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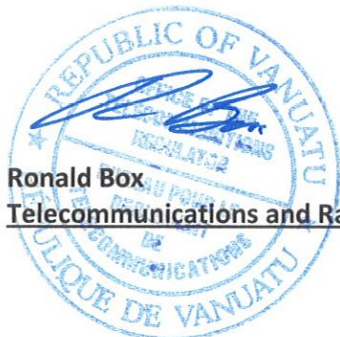
DECISION 03 OF 2014

The Telecommunications and Radiocommunications Regulator's Decision on Fixed Services Band Planning Arrangements in Vanuatu

Pursuant to the powers conferred to me under section 7(1) and (2)(e) of the Telecommunications and Radiocommunications Regulation Act 2009, I, the Telecommunications and Radiocommunications Regulator, hereby issue this decision to adopt the Schedule hereto in regards to the Fixed Services Band Planning Arrangements for Vanuatu.

The Fixed Services Band Planning Arrangements Schedule is available on the Regulators official website at www.trr.vu

Dated on this 19th day of November 2014



Ronald Box
Telecommunications and Radiocommunications Regulator

Schedule

FIXED SERVICES PLANNING ARRANGEMENTS

I. INTRODUCTION

This document sets out planning guidelines for the frequency assignment and coordination of terrestrial microwave fixed services in Vanuatu. It provides band planning arrangements for the 1.5 GHz, 5 GHz, 6 GHz, 6.7 GHz, 7.2 GHz, 7.5 GHz, 8 GHz, 10 GHz, 11GHz, 13 GHz, 15 GHz, 18 GHz and 22 GHz bands. It specifies key technical requirements for the use of these bands including channeling arrangements, assignment guidelines, antenna requirements and protection ratios.

Licensees deploying microwave fixed services in Vanuatu must follow these planning arrangements unless the Telecommunications and Radiocommunications Regulator agrees in writing to vary the requirements set out in this document.

II. FIXED POINT TO POINT MICROWAVE SYSTEMS; SOME BACKGROUND

The fixed microwave radio service (the fixed service) provides medium to high capacity connectivity between two points or between a central point and stations within a given area where access to cable or fibre is not available or economically viable.

The fixed service also provides connectivity over long distances where the inherent time delay associated with satellite connections makes these less attractive.

The fixed service is used in a number of ways. For example, it may transmit data over long distances (referred to as trunk services) between two towns or cities. It may also serve to interconnect numerous base stations within a cellular network. The fixed service is also used in a number of non-telecommunications networks. Some examples are the connection of a civil or military radar installation to an aircraft control tower, the transmission of supervisory control and data signals (SCADA) associated with the operation of an electricity transmission network and the interconnection of a private data network between two buildings.

Generally speaking, certain bands are suited to certain applications. For example, the 1.5 GHz microwave band is considered to be 'low frequency' in terms of fixed systems while still having the capacity to transmit large amounts of data. Other advantages of the 1.5 GHz band are low attenuation over distance, very little susceptibility to fade during heavy rain and the ability to use light 'grid-pak' type antennas on relatively light tower structures or supports. This means the 1.5 GHz band provides an economically viable method of transmitting data over relatively long distances (up to around 80 km) and is thus viable on many over water paths typical of Vanuatu geography.

Higher bands are suited to different purposes. For example the 10 GHz band still retains good rain fade characteristics and can provide high data rates over distances of up to 40km. This means it is useful for the interconnection of electricity substations, telephone exchanges or radar systems using solid antennas of about 1 metre diameter.

Higher bands, such as 15 GHz can carry high data rates and use much smaller solid antennas which allow integrated radio and antenna systems to be deployed. While these and higher bands are more susceptible to rain fade they are useful when interconnecting mobile base stations or for short hop length systems within cities.

III. PROPAGATION AND SYSTEMS DESIGN AT MICROWAVE FREQUENCIES

This section of this document is not intended to serve as a fixed service design guide. However, some background may be useful to those not involved in fixed service design.

- **Microwave antennas**

Antennas used at microwave frequencies are usually parabolic reflectors. The gain of an antenna is frequency dependant; for example a 1.2 metre Grid-Pak at 1.5 GHz has a gain of around 23 dBi while a 1.2 metre parabolic antenna at 15 GHz has a gain of around 42 dBi. While the 1.5 GHz Grid-Pak design offers lighter weight and lower wind loading the higher gain at 15 GHz means much smaller antennas can be used making the higher bands viable for short hop deployment.

Microwave antennas also have very narrow beam widths, around 10 degrees for the 1.5 GHz Grid-Pak and around 1.5 degrees for the 1.2m 15 GHz parabolic. This means sharing the same frequencies within the same area is possible provided careful coordination is undertaken.

Sharing with other systems is also possible, again provided careful coordination is undertaken. Where systems are 'ubiquitous', a term used to mean deployed without the need for licensing and registration into a common database, coordination is not possible. In these cases it is prudent spectrum management to avoid conflict by restricting the band to a certain service type.

- **Propagation at microwave frequencies**

Radiowave propagation through the atmosphere is a complex science, but some basic rules of thumb are provided to aid the reader not familiar with fixed service design.

The power loss of a system over a line of sight path between two points can be calculated from:

$$\text{FSL} = 32.5 + 20 \text{ Log}(D \times F)$$

where:

FSL is Free Space Loss

F is frequency in MHz

D is distance between the two points in kilometres.

For example, the free space loss at 1.5 GHz over a 50 km path is 130 dB.

Over very long paths the surface of the earth (or Earth bulge) can block a straight line path. This is overcome by using high towers, but the atmosphere also assists by bending (refracting) the radio waves around the earth thus increasing the horizon visible to the system (the radio horizon).

Attenuation by rain is also a problem for designers of systems in tropical areas. For example a rain event of 40 mm per hour can reduce a usable 20 km path length by a factor of two to 10 km. This means rain fade in tropical regions must be taken into account by the system designer and when coordinating interference between systems. It is important to note that rain fade may not be the same on both the wanted and unwanted path.

A final and important consideration, especially on overwater paths, is atmospheric multipath or ducting. This happens when a signal is refracted when passing through a change in the atmosphere, returning to the receive antenna out of phase with the wanted signal causing a fade. Another mechanism occurs when an interfering signal is trapped within a duct and arrives at a much higher power than line of sight calculations suggest causing interference and a systems failure.

All of these mechanisms are taken into account when deciding which bands to plan for the fixed service and which to preserve for other services. If the reader would like more information on digital fixed service design the International Telecommunications Union (ITU) produces an excellent manual called the 'Handbook on Digital Radio-Relay Systems'.

- **Fixed service availability**

Fixed services are designed for a specific error performance or availability depending on the service they provide. Examples of a high grade of service are a trunk network servicing a large town or a link between a radar and an airport control tower. Cellular systems are able to tolerate a lower grade of performance depending on how many cells the actual link services.

Fixed service availability is also a complex topic covered by a number of ITU publications. For more information the reader is directed to ITU Recommendations ITU-R F.634, ITU-R F.557, ITU-R F.697, ITU-T G.821 and ITU-T G.826. Reference antenna patterns are found in R F 699. These can be found by searching the ITU site at www.itu.int.

As an example, the unavailability over time of a fixed, two-way link over 40 km should not exceed 0.0048% (ITU-R F.557) and that of a short hop system, such as that servicing a cellular

mobile network should not exceed between 0.001% and 0.01% depending on the system parameters (ITU-R F.697).

- **Cross Polarization.**

Cross polarization enables coordination between two systems operating on the same channel. The actual level of cross polar discrimination can be found from manufacturer's data or an amount of -20 dB can be used when ITU Rec F.699 is used. Cross polar discrimination cannot be applied over the whole antenna pattern as it varies considerably in the side lobes. Thus a discrimination of -20 dB can be applied in the main lobe until that level (Max gain – 20 dB) is reached and from there follow the R.F.699 pattern. An example of this is shown in Figure 1.

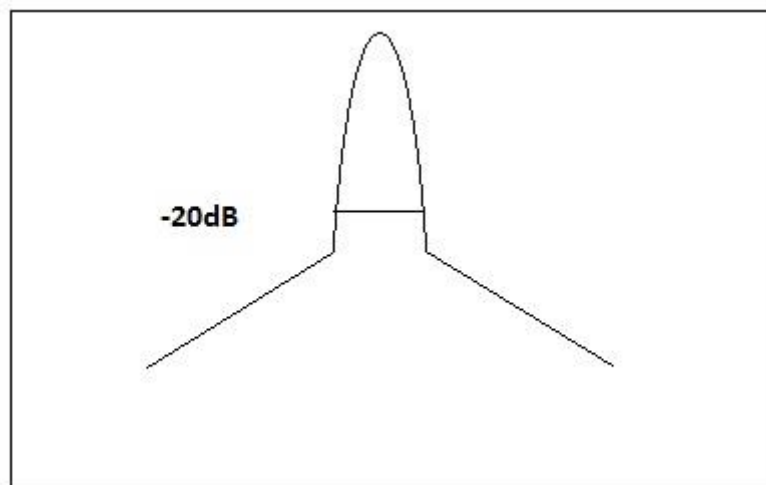


Figure 1.
Cross Polar Discrimination.

