Wireless Institute of Australia

NATIONAL TECHNICAL ADVISORY COMMITTEE

PROPOSED 2 METRE BAND PLAN CHANGES 2012

Contents

Introduction

In 2011, the WIA Board gave the Technical Advisory Committee the task of reviewing the 2 metre band plan and considering ways of improving the efficiency of spectrum use. In particular, the TAC was asked to consider the feasibility of adopting 12.5 kHz channel spacing in the repeater and simplex segments of the band.

The TAC circulated a discussion paper and a proposal developed by the National Repeater and Beacon Coordinator, Peter Mill VK3APO. This draft proposal was supported by the TAC regional representatives and was submitted to the Board along with a report and recommendations. The Board adopted the report and gave approval for these changes to be made.

The essence of the report to the Board was that it is not feasible to adopt 12.5 kHz channel spacing for existing FM repeater and simplex channels, where the equipment in use is all designed for 16 KHz occupied bandwidth and 25 kHz channel spacing. The result would be unacceptable levels of adjacent channel interference. However it is feasible to use a 12.5 kHz channel raster for newer digital modes that have narrower occupied bandwidth and are designed for 12.5 kHz channel spacing.

Due to the limited spectrum available, the only practical approach is to interleave 12.5 kHz channels in between existing 25 kHz channels, where this can be done without creating unacceptable adjacent channel interference. In particular, it is recommended that new repeaters using digital modes such as D-Star and P25 should be allocated frequencies on odd multiples of 12.5 kHz, interleaved between existing 25 kHz spaced channels.

It was also recommended that to minimise interference, it would be desirable if these new repeaters using a 12.5 kHz channel raster were allocated input frequencies in a different band segment from that used by existing FM repeaters. The band segment 145.000 - 145.400 MHz was identified as being suitable for this purpose because it is only lightly used and has very few assigned frequencies. This allows new digital repeaters to share the existing repeater output segment, but to use a transmit-receive offset of 1.6 MHz, which will eliminate the possibility of adjacent channel interference on their input frequencies.

This proposal requires a rearrangement of the band plan between 145.000 and 145.400 MHz. This can be done with minimal effect on existing operation in this segment. A transition plan has been developed which will have no effect on any existing packet, APRS or WICEN allocations. However it does entail a change for one of the frequencies recommended for simplex D-Star operation. The proposed changes are detailed on the following pages.

The report to the Board also includes other recommendations on spectrum efficiency and the problem of overcrowding of the 2 metre repeater segments.

Wireless Institute of Australia

NATIONAL TECHNICAL ADVISORY COMMITTEE

REPORT TO THE WIA BOARD:

USE OF 12.5 kHz CHANNEL SPACING FOR 2 METRE REPEATERS

The WIA Board asked the TAC to discuss the possibility of creating more 2 metre repeater channels by changing over to 12.5 kHz channel spacing. This issue has been discussed within the TAC and the following conclusions have been reached.

1. Feasibility of using 12.5 kHz channel spacing for FM repeaters

12.5 kHz channel spacing would require narrower deviation and narrower IF filters. Suitable equipment is not readily available, and it would not be feasible to create a plan which would require the adjustment of deviation and replacement of the IF filters in thousands of existing radios.

Any plan that involved the use of two different bandwidths on the same set of channels would result in adjacent channel interference in both directions. Co-channel problems would also occur, with wider signals appearing to be over-deviated when received by narrower band receivers, and signals from narrow band transmitters appearing to be under-deviated when received with wider band equipment.

Over a longer time span - possibly ten years - newer models of FM radios will be able to support both 25 kHz and 12.5 kHz channel rasters. This would allow FM systems to gradually convert from 25 kHz to 12.5 kHz channel spacing. But we have concluded that in the short to medium term, it is necessary to retain the 25 kHz channel spacing for existing FM repeater systems that occupy 16 kHz bandwidth.

2. Use of 12.5 kHz channel spacing for digital repeaters

However 12.5 kHz is appropriate for newer modes such as D-Star, which is designed to operate on 12.5 kHz channels. There are also other digital modes in this category, such as APCO P25 and Moto Turbo. The use of these modes will increase greatly in the future, and it is important to find suitable spectrum space for them before the band becomes even more overcrowded. For repeaters using these modes, it is logical to implement 12.5 kHz channel spacing immediately. We also need to plan ahead with a view to the time when the number of FM repeaters will decline as they are supplanted by repeaters using these newer modes.

