site-High Site Propagation Model (Lb)

The propagation loss for a high site-high site transmit-receive path (Lb) may be worked out in accordance with the general method for estimating diffraction loss described in ITU-R Recommendation P.526 using a path profile derived from the ACA's digital elevation model (RadDEM terrain data) and an effective earth radius factor of $4/3$, or some other appropriate method.

The path profile may be obtained by calculating equi-spaced (in degrees) locations every 9 seconds along the radial from the transmitter site, reading the elevation of the RadDEM cell in which each calculated location occurs.

[Note: Path profiles may also be obtained by bi-linear interpolation]

The notional receiver antenna height above ground is 30 metres.

The procedure of ITU-R Recommendation P.526 for calculating propagation loss is unusually complex and licensees should exercise particular care when establishing whether a particular service might meet the compatibility requirements under these guidelines. Licensees would be well advised to confirm results calculated under the guidelines before taking any decisions in relation to proposed services.

Compatibility Requirement

The level of protection for notional receivers (typically a base station) is -126 dBm/30 kHz. The Notional antenna for a fixed receiver has a total gain of 19 dBi in all directions, including feeder losses.

APPENDIX 8 : Coordination of DRCS Outstations with Point-to-Point Links

1.1 INTRODUCTION.....	2
1.2 DRCS NETWORK TOPOLOGY	2
1.3 DRCS CELL PLAN AND INTRA-SYSTEM COORDINATION.....	3
1.4 INTERFERENCE POTENTIAL TO/FROM POINT-TO-POINT LINKS	3
1.5 METHODOLOGY	3
<i>1.5.1 Interference from a point-to-point link transmitter to a DRCS outstation receiver</i>	<i>4</i>
<i>1.5.2 Interference from a DRCS outstation transmitter to a point-to-point link receiver</i>	<i>4</i>
1.6 DETAILED COORDINATION	4

Annex A 1.5 GHz DRCS OUTSTATION CHARACTERISTICS

1.1 Introduction

This document provides information and guidance for the coordination between 1.5 GHz Digital Radio Concentrator System (DRCS) point-to-multipoint services and point-to-point systems. As outlined in Part 3 of RALI FX-3, DRCS systems provide public telecommunication services in rural and remote areas. The majority of Australian DRCS rural telephony networks utilise the 1.5 GHz (1427-1535 MHz) DRCS band, although in some areas 500 MHz¹ and “hybrid” 500/1500 MHz systems may also operate. Spectrum within the band 1427-1535 MHz² is shared between DRCS and regular point-to-point fixed services and, in accordance with the (Appendix 1) RF Channel Arrangements, separate but overlaid arrangements are specified for point-to-point and DRCS multipoint systems.

Given the inherent spectrum denial of DRCS hub stations (due to omnidirectional antennas) and the unpredictable nature of potential interference between point-to-point links and uncoordinated DRCS outstations, the deployment of 1.5 GHz point-to-multipoint systems is not normally permitted within designated HSDA. Operation in other areas with high point-to-point link densities should also be avoided. All applications seeking point-to-multipoint operation within the band 1427-1535 MHz and which encroach upon designated HSDA must be referred to the Manager, Spectrum Planning Team, Spectrum Planning and Standards Group for policy advice.

1.2 DRCS Network Topology

The DRCS is essentially a low-traffic density wireless local loop system, providing radio based customer access network connections between a population of customer units and a parent telephone exchange (TDM Concentrator).

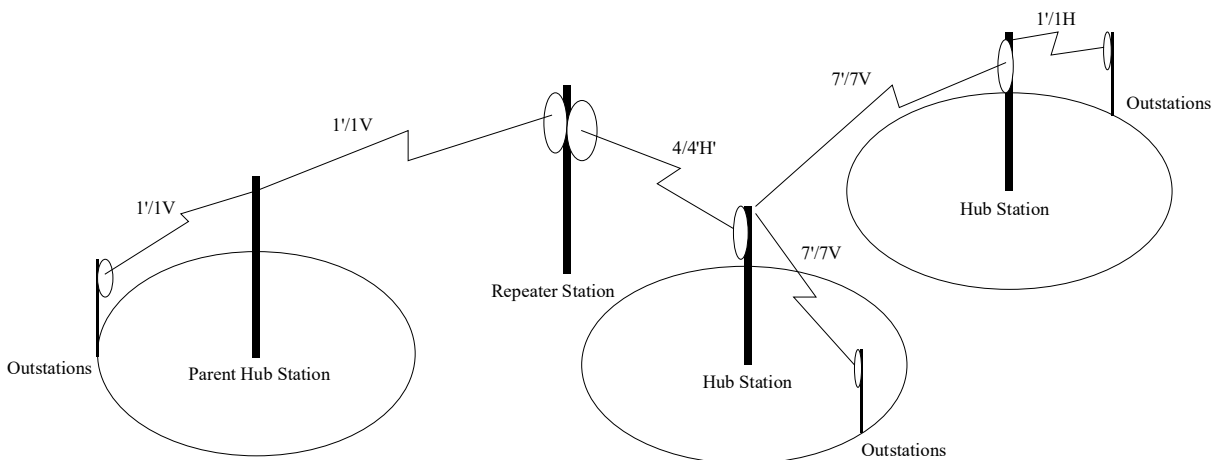


Fig. 8.1 An arbitrary example of a small DRCS network.

A DRCS hub station utilises an omnidirectional antenna to communicate with a population of outstations (ie. customer terminals) and where necessary to the next hub/repeater station. A hub/repeater station receives the downward (ie. originating from the parent exchange) transmission and, following baseband regeneration, re-transmits this signal on another frequency through an omnidirectional antenna to customers and to any subsequent hub/repeater stations. Hub stations may be daisy-chained in this manner enabling a service area of hundreds of kilometres to be covered from the single parent switching centre. Customer stations are fitted with directional

¹ 500 MHz coordination arrangements are different and are detailed in "Radiocommunication Advisory Guidelines (Coordinating the operation of transmitters in the 500 MHz bands)"

² Note: The operation of DRCS and other 1.5 GHz radiocommunication services is subject to the provisions of the "1.5 GHz Band Plan", December 1996.

antennas, typically grid reflector or grid parabolic types depending upon the required system gain. The downward transmissions follow a continuous (TDM) RF carrier format, but the outstations (ie. upward transmissions to the parent exchange) operate in burst mode (TDMA). Further discussion regarding the general characteristics of radio concentrator systems is given in ITU-R Recommendation F.756 "*TDMA Point-to-Multipoint Systems Used as Radio Concentrators*".

1.3 DRCS Cell Plan and Intra-system Coordination

DRCS networks are designed to facilitate frequency re-use based on a cellular frequency plan. Accordingly, protection from intrasystem interference is principally afforded through geographic separation inherent to the DRCS cell plan, where each hub station is allocated a channel which results in acceptable co-channel and adjacent channel interference from other DRCS sites.

1.4 Interference Potential to/from Point-to-Point links

DRCS backbone repeaters and hub stations comprise a fixed network and may be coordinated using the information recorded in the ACA's RADCOM assignment database and regular (eg. RALI FX-3 Part 4) coordination methodologies. However, DRCS customer station numbers and locations are dynamic and (of necessity) must be managed on an operational basis. Consequently, DRCS outstations operating in rural and remote areas are not individually coordinated and records are not normally maintained in the ACA assignment database for such outstations.

The uncoordinated customer outstations around the DRCS parent and repeater hub stations represent a potential interference risk with respect to frequency sharing with regular point-to-point links. Since DRCS networks are normally confined to rural and remote areas where demand for point-to-point links is relatively modest, that risk is considered small and frequency coordination with non-DRCS point-to-point links does not normally represent a significant problem. Nevertheless, situations may arise where potential interference to/from outstations needs to be taken into account. The following sections define a coordination model and procedures for the assessment of interference between DRCS customer outstations and point-to-point fixed services.

1.5 Methodology

In cases where 1.5 GHz point-to-point links need to be coordinated with DRCS point-to-multipoint service outstations, for which detailed coordination data (ie. geographic coordinates & antenna type/azimuth) is unavailable, the following coordination model & methodology may be used. For outstation frequency coordination purposes:

- a minimum coordination radius of 200 km is defined for each corresponding hub station;
- a notional customer outstation, representative of all of the customer outstations within the service area of a particular hubstation, is assumed to be collocated with the hubstation.
- a notional hubstation to outstation path length of 35 km may be assumed; and
- unless otherwise determined, boresight azimuth may be assumed for the outstation antenna in relation to potential interference path(s). Outstation antenna RPE and detailed equipment parameters are provided in Annex A to this document.

In all other respects the methodology is consistent with the basic method of coordination (ref. Part 4 of RALI FX-3) and the application of the co / adjacent channel protection ratios given in the (Attachment 1) assignment instructions. Accordingly, an outstation interference assessment that

satisfies coordination at the hubstation location is deemed to satisfy the coordination requirements of the population of outstations serviced by that hubstation.

1.5.1 Interference from a point-to-point link transmitter to a DRCS outstation receiver

1. Determine the receive frequencies of co / adjacent channel DRCS outstations, noting that outstation receive frequencies correspond to the associated hubstation transmit frequencies (ie. all hubstation are coordinated and their details recorded in the ACA assignment database);
2. Search within 200 km of the proposed point-to-point link transmitter for the locations of any DRCS hubstations³ operating on the frequencies determined in Step 1;
3. Applying the basic method of coordination described in Part 4 of RALI FX-3 and the outstation model criteria defined in this Appendix, determine whether the interference from the proposed point-to-point link(s) to the notional outstation located at the hubstation location is acceptable;

1.5.2 Interference from a DRCS outstation transmitter to a point-to-point link receiver

1. Determine the transmitting frequencies of any co / adjacent channel DRCS outstations, noting that outstation transmit frequencies correspond to hubstation receive frequencies;
2. Search within 200 km of the proposed point-to-point system receiver for the locations of any DRCS hubstations³ receiving on frequencies determined in Step 1;
3. Applying the basic method of frequency coordination and the outstation model criteria described in this Appendix, determine whether the interference from the notional outstation transmitter located at the hubstation location is acceptable at the proposed point-to-point link receiver location.

1.6 Detailed Coordination

Situations may arise where the above procedure may not yield a sufficient degree of confidence. In such cases additional information concerning particular outstation locations/criteria may be sought from the DRCS system licensee.

³ Hubstations may be identified in the ACA assignment database using the antenna type field - hubstation omnidirectional antennas are designated "U", with repeater network sections using parabolic ("MP") antennas.

ANNEX A TO APPENDIX 8: 1.5 GHz DRCS Outstation Characteristics

This annex to Appendix 8 of the RALI FX-3 provides information intended for use in DRCS (customer) outstation coordination with 1.5 GHz point-to-point links. In cases where specific outstation equipment characteristics and antenna characteristics are not available, the following equipment and antenna parameters are to be used.

Modulation	4 QAM
Capacity	2 Mb/s
Channel spacing	2 MHz
Feeder loss	2 dB
Max Tx output power	+30 dBm
Receiver IF bandwidth	1.5 MHz
Receiver noise figure	3.5 dB
Rx input level for BER= 10^{-3}	-93 dBm
Antenna type	0.8 m grid
Antenna half power beamwidth	13 degrees
On-axis gain	20.3 dBi

Table 1. 1.5 GHz DRCS outstation equipment characteristics

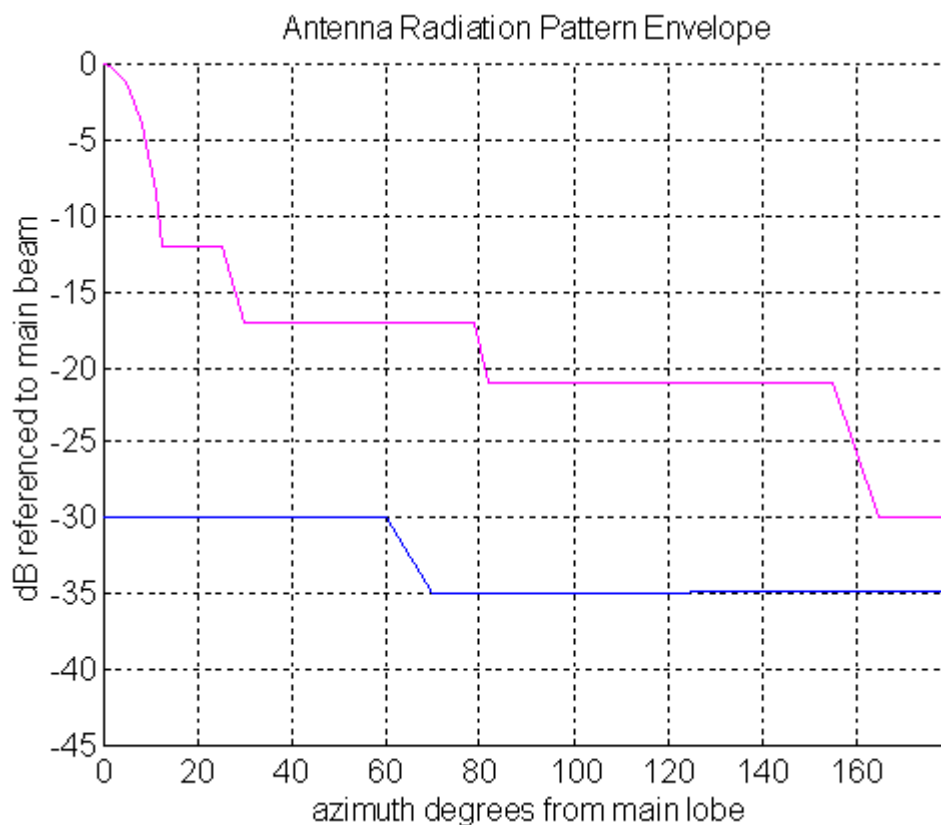


Figure 1. DRCS outstation¹ antenna RPE

¹ NOTE: Individual outstations may and often do employ antennas different to that described in this Annex. However, where specific antenna data is unavailable, the RPE described in this Annex should be used.

APPENDIX 9 : Adaptive Transmit Power Control

1	INTRODUCTION.....	2
2	ATPC POWER LEVEL DEFINITIONS.....	3
3	CONSTRAINTS ON THE USE OF ATPC	4
4	COORDINATION AND LICENSING OF LINKS USING ATPC	6
4.1	No COORDINATION ADVANTAGE CLAIMED.....	6
4.2	COORDINATION ADVANTAGE CLAIMED.....	6
5	ATPC AND INTERSERVICE COORDINATION	7

Annex:

- A.** *“ATPC Example Calculations”.*

1 Introduction

Adaptive Transmit Power Control (ATPC) is a feedback control system¹ which temporarily increases transmitter output power during periods of fading, thus eliminating or at least reducing the adverse effects of fade events on digital point-to-point microwave fixed services. ATPC offers immediate and long term advantages to the link operator including reduced average power consumption, extended equipment MTBF and lower long term RF interference levels.

Under the arrangements detailed in this document² and subject to certain limitations, systems fitted with ATPC may also provide a coordination advantage over systems without this facility.

Propagation statistics indicate that fade events on physically different propagation paths are non-correlated, thus the probability of simultaneous sensitivity to interference for two separate systems is small, at least for situations where multipath fading is the dominant limiting factor. As long as link paths are properly designed with adequate path clearance and are not significantly affected by rain fade events, the ATPC maximum transmit power boost is required only for appropriately short periods of time (with annual limits as detailed in Figure 1) and:

- a transmit power less than the maximum power may be used for the calculation of interference into other systems; and
- the calculation of interference into the receiver of a system using ATPC may assume that the wanted signal transmitter is operating at maximum transmit power.