IV. BANDS PROPOSED FOR THE MICROWAVE FIXED SERVICE

- **Bands available to the Fixed Service (FS)**

TRR has planned bands between 1500 MHz and 22 GHz for the fixed service because these encompass a range that is able to support the requirements of a range of services. Should plans for bands in higher frequency ranges be needed, these will be planned when the Fixed services Plan is reviewed.

Individual Fixed Service Band Plans are attached as Annex A.

- **Channel aggregation**

Often the services supported by the fixed service evolve to provide or require more data. An example is the 4th Generation Mobile Service known as LTE. In order to provide flexibility for such services, spectrum managers have allowed channel aggregation in most bands (with some restrictions depending on the band). Channel aggregation may only be feasible where channels are unencumbered and coordination with other services is possible.

- **Bands proposed for planning to accommodate the fixed microwave (point to point) service**

- *The band 1427 MHz to 1535 MHz; the 1.5 GHz band*

This band is capable of supporting low to medium capacity fixed point to point links. The 1.5 GHz band is shared with the Broadcasting Satellite Service (Sound) (BSS-S). This service has restrictions on the PFD achieved at the ground which will protect the fixed service. There are no restrictions on the fixed service. In Vanuatu, the 1.5 GHz band is being used by TVL for fixed links.

Portions of the 1.5 GHz band are also under consideration in the ITU and APT for future mobile broadband systems. These systems will most likely be used to augment existing systems in areas of high population density and high data demand. Given the number of bands proposed by TRR for consideration for mobile broadband in Vanuatu and considering the need for robust long distance fixed communication in Vanuatu, TRR considers that the greatest economic benefit to Vanuatu will be achieved by planning this band for fixed microwave point to point links.

The planning arrangements for this band are given in Annex A.

- *The band 4400 MHz to 5000 MHz; the 5 GHz band*

The band 4400 MHz to 5000 MHz is capable of supporting high capacity fixed point to point microwave links.

The band is already being used for fixed services in accordance with ITU recommendation (ITU-R F. 1099-2). Given its value as a high capacity band with hop lengths of 40km or greater, TRR has planned this band in accordance with the 5 GHz fixed services plan shown in Annex A.

- *The band 7128 MHz to 7422 MHz; the 7.2 GHz band*

This band is allocated to the fixed service in ITU Region 3 with one caveat; the band 7250 MHz to 7375 MHz is allocated on a co-primary basis. The band is shared with the primary fixed satellite service and the primary mobile satellite service. Operations of fixed services in this band shall not cause interference to these services.

As there are no known fixed or mobile satellite services in this band in Vanuatu, this band has been planned for fixed services in Vanuatu.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.385-10 provide a number of channel bandwidths ranging from 7 MHz to 56 MHz. Planning arrangements for this band are based on a 14 MHz channel structure which may be aggregated to achieve 56 MHz channels where needed.

Proposed planning arrangements are given in Annex A as the 7.2 GHz band.

- *The band 7425 – 7725 MHz; the 7.5 GHz band*

This band is allocated to the fixed service in ITU Region 3. The band is shared with the primary fixed satellite service and the primary and secondary (depending on band segment) mobile satellite service. The band 7450 – 7550 MHz is also allocated to the Meteorological Satellite

Service on a worldwide basis, which must be protected from interference. Operations of fixed services in this band shall not cause interference to these services.

As there are no known fixed or mobile satellite services in this band in Vanuatu, this band has been planned for fixed services.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.385-10 provide a number of channel bandwidths ranging from 7 MHz to 56 MHz. TRR has adopted a 7 MHz and 14 MHz channel structure.

Planning arrangements are given in Annex A as the 7.5 GHz band.

- *The band 7725 MHz to 8275 MHz; the 8 GHz band*

This band is allocated to the fixed service and the fixed satellite service (space to Earth) as well as the mobile service. The band is used heavily throughout the region for fixed services. The fixed satellite service is used in some countries for defence purposes.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.386-9 provide a number of channel bandwidths ranging from 10 MHz to 30 MHz and portions of those.

TRR has adopted a raster used within the region of 14.825 MHz and 29.65 MHz which is also capable of supporting 14 MHz and 28 MHz channels.

These channel arrangements for the 8 GHz band are given in Annex A.

- *The band 10.55 to 10.68 GHz; the 10 GHz band*

This band 10.55 GHz to 10.6 GHz is allocated to the fixed and mobile services in ITU Region 3. The band 10.6 GHz to 10.68 GHz is also allocated to the Earth exploration service. This sub-band is used extensively for space based weather measurements including but not limited to wind speed determination, tropical rainfall measurement and microwave radiation imagery.

These services are important to Vanuatu's Meteorological Service and aid in the prediction of severe tropical storms.

ITU-R Resolution 751 (Res. 751) defines measures to ensure the continued viability of space based sensors and these will be applied by TRR so as to protect these systems.

Res. 751 defines the maximum antenna pointing elevation for fixed services in the band to be 20 degrees above the horizon. The maximum power at the antenna port is to be -15 dBW (14 mW) except where automatic transmitter power control (ATPC) is used when the power to the antenna port may be -3dBW (500 mW). TRR has implemented these protections in the 10 GHz fixed services plan available in Annex A.

- *The band 12.75 – 13.25 GHz; the 13 GHz band*

This band is allocated to the fixed service in ITU Region 3 and used in some Region 3 countries for Television Outside Broadcasting. The band is shared with the primary fixed satellite service

and the primary mobile service. Operations of fixed services in this band shall not cause interference to these services.

As there are no known fixed satellite or mobile services in this band in Vanuatu, this band has been planned for fixed services.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.497-7 provide a number of channel arrangements. TRR has specified a 28 MHz channel capable of supporting 34 Mbit systems.

Planning arrangements are given in Annex A as the 13 GHz band.

- *The band 14.5 - 15.35 MHz; the 15 GHz band*

This band is allocated to the fixed service in ITU Region 3. The band is shared with the primary fixed satellite service and the primary mobile service. Operations of fixed services in this band shall not cause interference to these services.

As there are no known fixed or mobile satellite services in this band in Vanuatu, this band has been planned for fixed services.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.636-4 provide a number of channel arrangements. TRR has specified a 7, 14 and 28 MHz channel structure all of which may be divided or aggregated in 7 MHz lots.

Planning arrangements are given in Annex A as the 15 GHz band.

- *The band 17.7 – 19.7 MHz; the 18 GHz band*

This band is allocated to the fixed service in ITU Region 3. The band is shared with the primary fixed satellite service and the primary mobile service. The band 18.6 – 18.8 GHz is also allocated to the earth Exploration Satellite Service (passive). Operations of fixed services in this band shall not cause interference to these services.

As there are no known fixed or mobile satellite services in this band in Vanuatu, this band has been planned for fixed services.

The band has good rain fade characteristics and is capable of supporting high capacity digital systems. The ITU through Recommendation ITU-R F.595-10 provide a number of channel arrangements. TRR has specified a 7.5, 13.75, 27.5 and 55 MHz channel structure.

Planning arrangements are given in Annex A as the 18 GHz band.

- *The band 21.2 GHz to 23.6 GHz; the 22 GHz band*

This band is allocated to the fixed service in ITU Region 3. While susceptible to severe rain fade the band supports a number of options for short range high capacity fixed links. Other services using the band include the radio Astronomy Service, but no restrictions have been placed on the deployment of fixed links. This band has been planned for fixed services in Vanuatu.

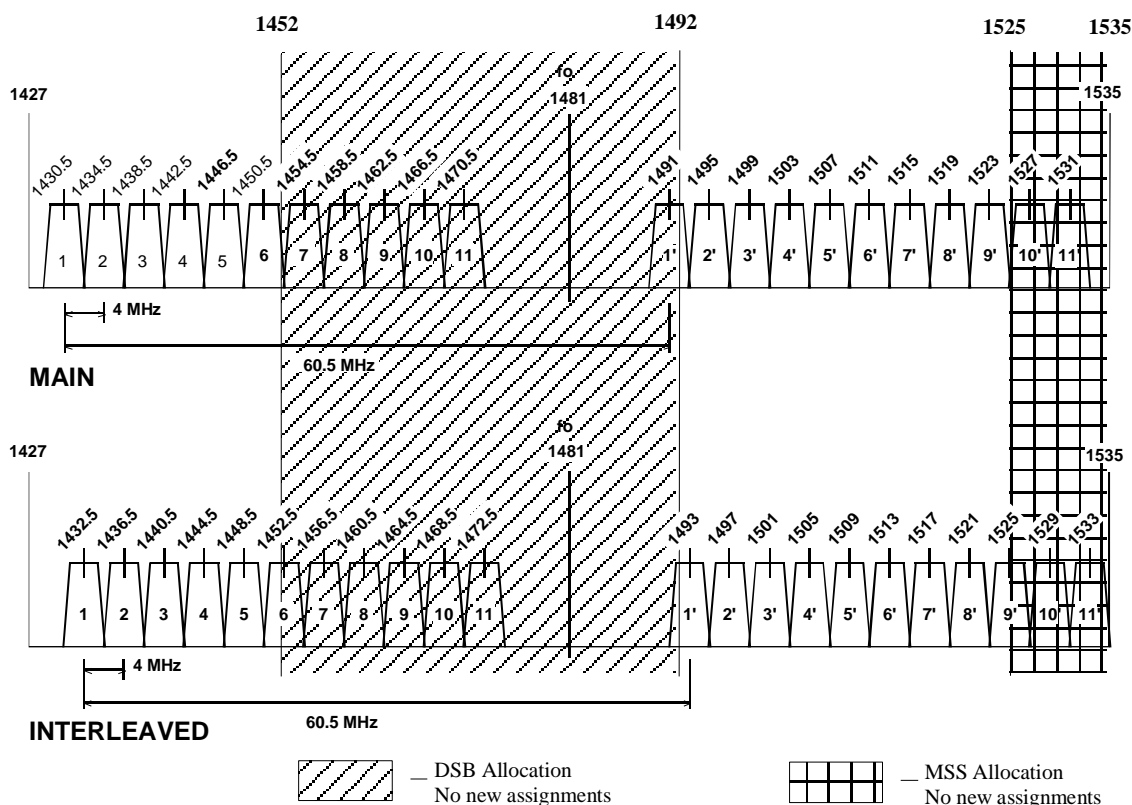
Planned channel arrangements are available in Annex A.