3. Options for using 12.5 kHz channels in the existing band plan repeater segments

In the 2 metre band plan, there are 31 frequency pairs set aside for FM repeaters using 25 kHz channel spacing and an offset of 600 kHz. It is not possible to add any frequency pairs using this offset, because this would require reallocation of band segments that are used for other purposes and have nowhere else to go. In any case, allocation of more frequency pairs using 25 kHz channel spacing would not be an efficient use of the band. It is therefore necessary for any future use of 12.5 kHz spaced channels to be shared, in whole or in part, with frequencies that are already in use by 25 kHz spaced systems.

(a) Interleaving 12.5 kHz and 25 kHz channels

It is possible for repeaters on 12.5 kHz offsets to coexist with 25 kHz spaced systems under certain conditions. The channel re-use distance between adjacent 12.5 kHz and 25 kHz repeaters can be less than the re-use distance normally required between co-channel systems. The capture effect of FM receivers allows the receiver to be captured by the stronger local repeater and remain unaffected by the weaker adjacent channel signal.

This approach has been used successfully to allocate frequency pairs for D-Star repeaters on the 2 metre band, using channel pairs on odd multiples of 12.5 kHz. This method also has the advantage of not requiring any expansion of the existing band plan repeater segments, which would impact on the spectrum available for other uses.

(b) Interleaving output frequencies, but separating input frequencies

The channel re-use distance can be further reduced if it is possible to separate the input frequencies of adjacent 12.5 kHz and 25 kHz repeaters, i.e. repeaters using 25 kHz channel spacing have their input frequencies in one band segment, and repeaters using 12.5 kHz channel spacing use a different input segment. Under these circumstances, the possibility of adjacent channel interference on the repeater input frequencies is completely eliminated,

so that no repeater can be triggered by an input signal 12.5 kHz away from its passband centre. The only concern then is to ensure that repeaters using adjacent output frequencies have sufficient geographical separation. As noted above, because of capture effect in the receivers of repeater users, this geographical separation can be less than would be necessary for
co-channel stations.

This approach has been used successfully on the 70 cm band, where D-Star repeaters share the common output frequency segment with FM repeaters, but use a separate input segment with a 5.4 MHz offset which eliminates any possibility of adjacent channel interference on the repeater inputs.

This approach is less spectrum efficient than option (a) above. However if spectrum can be found for a separate input segment for 12.5 kHz spaced repeaters, it offers the ability to allocate a number of new frequencies for D-Star and other digital repeaters. This would reduce the pressure on the available 25 kHz channel pairs used by FM repeaters.

4. Proposal for 2 metre band plan revision

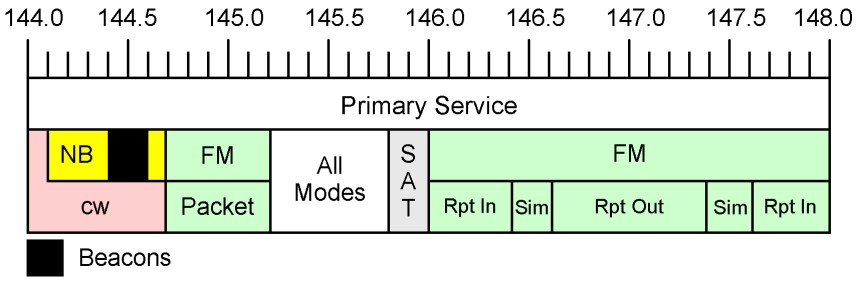
Examination of the 2 metre band plans shows that there is some spectrum that could be reallocated for 12.5 kHz channel spacing with little or no disruption to existing operation. It is not possible to find an new spectrum for repeater outputs, however it possible to create a new band segment for the exclusive use by the inputs of digital repeaters.

Spectrum between 144.700 and 145.800 MHz is used for packet radio and other FM simplex operation. Except for APRS, packet activity has declined and will continue to do so, therefore it is possible to reduce the packet radio segment and reallocate a portion of it to other uses with 12.5 kHz channel spacing. This can be done without causing any clashes with the packet systems that remain. Apart from the APRS and WICEN packet channels, there are only three packet systems licensed on frequencies above 145.000 MHz. The proposed changes would leave their frequencies, and the 12.5 kHz channels on either side, clear of any other use.