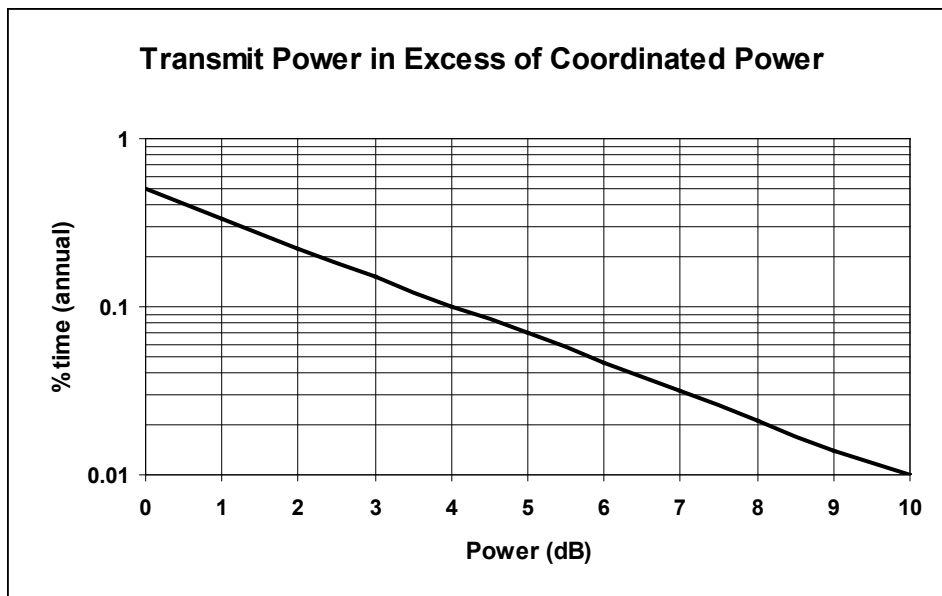


Fig. 1: Permitted Time Above Coordinated Transmit Power for ATPC Systems

¹ A feature fitted to an increasing proportion of digital fixed service equipment. For basic principles and application, refer to chapters 4.3.4 and 5.3.5.2 of ITU-R "Digital Radio Relay Systems" Handbook, Geneva 1996.

² Consistent with (US) Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin TSB10-F, June 1994.

Consequently, the use of ATPC can facilitate tighter intra-service frequency coordination, an important consideration in congested areas. The following sections detail regulatory criteria and limitations on the use of ATPC by microwave fixed services.

2 ATPC Power Level Definitions

Table 1 defines criteria for the coordination of microwave fixed services using ATPC.

Level	Definition	Limits
$P_{t_{max}}$	<i>The maximum transmit power that will not be exceeded at any time, used for fade margin and path reliability (outage) computations; and for calculating the C/I into an ATPC receiver.</i>	$\leq +43$ dBm (1 GHz < 10 GHz) $\leq +40$ dBm (> 10 GHz) See Part 3.2.2 of the RALI FX 3.
$P_{t_{coord}}$	<i>The coordinated transmit power selected by the ATPC system licensee as the power to be used in calculating interference into a victim receiver.</i>	Between 0 to 10 dB below $P_{t_{max}}$;
$P_{t_{nom}}$	<i>The nominal transmit power level at or below the coordinated power at which the system will operate in normal (unfaded) conditions.</i>	$\leq P_{t_{coord}}$.
$P_{r_{norm}}$	<i>Normal (unfaded) ATPC link receive level.</i>	As designed with adequate link availability.
$P_{r_{trig}}$	<i>The receive level at which ATPC is activated - ie. ATPC Trigger Level.</i>	At least 10 dB below $P_{r_{norm}}$

Table 1. ATPC Power Level Definitions and Limits.

3 Constraints on the use of ATPC

ATPC is a desirable equipment feature and in general there is no restriction on the deployment of systems fitted with ATPC. However, system planners and frequency assigners must note that an ATPC coordination advantage can only be claimed against other microwave fixed services if all of the following criteria are satisfied:

1. the system being coordinated is a compliant ATPC system operating in a band below 12.2 GHz. *(Systems operating above 12.2 GHz may still make use of ATPC, but no coordination advantage may be claimed and for coordination purposes, $P_{t_{coord}} = P_{t_{max}}$)*³; and
2. the ATPC system operational parameters must be consistent with the criteria and limits defined in Table 1 (see paragraph 1.2); and
3. full path clearance (0.6 of the first fresnel zone for the worst month) exists over the ATPC system transmission path. *(Systems operating over propagation paths that do not meet this criteria can still make use of ATPC, but no coordination advantage may be claimed and for coordination purposes $P_{t_{coord}} = P_{t_{max}}$);* and
4. propagation reliability calculations, based on ITU-R Recommendation P.530 (see 4.1 of Appendix 4 to RALI FX 3), demonstrate that the expected annual time percentages for path fading do not exceed the limits specified in Table 2; and
5. ATPC power increases are triggered on the basis of propagation (ie. path fading). Interference or error correcting information alone is not sufficient justification for increasing transmit power, but either or both may be used as an additional criterion; and
6. the ATPC system must not remain at $P_{t_{max}}$ for more than five consecutive minutes at a time. Any event which exceeds this criterion must be treated as an alarm condition which automatically returns the transmit power back to $P_{t_{coord}}$. ATPC should not be reenabled until the reason for the problem has been established and corrected; and
7. if an ATPC system is fitted with space diversity, the ATPC control signal must be derived from the strongest signal of the diversity system where baseband switching is used. For systems employing IF (Intermediate Frequency) combiners, the ATPC control signal is derived from the combined signal of the diversity system. In calculating percentages of time above $P_{t_{coord}}$, the space diversity improvement factor may be found to be less than unity if the fade depth is small. In this case, the space diversity improvement factor must be assumed as unity (no improvement or penalty).

If all of the above constraints are satisfied, then an effective coordination advantage (equal to $P_{t_{max}} - P_{t_{coord}}$) of up to a maximum of 10 dB may be claimed in coordination against other terrestrial microwave fixed services - ie. interference calculations from an ATPC system may assume the lower coordinated $P_{t_{coord}}$ transmit power level. Conversely, interference and fade margin calculations into the receiver of an ATPC equipped system can then assume that the maximum $P_{t_{max}}$ transmit power level is in use over the wanted signal path.

Note: An ATPC coordination advantage can only be claimed for intra-service coordination against other microwave fixed services (refer to Section 5 of this document).

³ The impact of rain rates and duration on interference events is subject to further studies.

Power above $P_{t_{\text{coord}}}$ (dB)	Permitted time %	(annual) seconds/ year
(\leq) 0.0	100	31536000
(>) 0.0	0.50	157500
1	0.33	103950
2	0.22	69300
3	0.15	47250
4	0.10	31500
5	0.07	22050
6	0.047	14805
7	0.032	10080
8	0.021	6615
9	0.014	4410
10	0.010	3150

Table 2. Time Permitted Above the Coordinated Transmit Power in an ATPC Link

Table 2 shows the permitted time percentages and annual power boost times for ramp type ATPC systems. For step type systems, only single values (eg. +6dB, +10 dB) need be considered.

4 Coordination and Licensing of Links Using ATPC

An applicant must clearly indicate on their licence application that ATPC is to be used and the type of ATPC (ramp or step) described. The coordination and licensing procedure must take account of whether or not a coordination advantage is being claimed for ATPC.

4.1 No Coordination Advantage Claimed

If no coordination advantage is claimed for an ATPC system, the Coordinated Transmit Power ($P_{t_{\text{coord}}}$) is deemed to equal the ATPC Maximum Transmit Power ($P_{t_{\text{max}}}$) and no special account needs to be taken in the coordination and licensing context.

4.2 Coordination Advantage Claimed

Where a coordination advantage is claimed for a proposed new link, the frequency assigner must be satisfied that compliance is demonstrated against all of the criteria specified in sections 2 and 3 of this document. Where an assigner is unable to verify compliance with all relevant criteria, no coordination advantage can be allowed unless the system licensee or their authorised agent furnishes a written statement certifying compliance.

The spectrum access record⁴ of a system for which a coordination advantage is approved should clearly indicate that ATPC is being used and must be endorsed with:

1. Special Condition FB which states, '*The licensed transmitter power may be exceeded for short periods of time but must not exceed the limits specified in Appendix 9 of the RALI FX 3 'Microwave Fixed Services Frequency Coordination'.*' and
2. Advisory Note FC which states, '*This microwave fixed service uses Adaptive Transmit Power Control (ATPC) in accordance with the provisions of Appendix 9 of the RALI FX 3 'Microwave Fixed Services Frequency Coordination'.*' "

The coordination procedure for an ATPC system is the same as for systems without ATPC and consistent with Part 4 of the RALI FX 3. However, for the purposes of calculating:

- the wanted signal receive levels (Part 4.2.2 of RALI FX 3) into an ATPC system, P_t (the wanted signal transmit power) is deemed to equal the maximum available ATPC power ($P_{t_{\text{max}}}$); and
- the interference levels from an ATPC transmitter undergoing coordination against other systems, the ATPC transmit power is deemed to equal the coordinated transmit power ($P_{t_{\text{coord}}}$).

An essential requirement, consistent with section 3(4) of this document, is that propagation reliability calculations for the ATPC system must demonstrate that the expected annual time percentages for the wanted signal path fading do not exceed the limits specified in Table 2. Time percentages can be calculated using the relevant reliability prediction algorithms provided in ITU-R Recommendation P.530 (see section 4.1 of Appendix 4 of RALI FX 3). Reliability calculations are performed using the fade margin found as the difference between the receive signal level under the maximum available ATPC power ($P_{t_{\text{max}}}$), and the receiver threshold.

- For an ATPC system which steps (switches) to a single higher transmit power level, only a single calculation of the time that the fade depth to the ATPC Trigger Level ($P_{t_{\text{trig}}}$) is exceeded is necessary.

⁴ The current ACA licensing database does not support a specific ATPC identifier field.

- For a continuous (ramp) type ATPC system, calculations of the time that ($P_{t_{\text{coord}}}$) is exceeded and the time that ($P_{t_{\text{max}}}$) is reached are sufficient.

Future ATPC implementations that rely on different algorithms may require time percentage calculations for the entire range of transmit powers in excess of ($P_{t_{\text{coord}}}$). Example calculations of ATPC time above Coordinated Transmit Power are provided in Annex A to this document.

5 ATPC and Interservice Coordination

Interference events and their duration to/ from other (especially non-terrestrial) services may not be de-correlated in the same manner as the homogenous fixed service⁵. Accordingly, an ATPC coordination advantage cannot be claimed when calculating interference levels to/ from ATPC links against other (non fixed) radiocommunication services.

For the purposes of interservice coordination and the calculation of:

- the wanted signal receive levels (Part 4.2.2 of RALI FX 3) in an ATPC system, P_t (the wanted signal transmit power) is deemed to equal the Coordinated Transmit Power ($P_{t_{\text{coord}}}$); and
- the interference levels from an ATPC transmitter undergoing coordination against other (non-fixed) radiocommunication services, the ATPC system transmit power is deemed to equal the Maximum Transmit Power ($P_{t_{\text{max}}}$).

Note: In the absence of internationally accepted standards for ATPC, the arrangements detailed in this document are based on and generally consistent with Section 4.3 of (US) Telecommunications Industry Association (TIA) Telecommunications Systems Bulletin TSB10-F, June 1994. The ACA may consider other recognised standards in the future and detailed proposals may be forwarded to the Manager, Spectrum Planning Team, ACA, for consideration.

⁵ Refer to ITU-R Recommendation F.758 "Considerations in the Development of Criteria for Sharing Between the Terrestrial Fixed Service and Other Services".

ANNEX A TO APPENDIX 9: ATPC EXAMPLE CALCULATIONS

This document provides example calculations for the determination of Adaptive Transmit Power Control (ATPC) operating parameters in cases where an ATPC coordination advantage is to be claimed (see Section 4.2 of Appendix 9 “*Adaptive Transmit Power Control*” of the RALI FX 3).

Examples of determining the operating parameters, i.e., Receive Signal Level (RSL), Transmit Power versus Net Path Loss (NPL), Coordinated Transmit Power (P_{coord}) and fraction of time spent at a given transmit power are given, with and without space diversity. Operating parameters and calculations given in the examples are based on:

- an arbitrary 6.7 GHz long-haul high capacity system. However, through appropriate substitution, calculations can be performed for other system types;
- an assumed design NPL of 65 dB;
- a four segment ATPC transfer function (see Fig.1). Other ATPC transfer functions can be adapted by redefining the step boundaries;
- an ATPC algorithm driven by RSL, evaluated in a narrow spectrum around the carrier frequency;
- fade depth probability calculations given in ITU-R Recommendation P.530-7, §2.3 “*Fading and enhancement due to multipath and related mechanisms*”; and
- space diversity improvement factor taken from ITU-R Recommendation P.530-7, §6.2.1 “*Diversity techniques in analogue systems*”, since this method is appropriate for cases where signal is confined to a relatively narrow spectrum.

ATPC (example) Transfer Function

$$P_t = \begin{cases} P_{t_{\min}} , & NPL < BP_1 \\ P_{t_{\min}} + s_1(NPL - BP_1), & BP_1 \leq NPL < BP_2 \\ P_{t_{\min}} + s_1(BP_2 - BP_1) + s_2(NPL - BP_2), & BP_2 \leq NPL < BP_3 \\ P_{t_{\max}} , & NPL \geq BP_3 \end{cases}$$

Where:

$P_{t_{\min}}$	= +17 dBm	{ minimum transmit power }
$P_{t_{\max}}$	= +37 dBm	{ maximum transmit power }
BP_1	= 45 dB	{ 1 st transfer function break point }
BP_2	= 84 dB	{ 2 nd transfer function break point }
BP_3	= 94 dB	{ 3 rd transfer function break point }
s_1	= 1/4	{ transfer function proportionality constant }
s_2	= 1	{ second proportionality constant }

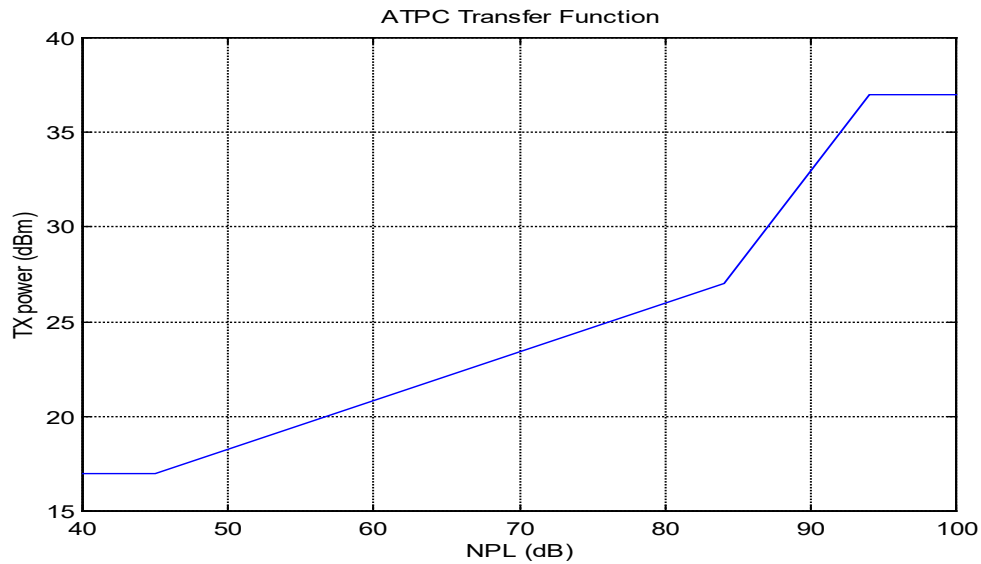


Figure 1 ATPC example (RSL vs Transmit Power) transfer function

Calculation Procedure

A step-by-step procedure for manual calculations is given below. Using a spreadsheet, and built-in optimization or iterative functions, the entire process can be automated. The parameters and derivations used in the following examples are defined in ITU-R Recommendation P.530-7; Table 1 lists the values assigned to these parameters in the following examples.