ANNEX A. FIXED SERVICES PLANS.

1.1 The 1.5 GHz band

THE 1.5 GHz BAND (1427-1535 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

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

Typical Use : >2 Mbit/s data

Minimum Path Length : 20 km

Antenna Requirements : Minimum 1.2 m grid-pak style antenna or minimum 21 dBi gain.

Channel Aggregation : Channel aggregation up to 20 MHz (5 channels) is permitted providing coordination can be achieved and only for paths exceeding 20 km. In order to preserve the band for longer hops channel aggregation is not permitted for any path below 20 km.

Notes:

1. The use the minimum antenna type preserves the band for future users.
2. Due to evaporation ducting coordination for an over water path shall use the actual path length or 20 km **whichever is the lesser**.

PROTECTION RATIOS

1. Protection ratios required between digital systems operating on 2, 4 and 8 MHz and greater aggregated bandwidth channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)				Aggregated Channels	Greater
	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	8 MHz → Any width	> 8 MHz into any other channel
2	30	55	50	55	55	60
4		25	20	30	40	50
6				8	20	30

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. No aggregation of legacy analogue systems is permitted.

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				40
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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. No aggregation of legacy analogue systems is permitted. Analogue systems receive maximum protections specified below from any digital system whether greater than 4 MHz bandwidth or otherwise.

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:

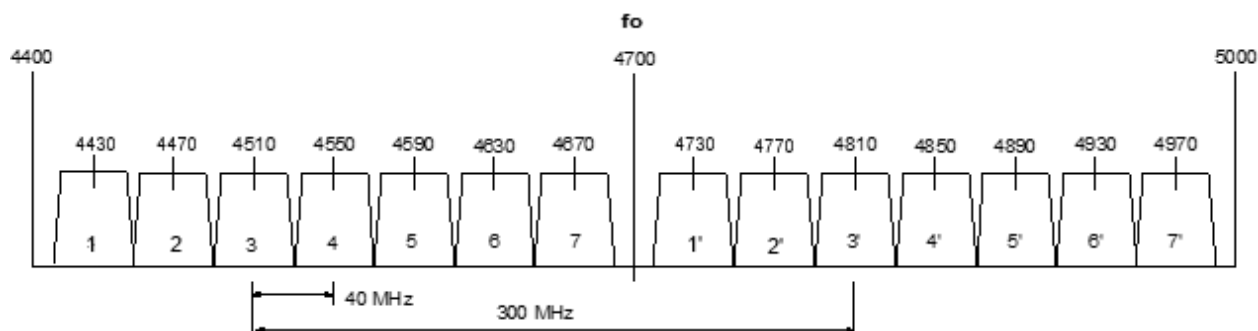
1. Protection ratio for digital systems are based on a 60 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20. Currently path length correction is not deemed necessary.

The 5 GHz band

This plan provides radio-frequency channel arrangements for fixed services operating in the 5 GHz band (4 400-5 000 MHz), which may be used for high- and medium-capacity fixed systems, based on a 10 MHz common pattern.

THE 5 GHz BAND (4400 - 5000 MHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

Typical Use	: 155 Mbit/s (STM-1) or equivalent.
Assignment Priority	: Assign from Channel 1.
Minimum Path Length	: 20 km
Antenna Requirements	: 1.2 m parabolic dish minimum.
Protection Requirements	: 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

Orthogonal polarization may be used to achieve coordination; allow 20dB.

Channel aggregation

Channels may be aggregated to form 80 MHz channels or split to form 20 MHz channels in line with ITU-R F1099. Where aggregation is used the term '2nd adjacent channel' refers to a channel separated by the bandwidth of the aggregated channel.

References:

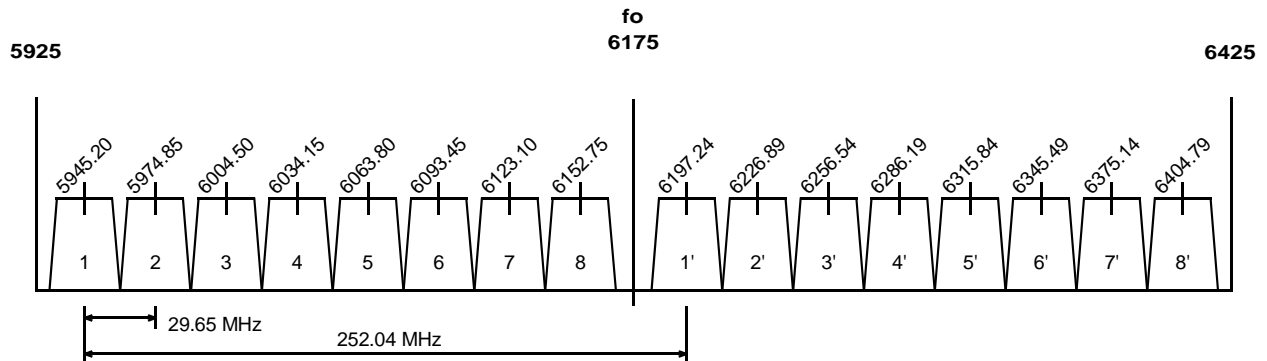
1. Rec. ITU-R F.1099-3, "Radio-frequency channel arrangements for high-capacity digital radio-relay systems in the 5 GHz (4400-5000 MHz) band", 2013.

The 6 GHz band

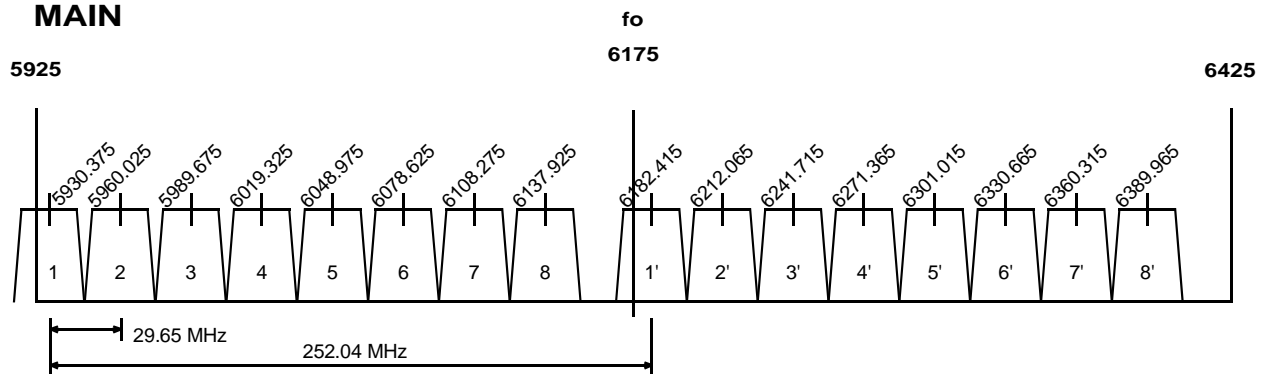
This plan provides radio-frequency channel arrangements for fixed services operating in the 6 GHz band (5925 - 6425 MHz), which may be used for high- and medium-capacity fixed systems, based on a 29.65 MHz common pattern.

THE 6 GHz BAND (5925 - 6425 MHz)

RF CHANNEL ARRANGEMENTS



MAIN



INTERLEAVED

ASSIGNMENT INSTRUCTIONS

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

Typical Use : 34 Mbit/s data, FM Video

Assignment Priority : not specified

Minimum Path Length : 20 km

Antenna Requirements : 1.2 m parabolic.

Note:

- Proposed links need to be coordinated with licensed earth stations operating in this band.

