

# RALI-AA2

Radiocommunications Assignment and Licensing Instruction - Amateur Assigned 2

## Amateur (Assigned) Repeater Station Frequency Assignment Requirements (Excluding the 146 & 438 MHz bands)

FINAL RELEASE Version 5.0

23<sup>rd</sup> October 2024

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# 1 Introduction

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This document contains technical instructions to facilitate the selection of frequencies for the operation of amateur assigned repeater stations within the amateur service spectrum in Australia, once the need to obtain an amateur assigned licence has been determined. For any questions on whether a particular licence is required, applicants should first contact the [Australian Communications and Media Authority](#).

Specifically, this document details frequency selection criteria for the following types of assigned frequency amateur repeater stations.

- All stations operating on the 29 MHz amateur band.
- All stations operating on the 53 MHz amateur band.
- All stations operating on the 1273 MHz amateur band.
- Amateur television (ATV) repeater stations operating between 400 MHz and 10.5 GHz.

Assignment requirements for repeater stations on the following frequency bands are found in the associated corresponding RALI.

- Beacon Stations – RALI-AA01.
- Repeater & Link Stations operating between 144 – 148 MHz – RALI-AA03.
- Repeater & Link Stations operating between 430 – 450 MHz – RALI-AA04 (excluding ATV).

Where interactions are required to be assessed between amateur repeater stations and amateur beacon stations, information about those beacon stations can be obtained from document RALI-AA01.

## 1.1 Basis for amateur service spectrum planning

The Amateur Radio Service band-plans plans are derived from international plans set down by the International Amateur Radio Union (IARU). Broad segment allocations, particularly for international activity relating to satellites and inter-continental communications, have been defined across all amateur service radio spectrum. The WIA, as the representative body of the IARU in Australia, is responsible for maintaining the amateur service band plans in Australia while ensuring they are always consistent with the Radiocommunications Licence Conditions (Amateur Licence) Determination 2015<sup>1</sup>.

Australian Amateur Service Band plan information is available here:

- <https://www.wia.org.au/members/bandplans/data/>

For amateur assigned repeater stations, it is a requirement that an assignment first be attempted based on the instructions provided in this RALI. The channel plans in this RALI for assigned amateur repeater stations are derived from the Australian amateur radio band plans. They have been designed to minimise interference to both assigned and class licenced amateur radio stations. Where no assignment

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<sup>1</sup> <https://www.legislation.gov.au/F2015L01113/latest/text>

solution can be found or the proposed amateur assigned repeater station does not fit the service models described in this instruction, then the ACMA non-standard assignment process should be followed as described in the ACMA Amateur (Assigned) Station Frequency assignment practices ‘**Guideline No. 10 — Application process for assigned amateur beacons and repeaters**’<sup>2</sup> (FAP 10)

Operators of amateur assigned stations should also recognise that class licenced amateur stations are not prevented from operating anywhere in the radio spectrum assigned to the amateur service (in accordance with their own licence conditions). However, class licenced amateur stations have been requested to voluntarily follow the defined amateur radio band plan to manage interference between different activities and in particular amateur assigned stations.

## 1.2 Grand-fathered frequency allocations

The Amateur band plans have evolved multiple times particularly over the past 30 years. This evolution has occurred in response to changing environmental conditions, particularly on spectrum bands where the amateur service has only secondary status in the Australian Radiofrequency Spectrum Plan (ARSP).

Due to the costs and disruption involved in making changes to established systems, the current practice is that those established legacy stations are not expected to change frequencies when the band plans are revised, unless:

- a) They are required to make changes to their station in response to changes within the amateur radio service LCD; or
- b) Wish to take advantage of the improved arrangements offered by the new band plan; or
- c) Are planning other changes to services co-located with the legacy service, in which case they are encouraged to migrate their existing systems to the new channel plan at the same time.

It should be noted that that legacy band plans are not relevant when selecting frequencies for new or upgraded services. Should an assigned amateur service station operator seek to amend or change the nature of their service, they should align their service frequencies with the band plan in force on the day.

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<sup>2</sup> <https://www.acma.gov.au/frequency-assignment-practices>

## 2 Assigned Amateur Station Classifications

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### 2.1 Amateur Analogue Voice Repeater Station

An analogue voice repeater station in the amateur service is typically a duplex station using 16K0F3E modulation (narrowband FM) where the station is transmitting and receiving simultaneously using two frequencies, one for transmit and one for receive. These stations are usually sited at elevated locations to provide a wide area service to multiple amateur radio operators.

### 2.2 Amateur Digital Voice Repeater Station

A digital voice repeater station in the amateur service is typically a duplex station using 6K25F9W modulation (D-STAR<sup>3</sup> protocol-based systems) or 11K3F9W (C4FM<sup>4</sup> or DMR<sup>5</sup> (P25 derivative) based systems where the station is transmitting and receiving simultaneously using two frequencies, one for transmit and one for receive. These stations are usually sited at elevated locations to provide a wide area service to multiple amateur radio operators.

### 2.3 Amateur Mixed Analogue/Digital Voice Repeater Station

A mixed analogue/digital voice repeater system station in the amateur service is a station that can operate in both analogue and digital modes on a time-shared basis. Currently the C4FM repeater systems can also operate in analogue mode. These systems should only be assigned to operate on certain repeater sub-bands (see information below for details).

### 2.4 Amateur Analogue/Digital Gateway Station

An analogue gateway station in the amateur service provides a connection from a tunnelled audio link (often carried via VOIP technologies on the Internet) onto the amateur radio spectrum, typically using 16K0F3E narrowband FM modulation or 11K3F9W GMSK Digital modulation. These stations use single frequency Tx/Rx operations to relay amateur station audio from licenced radio amateurs received via commercial carriage services out onto local amateur frequencies.

### 2.5 Amateur Store and Forward Single Frequency Data Repeater Station

A store and forward single frequency repeater station is using typically AFSK, GMSK or QPSK (or similar) signals formatted to send packets of data that are stored and then on-forwarded once they are received

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<sup>3</sup> DSTAR system specification (Japan Amateur Radio League) <https://www.jarl.com/d-star/shogen.pdf>

<sup>4</sup> C4FM System Specification document (Yaesu) [https://www.yaesu.com/downloadFile.cfm?FileID=9039&FileCatID=263&FileName=Yaesu\\_Amateur%20Radio%20Digital%20Specs\\_1V02\\_EN-GB.pdf](https://www.yaesu.com/downloadFile.cfm?FileID=9039&FileCatID=263&FileName=Yaesu_Amateur%20Radio%20Digital%20Specs_1V02_EN-GB.pdf)

<sup>5</sup> Amateur Radio adaptation of the commercial DMR standards <https://www.dmrassociation.org/dmr-standards.html>



within a single frequency network. The amateur service typically uses the Amateur (AX.25)<sup>6</sup> transmission protocol for this purpose. The channels are typically low-rate data (1200 bps) although some systems run much higher data rates (and hence higher bandwidths).

A particular use of this technology has been in the APRS<sup>7</sup> (Amateur Position Reporting System) network which is used for various information broadcast and location tracking applications within the amateur service. This, however, is not the only use of these AX.25 protocol-based store and forward repeater stations. These stations are not generally found on the frequency bands referenced in this RALI.