- 1 - Determine the geoclimatic factor K (§2.3.1.1).
- 2 - Calculate the path inclination $|\epsilon_p|$ §2.3.1.2.
- 3 - Calculate the percentage of time p_w that fade depth of 35 dB is exceeded in the average worst month (§2.3.1.3).
- 4 - Determine the value of q_a (§2.3.2) using equations (21), (22), and (24).
- 5 - Find the fade depth A_c , with the probability $p_w = 0.5$ from (1).

$$A_c = -\frac{20}{q_a} \cdot \log \left[-\ln \left(1 - \frac{p_w}{100} \right) \right] \quad (1)$$

Here, A_c , in dB, is the path loss in addition to the nominal NPL due to fading, that would be experienced for 0.5 % of the time. Net Path Loss now becomes NPL_c , calculated from (2).

$$NPL_c = NPL + A_c \quad (2)$$

6 - From the ATPC transfer function, (3), calculate the Transmit Power level P_t , corresponding to NPL_c .

$$P_t = \begin{cases} P_{\min} , & NPL < BP_1 \\ P_{\min} + s_1(NPL - BP_1), & BP_1 \leq NPL < BP_2 \\ P_{\min} + s_1(BP_2 - BP_1) + s_2(NPL - BP_2), & BP_2 \leq NPL < BP_3 \\ P_{\max} , & NPL \geq BP_3 \end{cases} \quad (3)$$

This would be initial value for the Coordinated Power, P_c .

7 - Find the depth of fade, ΔF corresponding to the Maximum Transmit Power P_{\max} , at BP_3 . This value will be used to verify that the percentage of time permitted above the Coordinated Transmit Power level is met.

$$\Delta F = BP_3 - NPL \quad (4)$$

8 - Calculate the probability $p_{\Delta F}$ of a fade at the depth of ΔF dB from (5).

$$p_{\Delta F} = 100 \cdot \left[1 - \exp\left(-10^{-q_a \cdot \Delta F / 20}\right) \right] \quad (5)$$

9 - Determine the difference ΔP , between the Maximum Power P_{\max} , and the Coordinated Power P_c .

$$\Delta P = P_{\max} - P_c \quad (6)$$

10 - Check from Appendix 9 (Table 2, Part 3) to see if the percentage of time permitted at ΔP dB above Coordinated Power is equal or greater than $p_{\Delta F}$. If this requirement is not met, increase P_c by a suitable increment, (e.g., 0.5 dB), and repeat step 9 until the requirement is met.

11 - Using the final values obtained for the Coordinated Power P_c , and ΔF , the level of the Maximum Transmit Power P_{\max} above Coordinated Power, recalculate the percentage of time these values would be experienced by applying (7).

$$p_X = 100 \cdot \left[1 - \exp\left(-10^{-q_a \cdot X / 20}\right) \right] \quad (7)$$

Note: Intermediate values can be found by logarithmic interpolation between the steps of Appendix 9, Table 2 (ie. per Figure 1 “Permitted time above Coordinated Power for ATPC systems”).

parameter	definition	value	notes
C_0	<i>coefficient in definition of K</i>	4.2	<i>value selected applicable to Australia</i>
ξ	<i>latitude</i>	<40	<i>value selected applicable to Australia</i>
C_{Lat}	<i>coefficient in definition of K</i>	0	<i>value selected applicable to Australia</i>
C_{Lon}	<i>coefficient in definition of K</i>	0	<i>value selected applicable to Australia</i>
p_L	<i>climatic variable</i>	25	<i>worst case applicable to Australia</i>
ε_p	<i>path inclination</i>	1	<i>assumed worst case</i>
d	<i>path length</i>	25 / 50	<i>without / with, space diversity</i>
f	<i>frequency</i>	6.7	
S	<i>vertical separation of antennas</i>	10	<i>typical</i>
V	<i>gain difference between antennas</i>	1	<i>Typical</i>

Table 1: Geoclimatic and path parameters for example cases.

Examples

A. Without Space Diversity

Figure 2 shows the characteristics of a high capacity digital ATPC system without space diversity. Calculation results of from each step are given below.

- | | |
|---------------------------------------------------|-------------------------------|
| 1 - $K = 2.38 \cdot 10^{-5}$. | 6 - $P_c = 30.5$ dBm. |
| 2 - Worst case assumed as $ \varepsilon_p = 1$. | 7 - $\Delta F = 29$ dB |
| 3 - $p_w = 2.44 \cdot 10^{-3}\%$. | 8 - $p_{\Delta F} = 0.1069\%$ |
| 4 - $q_a = 2.05$. | 9 - $\Delta P = 6.5$ dB |
| 5 - $A_c = 22.5$ dB | |
| $NPL_c = 65 + 22.5 = 87.5$ dB. | |

10 - The time allowed at 6.5 dB above the Coordinated Power is 0.0376%, showing that the requirement is not met. By incrementing P_c in 0.5 dB steps, it is found that at $P_c = 33.5$ dBm, ΔP value obtained in step 9 becomes 3.5 dB with the time allowed being 0.1242% from the table. Since this is greater than $p_{\Delta F} = 0.1069\%$, in step 8, the requirement has been met.

- 11 - Thus a Transmit Power level of 33.5 dB can be used for interference calculations.
 Note: With an increment of 0.1 dB, it is found that a Coordinated Power level of 33.1 dBm would satisfy the requirements. See Figure 3.

B. With Space Diversity

Figure 4 shows the characteristics of a high capacity digital ATPC system with space diversity. Calculations results from each step are given below.

- | | |
|---------------------------------------------------|-------------------------------|
| 1 - $K = 2.38 \cdot 10^{-5}$. | 6 - $P_c = 25.7$ dBm. |
| 2 - Worst case assumed as $ \varepsilon_p = 1$. | 7 - $\Delta F = 29$ dB |
| 3 - $p_w = 2.96 \cdot 10^{-2}\%$. | 8 - $p_{\Delta F} = 0.0042\%$ |
| 4 - $q_a = 1.43$. | 9 - $\Delta P = 11.3$ dB |
| 5 - $A_c = 13.9$ dB | |
| $NPL_c = 65 + 13.9 = 78.9$ dB. | |

10 - The time at 11.3 dB above the Coordinated Power is 0.0042% (see Figure 5). However, (in accordance with Table 2 of Appendix 9) ΔP may not exceed 10 dB.

11 - Thus it is necessary to either recalculate for a P_c with $\Delta P \leq 10$ dB or for a P_{max} that meets the criteria. Further calculations show that a P_c of +25.7 dBm can still be used for interference calculations, provided that P_{max} is limited to +35.7 dBm.