- All terrestrial fixed services in this band operate on a no protection basis from interference from uplinks in the Fixed satellite Service (FSS) except where those services are aboard visiting ships or aircraft.

Reference

- 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

- Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	14.825 MHz ↓ 14.825 MHz	14.825 MHz ↓ 29.65 MHz	29.65 MHz ↓ 14.825 MHz	29.65 MHz ↓ 29.65 MHz
0	60	60	60	60
14.825	30	45	55	57
29.65		23	20	30

- 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 ↓ 14.825 MHz	29.65 MHz ↓ 29.65 MHz	14.825 MHz ↓ 29.65 MHz	29.65 MHz ↓ 29.65 MHz

0	60	60	60	60
14.825	42	55	40	58
29.65		21	0	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

Notes:

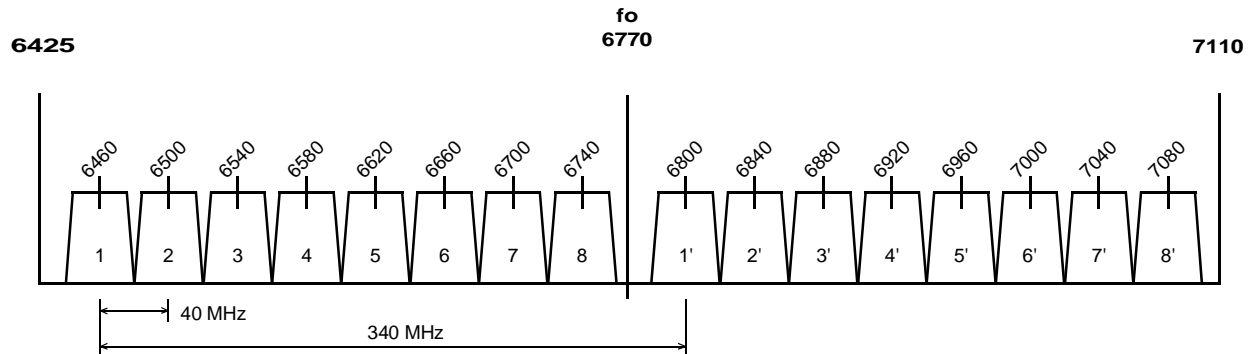
1. Protection ratio for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20.

The 6.7 GHz band

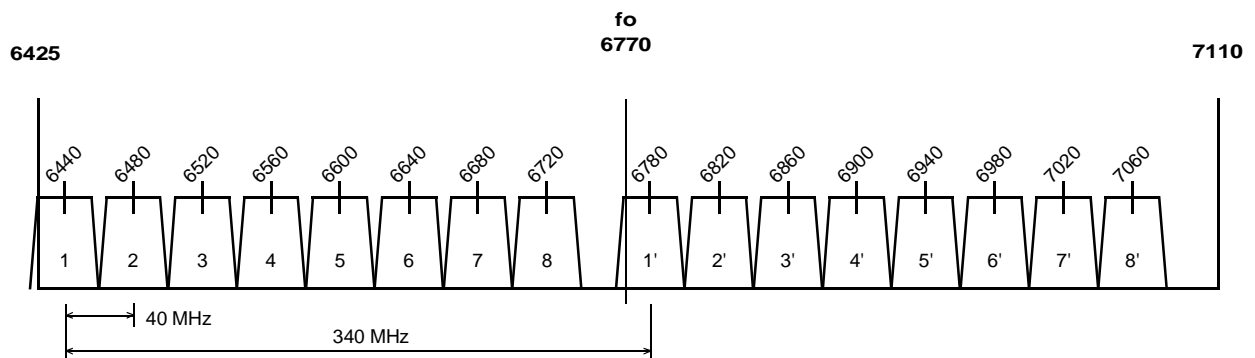
The 6.7 GHz band is designed to offer high capacity channels capable of supporting 140 Mbit throughput.

THE 6.7 GHz BAND (6425 - 7110 MHz)

RF CHANNEL ARRANGEMENTS



MAIN



INTERLEAVED

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 : 1.2 m parabolic

Note:

1. Proposed links need to be coordinated with licensed earth stations operating in this band.

2. All terrestrial fixed services in this band operate on a no protection basis from interference from uplinks in the Fixed satellite Service (FSS) except where those services are aboard visiting ships or aircraft.

Reference

1. Rec. ITU-R F.384-10, "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

Protection Ratios are:

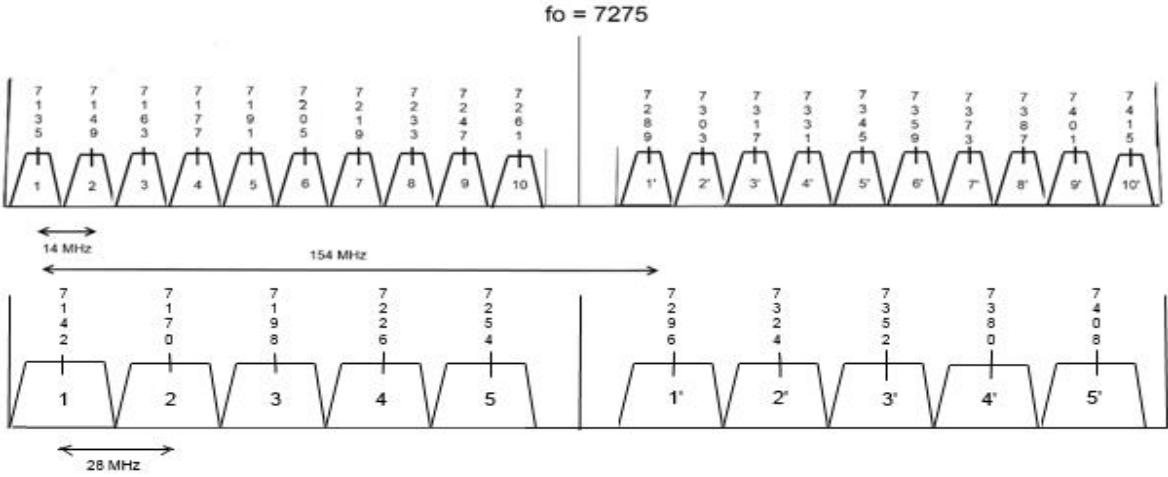
Co-channel:	60 dB
1st adjacent channel:	30 dB
2nd adjacent channel:	0 dB

Note:

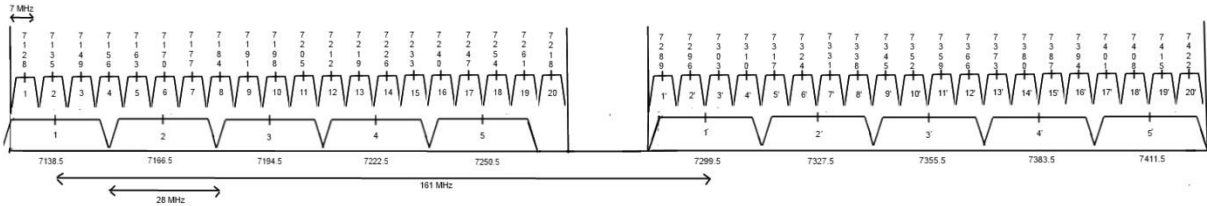
1. Protection ratios for digital systems are based on a 50 km path length and P_L (Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to $-100 N$ units/km) of 20.

The 7.2 GHz Band (7125 – 7425 MHz).

The 7.2 GHz band is designed to offer flexible arrangements capable of supporting channel bands widths of 14MHz, 28MHz and 56 MHz through aggregation of 14 MHz channels.



Preferred Arrangements from F.385 (10) (154 MHz Duplex)



Alternate Arrangements (161 MHz Duplex)

The alternate arrangements should only be used in extenuating circumstances. There are included to allow flexibility.

ASSIGNMENT INSTRUCTIONS

- Typical Use** : flexible high capacity data links.
- Assignment Priority** : Assign from Channel 1.
- Minimum Path Length** : 20 km
- Minimum Antenna Requirements** : 1.2 m parabolic dish minimum.
- Protection Requirements** : Protection ratios required between digital systems operating on the same channel raster.

Co Channel: 60 dB

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

Some systems in Vanuatu may not be compliant with Rec F.385-10 and instead use an older Recommendation or an Annex to F.385. In this case any overlap means the system is co-channel. 1st adjacent must not overlap at all and 2nd adjacent must be one equivalent channel width away.

Orthogonal polarization may be used to achieve coordination; allow 20dB cross polar discrimination in the main beam but take care where reflections may be possible. Note that cross polar discrimination reduces beyond the main beam of an antenna.

Example: An antenna has a gain of 40 dBi. If another system uses orthogonal polarization then this may be reduced to 20 dBi. The cross polar discrimination of 20 dB may be subtracted from the gain of the antenna and the highest of this or the antenna gain used. If actual antenna patterns and discriminations are available these may be used.

Channel aggregation

Channels may be aggregated or split to form from 7 MHz up to 56 MHz channels in line with ITU-R F.385-10. Where aggregation is used the term '2nd adjacent channel' refers to a channel separated by the bandwidth of the aggregated channel.