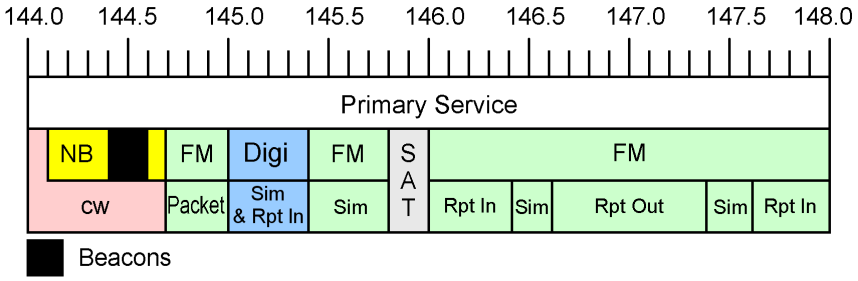
Above 145 MHz there are also various frequencies recommended in the band plan for FM simplex, IRLP nodes, and some specialised channels for non-voice modes that have received no use. Others can be slightly reshuffled, allowing most of the 145.000 - 145.400 MHz segment to be allocated to new uses with 12.5 kHz channel spacing. This would provide up to 11 frequency pairs that could be used for new digital repeaters. These repeaters would share the existing 146 MHz repeater output segment, but use input frequencies at 145 MHz with an offset of 1.6 MHz. The use of the separate input segment for digital repeaters would make frequency allocation much more flexible.

The effect on the band plan would be as shown below, with changes between 145.000 and 145.400 MHz:

EXISTING BAND PLAN



REVISED BAND PLAN



The finer details of the proposed changes are outlined in the following pages, which contain a copy of the paper that was circulated to the members of the TAC regional advisory panel for their comments. The TAC members have agreed with this proposal.

5. Comments on related matters

(a) Repeater power levels

Appropriate power output limits are important at the majority of repeater sites, which are shared with other services. At these sites ACMA much prefers the use of moderate power levels which reduce intermod problems at the site, and enable channel re-use distances to be reduced. It is not reasonable for amateur repeaters to run the maximum permitted power of 120 watts (into an antenna with gain) when other services at commercial sites commonly use an output power of 83 watts ERP.

Power levels at stand-alone sites can be greater, however the effect will be to increase the possible channel re-use distance. This is not desirable because it effectively reduces the number of repeaters that can be accommodated in the band.

One possible exception to this policy would be ATV repeaters, which occupy such a wide bandwidth that high power becomes important if they are to acheieve a reasonable coverage.

- It was suggested that the licence application forms could include a field where the applicant would give details of the targeted service area for the repeater. If the proposed power output of the repeater was greater than say 50 watts - or a power level regarded by the Repeater Co-ordinator as most suitable for the majority of repeaters - the applicant should give a reason why there is a need for greater power. Some valid reasons could be that the proposed repeater was to be used in a remote area; for emergency use (i.e. WICEN); or for WIA broadcasts.
- It was also noted with some repeaters, the output power could be varied depending on need.

(b) CTCSS access control

Use of CTCSS can reduce interference by preventing repeaters from being triggered by unwanted signals. However interfering signals will still be within the receiver passband of the repeater receiver even if the tone squelch has not been opened. Once the squelch is open, interfering signals will still be heard. Therefore CTCSS is useful in preventing repeaters from being triggered by unwanted signals, but CTCSS alone is not the solution to the problem.

(c) Channel re-use distances

Significant reduction of channel re-use distances will inevitably result in increased interference problems.

(d) Limiting the numbers of repeaters

Very many repeaters are underutilised, and many repeaters do not actually serve a need in terms of demand for use. Some have been set up in areas that were already served by existing repeaters, and often simply because the licensees wanted to build a repeater, either as an experimental project or because their club wished to have its own repeater. The result is that over the years, the available spectrum has become congested, and in many areas there are very few channel pairs available for new repeaters. Yet applications for new repeaters keep coming in.