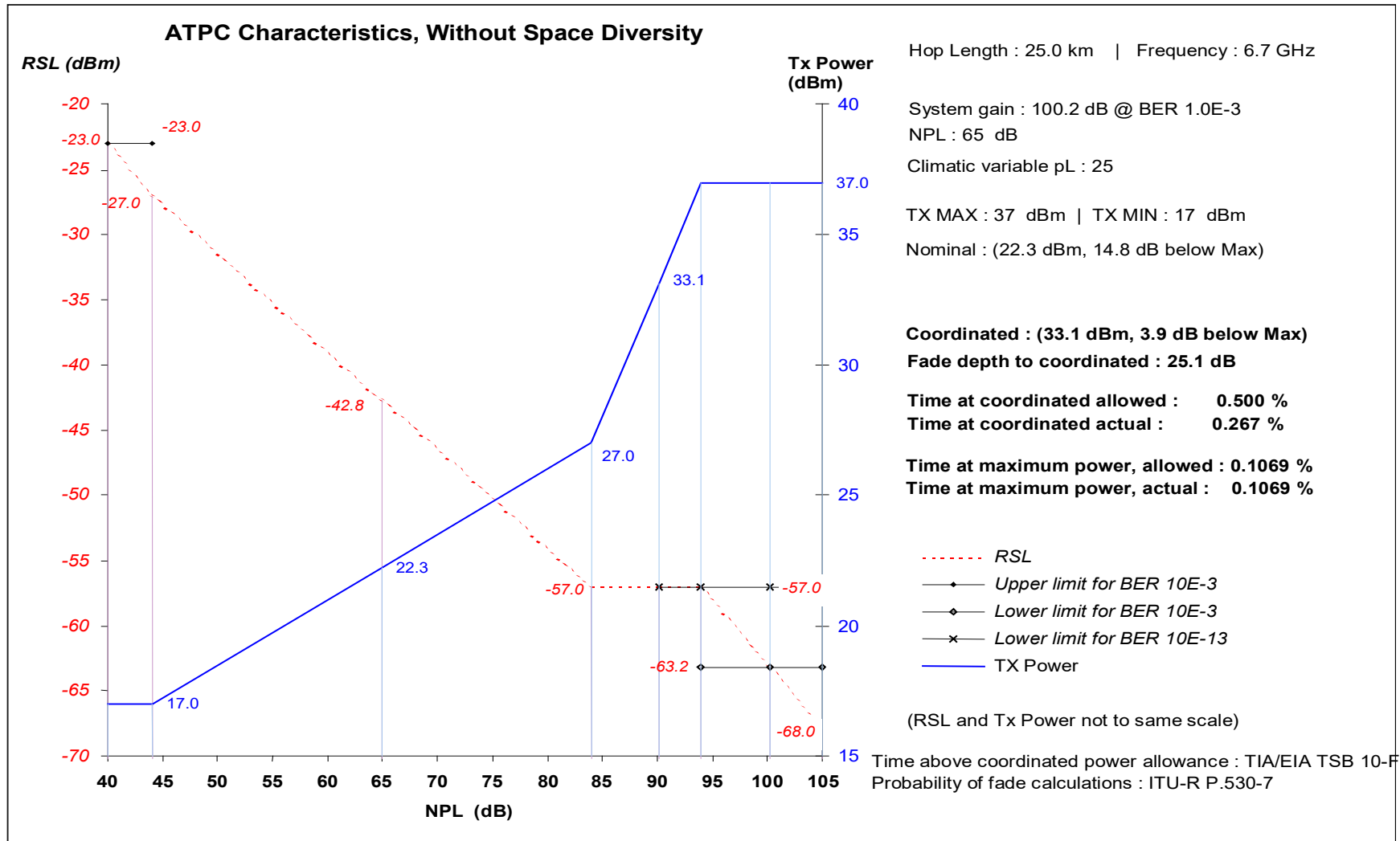


Figure 2: ATPC Characteristics, without Space Diversity for 25 km hop

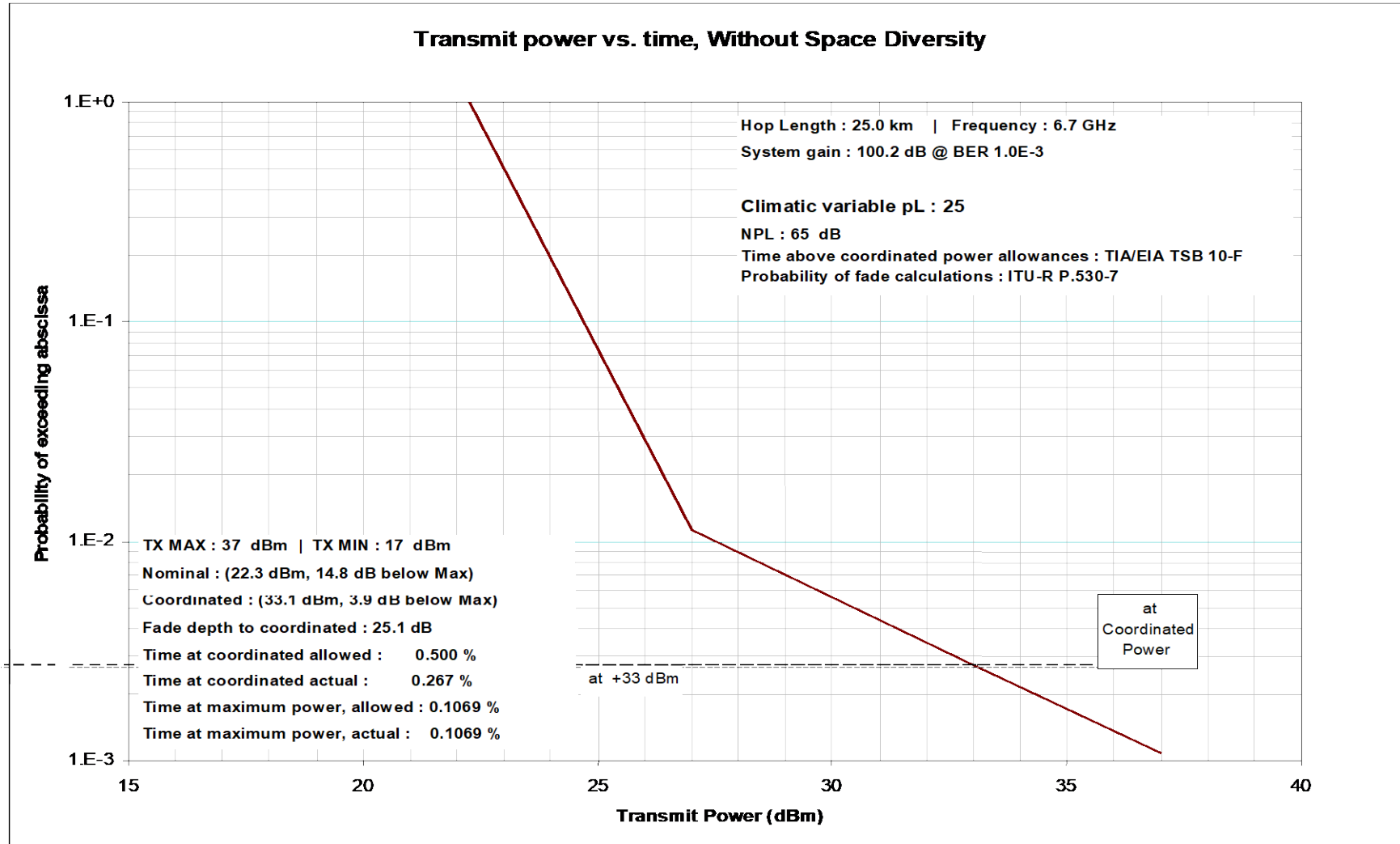


Figure 3: ATPC Characteristics, without Space Diversity

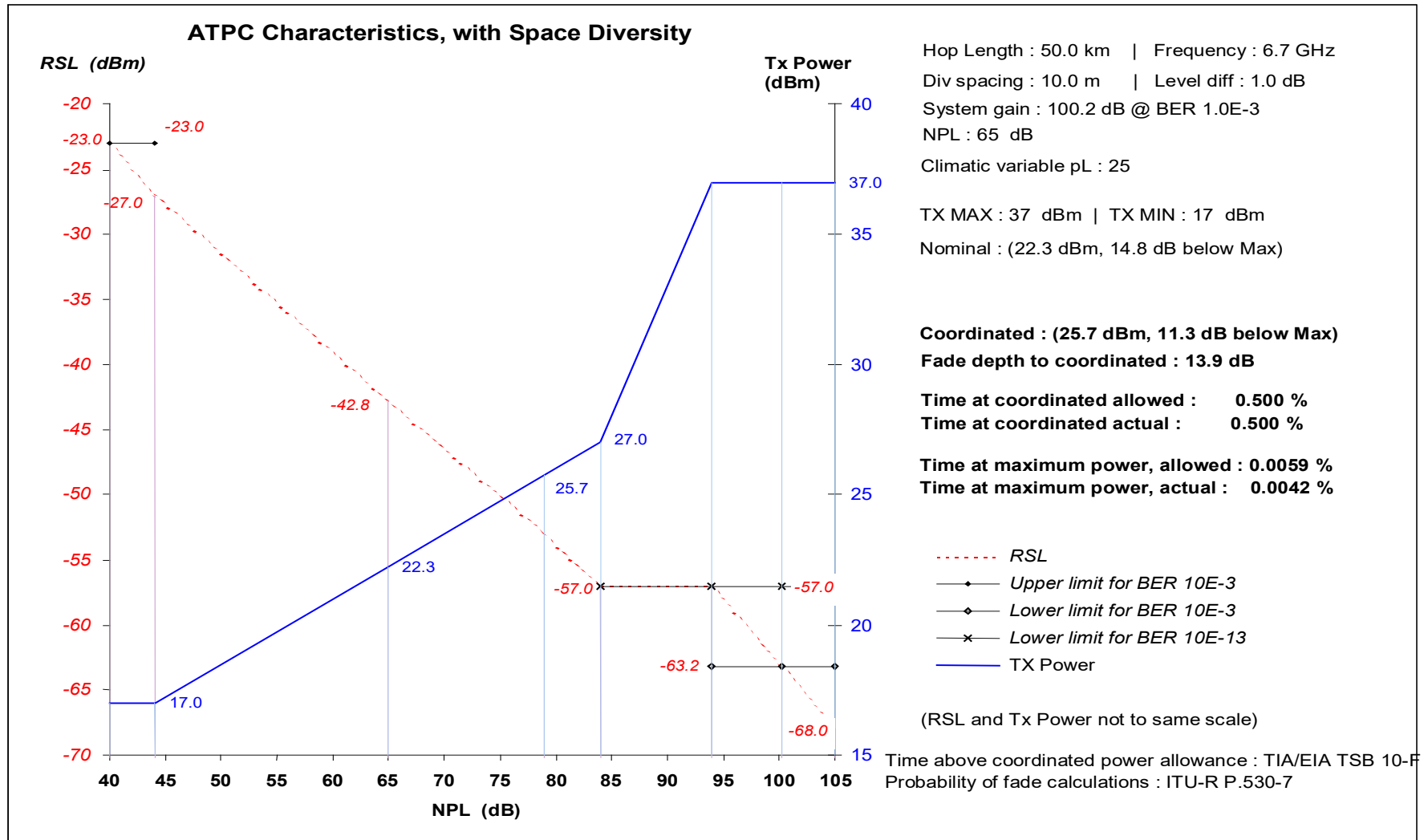


Figure 4: ATPC Characteristics, Space Diversity

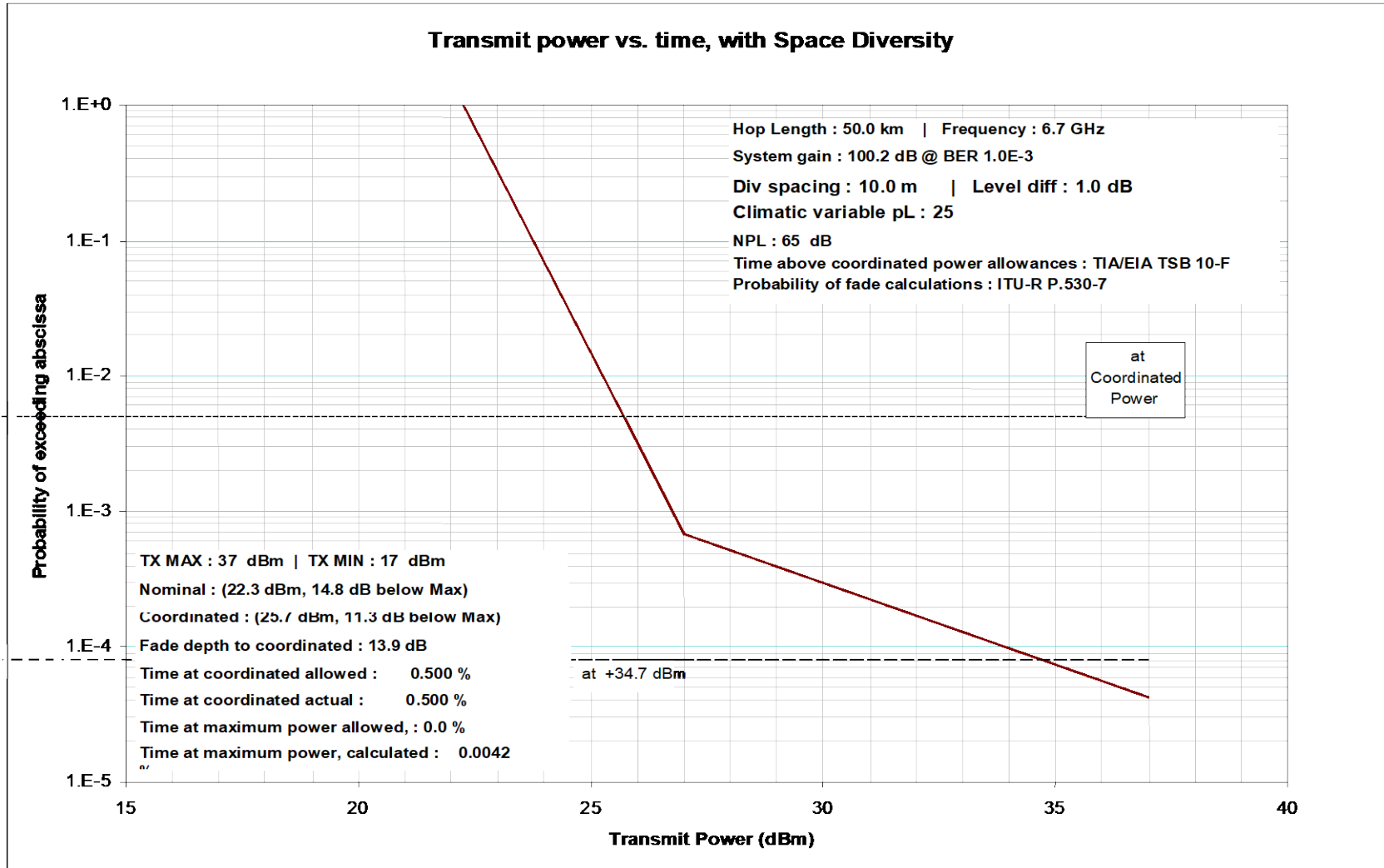


Figure 5: ATPC Characteristics, Space Diversity

APPENDIX 10: Notional Antennas

Introduction

After 31 March 2005 the use of notional antennas for new assignments will not be accepted. For antenna compliance requirements for point-to-point microwave fixed services after 31 March 2005 refer to Appendix 11.

Note: During a phase-in period between 31 March 2004 and 31 March 2005, the requirements of either Appendix 10 or Appendix 11 can be used to determine antenna compliance.

Use of Notional Antennas in coordination studies

The use of notional antennas in coordination studies will not be accepted for new assignments after 31 March 2005. Notional antenna radiation pattern envelopes may only be used in coordination studies for fixed services licensed prior to 31 March 2005 for which no actual antenna radiation pattern envelope is available.

Antennas authorised before 31 March 2005

Antennas associated with assignments that have been co-ordinated and licensed before 31 March 2005 under the Appendix 10 requirements will not be required to be re-evaluated for compliance with Appendix 11¹.

Background

The notional antenna specifies the radiation characteristics of the minimum performance antenna that may be used in a given point-to-point microwave fixed service frequency band. Licensees are required to employ antennas with equivalent or better performance than the specified notional, with particular emphasis on HSDA. In some instances, in order to achieve coordination in a difficult area, that ACA may require that antennas with performance exceeding that of the notional antenna be used in order to facilitate coordination and maximise spectrum utilisation.

Minimum Performance Specifications

The minimum performance antennas defined in Annex A for each microwave fixed service band are based on rotationally symmetric parabolic dishes and include specifications for notional:

- Gain - on axis power gain as a ratio, referred to an isotropic antenna (dBi);
- Half Power Beamwidth - beamwidth (in degrees of arc), representing the fixed (3dB) points of the notional RPE; and
- RPE - the radiation envelope of the notional antenna as a ratio (in dB) in relation to the antenna beam (on axis) response.

¹ Antennas authorised under the Appendix 10 requirements but which are **not** compliant under the Appendix 11 regime can continue to be used at their authorised location and in their authorised configuration but will not be allowed to be redeployed after 31 March 2005.

Development of Notional Antennas

The notional performance specifications detailed in Annex A were developed² with a view to optimising system costs against spectrum productivity considerations and represent the consolidation of envelope patterns of actual manufactured antennas for each microwave fixed service band, based on:

- grid parabolic antennas for the bands below 3 GHz;
- high performance (HP) solid parabolic antennas in the 3.8/6.7/11/18 GHz bands supporting homogeneous high capacity telecommunication services; and
- standard solid parabolic dishes for the remaining bands.

Although the gain, beamwidth and RPE characteristics of all parabolic antennas are proportional to the antenna effective aperture (ie. proportional to physical size), the Annex A specified size (diameter) parameter should not be construed as a part of the minimum performance specification. This parameter simply refers to the diameter of the basis (grid/standard/HP) antenna used to derive a particular notional specification and in some cases an antenna of smaller diameter (or different type) to the notional may meet or substantively exceed the specified minimum performance criteria.

Compliance Issues

A problem of interpretation could arise in situations where a particular antenna might not quite meet the notional specification in all respects but clearly demonstrates equivalent or superior performance over the principal range of azimuths. This is sometimes evident in comparisons of the RPE of a notional antenna based on a standard antenna against an actual (typically high performance) antenna of slightly smaller diameter than the notional. Enquiries concerning minimum antenna performance and other notional antenna related matters should be referred to the Manager, Spectrum Planning and Engineering Team, Radiofrequency Planning Group for policy advice.

Note: The minimum performance (notional) antenna requirement will not normally be relaxed within designated HSDA locations. In the event of interference, a victim system antenna will be expected to at least meet the notional antenna performance criteria.

² Spectrum Planning Report 5/90 “*Notional Antenna Radiation Patterns*”, Department of Transport and Communications, July 1990.

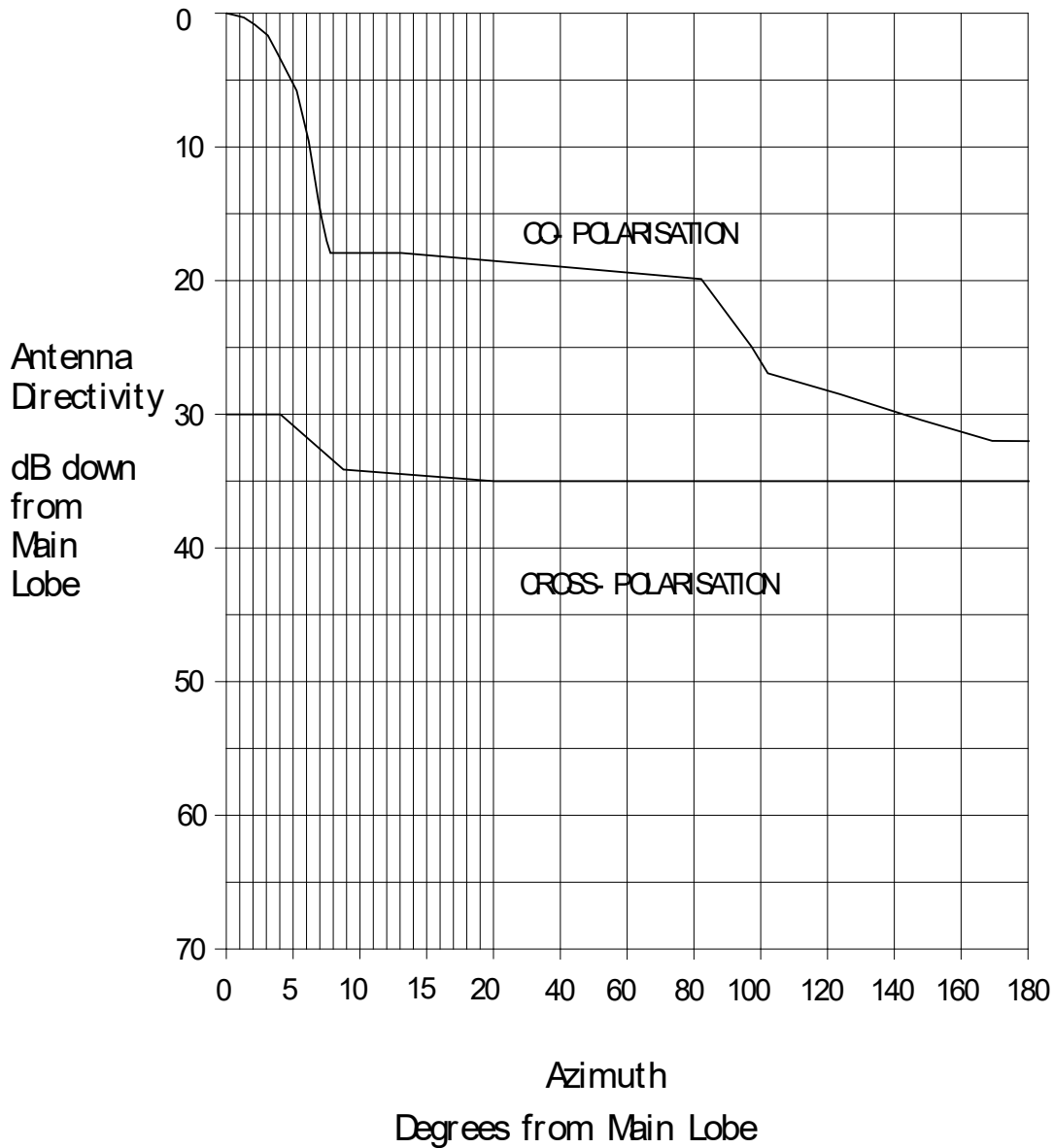
ANNEX A TO APPENDIX 10: Notional Antenna Radiation Pattern Envelopes

This annex consolidates the notional antenna radiation pattern envelopes for fixed microwave point-to-point bands.

THE 1.5 GHz BAND (1427-1535 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

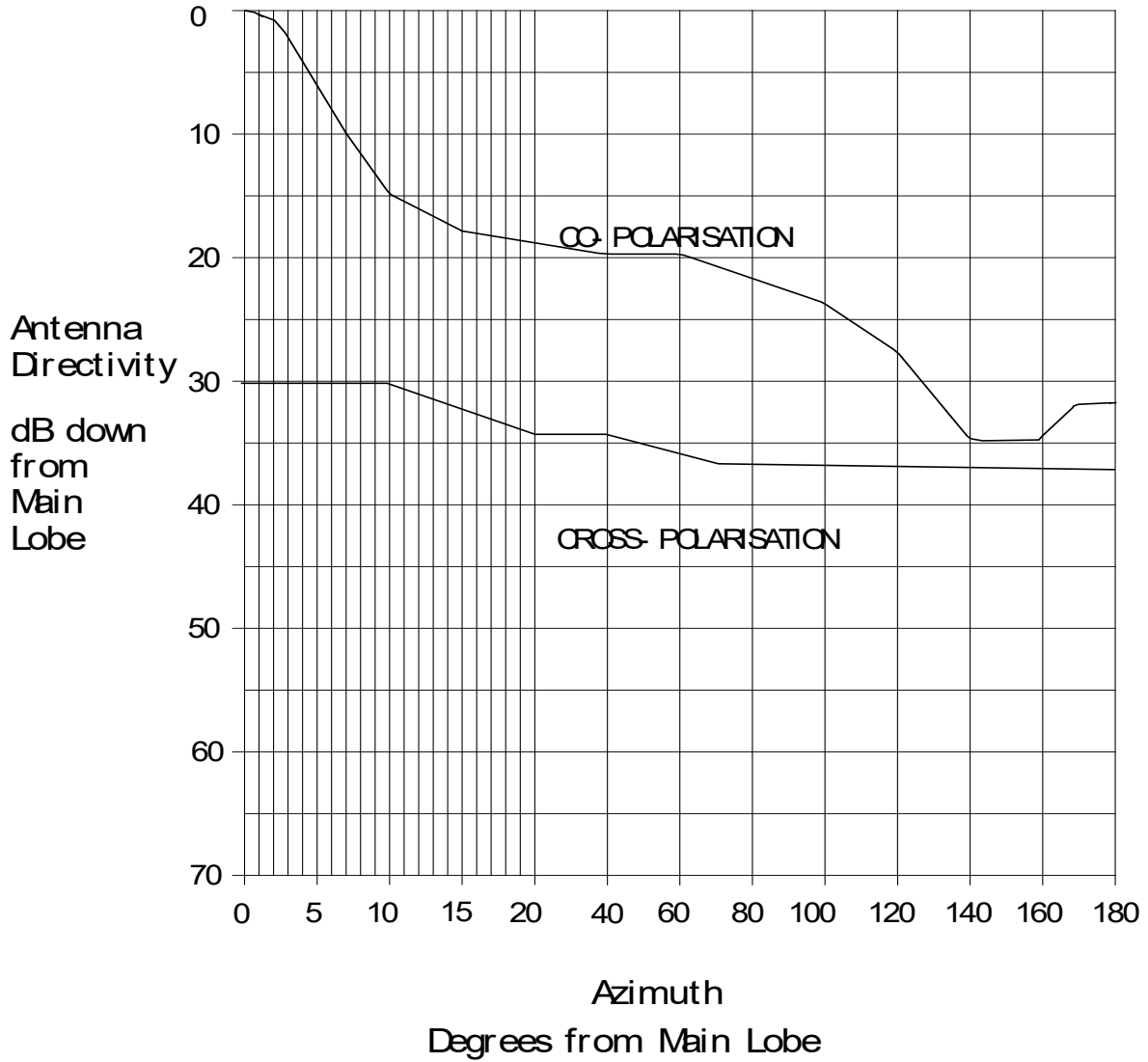
Diameter	1.8 m (grid parabolic dish)
Notional Half Power Beam Width	8 degrees
Notional On-axis Gain	26 dBi