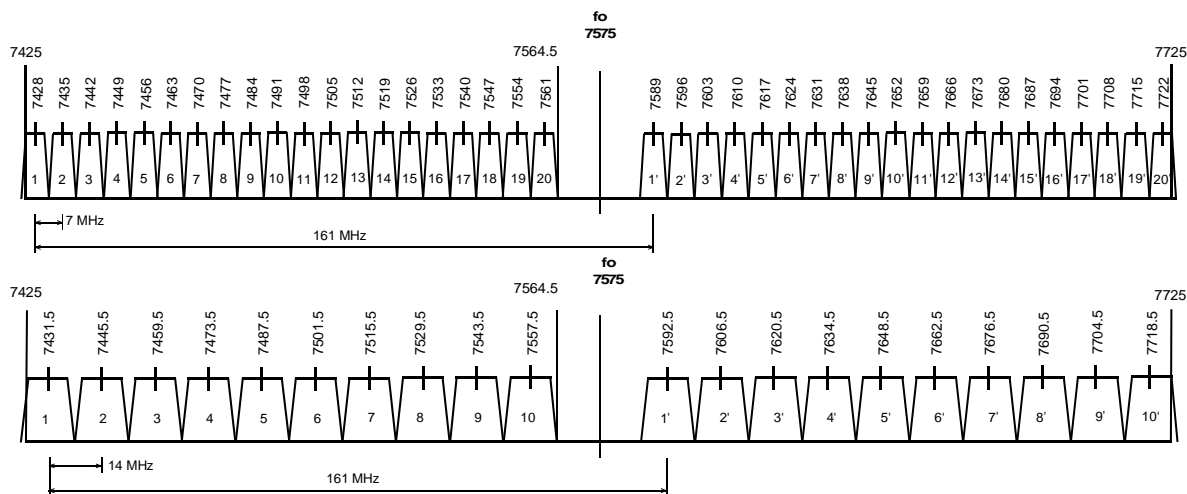
Note: Protection ratio for digital systems are based on a 50 km path length and P_L (*Percentage of time that the average refractivity gradient in the lowest 100 m of the atmosphere is less than or equal to -100 N units/km*) of 20.

References:

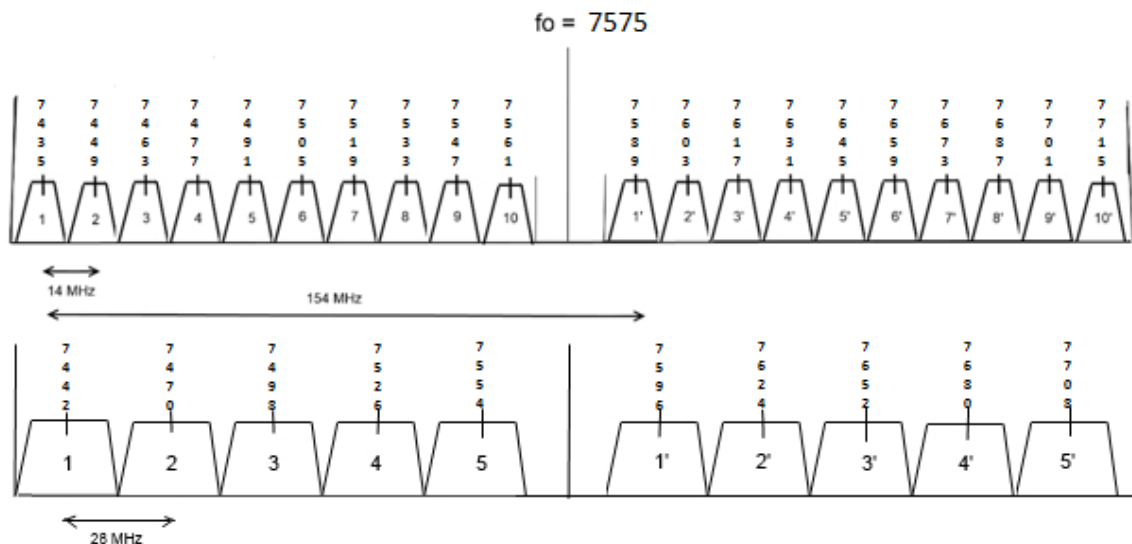
1. Rec. ITU-R F.385-10, " Radio-frequency channel arrangements for fixed wireless systems operating in the 7 110-7 900 MHz band ", 2012.

The 7.5 GHz band.

**THE 7.5 GHz BAND (7425 - 7725 MHz)
RF CHANNEL ARRANGEMENTS**



Preferred Arrangements with 161 MHz Duplex.



Alternative Arrangements with 154 MHz Duplex.

ASSIGNMENT INSTRUCTIONS

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

Typical Use : 2-20 Mbit/s data

Assignment Priority : See Note 1.

Recommended Minimum Path Length : 20 km

Minimum Antenna Requirements : 1.2m Parabolic.

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. Assignments on the 7 MHz Ch1 must coordinate with services in the 7.2 GHz band using the same protection ratios defined below.
3. Channel aggregation is permitted. Where aggregation is used the term '2nd adjacent channel' refers to a channel separated by the bandwidth of the aggregated channel.

References

1. Rec. ITU-R F.385-10, "Radio-frequency channel arrangements for radio-relay systems operating in the 7 GHz band".

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

Some systems in Vanuatu may not be compliant with Rec F.385-10 and instead use an older Recommendation or an Annex to F.385. In this case any overlap means the system is co-channel. 1st adjacent must not overlap at all and 2nd adjacent must be one equivalent channel width away.

Orthogonal polarization may be used to achieve coordination; allow 20dB cross polar discrimination in the main beam but take care where reflections may be possible. Note that cross polar discrimination reduces beyond the main beam of an antenna.

Example: An antenna has a gain of 40 dBi. If another system uses orthogonal polarization then this may be reduced to 20 dBi. The cross polar discrimination of 20 dB may be subtracted from the gain of the antenna and the highest of this or the antenna gain used. If actual antenna patterns and discriminations are available these may be used.

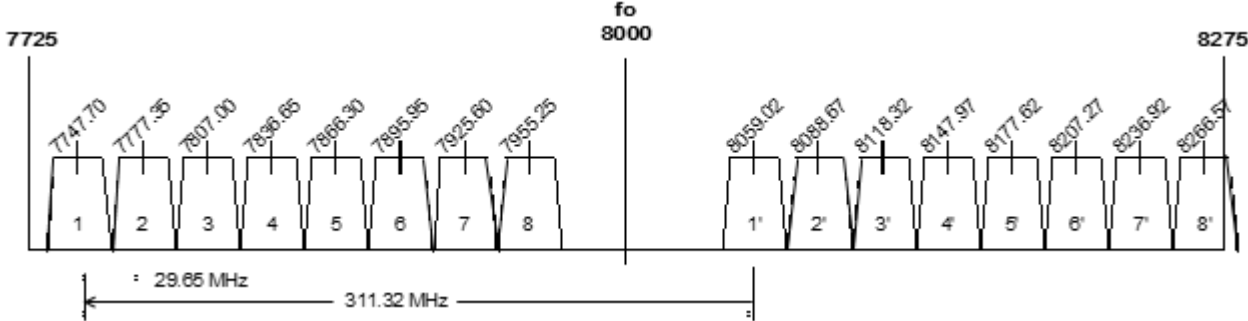
Notes:

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.

The 8 GHz Band

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** : 34 Mbit/s data or greater
- Assignment Priority** : from the lowest channel upwards.
- Minimum Path Length** : 10 km
- Antenna Requirements** : 1.2 m parabolic minimum

Reference

1. Rec. ITU-R F.386-9 (2013), "Radio-frequency channel arrangements for fixed wireless systems operating in the 8 GHz (7725 to 8500 MHz) band".