This increasing congestion, combined with the low level of use of many repeaters, suggests that there is a need for some mechanism to distinguish between what could be described as primary and secondary repeaters. A primary repeater would be one that covered a wide area, or was the sole repeater serving its coverage area, and such repeaters should always have priority for spectrum access. Low use repeaters, or repeaters in areas that are already served by a wide coverage repeater, should be prepared to accept a higher level of potential interference than major repeaters. Radio clubs should also consider closing underutilised repeaters.

The current procedures for repeater licensing place the WIA in a difficult position. The processing of licence applications is one of the services the WIA provides to amateurs, and any amateur is entitled to apply for a repeater licence. This places the WIA under strong pressure to find suitable frequncies. Yet the available spectrum is limited and it is simply not possible to keep on plucking more repeater channels like rabbits from a hat.

In the more congested parts of the country, the time will come when it is simply not possible to find frequencies for new repeaters. The WIA will then have to choose one of two options: saying no to licence applications when suitable frequencies are no longer available; or approving new licences at the cost of causing an unacceptable level of interference to existing repeaters. The second of these two options is obviously the more reasonable one, because the licensees of existing repeaters have prior claim to their frequencies. The WIA needs to consider the implications of this problem, and the need to make all amateurs more aware of the fact that our spectrum is not a bottomless pit.

6. Conclusions and recommendations

(a) A change to 12.5 kHz channel spacing is not practical for existing FM radios and repeaters that are designed for 16 kHz occupied bandwidth. Transition to narrower channel spacing can be achieved only over a long period as FM equipment is replaced by equipment that has narrower receiver IF bandwidth.

(b) However, use of 12.5 kHz channel spacing is practical and desirable for repeaters using newer digital modes that are designed for 12.5 kHz channel spacing. This will require interleaving of 12.5 kHz and 25 kHz channels in the repeater output frequency segment, but in the input segment it is possible to reallocate spectrum so that future FM and digital repeaters will be using separate input frequency segments. The necessary band plan changes have been discussed and approved by the TAC representatives.

(c) Apart from narrower channel spacing, there are various strategies that can be helpful in making the most efficient use of the available spectrum. These include limiting the licensed power of repeaters to the minimum, and using CTCSS to prevent repeaters from being triggered by unwanted signals.

(d) It is also necessary to consider ways of addressing the fact that the available spectrum is limited, and in the more congested parts of the country it is simply not possible to keep on adding unlimited numbers of new repeaters without creating significant interference problems for existing repeaters. The WIA should consider the implications of this in the context of its role in the licence application process.

John Martin VK3KM
Chairman, WIA TAC

15/7/12

APPENDIX

Band plan revision proposal as discussed by TAC regional representatives

PROPOSAL FOR REVISION OF 144 MHz BAND PLAN

Peter Mill VK3APO is proposing certain changes to the 2 metre band plan in order to make more frequencies available for digital modes, including new repeaters using APCO and Mototurbo.

These new modes are designed for 12.5 kHz channel spacing, so it is proposed to follow the procedure that already applies to D-Star repeaters, i.e to allocate output frequencies for these repeaters in the 146 MHz repeater output segment, using frequencies on odd multiples of 12.5 kHz interleaved between the FM repeater channels.

However the flexibility to find suitable repeater pairs - and to avoid interference to FM repeaters - can be increased by using a different offset from the standard 600 kHz offset used by FM repeaters. This approach is already working successfully on the 70 cm band, where FM repeaters use the traditional 5.0 MHz offset, but D-Star repeaters (and other future digital repeaters) use a 5.4 MHz offset. This places their inputs in a separate band segment where there is no problem of adjacent channel interference on the repeater input frequency.

Peter is proposing that future repeaters using modes like APCO and Mototurbo operate using an offset of 1.6 MHz rather than the 600 kHz used by FM repeaters. Therefore the input frequencies for these new repeaters would fall between 145.000 and 145.400 MHz. Systems such as APCO are designed for use with 12.5 kHz channels and a 1.6 MHz offset, and the wider offset would also have the benefit of making repeater filtering easier.

This would require the reallocation of some frequencies between 145.000 and 145.400 MHz. Specifically, the proposed changes are:

1. Packet Radio segment (up to 145.200 MHz)

- No changes to the existing packet radio segment below 145 MHz.
- Existing packet channels from 145.025 to 145.150 MHz to be reallocated simply as “Digital Modes”.
- No new assignments to packet stations between 145.000 and 145.150 MHz.
- Existing packet activity on 145.175 MHz (APRS) and 145.200 (WICEN) to remain unchanged.