THE 1.8 GHz BAND (1700 - 1900 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

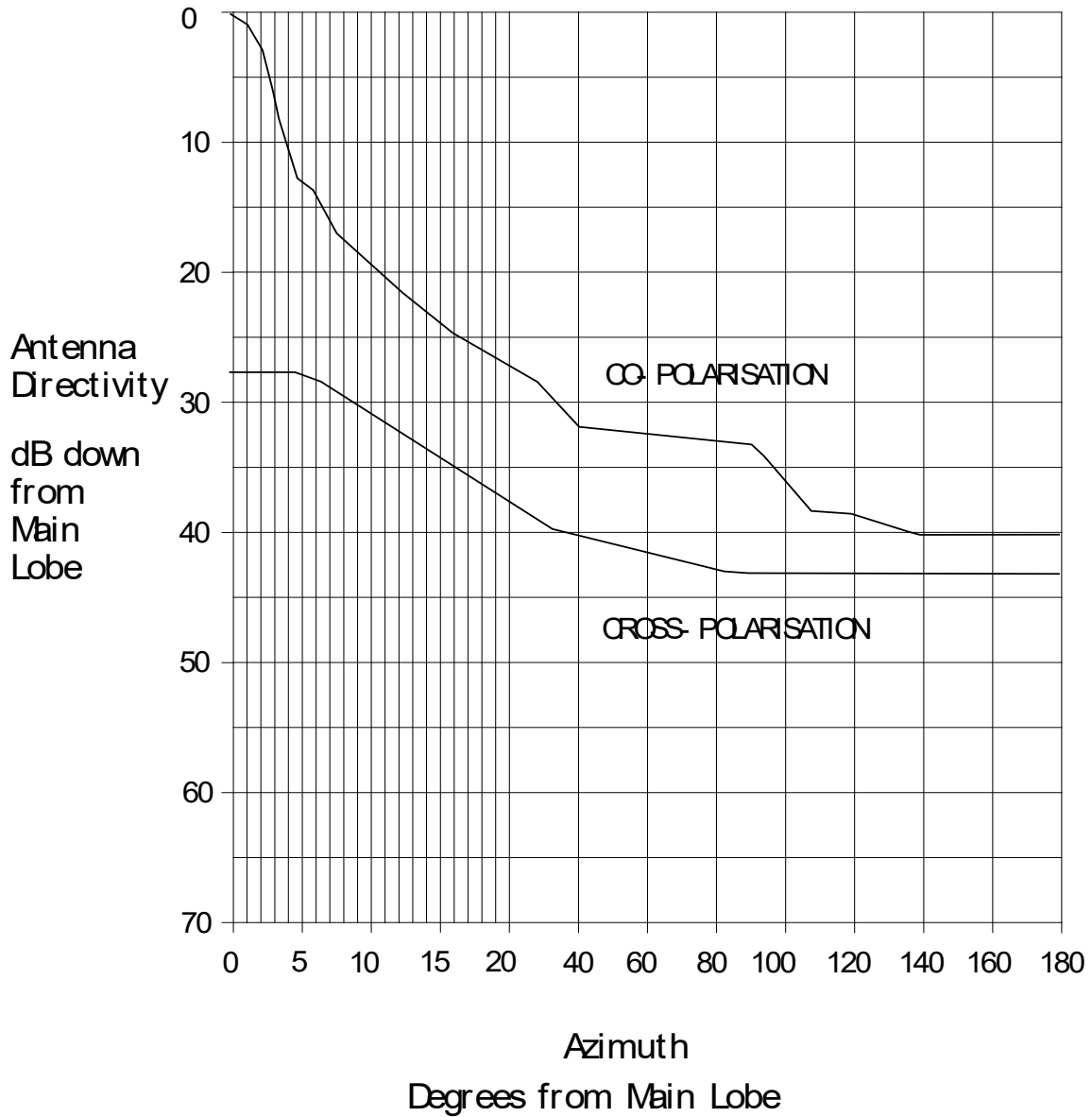
Diameter	1.8 m (grid parabolic dish)
Notional Half Power Beam Width	6 degrees
Notional On-Axis Gain	28 dBi



THE 2.1 GHz BAND (1900 - 2300 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

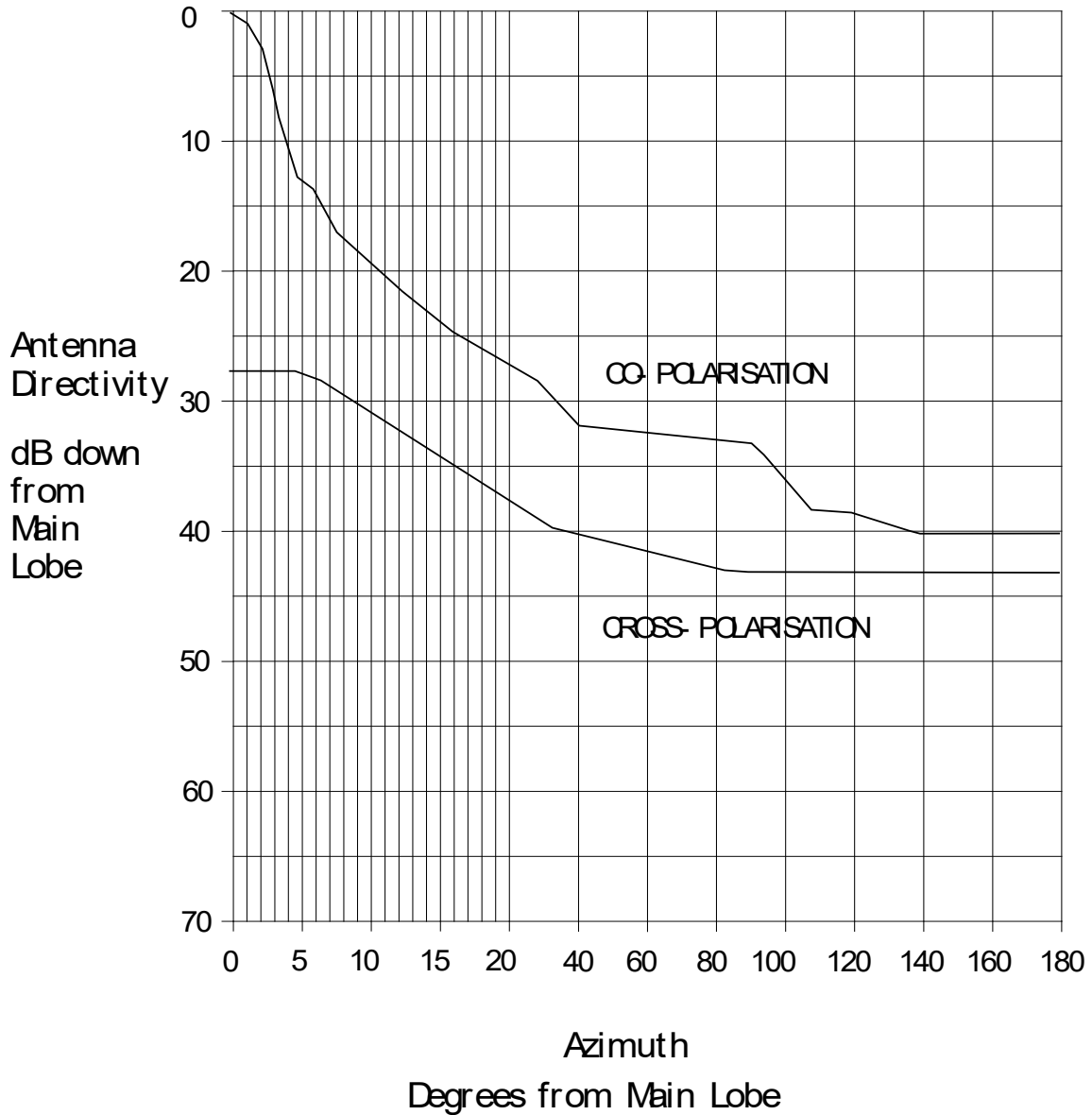
Diameter	3.0 m (grid parabolic dish)
Notional Half Power Beam Width	3.3 degrees
Notional On-Axis Gain	33 dBi



THE 2.2 GHz BAND (2025 - 2285 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

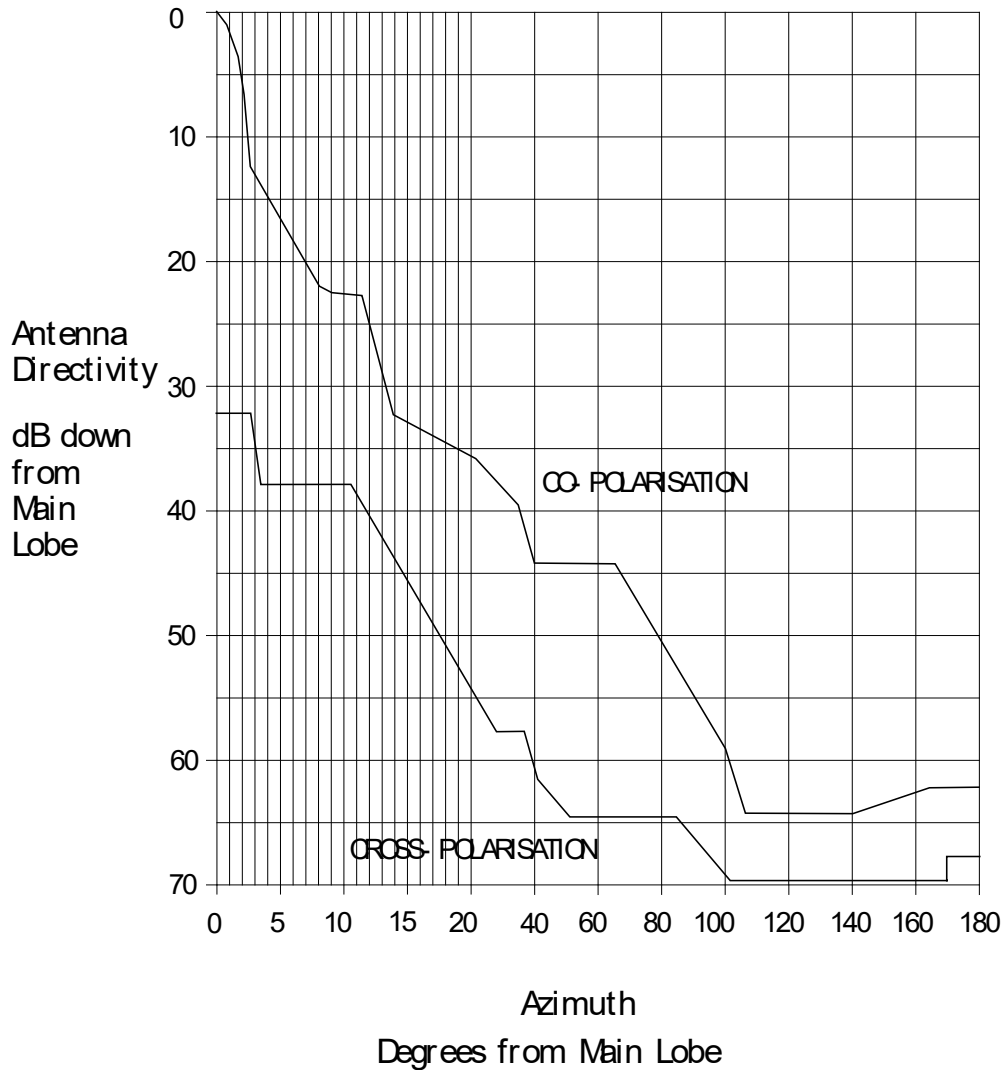
Diameter	3.0 m (grid parabolic dish)
Notional Half Power Beam Width	3.3 degrees
Notional On-Axis Gain	33 dBi



THE 3.8 GHz BAND (3580 - 4200 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

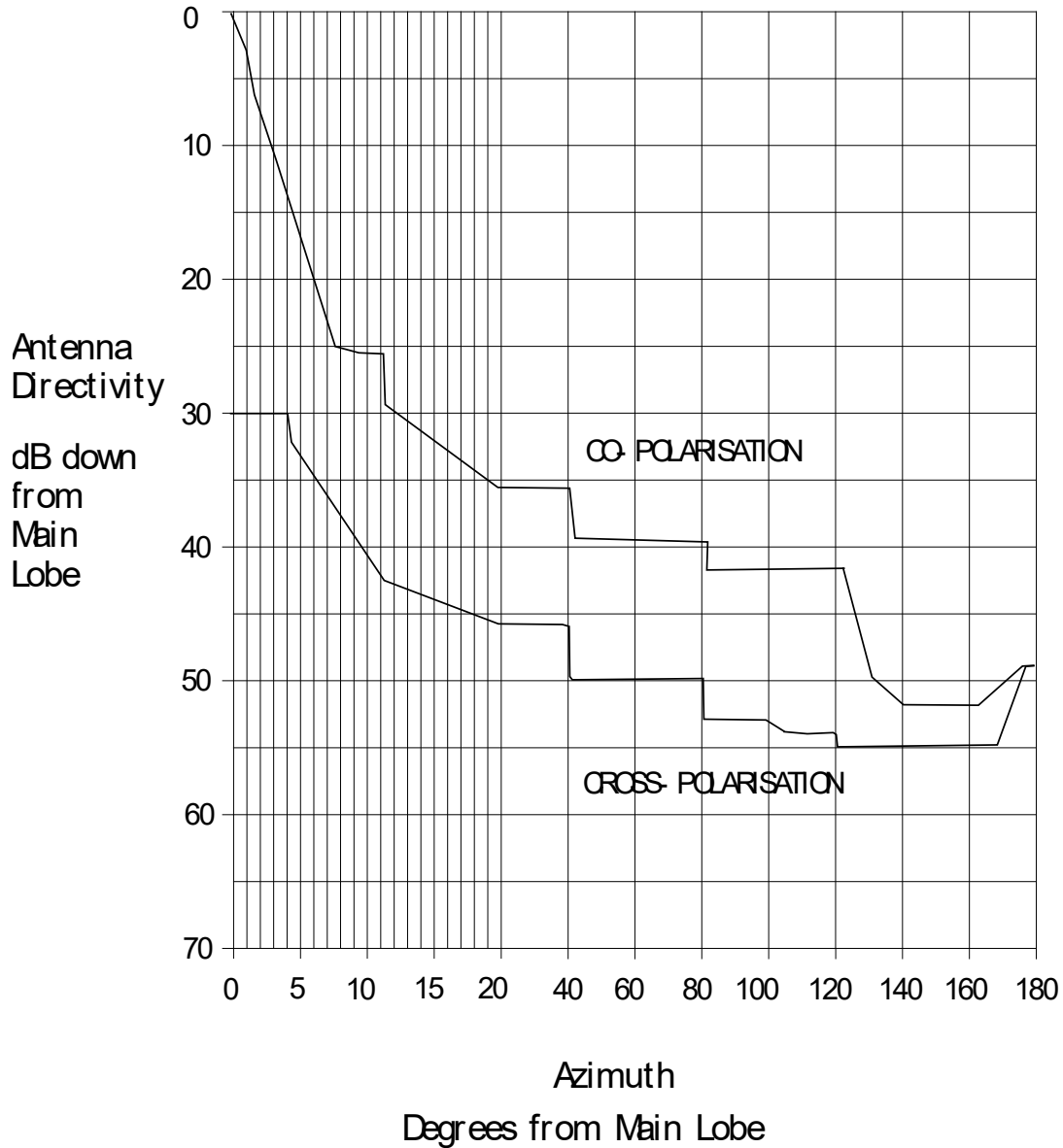
Diameter	3.0 m (high performance parabolic dish)
Notional Half Power Beam Width	1.7 degrees
Notional On-Axis Gain	39 dBi