PROTECTION RATIOS

1. Protection ratios required between digital systems.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Interferer Tx → Digital Victim Rx			
	14.825 MHz	14.825 MHz	29.65 MHz	29.65 MHz
	↓	↓	↓	↓
	14.825 MHz	29.65 MHz	14.825 MHz	29.65 MHz
0	60	60	60	60
14.825	30	45	55	57

29.65		23	20	30
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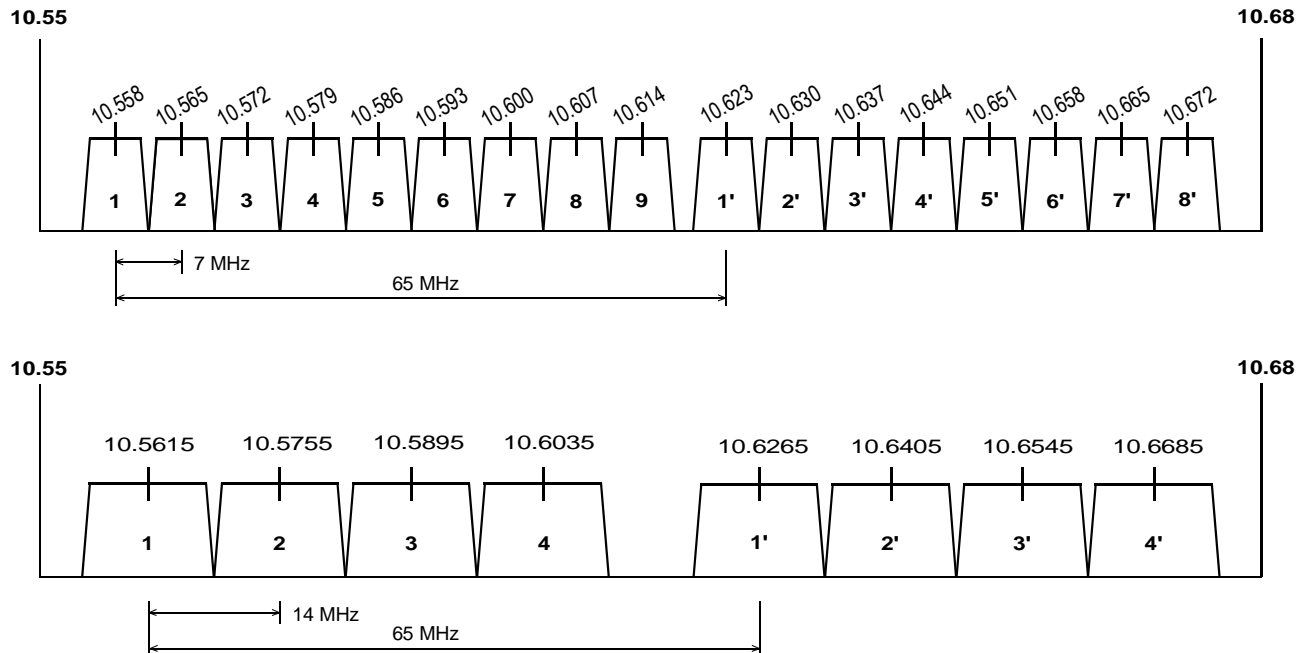
Notes:

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.
2. These arrangements are based upon the 29.65 MHz channel bandwidths specified in ITU-R F.386-9. Channels of 14 and 28 MHz are also supported within these arrangements. If these channels overlap any portion of another channel then the protection ratio for a 0 MHz offset must be used. If there is a 14 MHz separation the 14.825 MHz protections may be used and if there is a 28 MHz separation then those for 29.65 may be used.

The 10 GHz band

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 or greater

Assignment Priority : See Note 1.

Minimum Path Length : 1 km

Antenna Requirements : 0.8 m parabolic minimum

Maximum Antenna Elevation : < 20 degrees above the horizon. See Note 2.

Maximum power to the antenna port : -15 dBW. See Note 3.

Notes:

- 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. When feeding towers from low structures such as buildings designers must ensure a maximum elevation of 20 degrees is not exceeded.
3. Where automatic transmitter power control is used to overcome rain fade the power to the antenna port may be increased to -3 dBW.

References

Rec. ITU-R F.747, "Radio-frequency channel arrangements for radio-relay systems operating in the 10 GHz band".

PROTECTION RATIOS

1. 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	60	60	60	60
3.5		60	60	
7	35	60	55	60
10.5		55	45	
14	20	30	20	55
17.5		10	10	

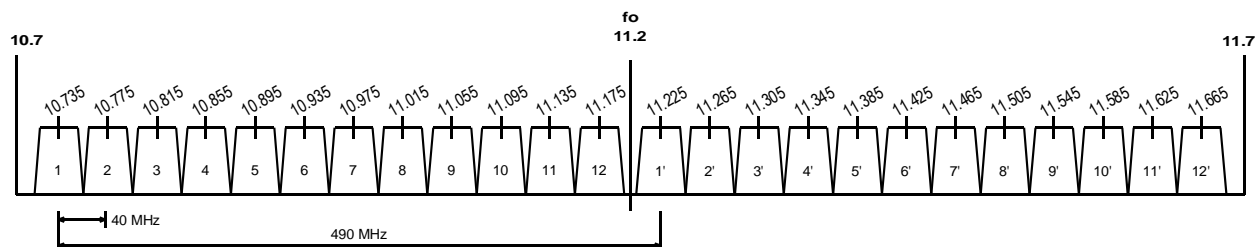
Notes:

1. 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. The protections above take into account a fade into the victim receiver of 5dB. Designers are advised to properly design systems for rain depending on system availability requirements.

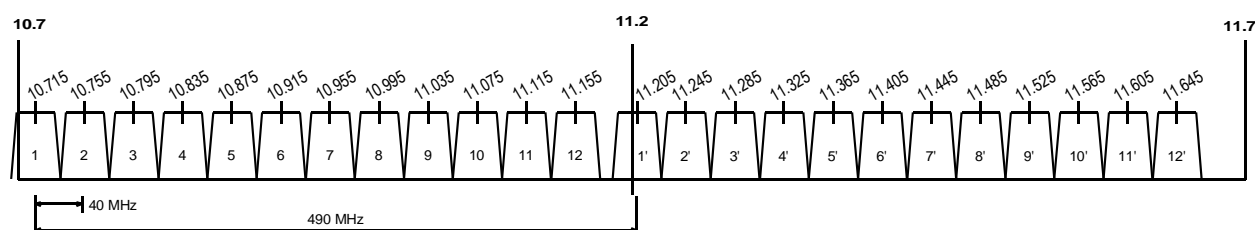
The band 10.7 – 11.7 GHz; the 11 GHz band.

11 GHz BAND (10.7 - 11.7 GHz)

RF CHANNEL ARRANGEMENTS



MAIN



INTERLEAVED

ASSIGNMENT INSTRUCTIONS

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

Typical Use : 140/155 Mbit/s data

Assignment Priority : not specified

Minimum Path Length : 1 km

Antenna Requirements : 1.2 m parabolic

Note:

1. Assignments made on interleaf channel 1 must coordinate with systems using the 10 GHz plan due to adjacent band considerations.
2. Proposed fixed links need to be coordinated with earth stations operating in this band.
3. All terrestrial fixed services in this band operate on a no protection basis from interference from uplinks in the Fixed satellite Service (FSS) except where those services are aboard visiting ships or aircraft.

Reference

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

11 GHz BAND (10.7 - 11.7 GHz)

PROTECTION RATIOS

Protection ratios for systems operating in the 11 GHz band are:

Co-channel or overlapping channels:	60 dB
1st adjacent channel:	30 dB
2nd adjacent channel:	0 dB

Notes:

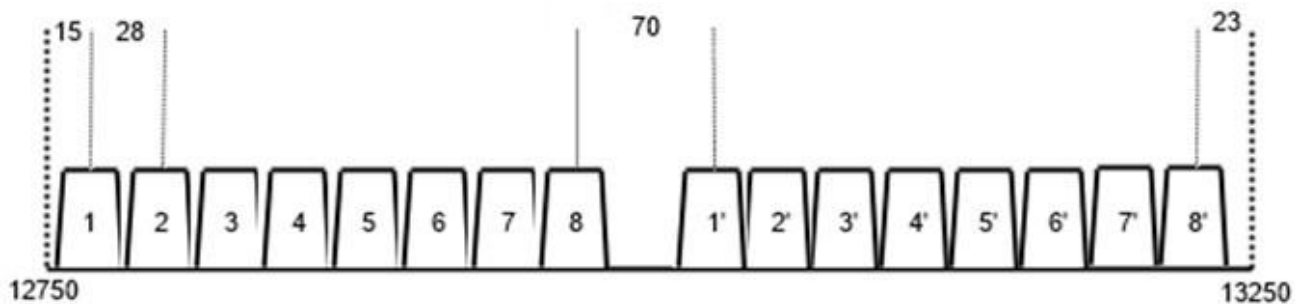
1. The “co-channel” protection ratio shall apply in cases where any portion of the interfering and victim channels overlap.
2. The “1st adjacent channel” protection ratio shall apply in cases where the interfering and victim channels do not actually overlap but are immediately adjacent to each other.
3. Protection ratios for digital systems are based on a 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.

The 13 GHz band

The 13 GHz band provides channels capable of supporting data rates of up to 34 Mbits over short paths.

THE 13 GHz BAND (12.75 - 13.25 GHz)

RF CHANNEL ARRANGEMENTS



ASSIGNMENT INSTRUCTIONS

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

Typical Use : FIXED - 34 Mbit/s data

Assignment Priority : not specified

Minimum Path Length : not specified

Antenna Requirements : 0.6 m standard parabolic dish

Notes:

1. Each channel may be subdivided into 14 MHz or 7 MHz channels within a 28 MHz channel maintaining the duplex spacing of 266 MHz.
2. Proposed fixed links need to be coordinated with earth stations operating in this band.
3. All terrestrial fixed services in this band operate on a no protection basis from interference from uplinks in the Fixed satellite Service (FSS) except where those services are aboard visiting ships or aircraft.