This would free up four 12.5 kHz raster frequencies for use as digital repeater inputs:
145.0125, 145.0375, 145.0625, 145.0875.

Three frequencies in this range are assigned to packet BBS stations:
145.205 (VK3BBS), 145.050 (VK2RPL), 145.075 (VK4RAI), 145.100 (VK4RPK).
These frequencies, and the adjacent 12.5 kHz offset channels, would be avoided in the areas served by these stations.

2. D-Star Simplex Channels

At present there are three D-Star channels between 145.000 and 145.400 MHz:
- 145.1125 D-Star simplex channel 2
- 145.125 D-Star simplex channel 1 (primary)
- 145.1375 D-Star simplex channel 3 and hot spot frequency

The proposed changes are:
- Simplex channel 2 to move to 145.100 MHz.
- Simplex channel 3 to move to 145.150 MHz.

This would free up these frequencies for use as digital repeater inputs:
145.1125, 145.1375 MHz.

3. Current "All Modes" segment (145.200 - 145.400 MHz)

Currently there are three 25 kHz channel tagged as "General/Experimental", for any experimental purpose including possible linear translators. These channels can remain unchanged provided their bandwidth is limited to 12.5 kHz rather than the existing 25 kHz.

This would free up the following frequencies for use as digital repeater inputs:
145.2375, 145.2625.

The frequencies 145.2875 and 145.3125 MHz would not be available for digital repeater use because they are adjacent to the national ARDF frequency (145.300 MHz).

4. IRLP/Echolink Node Channels

The following frequencies are currently allocated to simplex IRLP or Echolink nodes: 145.325, 145.350, 145.375 MHz. It is proposed to move these three channels above 145.400 MHz.

This would free up the following 12.5 kHz offset channels for use as digital repeater inputs:
145.3375, 145.3625, 145.3875 MHz.

The frequencies 145.325, 145.350 and 145.375 MHz could then be reassigned for future use as digital mode simplex channels using 12.5 kHz bandwidth.

Three nodes are assigned to the existing IRLP/Echolink channels:
VK3RFS 145.325, VK3RVZ 145.350 MHz, and VK3RSV 145.375.
These three frequencies, and the adjacent 12.5 kHz interleaved frequencies, would not be available for digital repeater use within the service areas of these three stations.

5. Revision of Simplex channels above 145.400 MHz

The only change to the simplex segment above 145.400 MHz would the reallocation of 145.425 and 145.450 MHz as channels for future IRLP or Echolink nodes. These channels are not presently assigned to any other purpose.

6. Summary

The above changes would provide a total of 11 frequency pairs on 12.5 kHz spaced channels that could be used for digital voice repeaters using a 1.6 MHz offset. This would allow more efficient use of the available spectrum and reduce the possibility of adjacent channel interference between FM and digital repeaters. It would also create 7 new Digital Simplex channels for future use with 12.5 kHz bandwidth.

The effects of the reshuffle on 145 MHz would be minor:

- Two D-Star simplex frequencies changed - this is the only change that would cause any inconvenience
- No effect on existing assigned packet BBS stations, and no change for APRS or WICEN
- No effect on the national ARDF frequency

The proposed changes are presented in chart form on the following page.

John VK3KM

DIGITAL VOICE REPEATER ASSIGNMENTS - APCO, MOTOTURBO ETC

PROPOSED USE OF 145 MHz INPUTS (ON 12.5 KHz OFFSET CHANNELS) AND 1.6 MHz OFFSETS

Bold type	**Changes to existing band plan allocations in bold type.**
Light blue highlighting	Frequencies on 12.5k splits that could be used for repeater pairs with 1.6 MHz offset This would immediately provide 11 channel pairs for digital repeaters.
Grey highlighting	Frequencies on 12.5k splits that could **not** be used for 1.6 MHz offset repeaters.
Red type	Existing assigned stations; these frequencies not available in their service areas

145.000 - 145.2125 DIGITAL AND PACKET RADIO
(no new packet assignments 145.000 - 145.150)