## 2.6 Amateur Repeater Link Single Frequency Station

An amateur repeater link station is used to provide a channel to carry the voice information from one repeater site to another, such that it may be broadcast on an additional amateur repeater station in addition to the one where the voice signal was originated from.

A single frequency amateur repeater link station may be one of:

- TX Only – typically used at the TX site of a 29 MHz two frequency repeater station.
- RX Only – typically used at the RX site of a 29 MHz two frequency repeater station.
- TX/RX – typically used between any two repeater stations on any band.

## 2.7 Amateur Repeater Link Two Frequency Station

An amateur repeater link station is used to provide a channel to carry the voice information from one repeater site to another, such that it may be broadcast on an additional amateur repeater station in addition to the one where the voice signal was originated from.

Two frequency link stations are only relevant on the 1296 MHz amateur band in the context of this RALI. No dedicated linking channels are provided for in the 29 MHz, 53 MHz, and any other band above 2.3 GHz in the current amateur radio service band plans.

# 3 Amateur Repeater Station Service Models

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## 3.1 Service Model Overview

The purpose of the service model for assigned Amateur Repeater stations is to define a set of characteristics that will achieve an agreed service level and acceptable levels of short-term interference that can be tolerated by class licenced amateur radio stations using these assigned repeater services.

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<sup>6</sup> AX.25 standard <https://www.tapr.org/pdf/AX25.2.2.pdf>

<sup>7</sup> Refer to <http://www.aprs.org/> for more information about APRS

Class licenced amateur stations typically have several different configurations.

- Vehicle mounted mobile.
- Handheld.
- Base station – elevated omni-directional antenna.
- Base station – elevated directional antenna (up to 10-18dBi depending on the operating band).

Frequency reuse distances described in this document are defined based on notional vehicle based mobile station characteristics which have been built into the frequency reuse rules defined throughout this document. Home based fixed location and itinerant stations temporarily located on elevated terrain are not considered as their typical configurations would drive excessive frequency reuse requirements (noting home stations can operate using very high gain (10dBi+) directional antennas).

The service model also needs to consider the nature of the spectrum being used and what propagation mechanisms will affect that spectrum. The Amateur Service typically operates repeater stations in all amateur bands between 29 MHz and 1300 MHz. While tropospheric propagation is the dominant mode affecting mode frequency selection decisions, for amateur bands below 100 MHz, additional ionospheric propagation considerations are made which result in additional frequency re-use restrictions. This has led to different service models being developed for different frequency ranges.

For 50 MHz and above systems, the target grade of service is defined as a signal quality of 12 dB SINAD for voice systems or a bit error rate of  $10^{-2}$  for data systems at the receiver output for a 5 dB ratio of wanted to unwanted signals at the receiver RF input terminal. The model defines values that, when satisfied, will on average achieve the expected service level while aiming to provide sufficient adjacent site interference protection for 90% of the time for vehicle mobile based stations.

Below 30MHz, systems also should expect to operate on a no protection from interference basis due to the very scarce number of channels available and the international nature of radio propagation on those frequencies particularly between the regions of Oceania, Asia and North America.

### 3.2 Analogue / Digital (two frequency) Voice Repeater Model 29 / 53 MHz

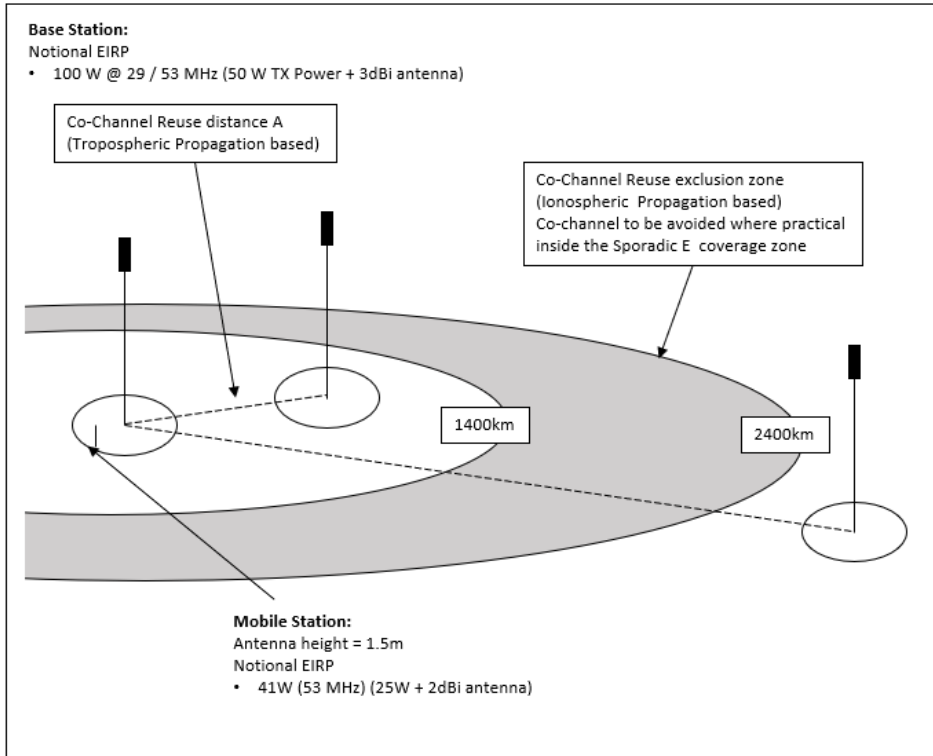


Figure – Amateur Repeater Model < 100 MHz

The key requirements of the service model are:

- Assumed receiver blocking performance of 90dB above the minimum receiver usable sensitivity.

- The use of CTCSS tones to control access to these repeater stations should be a feature of any new system design. Details of the tones available for use are available from the Amateur LCD<sup>8</sup>. While CTCSS use is not mandated or coordinated by ACMA, where co-channel assignments are required, the selection and coordination of CTCSS tone frequencies between systems should be completed by the station custodians prior to commissioning the service. Guidelines for this are set down within the Australian Amateur Radio Band plan.

### 3.2.1 29 MHz Repeater system Assumed System Performance

In assessing amateur repeater system frequency compatibility for all repeater types assigned within the 29.0-29.7 MHz sub-band, the following station characteristics shall be considered.

Characteristic	Value
TX Power	50W Py (47dBm)
TX Antenna Gain	2.2dBi
Feeder / Filter Losses	1dB
Notional Receiver Sensitivity	1.0uV @ 20dB SINAD (-107dBm)
RX Antenna Gain	2.2dBi
Maximum Allowable Path Loss	157dB

When considering these systems below 30MHz the following additional requirements are applied:

- It is typical for 29 MHz repeater stations to be split across 2 sites, with between 2-5 km physical separation between the transmitter and receiver. This is to facilitate the necessary TX/RX isolation. The TX and RX are typically inter-connected using a one-way UHF 430-450 MHz low power links (refer to RALI AA04 for details on assigning this link frequency if it is required).

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<sup>8</sup> Amateur LCD Tone standard definition

### 3.2.2 53 MHz Repeater system Assumed System Performance

In assessing frequency re-use for the amateur repeater stations on this band, the following system characteristics should be considered.