References

1. Rec. ITU-R F.497-7, "Radio-frequency channel arrangements for fixed wireless 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	28 MHz	28 MHz
	↓	↓	↓	↓
	14 MHz	28 MHz	14 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 Interferer Tx	
	↓		↓	
	Digital Victim Rx		Analogue Victim Rx	
	28 MHz	28 MHz	14 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

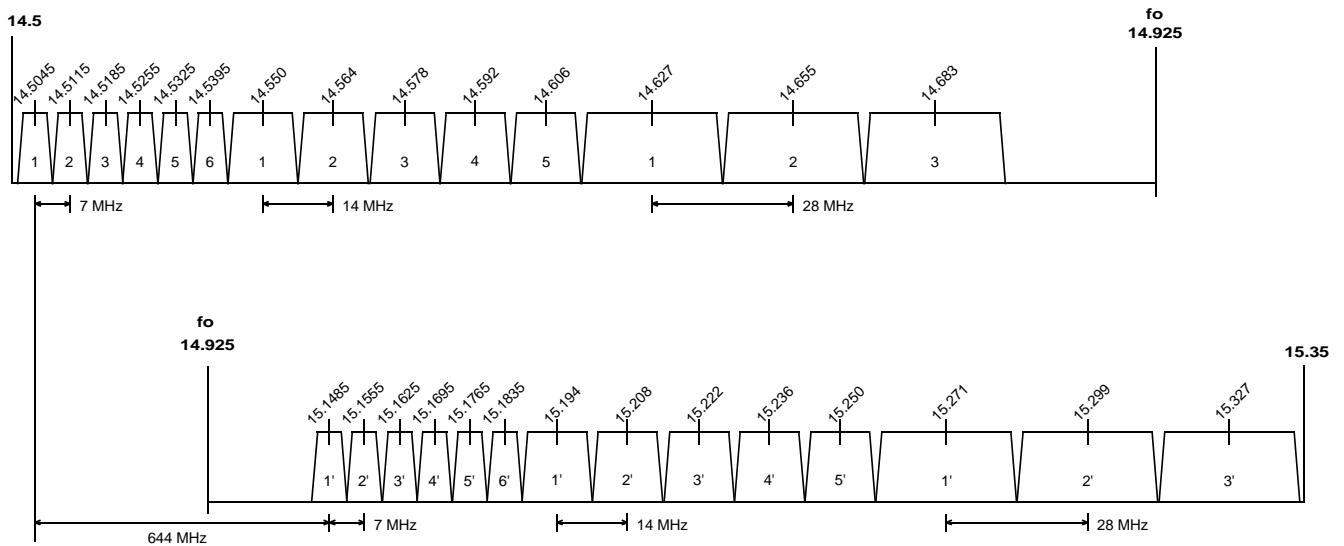
Notes:

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.

1.11 The 15 GHz Band

The 15 GHz band (14.5 – 15.35 GHz) is designed to provide channels for low and medium capacity fixed links over short path lengths.

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 : Not specified.

Antenna Requirements : Not specified.

Note:

- Assignment priorities are defined as follows:
 - 28 MHz channels - from highest channel downward;
 - 14 MHz channels - from lowest channel upward; and
 - 7 MHz channels - from lowest channel upward.

References

- Rec. ITU-R F.636-4, "Radio-frequency channel arrangements for fixed wireless 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 and analogue systems requiring 14 and 28 MHz channels.

Frequency Offset (MHz)	PROTECTION RATIO (dB)			
	Digital Tx ↓ Digital Rx		Analogue Tx ↓ Digital Rx	Digital Tx ↓ Analogue Rx
	14 MHz ↓ 28 MHz	28 MHz ↓ 14 MHz	28 MHz ↓ 14 MHz	14 MHz ↓ 28 MHz
0	60	60	60	60
7	60	58	60	60
21	35	33	30	30

4. 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

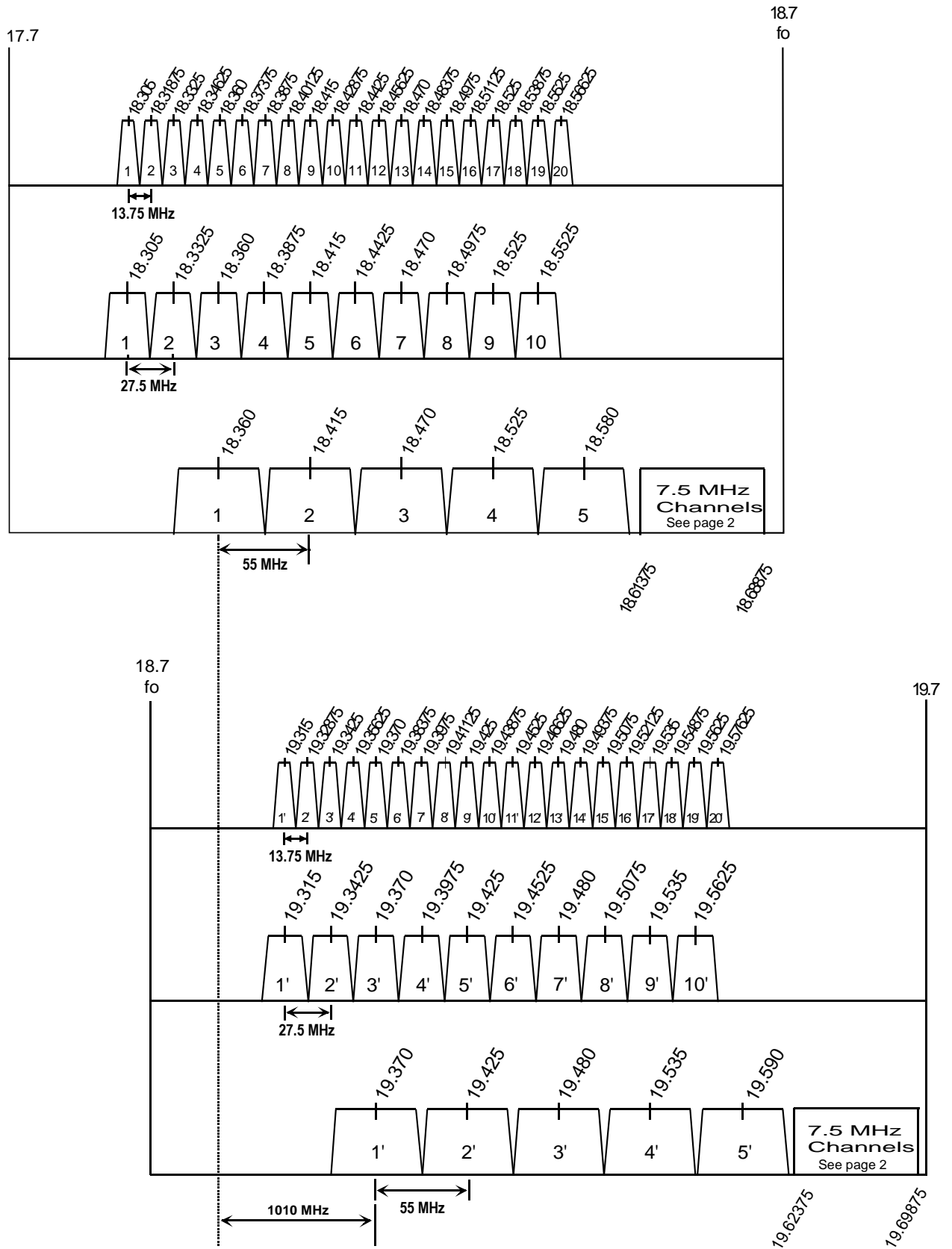
Notes:

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.

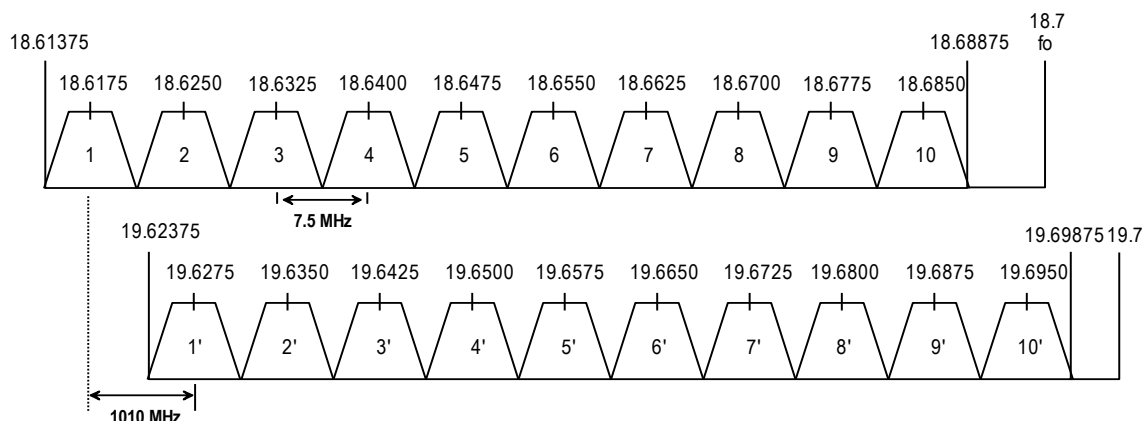
The 18 GHz Band

The 18 GHz band (17.7 – 19.7 GHz) provides highly flexible arrangements for data systems operating over short paths.