145.000	**DIGITAL SIMPLEX**
145.0125	Available except in VK3BBS area (?)
145.025	**DIGITAL SIMPLEX** (VK3BBS)
145.0375	Available outside VK2RPL or VK3BBS areas
145.050	**DIGITAL SIMPLEX** (VK2RPL)
145.0625	Available outside VK2RPL/VK4RAI areas
145.075	**DIGITAL SIMPLEX** (VK4RAI)
145.0875	Available outside VK4RAI area
145.100	**DIGITAL SIMPLEX** (VK4RPK)
145.1125	Available outside VK4RPK area
145.125	D-Star simplex 1 (primary)
145.1375	Available for digital repeaters
145.150	**D-Star simplex and hot spot** (VK4RZB)
145.1625	NOT USED - Guard for APRS
145.175	PACKET - APRS
145.1875	NOT USED - Guard for WICEN/APRS packet
145.200	PACKET - WICEN
145.2125	NOT USED - Guard for WICEN packet

146.600 - 146.8125 SIMPLEX & REPEATER OUTPUTS

146.600	RTTY SIMPLEX CHANNEL
146.6125	Available for digital repeaters (1.6 MHz offset)
146.625	FM REPEATER OUTPUT
146.6375	Available for digital repeaters (1.6 MHz offset)
146.650	FM REPEATER OUTPUT
146.6625	Available for digital repeaters (1.6 MHz offset)
146.675	FM REPEATER OUTPUT
146.6875	Available for digital repeaters (1.6 MHz offset)
146.700	FM REPEATER OUTPUT
146.7125	Available for digital repeaters (1.6 MHz offset)
146.725	FM REPEATER OUTPUT
146.7375	Available for digital repeaters (1.6 MHz offset)
146.750	FM REPEATER OUTPUT
146.7625	Available for D-Star only (input 146.1625)
146.775	FM REPEATER OUTPUT
146.7875	Available for D-Star only (input 146.1875)
146.800	FM REPEATER OUTPUT
146.8125	Available for D-Star only (input 146.2125)

145.225 - 145.400 ALL MODES SEGMENT

145.225	GENERAL/EXPERIMENTAL **(12.5 kHz bandwidth)**
145.2375	Available for D-Star and other digital voice repeaters
145.250	GENERAL/EXPERIMENTAL **(12.5 kHz bandwidth)**
145.2625	Available for D-Star and other digital voice repeaters
145.275	GENERAL/EXPERIMENTAL **(12.5 kHz bandwidth)**
145.2875	Guard for National ARDF Frequency
145.300	NATIONAL ARDF FREQUENCY (25 kHz bandwidth)
145.3125	Guard for National ARDF Frequency
145.325	**Reserved: 12.5 kHz simplex** (VK3RFS)
145.3375	Available outside VK3RFS or VK3RVZ areas
145.350	**Reserved: 12.5 kHz simplex** (VK3RVZ)
145.3625	Available outside VK3RVZ or VK3RSV areas
145.375	**Reserved: 12.5 kHz simplex** (outside VK3RSV area)
145.3875	Available outside VK3RSV area
145.400	IRLP/ECHOLINK NODES

146.825 - 147.000 REPEATER OUTPUTS

146.825	FM REPEATER OUTPUT
146.8375	Available for digital repeaters (1.6 MHz offset)
146.850	FM REPEATER OUTPUT
146.8625	Available for digital repeaters (1.6 MHz offset)
146.875	FM REPEATER OUTPUT
146.8875	Available for D-Star only (input 146.2875)
146.900	FM REPEATER OUTPUT
146.9125	Available for D-Star only (input 146.3125)
146.925	FM REPEATER OUTPUT
146.9375	Available for digital repeaters (1.6 MHz offset)
146.950	FM REPEATER OUTPUT
146.9625	Available for digital repeaters (1.6 MHz offset)
146.975	FM REPEATER OUTPUT
146.9875	Available for digital repeaters (1.6 MHz offset)
147.000	FM REPEATER OUTPUT

145.425 - 145.750 FM SIMPLEX

145.425	**IRLP/ECHOLINK NODES**
145.450	**IRLP/ECHOLINK NODES**
145.475	FM voice simplex
145.500	FM voice simplex
145.525	FM voice simplex
145.550	FM voice simplex - Space communications only
145.575	Information Beacons
145.600	RTTY (AFSK)
145.625	SSTV / Fax (AFSK)
145.650	CW practice beacons / broadcast relays
145.675	CW practice beacons / broadcast relays
145.700	ARDF homing beacons
145.725	D-Star Comms Site Elevated Hot Spot