Characteristic	Value
TX Power	50W Py (47dBm)
TX Antenna Gain	2.2dBi
Feeder / Filter Losses	1dB
Notional Receiver Sensitivity	1.0uV @ 20dB SINAD (-107dBm)
RX Antenna Gain	3dBi
Maximum Allowable Path Loss	157dB

### 3.3 Analogue (single frequency) Gateway Station Model (29.12 - 29.14 MHz)

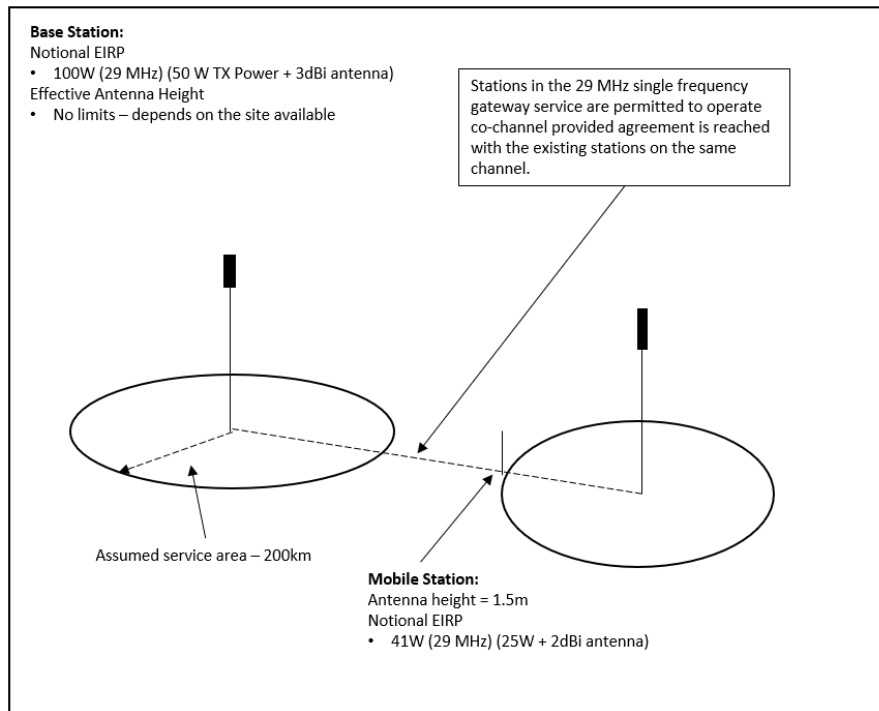


Figure – Amateur 29 MHz Gateway Model

29 MHz simplex (single frequency) analogue narrowband FM gateways are stations which transmit and receive on a single frequency, relaying the audio received signal to/from either an off-band telecommunications carriage service accessible only by licenced amateur radio operators or potentially another linked amateur repeater station on another frequency band (the details of which are of no consequence to the assignment on the 29 MHz band).

Only limited support for these 29 MHz gateway services is possible due to spectrum scarcity. They are to be operated on a shared channel basis where each station operator accepts that interference may occur from other amateur assigned gateway stations as well as class licenced amateur operators using the band.

The use of specific distinct CTCSS tones is encouraged to trigger access to the assigned gateway station. While not a ACMA recorded parameter, the selection of the CTCSS tone used at a particular site should be made by the applicant and in consideration of arrangements already in place with other assigned licence station custodians which are identified as being co-channel, and then that information should be made publicly available by the gateway operator.

These assignments operate on a non-exclusive basis noting that international class licenced amateur stations may also be operating on this band segment unaware of the assigned amateur station located in Australia.

Typical station characteristics are as follows:

Emission	Max Tx Power	Typical Antenna Gain	Polarisation
11K0F9W	50W Py	2dBi	Vertical

### 3.4 Analogue / Digital (Two frequency) Voice Repeater Model > 1 GHz

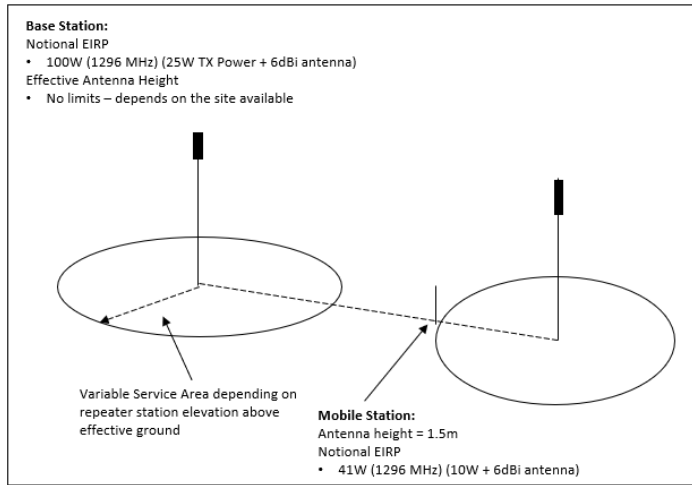


Figure – Amateur Repeater Model

The key requirements of the service model are:

- Assumed receiver blocking performance of 90dB above the minimum receiver usable sensitivity.

Note this model covers the 1296 MHz band only. For 146 or 438 MHz please refer to their respective RALI documents.

#### 3.4.1 1273 MHz Repeater system Assumed System Performance

In assessing frequency re-use for the amateur repeater stations on this band, the following system characteristics should be considered.

Characteristic	Value
TX Power	50W Py (47dBm)
TX Antenna Gain	6.0dBi
Polarisation	Vertical
Feeder / Filter Losses	3dB
Notional Receiver Sensitivity	1.0uV @ 20dB SINAD (-107dBm)
RX Antenna Gain	6dBi
Maximum Allowable Path Loss	161dB



### 3.5 Amateur Television Repeater Station Model

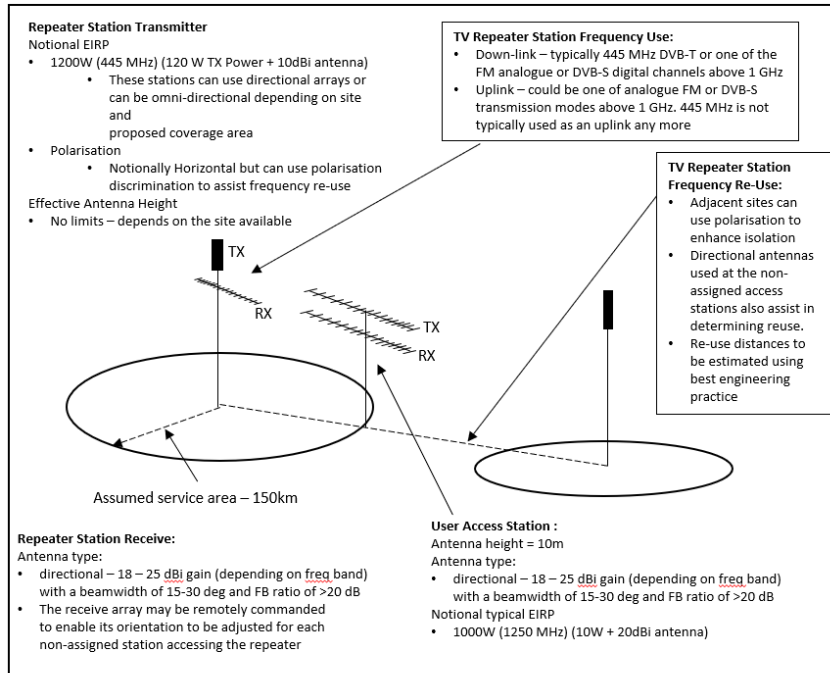


Figure – Amateur Television Repeater Model

Amateur Television repeaters operate in a completely different way to all other amateur radio repeaters.