THE 6 GHz BAND (5925 - 6425 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

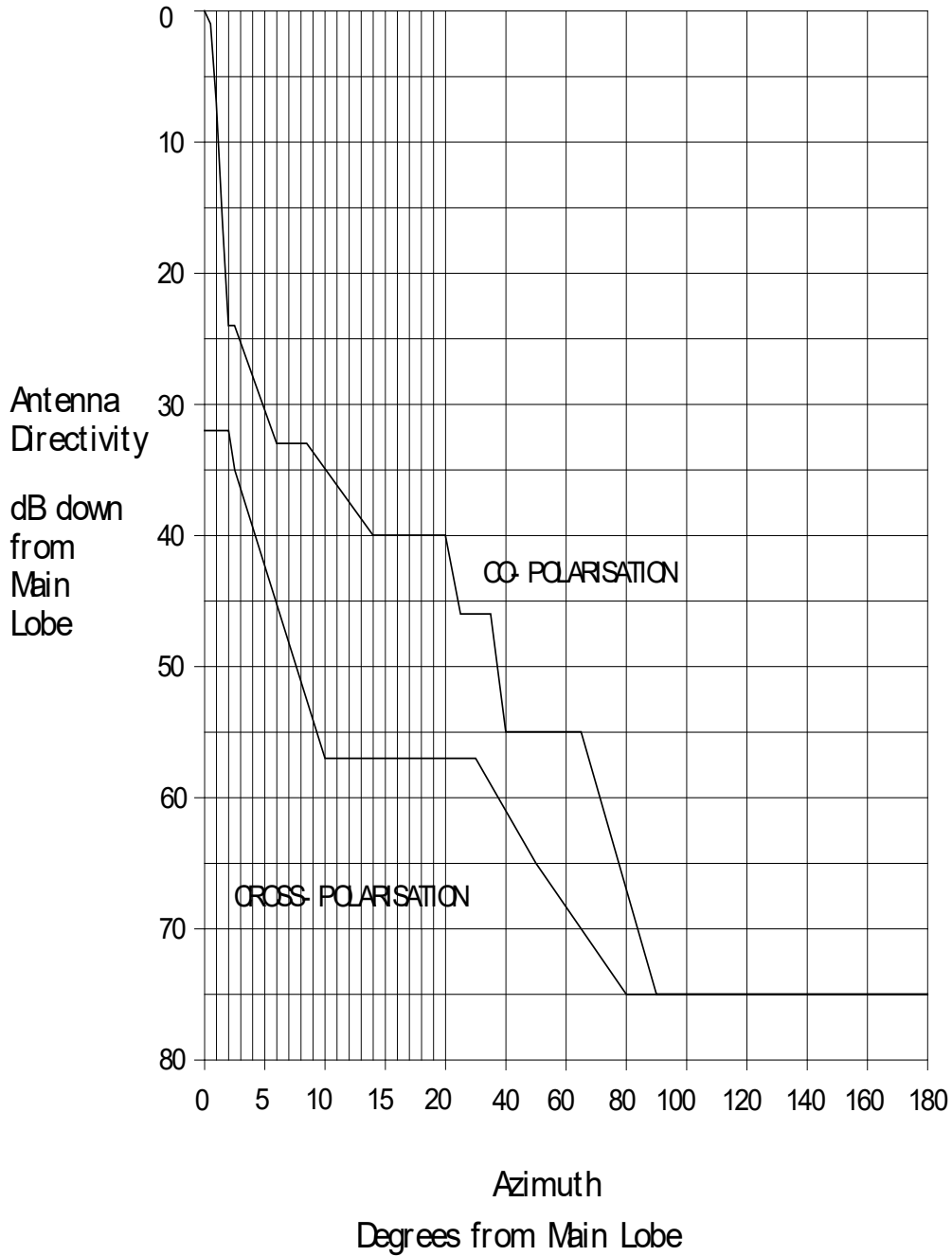
Diameter	3.0 m (standard parabolic dish)
Notional Half Power Beam Width	1.2 degrees
Notional On-Axis Gain	43 dBi



THE 6.7 GHz BAND (6425 - 7110 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

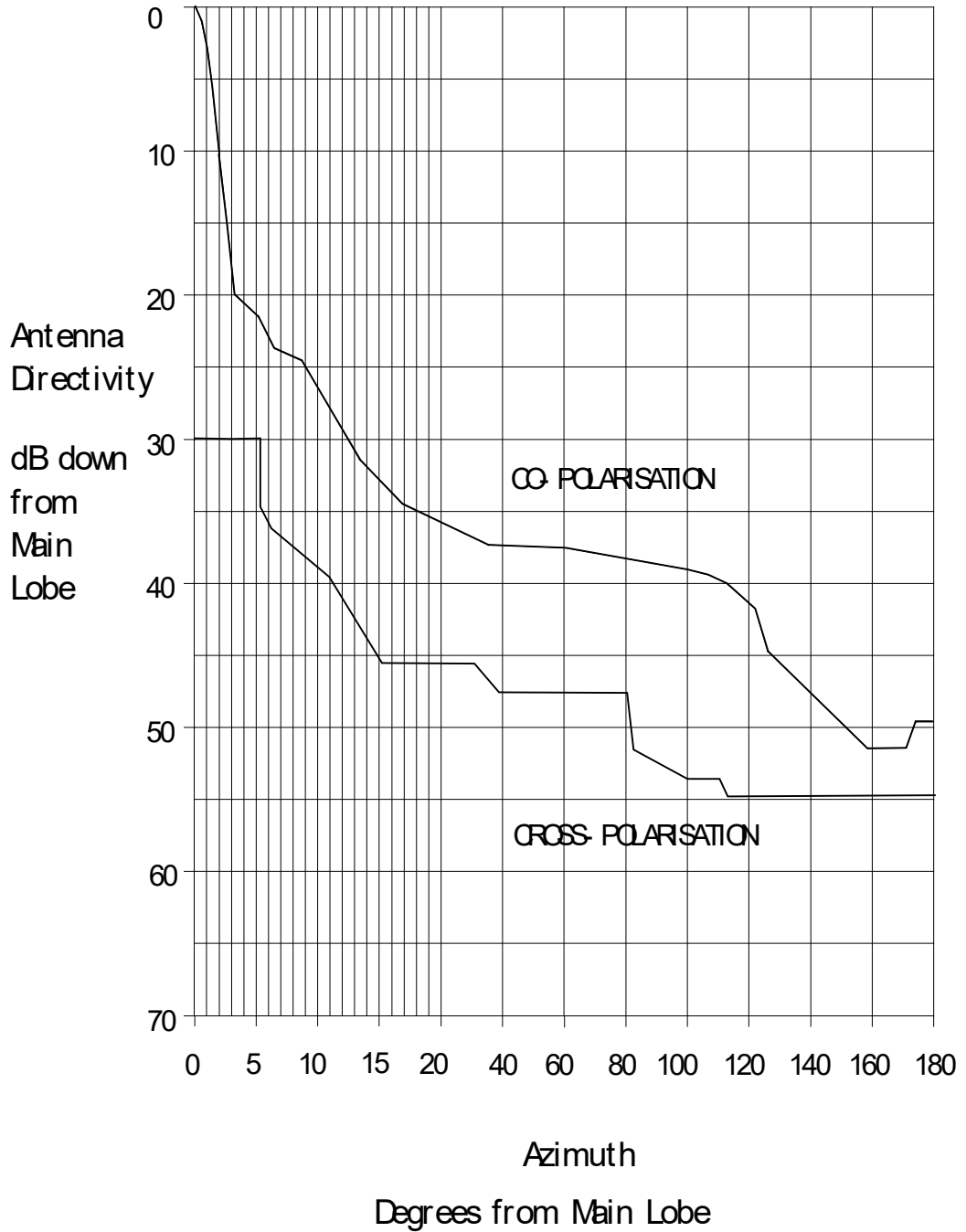
Diameter	3.0 m (high performance parabolic dish)
Notional Half Power Beam Width	1.1 degrees
Notional On-Axis Gain	44 dBi



THE 7.5 GHz BAND (7425 - 7725 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

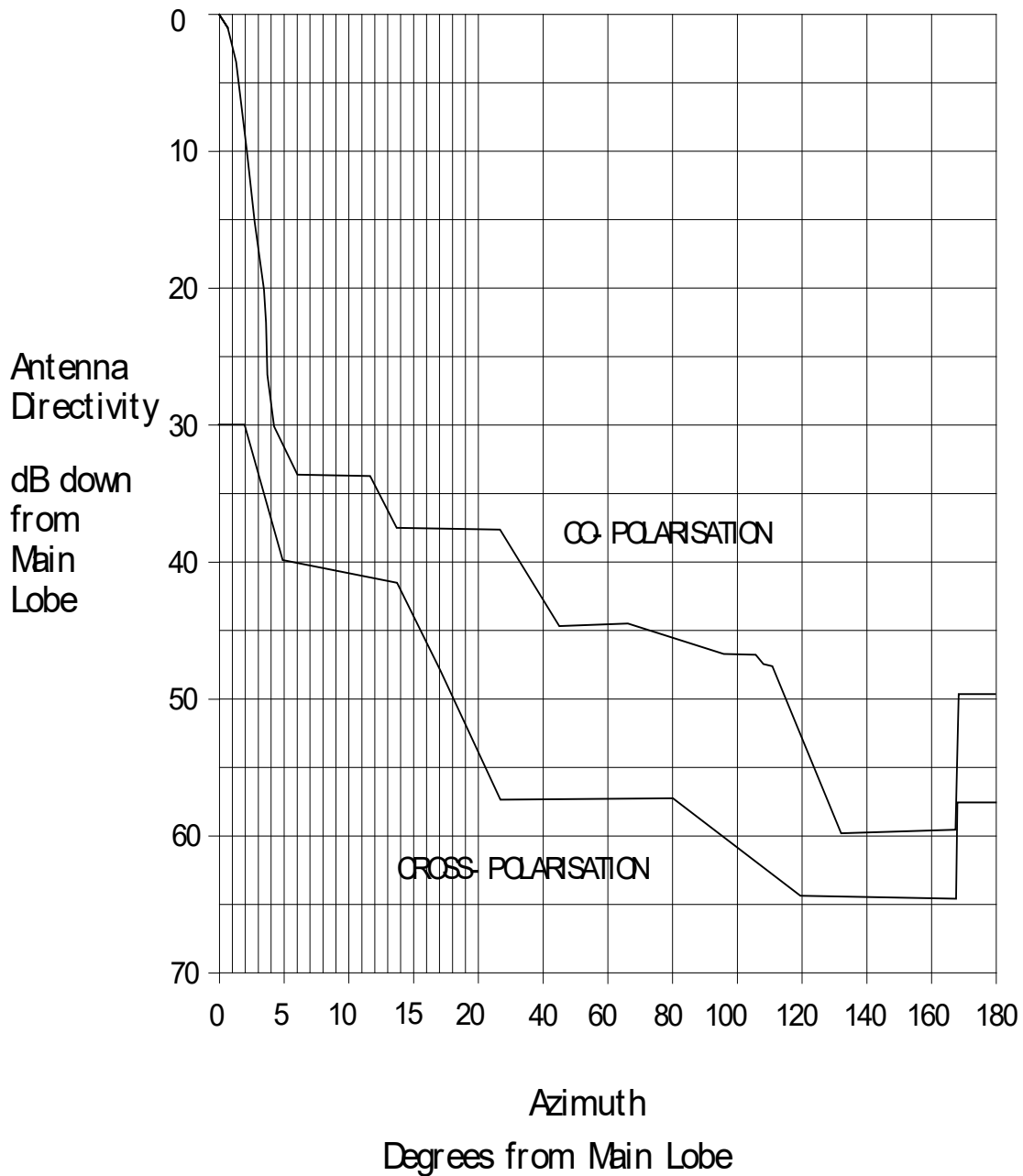
Diameter	1.8 m (standard parabolic dish)
Notional Half Power Beam Width	1.5 degrees
Notional On-Axis Gain	40 dBi



THE 8 GHz BAND (7725 - 8275 MHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

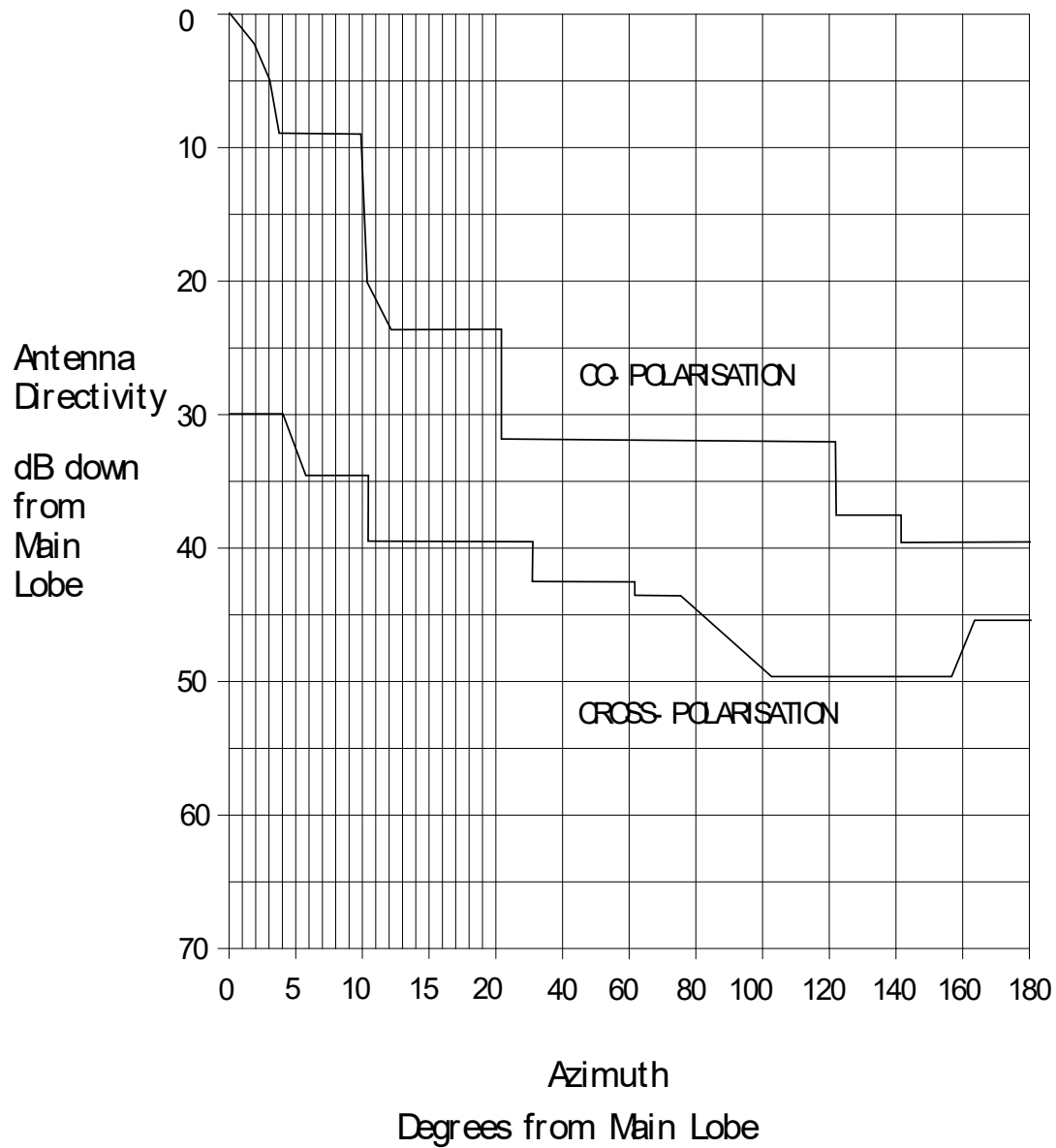
Diameter	2.4 m (standard parabolic dish)
Notional Half Power Beam Width	1.1 degrees
Notional Gain	43 dBi