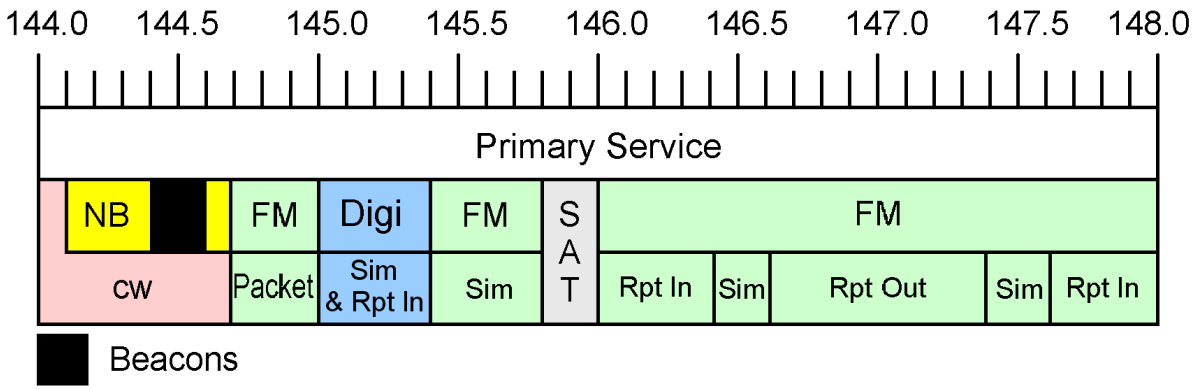
APPENDIX

Updated 2 Metre band plan

2 Metre Band – All licence classes

Band Allocation

144 - 148 MHz AMATEUR Primary Service



144.000 -	144.700	NARROW BAND MODES	(Note 1)
144.000 -	144.100	EME	
144.100 -	144.400	CW / SSB	
144.100		Calling frequency: national primary	
144.200		Calling frequency: national secondary	
144.220 -	144.240	Digital DX modes	
144.240 -	144.300	Guard band: New Zealand beacons	
144.300		SSB chat frequency	
144.320 -	144.340	Digital DX modes	
144.300 -	144.500	Space communications	
144.400 -	144.600	Beacons	(Note 2)
144.625 -	144.675	Reserved - Experimental	
144.700 -	145.000	FM PACKET RADIO	(Note 4)
144.950		Space communications only	

Please note proposed changes (in blue)
for frequencies between 145.000 and 145.450 MHz

145.000 -	145.150	DIGITAL MODES - **12.5 kHz CHANNEL SPACING**
145.000		Digital simplex
145.0125		Digital repeater input
145.025		Digital simplex
145.0375		Digital repeater input
145.050		Digital simplex
145.0625		Digital repeater input
145.075		Digital simplex
145.0875		Digital repeater input
145.100		Digital simplex
145.1125		Digital repeater input
145.125		D-Star simplex 1 (primary channel)
145.1375		Digital repeater input
145.150		D-Star simplex and hot spot channel