- They are almost always “cross-band” systems where the repeater transmitter and repeater receiver are on different amateur radio frequency bands.
- They can be cross mode as well –
- where the repeater downlink (transmitter) may be operating using (for example) DVB-T modulation (similar to the public broadcast stations) and the repeater uplink (receiver) may use one of various modulation schemes including analogue wideband (18MHz) FM, DVB-S (7MHz) or even VSB or DSB-AM transmission modes.

Repeater access control is not usually carrier activated. Access control systems including the use of DTMF tone standards via a separate control and command receiver (often operated on the 146 MHz band) are common. There is a high degree of flexibility permitted here. It should be noted that these access control receivers may or may not be recorded on the licence. They often (but not always) are found on one of 147.400, 147.425 or 147.450 MHz (which are the recognised class licenced television activity liaison frequencies used in the amateur service, as described in the amateur radio band plan).

## 4 Frequency Assignment Policy Guidelines

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### 4.1 Overview

Frequency assignment of amateur radio gateway and repeater stations should only be made in alignment with the amateur radio service's band plans. Where an application is made that does not follow the band plan, it should be referred to ACMA and will follow the non-standard application process outlined in FAP 10.

Assigned amateur repeater stations can take on several forms.

- Duplex (two frequency operation) repeater stations often located on elevated sites targeting mobile and / or portable amateur station activity.
- Simplex (single frequency operation) repeater stations used to either provide:
  - single frequency "gateway" stations which facilitate access to global voice relay networks (often internet based).
- Inter-repeater dedicated links (using either one or two frequency configurations) used to connect multiple repeater stations together into larger regional networks.

Frequency planning for the wide variety of services, where certain combinations of these services are requested in the same locality or region, can therefore be complex.

It should be noted that amateur radio repeater station frequency assignments do not consider the full range of station types found in the amateur service that would wish to access these assigned repeater stations. Amateur VHF/UHF/SHF activity can be carried out under a wide range of circumstances including from home stations with high gain elevated antennas or portable stations located atop terrain prominences etc. Interference protection for these additional types of stations uses is not required to be provided, nor is it practical given the limited channel capacity available on some frequency bands.

Assigned amateur stations are also not provided any special interference protection from class licenced amateur station activity, which is permitted to occur across any spectrum allocated to the amateur service in the ARSP. It should be noted, however, that class licenced (class licenced) amateur stations are encouraged globally to voluntarily confine their operating in certain segments of the amateur spectrum to transmission modes that are broadly compatible with each other, in accordance with the published amateur radio band plans that are sanctioned by the IARU representative bodies in each country.

## **4.2 136.7 kHz - 29.1 MHz not suitable for repeater / gateway use**

Amateur assigned repeater and gateway services should not be proposed for licensing on amateur bands between 136.7 kHz to 29.1 MHz due to the very limited amateur spectrum holdings and the international implications for licensing assigned amateur services within this frequency range.

Amateur radio repeater and gateway station operation is not supported by the IARU within the amateur radio bands between 136.7 kHz and 29.1 MHz. Any request for an assigned amateur licence in this frequency range for the purpose of providing a repeater or gateway station shall therefore be managed through the non-standard application process described in FAP 10.

Note: unattended and automatic operation of Class Licenced amateur transmitters is permitted in accordance with the Amateur Class Licence LCD and hence does not require an assigned frequency.

## **4.3 Additional Assigned Amateur Station guidelines between 29.1-29.7 MHz**

### **4.3.1 Repeater Stations – 29.50 – 29.70 MHz**

Applicants for assigned amateur stations in this band should first approach the Australian IARU representative body to obtain a recommended frequency or set of potential frequencies that have been coordinated internationally via the IARU.

This part of the process for the HF spectrum assignment should be completed prior to approaching an AP. This process can take some considerable time (up to 6 months) due to the effort required in contacting surrounding international jurisdictions when vetting applications for new services in this band.

### **4.3.2 Gateway Stations – 29.12 – 29.14 MHz**

Frequency reuse management is only considered on a tropospheric basis for these stations and may also be optional if the applicant has an agreement with other existing licensees that they wish to engage in fortuitous linking experiments with. As a result, ACMA APs when considering these services need to focus on obtaining evidence from the applicant confirming the intent of the operators of the existing and proposed gateways and people's willingness to share spectrum in this case. Should no agreement be reached, then the application should be referred to the non-standard process as outlined in FAP 10.

## **4.4 Assignment of Nominated Special Use Channels – 53 MHz Band**

Within the band channel plans, some channels are reserved for particular use cases. Typically, these are to support portable repeater stations that can be deployed anywhere in the named state for periods of less than 7 days at a time, typically to support community events or emergency services support communications.

Permanent assigned repeater stations should not be allocated to those frequencies (which are defined in the band plans state by state). Should an applicant wish to proceed with such an application, it should be referred to ACMA using the non-standard application process outlined in FAP 10.

To reduce the impact of ionospheric propagation, at least one frequency pair has been designated for exclusive (as far as practical) allocation within each state. These exclusive use channels should be allocated for systems with superior local coverage or those covering major population centres in the first instance. Systems with lesser coverage in terms of range or population coverage should be allocated one of the non-dedicated channels in the first instance, unless none of those channels are available.

The channels in question are:

- 52.750 / 53.750 – South Australia / Northern Territory.
- 52.800 / 53.800 – Western Australia.
- 52.825 / 53.825 - Tasmania.
- 52.850 / 53.850 – New South Wales.
- 52.900 / 53.900 – Victoria.
- 52.950 / 53.950 – Queensland.

#### 4.5 Frequency Reuse (Ionospheric Propagation) < 100 MHz

Various ionospheric propagation effects will occur to amateur services on amateur bands below 100MHz as described in ITU-R.844-1. Out of all the cases, the one most likely to affect amateur repeater services is sporadic E, which regularly affects services below 100 MHz particularly during the summer months.

The margins being considered are defined by how much additional loss must the ionospheric path introduce before the available signal received is less than the level necessary to be detected by the distant receiver. On the 50MHz band, this maximum acceptable path loss level is 157dB which comprises both free space plus ionospheric losses.

In selecting an amateur repeater frequency in Australia, where practical, some coordination thought is given to avoiding regular sporadic E path lengths and co-channel allocations. Sporadic E field strength predictions are determined in accordance with ITU-R.P.534-6 as follows:

- For 1% of the time to avoid sporadic E interference, using equivalent Australian data derived from Europe/North Africa. The ionospheric path loss falls below 25dB between 500 and 3600 km for 1% of the time in summer.
- For 10% of the time, the same or better path loss is achieved between 1400 and 2400 km.

The amateur service accepts that some interference is inevitable on lower VHF bands. Indeed, some branches of the amateur service seek out those occurrences and seek to exploit them for communications opportunities. Therefore the 10% interference probability is considered acceptable on bands below 54 MHz.

As a result, given ionospheric propagation-based re-use path loss margins, APs should seek to avoid co-channel frequency assignments where stations are located between 1400 and 2400 km apart.