THE 10 GHz BAND (10.55 - 10.68 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

Diameter	0.6 m (standard parabolic dish)
Notional Half Power Beam Width	3.6 degrees
Notional Gain	33 dBi



11 GHz BAND (10.7 - 11.7 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

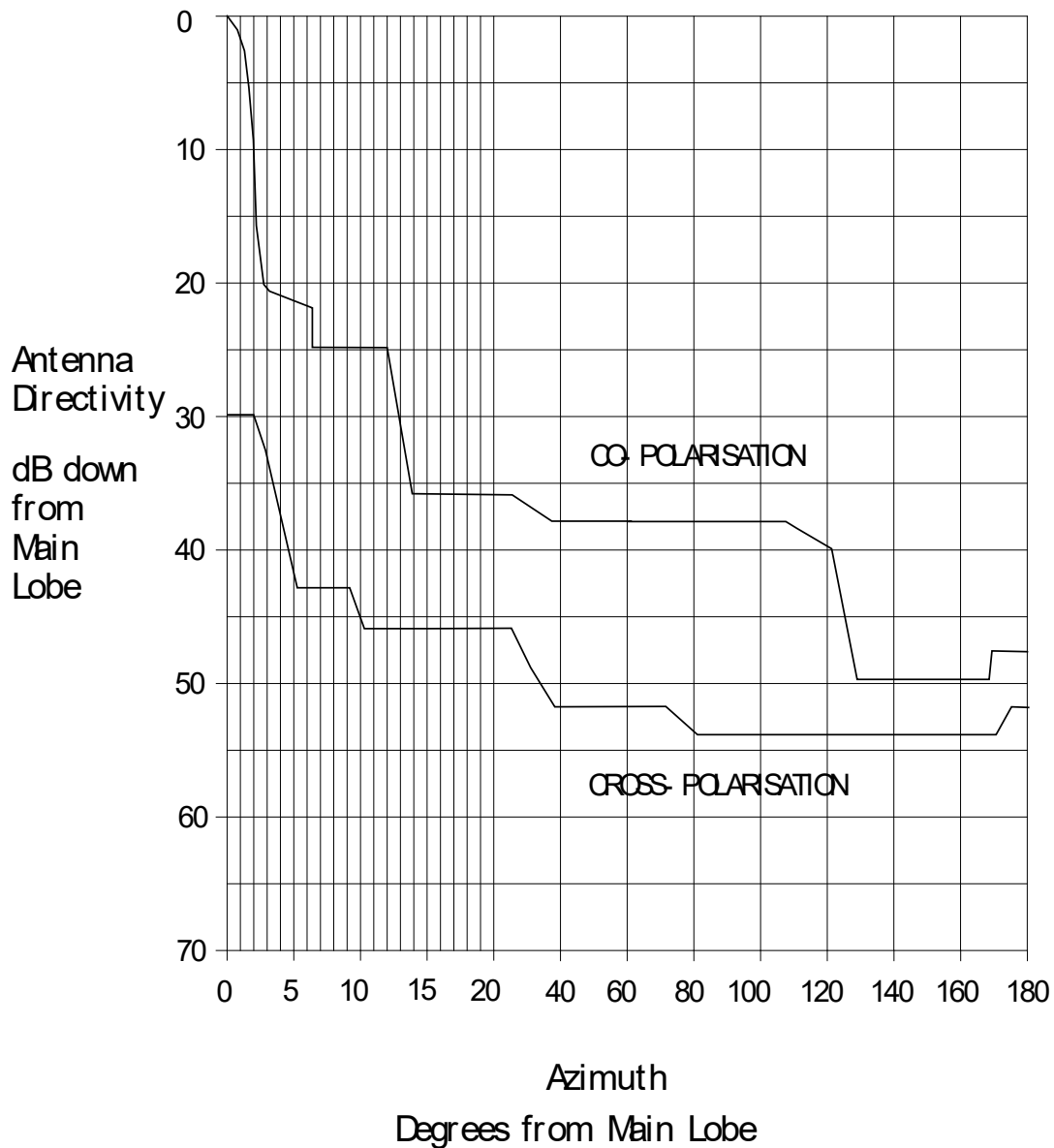
Diameter	1.8 m (high performance parabolic dish)
Notional Half Power Beam Width	1 degree
Notional On-Axis Gain	44 dBi



THE 13 GHz BAND (12.75 - 13.25 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

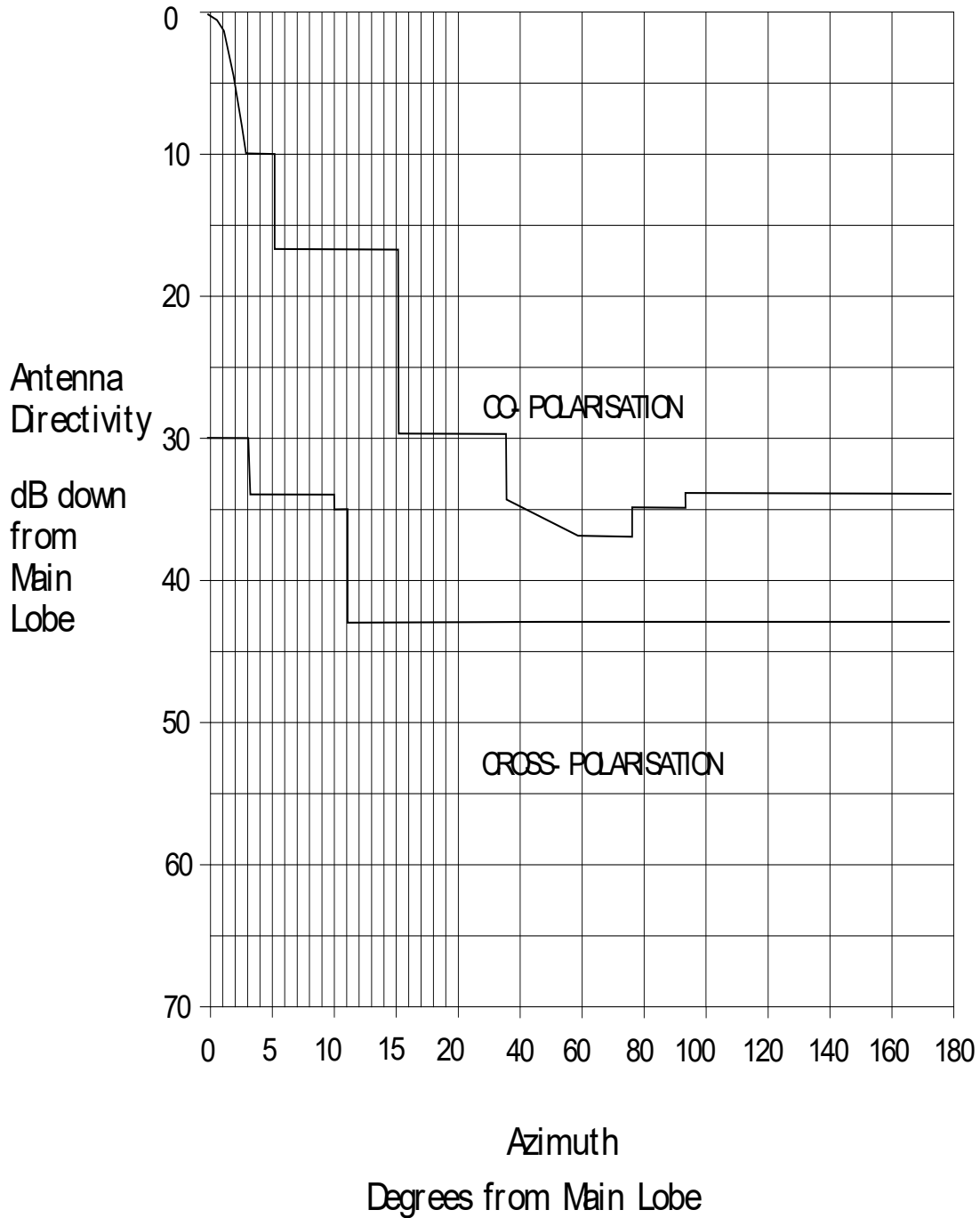
Diameter	1.2 m (standard parabolic dish)
Notional Half Power Beam Width	1.4 degrees
Notional On-Axis Gain	41 dBi



THE 15 GHz BAND (14.5 - 15.35 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

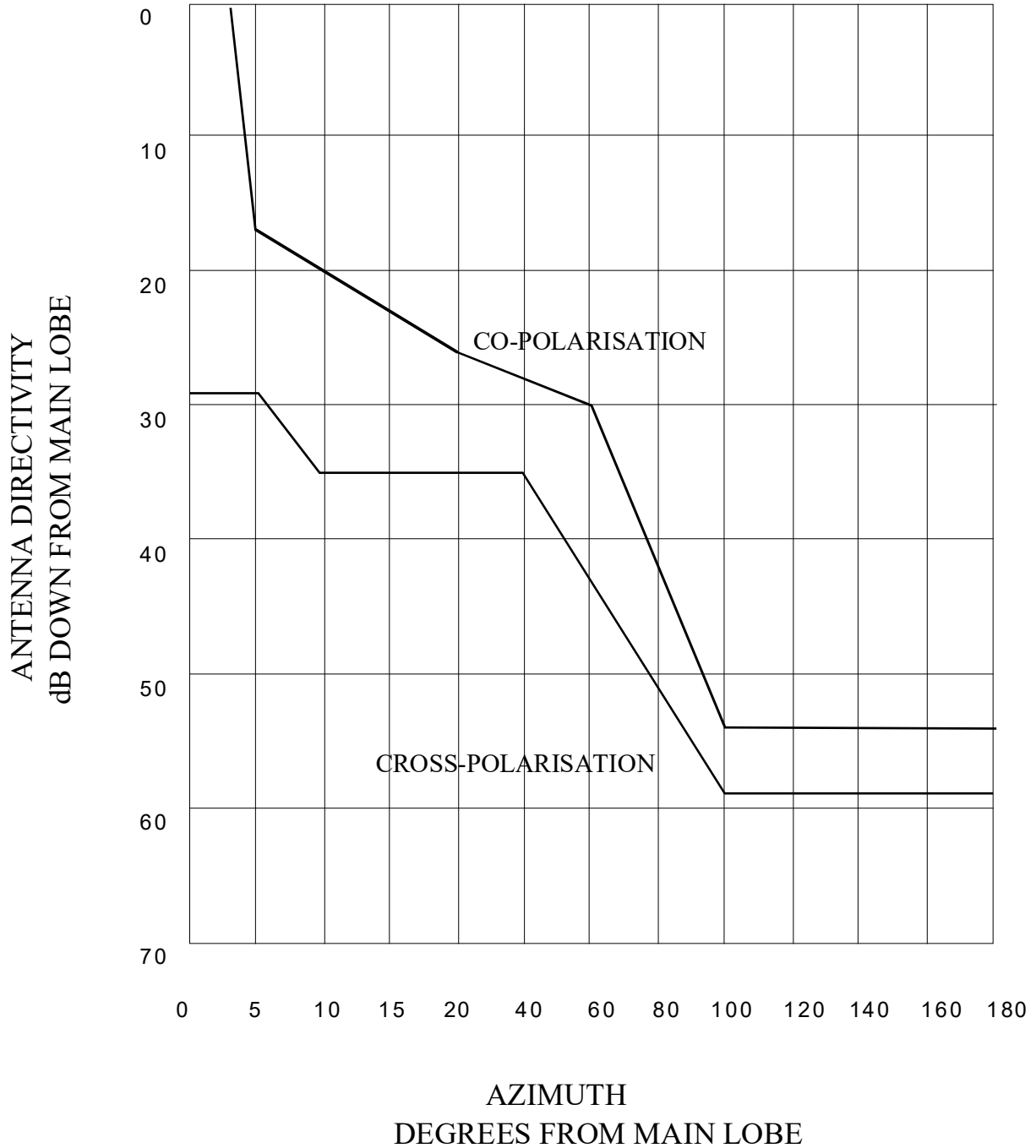
Diameter	0.6 m (standard parabolic dish)
Notional Half Power Beam Width	2.3 degrees
Notional On-Axis Gain	36 dBi



THE 18 GHz BAND (17.7 - 19.7 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

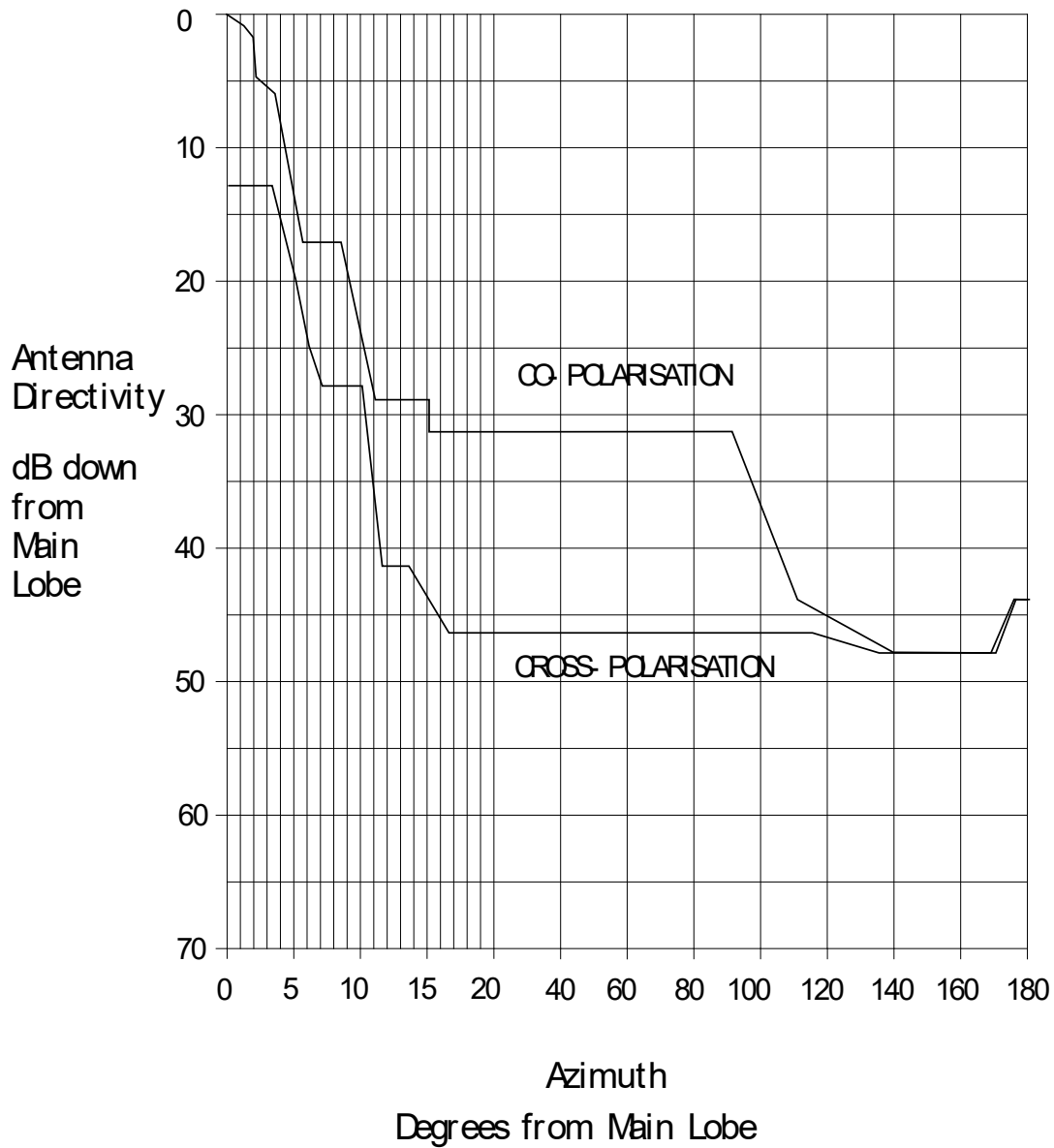
Diameter	0.3 m (high performance parabolic dish)
Notional Half Power Beam Width	3.6 Degrees
Notional On-Axis Gain	33.5 dBi