THE 18 GHz BAND (17.7 - 19.7 GHz) RF CHANNEL ARRANGEMENTS



RF CHANNEL ARRANGEMENTS
Sub-Bands 18.61375 - 18.68875 GHz and 19.62375 - 19.69875 GHz
(7.5 MHz Channeling)



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** : Not specified.
- Antenna Requirements** : Not specified.

Notes:

1. Assignments made which would overlap the frequency range 18.8 -19.3 GHz may be required to cease operation in the future.
2. 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.

References

1. Rec. ITU-R F.595-10, "Radio-frequency channel arrangements for radio-relay systems operating in the 18 GHz frequency band".
2. Article 21.5A, ITU Radio Regulations, Edition of 2001.

3. Resolution 802 (WRC-03) Agenda of the 2007 World Radiocommunication Conference, Agenda item 1.2.
4. 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:

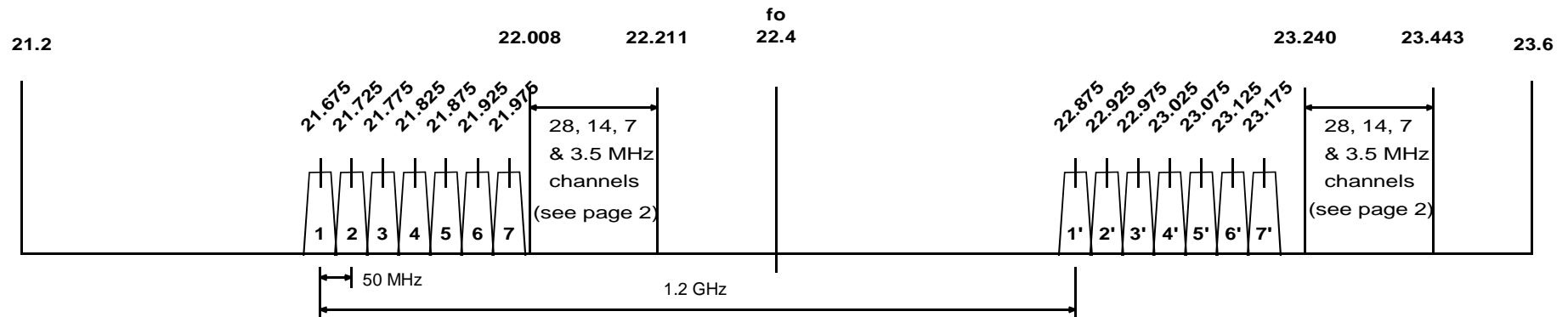
Co-channel or overlapping channels	60dB
1st Adjacent Channel	30dB
2nd Adjacent Channel	0 dB

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.

The 22 GHz band

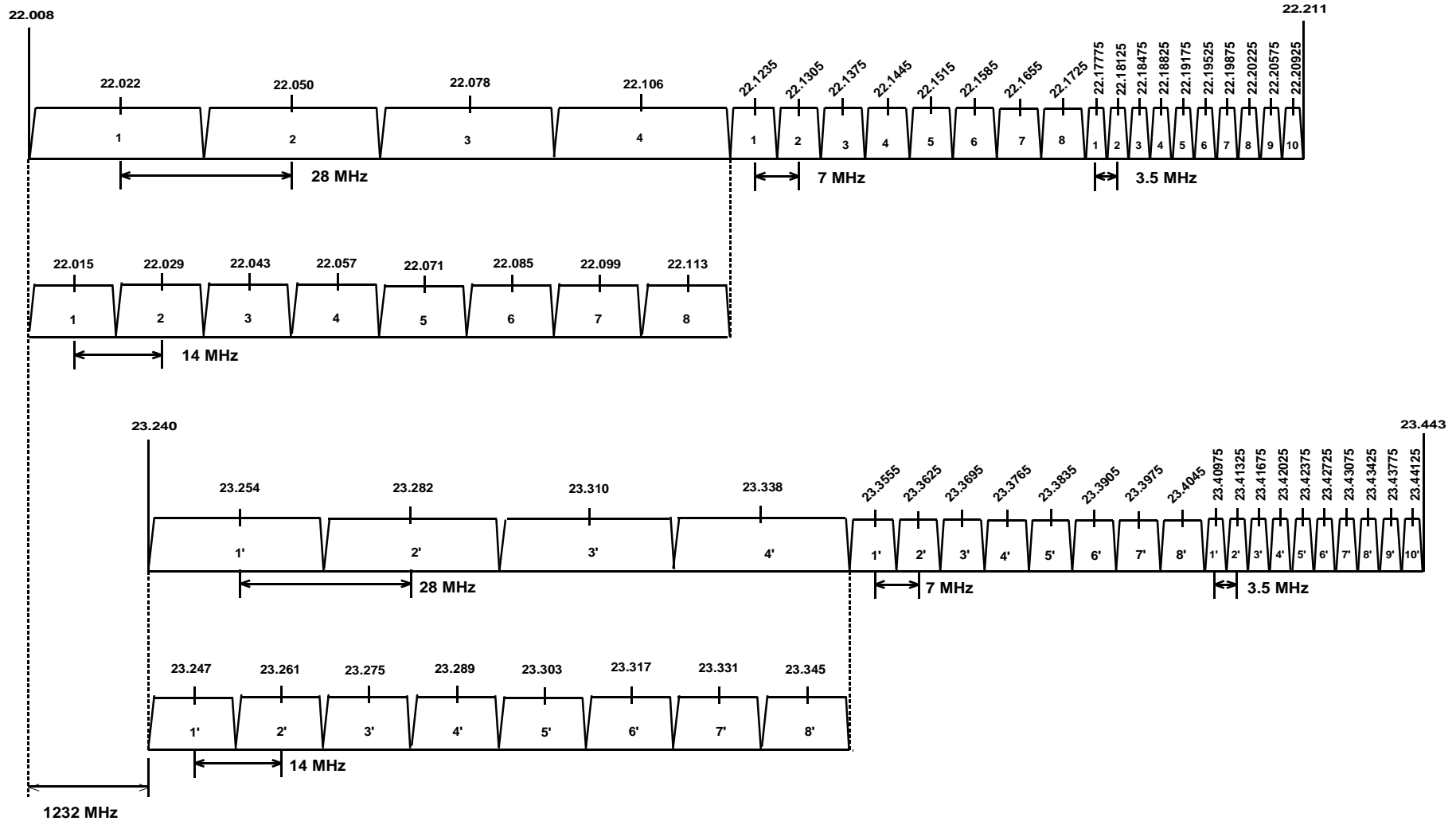
THE 22 GHz BAND (21.2 - 23.6 GHz) RF CHANNEL ARRANGEMENTS



CHANNEL CENTRE FREQUENCIES (GHz)											
Channels		50 MHz Channels		28 MHz Channels		14 MHz Channels		7 MHz Channels		3.5 MHz Channels	
1	1'	21.675	22.875	22.022	23.254	22.015	23.247	22.1235	23.3555	22.17775	23.40975
2	2'	21.725	22.925	22.050	23.282	22.029	23.261	22.1305	23.3625	22.18125	23.41325
3	3'	21.775	22.975	22.078	23.310	22.043	23.275	22.1375	23.3695	22.18475	23.41675
4	4'	21.825	23.025	22.106	23.338	22.057	23.289	22.1445	23.3765	22.18825	23.42025
5	5'	21.875	23.075			22.071	23.303	22.1515	23.3835	22.19175	23.42375
6	6'	21.925	23.125			22.085	23.317	22.1585	23.3905	22.19525	23.42725
7	7'	21.975	23.175			22.099	23.331	22.1655	23.3975	22.19875	23.43075
8	8'					22.113	23.345	22.1725	23.4045	22.20225	23.43425
9	9'									22.20575	23.43775
10	10'									22.20925	23.44125

THE 22 GHz BAND (21.2 - 23.6 GHz)

SUB-BANDS 22.008-22.211 and 23.240-23.443 GHz



THE 22 GHz BAND (21.2 - 23.6 GHz)

ASSIGNMENT INSTRUCTIONS

This band is designated for use by fixed point-to-point links and offers a wide variety of channel bandwidths to support a number of requirements.

Typical Use	: 2/8 Mbit/s data or greater.
Assignment Priority	: none
Minimum Path Length	: none
Antenna Requirements	: Parabolic. No requirements on diameter. See Note 2.

Notes:

1. Assignment priorities for point-to-point services are defined as follows:
 - 50 MHz channels (4/4'..7/7') - 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;
 - 3.5 MHz channels - from the highest channel downward.
2. This band is highly susceptible to rain fade. While no antenna size is specified to enable the use of compact equipment designers are advised to ensure there is sufficient margin to ensure availability targets are met.

References

1. Rec. ITU-R F.637-4, "Radio-frequency channel arrangements for radio-relay systems operating in the 23 GHz band".

PROTECTION RATIOS

1. Protection ratios required 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 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	

3. 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

4. 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
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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.