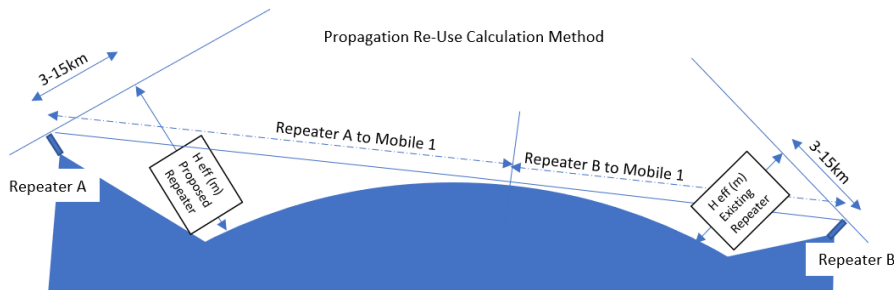
## 4.6 Frequency Re-use (Tropospheric Propagation) > 50MHz

In assessing frequency re-use for tropospheric based propagation effects within the amateur repeater station network, a simplified approach has been developed based on ITU-R P.1546-6.

The design of inter-site distance has also discounted any assessment of home-based class licenced amateur stations where the station antenna height is usually much more than 1.5m above ground and the station antenna gain is typically > 10dBi (using directional antennas). In this sense, inter-site interference is not precluded but is managed within the very diverse portfolio of usage within the amateur radio service.

To simplify frequency reuse assessment, tables have been developed that define the minimum acceptable reuse distance for a co-channel repeater given the calculated effective height of the proposed new station and a potential co-channel frequency candidate.

The value for the effective height  $h_{eff}$  is defined (in ITU-R.1546-6 Annex 5 Section 3) as its height in metres over the average level of the ground between distances of 3 and 15 km from the transmitting/base antenna in the direction of the receiving/mobile antenna. Where the value of effective transmitting/base antenna height,  $h_{eff}$ , is not known it should be estimated from available topographic information.



To use the tables, take the value determined for  $H_{eff}$  for each site, add the tower height to the  $H_{eff}$  value and then round up to the next highest pre-determined height bracket in the re-use table. Do this for each of the two sites in each reuse distance check. Then, using the matrix, new site on the horizontal axis, existing site on the vertical axis, determine the minimum acceptable reuse distance for that site pair.

### 4.6.1 53 MHz Repeater Reuse Distances for Co-Channel repeaters

The following table provides the specific tropospheric based minimum Co-Channel Reuse Distance between co-channel amateur repeater stations on the 53 MHz band.

Distance Between Sites (km)		New site effective height				
		Effective Height (m)	37.5	150	300	600
Existing site effective height	37.5	300 km	330 km	360 km	390 km	420 km
	150	330 km	360 km	390 km	420 km	450 km
	300	360 km	390 km	420 km	450 km	480 km
	600	390 km	420 km	450 km	480 km	510 km
	1200	420 km	450 km	480 km	510 km	540 km

#### 4.6.2 1273 MHz Repeater Reuse Distances for Co-Channel repeaters

The following table provides the specific tropospheric based minimum Co-Channel Reuse Distance between co-channel amateur repeater stations on the 1273 MHz band.

Distance Between Sites (km)		New site effective height				
		Effective Height (m)	37.5m	150m	300m	600m
Existing Site effective height	37.5m	80 km	100 km	115 km	140 km	170 km
	150m	100 km	120 km	135 km	160 km	190 km
	300m	115 km	135 km	150 km	175 km	205 km
	600m	140 km	160 km	175 km	200 km	230 km
	1200m	170 km	190 km	205 km	230 km	260 km

## 4.7 Assigned Amateur Television Repeater Stations

Amateur television repeater station assignment is complex when more than one system is proposed within 200km of another. There are a very limited number of channels available and each of the channels has different levels of complexity for the class licenced amateur stations seeking to use the system. For this reason, there are some obvious assignment preferences which are likely to be requested, but the way forward for selecting frequencies to support a second system in an area can be complex and require negotiation between all existing and new interested parties in a locality to determine the best outcome.

The main policy objectives to be considered include:

- If there is already an existing system in an area (within 150km), then the application is automatically deemed non-standard and should be referred to the ACMA to follow the non-standard assignment process outlined in FAP 10.

For assignments in areas without an existing allocation, the following policy considerations should be made:

- Applicants should be encouraged to use as narrow a modulation bandwidth as will meet their requirements. Digital ATV transmission technologies now exist that can use as little as 1-2 MHz of bandwidth. Should an application be received for a "narrowband" (< 7 MHz bandwidth) digital ATV repeater it should be referred to the ACMA to follow the non-standard assignment process outlined in FAP 10 (so that proper consideration of the band plan implications of such a service can be determined and the band plan be revised accordingly).
- If the 445.5 MHz channel is used as a repeater transmitter frequency, then the input should be selected from either the 1283 MHz wideband analogue channel or one of the 1278 or 1287 MHz 7MHz wide DVB-S/T channels (with DVB-S preferred). Alternatively, inputs can be assigned on any of the 2.4 GHz or higher ATV channels.
- If any of the channels within the 1274-1292 MHz frequency band are used as a repeater transmitter frequency, then the input should be selected from either the 1250 MHz wideband analogue channel or one of the 1246 or 1255 MHz 7MHz wide DVB-S/T channels (with DVB-S preferred). Alternatively, inputs can be assigned on any of the 2.4 GHz or higher ATV channels. In this situation, the use of 445.5 MHz as a repeater receive channel is not preferred.
  - If any other repeater channel combinations are requested, the non-standard frequency assignment process outlined in FAP 10 should be followed. Detailed steps to conduct an ATV repeater assignment are described in Section 5.6.

## 5 Amateur Repeater, Link & Gateway Station Frequency Coordination Procedure

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### 5.1 Amateur Repeater Stations – 29.5 – 29.7 MHz

This section is applicable to applications for two frequency repeater stations.

#### 5.1.1 Prerequisite Information

Prior to applying to an AP for an assignment, the applicant shall seek a current frequency list of existing active international amateur repeater or gateway stations within 2400 km of the proposed new amateur repeater service. This list is available by contacting the IARU Representative body in Australia (currently the Wireless Institute of Australia). Subsequent application by the applicant should be made within 6 months of receipt of this information otherwise an updated list will be required.

#### 5.1.2 ACMA AP Assignment Process

**Step 1** – prepare a list of services currently assigned services in the band segment 29.5 – 29.7 MHz.

- a) based within Australia based on the ACMA RRL database and then;
- b) add to this the list of services provided from the IARU enquiry as described in section 4.3.1.

**Step 2** – undertake a cull of available frequencies that have co-channel systems located within 300km of each other.

**Step 3** – undertake a cull of frequencies that fail the criteria in section 4.5 dealing with ionospheric based frequency reuse < 100 MHz.

- a) if no frequencies are available after the cull, then refer the assignment to the ACMA for action using the non-standard assignment process outlined in FAP 10.

**Step 5** – if a frequency is available, then conduct intermodulation checks in accordance with best engineering practice.

**Step 6** – if the HF frequency pair has been identified and the applicant intends to operate the repeater using separate sites for transmit and receive connected via a one-way UHF link, refer to RALI-AA4 to undertake the assignment of the 430 MHz band link.