145.175 -	145.200	FM PACKET SIMPLEX - 25 kHz CHANNEL SPACING	
145.175		National APRS frequency	
145.200		National WICEN packet frequency	
145.225 -	145.400	ALL MODES - **12.5 kHz CHANNEL SPACING**	
145.225		Reserved - experimental	
145.2375		Digital repeater input	
145.250		Reserved - experimental	
145.2625		Digital repeater input	
145.275		Reserved - experimental	
145.2875		Not used (guard for ARDF channel)	
145.300		National ARDF frequency	
145.3125		Not used (guard for ARDF channel)	
145.325		Simplex	
145.3375		Digital repeater input	
145.350		Simplex	
145.3625		Digital repeater input	
145.375		Simplex	
145.3875		Digital repeater input	
145.400 -	145.775	FM SIMPLEX	
145.400		IRLP/Echolink nodes	
145.425		IRLP/Echlink nodes	
145.450		IRLP/Echolink nodes	
145.475 -	145.525	FM voice simplex	
145.550		Space communications only	
145.575		Information Beacons	
145.600		Non-voice modes (RTTY, SSTV, Fax)	
145.600		WIA broadcast relays (VK2)	
145.650 -	145.675	CW practice beacons / broadcast relays	
145.700		ARDF homing beacons	
145.725		D-Star Comms Site Elevated Hot Spot	
145.800 -	146.000	AMATEUR SATELLITES	(Note 3)
146.025 -	147.975	FM SIMPLEX AND REPEATERS	(Notes 4, 5, 6)
146.025 -	146.400	FM Repeater inputs - group A	
146.0375 -	1463875	Digital Repeater inputs	
146.425 -	146.600	FM Simplex	
146.500		National voice calling frequency	
146.600		Non-voice modes (RTTY, SSTV, Fax)	
146.6125 -	146.9875	Digital Repeater outputs	
146.625 -	147.000	FM Repeater outputs - group A	
147.025 -	147.375	FM Repeater outputs - group B	
147.400 -	147.600	Simplex	
147.400		ATV liaison	
147.575 -	147.600	Packet radio	
147.625 -	147.975	FM Repeater inputs - group B	

Note 1: Narrow Band Modes

This segment is reserved for modes such as CW, digital modes and SSB with bandwidths up to 4 kHz. Weak signal operation has absolute priority. Calling frequencies should be used only to make initial contact and then vacated as soon as possible. Please avoid any terrestrial operation within the EME segment.
The following spot frequencies are recommended for digital DX operation using SSB-based modes:
144.220 / .320 Weak signal modes with bandwidths below 100 Hz, e.g. PSK and slow CW
144.225 / .325 Weak signal modes with bandwidths up to 500 Hz, e.g. MFSK, JT44 and similar
144.230 / .330 High speed meteor scatter modes with bandwidths up to 3 kHz, e.g. FSK441
SSB operators should note that the segment 144.110 – 144.165 MHz is used in some countries for international digital mode EME operation.
The band 144.3 - 144.5 MHz is not an IARU recognised satellite band, however some frequencies in this segment may be used at times for space communications.
The Experimental segment is reserved for specialised experimental use, including possible future linear translators.

Note 2: Beacons

Beacon frequencies are allocated on a call area basis, e.g. VK1: 144.410 - 144.419, VK2: 144.420 - 144.429 etc. Beacon frequency spacing is 2 kHz. The beacon segment should be kept clear of other transmissions, but note that the frequency 144.489 MHz is recognised internationally for DX experiments using WSPR mode.

Note 3: Amateur Satellites

The satellite segment should be kept clear of all terrestrial operation.

Note 4: All Mode, Digital, Packet and FM Simplex Segments

FM channel spacing is 25 kHz. D-Star and other digital channel spacing is 12.5 kHz. Channels reserved for special purposes should be kept clear of other operation. The space shuttle frequencies on 144.950 and 145.550 MHz should be kept clear of all terrestrial operation. For APCO P25 digital voice, (suggested Astro ID - ACMA Client Number; Network Access Code (NAC) – 293.

Note 5: Repeaters

FM repeaters: Channel spacing is 25 kHz, and offset is 600 kHz. Inputs and outputs may be reversed but this is not recommended. Vacant repeater output frequencies can be used as simplex channels, but repeater inputs should be avoided. The following channels are reserved for WICEN repeaters:

147.175	(all states)
147.125, 147.150	(NSW, Queensland)
146.925, 147.300	(Victoria)

Digital repeaters use frequencies on odd multiples of 12.5 kHz in between the existing 25 kHz spaced FM repeater channels.

Note 6: Repeater Linking

Our licence conditions require tone access for repeaters that are linked to repeaters in certain other bands, to prevent transmissions from being relayed on frequencies that the operators are not entitled to use. CTCSS is also used to activate selective linking or for interference protection.

The following CTCSS tones have been adopted for repeater access:

91.5 Hz:	For use with repeaters fitted with CTCSS for interference protection.
141.3 or 146.2 Hz:	To activate links to repeaters on other VHF/UHF bands.
85.4 Hz:	To activate links to other bands that some operators are not permitted to use.

The previously recommended 123 Hz tone is no longer recommended for future repeaters due to problems with false detecting.