THE 22 GHz BAND (21.2 - 23.6 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

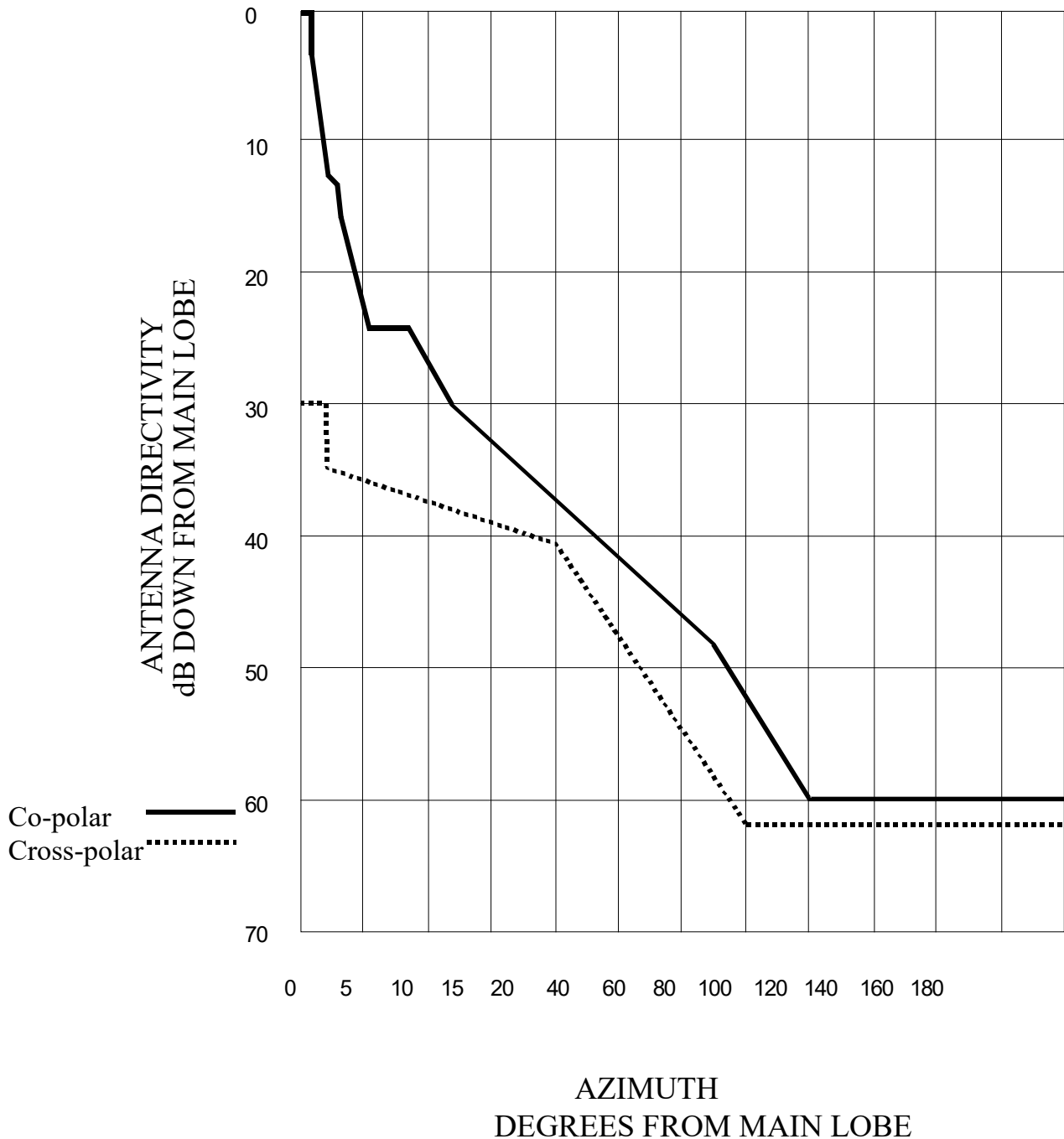
Diameter	0.3 m (standard parabolic dish)
Notional Half Power Beam Width	3 Degrees
Notional On-Axis Gain	33 dBi



THE 38 GHz BAND (37 - 39.5 GHz)

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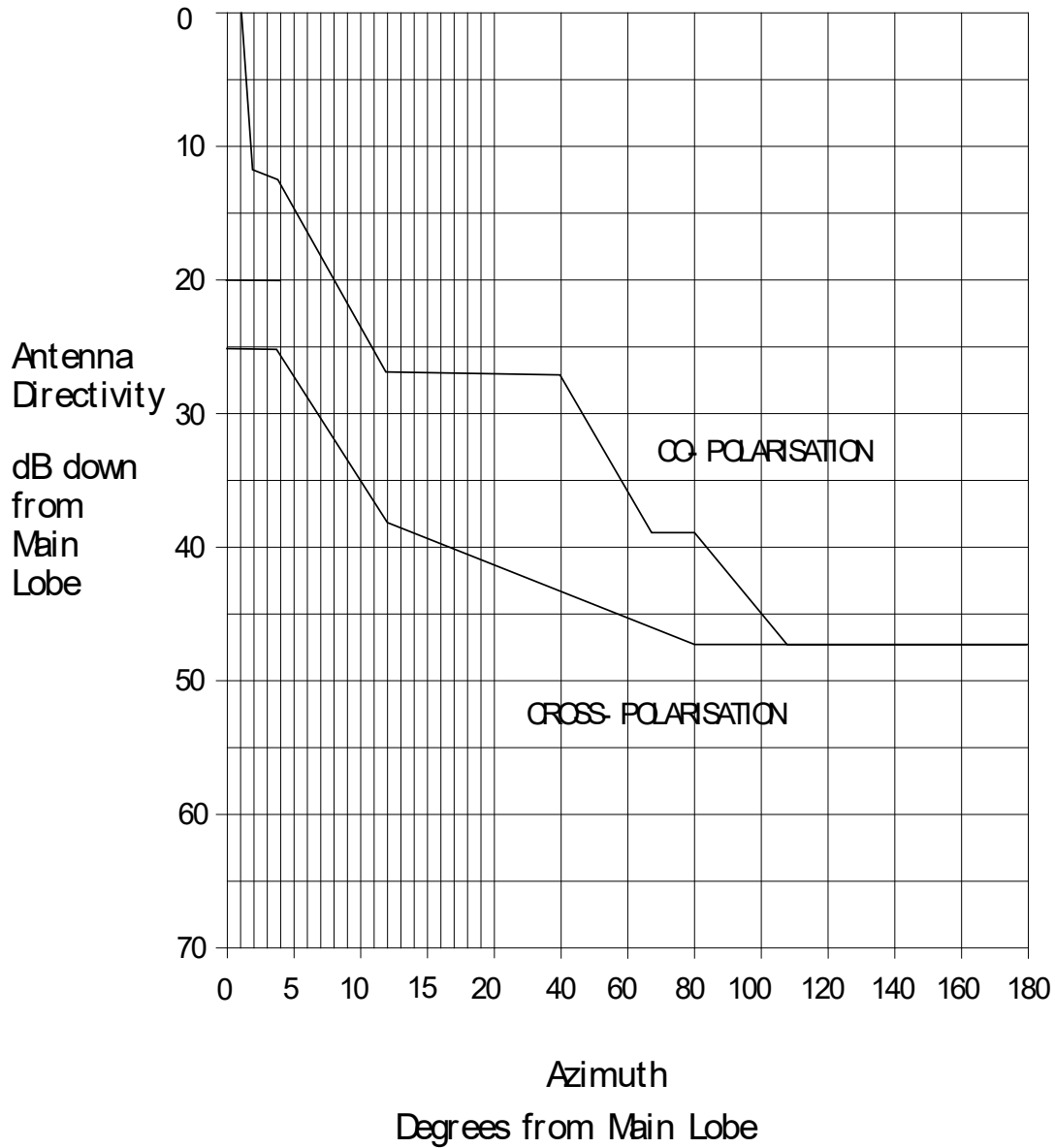
Diameter	0.3 m (standard parabolic dish)
Notional Half Power Beam Width	1.7 degrees
Notional On-axis Gain	39.5 dBi



THE 50 GHz BAND (50.4 - 51.15 GHz)

NOTIONAL ANTENNA RADIATION PATTERN ENVELOPE

Diameter	0.3 m (standard parabolic dish)
Notional Half Power Beam Width	1.3 degrees
Notional On-Axis Gain	44 dBi



APPENDIX 11: Antenna Compliance Requirements

Table of Contents

1. <i>Introduction</i>	1
2. <i>Minimum Antenna Performance Requirements</i>	1
3. <i>Coordination Requirements</i>	2
4. <i>Provision of RPE data</i>	3
5. <i>Trunk Bands</i>	3
6. <i>Prime Sites</i>	3
7. <i>Links Crossing HSDA boundaries</i>	3
8. <i>Antenna Measurement Standards</i>	4
9. <i>Exemptions</i>	4

1. Introduction

This appendix details the compliance requirements for antennas used in the point-to-point microwave fixed service frequency bands.

Antenna compliance is determined by reference to the antenna front-to-back (F/B) ratio and antenna cross-polar discrimination (XPD) as stated by the respective product manufacturer. These values are then compared to Table 1 which provides the minimum acceptable antenna performance requirements based on F/B ratios and XPD for each band.

2. Minimum Antenna Performance Requirements

Licensees are required to employ antennas with characteristics that meet or exceed those specified in Table 1. In some instances, in order to achieve coordination in a difficult area, the ACA may require that antennas with performance exceeding that specified in Table 1 be used in order to facilitate coordination and maximise spectrum utilisation.

The minimum requirements specified in Table 1 differ depending on the location of the fixed service:

- in designated High Spectrum Demand Areas¹ (HSDAs) point-to-point fixed service antennas must satisfy the minimum XPD performance and must satisfy the a minimum F/B ratio given in the Grade B column of Table 1; and,
- outside HSDAs point-to-point microwave fixed service antennas must satisfy the minimum XPD performance and must satisfy the minimum F/B ratio given in the Grade C column of Table 1.

¹ See section 3.3.2 of RALI FX-3

Band GHz	XPD (min) dB	Grade C F/B>x dB	Grade B F/B>x dB	Grade A F/B>x dB
1.5	25	25	30	40
1.8	25	30	35	45
2.1	25	30	40	50
2.2	25	30	40	50
3.8	30	60	60	65
6.0	30	60	60	75
6.7	30	65	65	75
7.5	25	45	55	70
8	30	60	60	75
10	30	45	55	65
11	30	60	60	75
13	25	45	55	70
15	30	45	55	65
18	30	45	55	65
22	30	45	55	65
28	30	45	55	65
38	30	45	55	65
50	30	45	55	65

Table 1: Minimum acceptable antenna performance requirements

Note 1: The three classes of antennas defined are differentiated on the basis of their F/B ratio. Essentially, standard (STD) antennas are Grade C, high performance (HP) antennas are Grade B and ultra high performance (UHP) antennas are Grade A. Whilst inclusion of Grade A antennas in this Table is not strictly necessary under these regulatory arrangements, it allows users to differentiate between HP and UHP antenna types and could provide a basis for future regulatory discrimination between antenna types. It might also provide a basis for a future consideration of a revision to the fees schedule to take account of the spectrum efficiency of the antenna.

Note 2: For the purposes of this appendix the front-to-back ratio is defined as the highest peak of the radiation pattern in the region $180^{\circ} \pm 40^{\circ}$ (i.e. azimuth from 140° to 220°) relative to the main beam. Cross-polar discrimination is defined as the difference between the peak of the co-polarised main beam and the maximum cross-polarised signal over an angle twice the half power beamwidth of the co-polarised main beam.

3. Coordination Requirements

The ACA requires that frequency coordination studies be performed using manufacturer's actual antenna radiation pattern envelope (RPE) data for both proposed and existing assignments².

As a consequence actual RPE data for all licensed services will need to be accessible for the life of these services for coordination purposes. In some cases manufacturer RPE data may not be available for assignments that were licensed prior to the introduction of these antenna regulatory compliance arrangements (i.e. prior to 31 March 2005) or assignments were licensed using the notional antenna. Only in these cases will the use of notional antenna RPEs, provided at Appendix 10, be allowed in frequency coordination studies.

² Note that previously, under the Appendix 10 notional antenna regime, whenever RPE data was not available assigners could have used "a notional antenna radiation pattern envelope".

4. Provision of RPE data

Antenna RPE data for proposed new assignments must be provided to the ACA as a condition of the proposed assignment being accepted, unless already held by the ACA. To facilitate the process, the ACA maintains a database of antenna RPE data files and provides a searchable list on the ACA website. This will enable licensees and assigners to verify if an RPE data file is already held by the ACA. Licensees only need to provide the ACA with an RPE data file if it is not on the ACA list.

The ACA will provide the RPE data only when other sources cannot. RPE data is readily available from most manufacturers and in the first instance users will be expected to contact the manufacturers to obtain the RPE data.

Note: the ACA expects that licensees submitting RPE data would normally submit it as an electronic data file in NSMA format, however, other formats may be accepted provided they provide similar information with regard to antenna pattern breakpoints and can be easily read and understood.

5. Trunk Bands

A geographic definition of trunk routes and prime sites is problematic due to the constant development of new sites and new trunk routes. However, as many trunk routes are located in non-HSDAs allowing the use of standard Grade C antennas would impact on the provision of trunk services. In order to maintain the spectrum efficiency for trunk services the front-to-back criteria in the trunk bands (3.8, 6, 6.7 and 8 GHz) for Grade C have been set to be the same as Grade B. This approach is administratively simple as it avoids a requirement to define trunk routes (and to update that definition as new trunk routes are developed). Also, specifying Grade B as a minimum for the trunk bands ensures that the spectrum efficiency in important trunk bands is not compromised by use of poorer performing antennas in those bands.

6. Prime Sites

A “prime sites” definition is also not necessary. Antennas used at sites within HSDAs are required to be Grade B or better so the spectrum utility is preserved. As mentioned above, the spectrum utility of sites that are used as part of a trunk route outside HSDAs will be subject to the tighter requirements that apply for trunk bands. For non-trunk bands spectrum availability is usually not critical at sites outside the HSDAs and so it was considered reasonable to set a less stringent compliance requirement in those cases.

7. Links Crossing HSDA boundaries

Fixed service point-to-point microwave links that simply traverse a HSDA (i.e. both ends of a link are outside the HSDA but the path partially crosses a HSDA) will not be considered to be within the HSDA. However, if one end of a link is located inside a HSDA and the other is outside, then both ends of the link will need to conform to the requirements for antennas within the HSDA for that band.

8. Antenna Measurement Standards

The ACA does not intend mandating measurement standards. However, it would be expected that the RPE data provided would be in accordance with internationally recognised standards and methodologies. If it is found that an antenna differs markedly from the published data and is causing a problem then the ACA may require that the antenna be replaced at the licensee's expense.

9. Exemptions

Given the flexibility provided by the new regime, no exemptions will be allowed with respect to minimum acceptable performance criteria.

The use of parabolic antennas was assumed in deriving the values included in Table 1, other types, such as 'patch' antennas, may be used as long as they conform to the requirement of having a single main axis of radiation and they meet the other relevant criteria specified for each band.