**Step 7** – once both a frequency has been identified that meets the criteria for the 29 MHz transmitter/receiver and the (where required) associated 430 MHz link transmitter and receiver, proceed to submit the application.



## 5.2 Amateur Gateway Stations – 29.12 – 29.14 MHz

### 5.2.1 Prerequisites

The applicant should contact existing gateway operators to determine their willingness to be co-channel (and hence be potentially available for itinerant linking experiments) or not. Their feedback should be considered by the AP when considering a frequency assignment.

### 5.2.2 Assignment Process

**Step 1** – prepare a list of services currently assigned in the band segment based within Australia.

**Step 2** – confirm with the applicant if they have any agreements with existing services and whether there is any intent to deliberately be co-channel to facilitate skywave based linking experiments.

**Step 3** – if there is a desire to not be actively co channel with existing services, then use section 4.5 as the basis for determining the channel least likely to interact with existing systems.

**Step 4** – if the proposed site(s) are located within 2km of a multi-service site, conduct intermodulation checks in accordance with the best engineering practice.

**Step 5** – once a frequency has been identified that meets the criteria for the 29 MHz transmitter / receiver proceed to submit the application.

## 5.3 Amateur Repeater Stations – 52.5 – 54.0 MHz

**Step 1** – prepare a list of amateur assigned repeater stations within Australia between 52.5 – 54.0 MHz from the ACMA RRL.

**Step 2** – determine if the application is the first use of a repeater service on this frequency band in the state the application is being made. If it is, prioritise the use of the planned state reserved frequency allocation first (see section 4.4).

**Step 3** – undertake a cull of available frequencies at the proposed site that fail the criteria in section 4.6 using the table in section 4.6.1 relating to tropospheric frequency reuse distances.

**Step 4** – undertake a cull of frequencies that fail the criteria in section 4.5 relating to ionospheric reuse distances for services under 100 MHz.

**Step 5** – select a frequency from the remaining available channels. If a frequency is not available, refer the application to the ACMA for assessment under the non-standard allocation process outlined in FAP 10.

**Step 6** – if the proposed site(s) are located within 2km of a multi-service site, conduct intermodulation checks in accordance with the requirements of ACMA RALI LM8 on the selected channel. If that fails return to Step 5 and repeat the process with another available channel.

**Step 7** – once both a frequency has been identified that meets all criteria proceed to submit the application.

## 5.4 Two Frequency Amateur Repeater Stations – 1273.0 – 1294.0 MHz

**Step 1** – refer to the ACMA RRL and obtain a list of all existing licenced amateur two frequency repeater stations in the 1273 - 1274 MHz TX channel segment.

**Step 2** – starting from the lowest available frequency, test to see if there are any existing systems within 260 km of the proposed new site on the frequency under test. If there are none, proceed to Step 3 otherwise repeat this step for the next channel. If you have exhausted all channels defined, then proceed to step 4.

**Step 3** – for each channel where an existing assignment has been found within 260km, calculate the effective height  $H_{eff}$  for each site as per section 4.6 and then use the table in section 4.6.2 to determine if the proposed new site is located less than the allowed minimum re-use distance. If the distance is greater proceed to step 4 otherwise select the next channel and repeat step 3.

**Step 4** – proceed to submit an application for the transmitter on the frequency identified.

## 5.5 Amateur Repeater Link Transmitting/Receiving Stations - 1240.0 – 1295.0 MHz

**Step 1** – identify all existing amateur TV and amateur repeater stations within 1 km of the proposed site.

**Step 2** – assess isolation requirements of the link receiver and the respective other transmitting services in the identified area.

**Step 3** – select a sub-band for the proposed service based on maximising frequency separation between existing amateur services.

**Step 4** – within the sub-band search for the first available unused frequency within 250 km. (Note there are few allocations on these link bands and so frequency re-use has not been defined at this time.)

## 5.6 Amateur Television Repeater Stations above 1GHz

**Step 1** – using the ACMA RRL database identify all existing amateur television repeater stations licenced within 150 km.

**Step 2** – if there are existing services, follow the non-standard frequency assignment process outlined in FAP 10.

**Step 3** - Amateur TV Repeater Transmitter Allocations.

For standard assignments, TV repeater transmitter channels should be selected from one of the following options:

1. If the applicant prefers using the 440 MHz band as the repeater transmitter band, then the assignment should be made for a DVB-T 7MHz bandwidth downlink on 445.5 MHz (442-449 MHz).
  - a. Note: such an allocation should not be made if either Repeater Link Band B or C on the 430 – 450 MHz band plan are in use for receiving within 1km of the proposed TV repeater site.
2. If the applicant prefers using the 1240 – 1300 MHz band as the repeater transmitter band, then:
  - a. If the TV repeater is planned to be within 1km of a 1273 MHz voice repeater or any 1272 / 1292 MHz link Band B1/B2 assignments, then the TV transmitter should not be allocated on the 1260 – 1300 MHz band.
  - b. if the repeater operator is seeking an analogue FM allocation, preference should be given to use the 1283.0 MHz analogue channel. (class licenced amateur TV transmissions are given priority on the 1250 MHz channel).
  - c. If the applicant is seeking a digital DVB-T or DVB-S channel, then the 1287 MHz channel should be assigned. Note that:
    - i. Given that the 1241-1259 MHz band is the potential repeater receiver band, consideration should be given to maximising the TX / RX frequency separation where possible to simplify repeater construction.
    - ii. class licenced digital amateur TV transmissions are given priority on the 1246 MHz / 1255 MHz and 1278 MHz channels).
3. The third repeater transmitter preference is for the station to operate on the 3310 MHz channel in the 3300 – 3400 MHz band.
4. The 2.4GHz band amateur band plan TV channels are not recommended for use in suburban areas due to the dense use of this band by Wi-Fi LIPD services. Significant interference is often experienced by amateur services on this band which diminishes it's utility for assigned amateur services. However, if such interference constraints are accepted, then assignments on any of the band plan defined amateur TV channels on the 2.4GHz band can be made.

**Step 4** - Amateur TV Repeater Receiver Allocations

TV Repeater receiver channels depend on which transmit channel was assigned, with consideration given to how to achieve suitable isolation between the transmitter and receiver within the repeater noting the wideband nature of the signals and filtering challenges that this provides.

Amateur TV repeater stations can operate using multiple receive allocations, particularly when digital transmissions are used, and channel multiplexing is employed.

Amateur TV repeater operators are requested to not use carrier detect channel access mechanisms and instead use command signalling systems (such as DTMF) on auxiliary control channels to activate repeater receivers. This helps facilitate sharing between repeater stations and class licenced amateur stations given the limited number of channels available for these wideband transmission modes.

If there is any doubt as to the merit of a particular assignment solution, the application should be referred to the ACMA and be assessed using the non-standard application process outlined in FAP 10.

## 6 APPENDIX A - Repeater/Gateway band and channel plans

The amateur service has established a set of guiding band plans to manage interference between different types of activities. These plans form the foundation of the frequency assignment policies for these amateur spectrum bands.

Within each repeater sub-band specific channel arrangements have been developed. Repeater, store and forward data and gateway stations should be assigned channels only from these defined channel plans.

### 6.1 Amateur Band Plan Overview – 29 / 53 / 1296 MHz and above

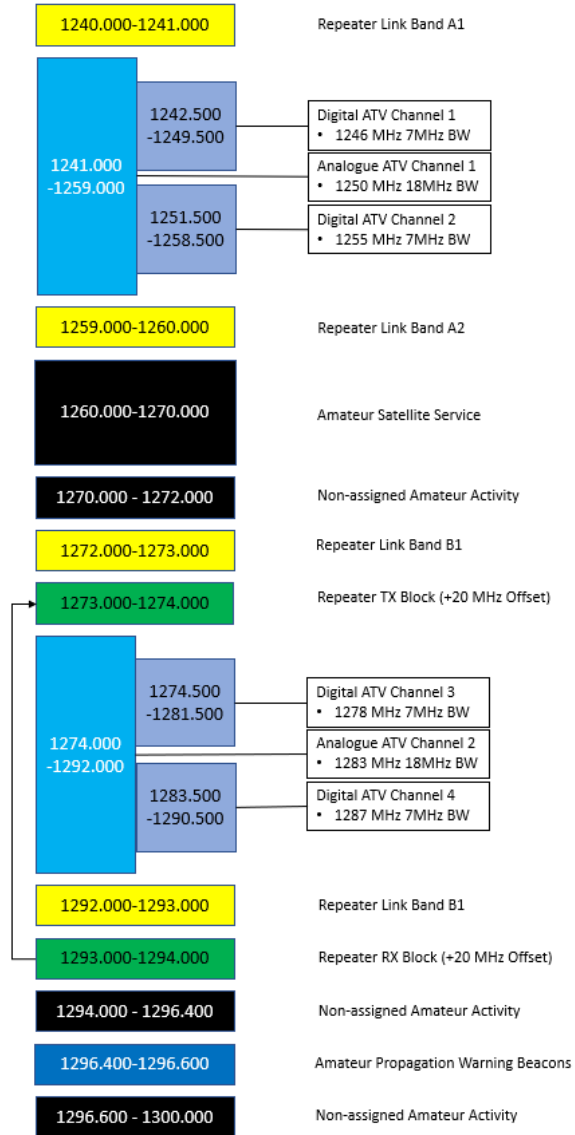
#### 6.1.1 Amateur 28.0 – 29.7 MHz Band Plan

28.000-28.250	Non-assigned Amateur Activity
28.250-28.280	Amateur Propagation Warning Beacons
28.280-29.100	Non-assigned Amateur Activity
29.100-29.140	Single Frequency Gateway Stations
29.140-29.300	Non-assigned Amateur Activity
29.300-29.500	Amateur Satellite Service
29.500-29.590	Repeater RX Block (-100 kHz Offset)
29.590-29.610	Non-assigned Amateur Activity
29.610-29.700	Repeater TX Block (-100 kHz Offset)

### 6.1.2 Amateur 50 – 54 MHz Band Plan

50.000-50.400	Non-Assigned Amateur Activity
50.400-50.600	Amateur Propagation Warning Beacons
50.600-52.5375	Non-Assigned Amateur Activity
52.5375-53.000	Repeater RX Block (-1.0 MHz Offset)
53.000-53.5375	Non-Assigned Amateur Activity
53.5375-54.000	Repeater TX Block (-1.0 MHz Offset)

### 6.1.3 Amateur 1240 – 1300 MHz Band Plan



## 6.2 Amateur Service Channel Plans – 29 MHz / 53 MHz / 1296 MHz / ATV

### 6.2.1 28 MHz Single Frequency Gateway

The following are the channels nominated for use by this type of assigned station.

These assignments operate on a non-exclusive basis. Assigned amateur stations operating on this band segment should not expect protection from interference from class licenced amateur activity.

Available channels are:

Mode	TX	RX
Single Frequency (Simplex)	29.120 MHz	29.120 MHz
	29.130 MHz	29.130 MHz
	29.140 MHz	29.140 MHz

### 6.2.2 29.5 – 29.7 MHz Two Frequency Repeaters

Duplex repeater stations are permitted to operate in the band segment 29.5 - 29.7 MHz. The segment is divided into 2x 100 kHz sub-bands, one for receive and one for transmit, with stations in this segment operating with a 100 kHz TX/RX offset. Adjacent channel interference is ignored in the case of these repeater stations as any coverage via skywave propagation is considered fortuitous.

Mode	TX Frequency	RX Frequency
Two Frequency (Duplex)	29.620 MHz	29.520 MHz
	29.630 MHz	29.530 MHz
	29.640 MHz	29.540 MHz
	29.650 MHz	29.550 MHz
	29.660 MHz	29.550 MHz
	29.670 MHz	29.570 MHz
	29.680 MHz	29.580 MHz



### 6.2.3 52-54 MHz Two Frequency Repeaters

The following channels are available for assignment on the 52 – 54 MHz band.

TX Channel (MHz)	RX Channel (MHz)	Regional Exclusive Use
53.550	52.550	
53.575	52.575	
53.600	52.600	
53.625	52.625	
53.650	52.650	
53.675	52.675	
53.700	52.700	
53.725	52.725	
53.750	52.750	SA / NT
53.775	52.775	
53.800	52.800	WA
53.825	52.825	TAS
53.850	52.850	NSW/ ACT
53.875	52.875	
53.900	52.900	VIC
53.925	52.925	
53.950	52.950	QLD
53.975	52.975	

#### 6.2.4 1273 MHz Two Frequency Repeaters

The following is the channel plan for the 1273 MHz amateur repeater networks.

Repeater Transmit (MHz) 25 kHz Channel Spacing	Repeater Receive (MHz) +20 MHz Offset
1273.025	1293.025
1273.050	1293.050
1273.075	1293.075
1273.100	1293.100
1273.125	1293.125
1273.150	1293.150
1273.175	1293.175
1273.200	1293.200
1273.225	1293.225
1273.250	1293.250
1273.275	1293.275
1273.300	1293.300
1273.325	1293.325
1273.350	1293.350
1273.375	1293.375
1273.400	1293.400
1273.425	1293.425
1273.450	1293.450
1273.475	1293.475
1273.500	1293.500
1273.525	1293.525
1273.550	1293.550
1273.575	1293.575
1273.600	1293.600
1273.625	1293.625
1273.650	1293.650
1273.675	1293.675
1273.700	1293.700
1273.725	1293.725
1273.750	1293.750
1273.775	1293.775
1273.800	1293.800
1273.825	1293.825
1273.850	1293.850
1273.875	1293.875
1273.900	1293.900
1273.925	1293.925
1273.950	1293.950
1273.975	1293.975

### 6.2.5 1240/1259/1272/1292 MHz Single Frequency / Two Frequency Links

Select which ever link frequency combination is appropriate for the service proposed. These can be used in either single frequency or two frequency pairs in any Link band combination given due consideration to the filtering requirements between link transmitters and repeater receivers.

Link Band A1 25 kHz Channel Spacing	Link Band A2 25 kHz Channel Spacing	Link Band B1 25 kHz Channel Spacing	Link Band B2 25 kHz Channel Spacing
1240.025	1259.025	1272.025	1294.025
1240.050	1259.050	1272.050	1294.050
1240.075	1259.075	1272.075	1294.075
1240.100	1259.100	1272.100	1294.100
1240.125	1259.125	1272.125	1294.125
1240.150	1259.150	1272.150	1294.150
1240.175	1259.175	1272.175	1294.175
1240.200	1259.200	1272.200	1294.200
1240.225	1259.225	1272.225	1294.225
1240.250	1259.250	1272.250	1294.250
1240.275	1259.275	1272.275	1294.275
1240.300	1259.300	1272.300	1294.300
1240.325	1259.325	1272.325	1294.325
1240.350	1259.350	1272.350	1294.350
1240.375	1259.375	1272.375	1294.375
1240.400	1259.400	1272.400	1294.400
1240.425	1259.425	1272.425	1294.425
1240.450	1259.450	1272.450	1294.450
1240.475	1259.475	1272.475	1294.475
1240.500	1259.500	1272.500	1294.500
1240.525	1259.525	1272.525	1294.525
1240.550	1259.550	1272.550	1294.550
1240.575	1259.575	1272.575	1294.575
1240.600	1259.600	1272.600	1294.600
1240.625	1259.625	1272.625	1294.625
1240.650	1259.650	1272.650	1294.650
1240.675	1259.675	1272.675	1294.675
1240.700	1259.700	1272.700	1294.700
1240.725	1259.725	1272.725	1294.725

Link Band A1 25 kHz Channel Spacing	Link Band A2 25 kHz Channel Spacing	Link Band B1 25 kHz Channel Spacing	Link Band B2 25 kHz Channel Spacing
1240.750	1259.750	1272.750	1294.750
1240.775	1259.775	1272.775	1294.775
1240.800	1259.800	1272.800	1294.800
1240.825	1259.825	1272.825	1294.825
1240.850	1259.850	1272.850	1294.850
1240.875	1259.875	1272.875	1294.875
1240.900	1259.900	1272.900	1294.900
1240.925	1259.925	1272.925	1294.925
1240.950	1259.950	1272.950	1294.950
1240.975	1259.975	1272.975	1294.975

### 6.2.6 Amateur (Assigned) TV Repeater & Amateur (class licenced) TV frequency plan.

The Amateur Service is permitted to operate amateur television transmitters. Both digital and analogue transmission modes are permitted. Digital transmission modes are not restricted to those used for broadcast television and may include experimental coding and operating bandwidths.

The following channels are available for amateur television repeaters in the UHF and SHF bands:

440MHz Band Channel / Use	Mode	Centre Frequency	Bandwidth
Ch 1 (Legacy)	Analogue Vestigial Sideband (VSB)	443.250 MHz (Vision) 448.750 MHz (Sound)	442-449 MHz (up to 7 MHz)
Ch 1 (class licenced) or Repeater outputs	Digital DVB-T	445.5 MHz	442-449 MHz (up to 7 MHz)

1250 MHz Band Channel / Use	Mode	Centre Frequency	Bandwidth
Ch 1 Simplex (class licenced) or Repeater Inputs	Analogue Wideband FM	1250.0 MHz	1241-1259 MHz (18 MHz)
Ch 2 Simplex (class licenced) or Repeater outputs	Analogue Wideband FM	1283.0 MHz	1274-1292 MHz (18 MHz)
Ch 1A Simplex (class licenced) or Repeater Inputs	Digital DVB-S/T	1246.0 MHz	1242.5-1249.5 MHz (up to 7 MHz)
Ch 1B Simplex (class licenced) or Repeater Inputs	Digital DVB-S/T	1255.0 MHz	1251.5-1258.5 MHz (up to 7 MHz)
Ch 2A Simplex (class licenced) or Repeater outputs	Digital DVB-S/T	1278.0 MHz	1274.5-1281.5 MHz (up to 7 MHz)
Ch 2B Simplex (class licenced) or Repeater outputs	Digital DVB-S/T	1287.0 MHz	1283.5-1290.5 MHz (up to 7 MHz)

2400 MHz Band Channel / Use	Mode	Centre Frequency	Bandwidth
Ch 1 Simplex (class licenced) or Repeater In/Out	Analogue Wideband FM	2415.0 MHz	2406-2424 MHz (18 MHz)
Ch 2 Simplex (class licenced) or Repeater In/Out	Analogue Wideband FM	2439.0 MHz	2430-2448 MHz (18 MHz)
Ch 1A Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	2411.0 MHz	2407.5-2414.5 MHz (up to 7 MHz)
Ch 1B Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	2419.0 MHz	2415.5-2422.5 MHz (up to 7 MHz)
Ch 2A Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	2435.0 MHz	2431.5-2438.5 MHz (up to 7 MHz)
Ch 2B Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	2443.0 MHz	2439.5-2446.5 MHz (up to 7 MHz)

3300 MHz Band Channel / Use	Mode	Centre Frequency	Bandwidth
Ch1 Simplex (class licenced) or Repeater In/Out	Analogue Wideband FM	3310.0 MHz	3300-3320 MHz (20 MHz)
Ch2 Simplex (class licenced) or Repeater In/Out	Analogue Wideband FM	3370.0 MHz	3360-3380 MHz (20 MHz)
Ch 1A Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	3305.0 MHz	3301.5-3308.5 MHz (up to 7 MHz)
Ch 1B Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	3315.0 MHz	3311.5-3318.5 MHz (up to 7 MHz)
Ch 2A Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	3365.0 MHz	3361.5-3368.5 MHz (up to 7 MHz)
Ch 2B Simplex (class licenced) or Repeater In/Out	Digital DVB-S/T	3375.0 MHz	3371.5-3378.5 MHz (up to 7 MHz)

Amateur Television (ATV) repeaters may also operate above 5GHz. The following frequency ranges are supported under the band plan. Allocation of these ranges shall follow the same principles as for the primary lower frequency ATV channels.

Lower (MHz)	Upper (MHz)	Usage
5680	5700	ATV Channel 1
5740	5760	ATV Channel 2
5810	5830	ATV Channel 3
10200	10220	ATV Channel 4
10260	10280	ATV Channel 5
10320	10340	ATV Channel 6
10420	10440	ATV Channel 7

Requests for amateur television assigned station frequencies above 10.5 GHz should in the first instance be follow the non-standard application process outlined in FAP 10 as channel plans have not yet been developed for those bands.

## 7 APPENDIX B - Distribution Rights

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## 8 APPENDIX C - Document Control

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Date	Version	Change Description
19-June-2022	0.1	First Draft for internal Review
19-June-2022	0.2	<ol style="list-style-type: none"><li>1. Added application process.</li><li>2. expanded 3rd harmonic considerations between 144 and 432 MHz bands.</li><li>3. Added 28 MHz Repeater frequency reuse determination section</li></ol>
Late 2022	0.3	Issued to ACMA for initial comment
10 <sup>th</sup> March 2023	0.4	Revised following industry feedback
30 <sup>th</sup> April 2023	0.5	Revised/restructured following industry feedback – Preliminary draft not for public distribution
9-March-2024	1.0	EXPOSURE DRAFT prepared for ACMA consultation
1 June 2024	2.0	Revised EXPOSURE DRAFT prepared for public release
28 August 2024	3.0	Amendments incorporated in sections 2.4, 2.5 and 4.7
25 <sup>th</sup> September 2024	4.0	Clarification on the purpose and intent of the document added to the introduction. Other sections revised accordingly.
23 <sup>rd</sup> October 2024	5.0	PUBLIC RELEASE – ACMA Endorsed

Feedback on this document can be made by contacting the WIA National Office via email with the subject "Attention Repeater Coordinator".

Email Address: [tac@wia.org.au](mailto:tac@wia.org.au)