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Radiocommunications Assignment and Licensing Instruction

FREQUENCY ASSIGNMENT REQUIREMENTS FOR NARROWBAND SINGLE CHANNEL TWO FREQUENCY POINT-TO-POINT SERVICES IN THE 400 MHz AND 900 MHz BANDS

AUSTRALIAN COMMUNICATIONS AND MEDIA AUTHORITY

SPECTRUM INFRASTRUCTURE BRANCH

RADIOCOMMUNICATIONS ASSIGNMENT AND LICENSING INSTRUCTIONS

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Table of Contents

FREQUENCY ASSIGNMENT REQUIREMENTS FOR NARROWBAND SINGLE CHANNEL TWO FREQUENCY POINT-TO-POINT SERVICES IN THE 400 MHz AND 900 MHz BANDS

1. Purpose

This Radiocommunications Assignment and Licensing Instruction (RALI) provides advice on frequency assignment policy and coordination procedures for Narrowband Single Channel Two Frequency (SCTF) Fixed Point to Point (P-P) services operating in accordance with:

- the *400 MHz Plan* (RALI MS22)[1][1]; and
- the *900 MHz Band Plan 1992*[2].[2]

The advice provided in this RALI is based upon frequency assignment policy and coordination procedures for SCTF P-P services that were initially promulgated in Spectrum Planning Report 3/86 [3] and further developed in Spectrum Planning Report 11/92 [4]. While this document essentially retains the approach to frequency co-ordination adopted in the original reports some important modifications have been made in order to account for the technological changes that have occurred since the original reports were written.

The information in this document reflects the ACMA's statement of current policy in relation to frequency assignment requirements for narrowband SCTF P-P services operating in the 400 MHz and 900 MHz bands. In making decisions, frequency assigners should take all relevant factors into account and decide each case on its merits. Issues relating to this document that appear to fall outside the enunciated policy should be referred to the Manager, Spectrum Engineering Section.

2. Service Description

SCTF P-P services in the 400 MHz and 900 MHz Bands are typically used to provide simultaneous bi-directional (full duplex) narrowband communications between two fixed points. Services may use either analogue or digital modulation.

Functionally a SCTF P-P system may be characterised as featuring:

- Line-of-site links between stations at high sites employing directional antennas;
- Full duplex operation; and
- Carriage of either:
  - Voice services; or

[1] A copy of the current 400 MHz Plan may be obtained through the ACMA website at http://www.acma.gov.au/ACMAINTER.1900810:STANDARD::pc=PC_2571

[2] A copy of the current 900 MHz Band Plan may be obtained through the ACMA website at http://www.acma.gov.au/ACMAINTER.1900810:STANDARD::pc=PC_2572

– Data services with bit-rates typically up to 19.2 kbps.

The channelling arrangements for SCTF P-P services, in both the 400 MHz and the 900 MHz Bands are tabulated in Annex A of these instructions.

3. Service Model

The following section presents a service model that is to be applied, with certain allowances to interservice[3] sharing, to all new frequency assignments for narrowband SCTF P-P services operating in the 400 MHz and 900 MHz Bands.

The model is intended to ensure a satisfactory grade of service, while still facilitating a reasonable density of co-channel services within the geographic vicinity.

3.1 Service Model Description

The service model for SCTF P-P services in the 400 MHz and 900 MHz bands is characterised as a radiocommunications system where full duplex communications, meeting or exceeding a target grade of service, occur between two terminal stations utilising directional antennas over a substantially unobstructed path.

3.2 Target Grade of Service

The target grade of service for SCTF P-P services in the 400 MHz and 900MHz bands is:

a. a received signal quality of 30 dB SINAD or better for analogue services[4] for more than 90% of the time; and

b. a BER of better than 10^{-6} for digital services[5] for more than 90% of the time.

Section 3.3 specifies planning rules intended to ensure that new SCTF P-P services achieve at least the target grade of service specified in the service model.

3.3 Planning Rules

SCTF P-P services in the 400 MHz and 900 MHz bands must comply with following planning rules:

1. operation is limited to frequencies authorised under the appropriate band plan;

2. where channelling arrangements cater for both 12.5 kHz and 25 kHz channels, 12.5 kHz channels should be used wherever operationally feasible. 25 kHz channels should only be assigned to digital services operating at bit rates of at least 9.6 kbps;

3. a flat co-channel protection ratio of 30 dB applies. However, this may be reduced in some circumstances - see Sections 3.4 and 3.5;

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[3] See RALI FX 1 "Narrowband Assignments In The Vicinity Of 400 MHz wideband Fixed Services"

[4] Refer to paragraph 2.3 of Spectrum Planning Report 3-86.

[5] Typical narrowband receivers will deliver output BERs of at least 10^{-6} at signal-to-noise ratios as low as 15 dB at the receiver input.

4. a maximum [average] transmitter output power (into the antenna) of 1 W, except for services where the link distance is less than 10 km where the maximum transmitter output power (into the antenna) shall be 100 mW; and

5. actual antenna radiation performance is to be at least equal to the following characteristics:

   In High and Medium Density Areas[6]:

   – in the 400 MHz band[7]: a directional antenna with a mid-band gain of least 13 dBi, a minimum front-to-back ratio of 17 dB and a maximum beam width (in E-plane) of 36°; and

   - in the 900 MHz band[8]: a directional antenna with a mid-band gain of at least 16 dBi, a minimum front-to-back ratio of 20 dB and a maximum beam width (in E-plane) of 30°.

   Outside of High and Medium Density Areas [7]:

   – in the 400 MHz band[8]: a directional antenna with a mid-band gain of least 9 dBi, a minimum front-to-back ratio of 15 dB and a maximum beam width (in E-plane) of 45°; and

   - in the 900 MHz band[8]: a directional antenna with a mid-band gain of at least 9 dBi, a minimum front-to-back ratio of 15 dB and a maximum beam width (in E-plane) of 45°.

3.4 Protection Ratios

The service model applies a flat co-channel protection ratio[8] of 30 dB for all co-channel SCTF P-P services, which reduces by a calculated amount for cases where a victim receiver is operating near its minimum useable sensitivity - see Section 3.5.

Due to the high level of adjacent channel isolation that is inherent to narrowband SCTF P-P receivers, the service model only considers co-channel interference. This assumes that services will operate at no more than the 1 Watt transmitter output power limit imposed by this RALI and that isolation between channels is 50 dB or better.

The basic 30 dB co-channel protection ratio is intended to ensure that SCTF P-P services achieve actual grades of service that are a least equal to those specified in Section 3.2.

Note: the same co-channel protection ratios apply to both 12.5 kHz and 25 kHz channels.

[6] See ACMA's current "Apparatus Licence Fee Schedule" for definitions and maps for "High", "Medium" and "Low" Density Areas.

[7] Consistent with Schedule 1 of the *Radiocommunications Licence Conditions (Fixed Licence) Determination No. 1 of 1997.*

[8] Protection Ratio: the minimum wanted-to-unwanted ratio that must be achieved for a successful co-ordination with a nearby service.

3.5 Reduced protection ratios for services operating close to minimum useable receiver sensitivity

Where a SCTF P-P receiver is operating close to its noise limited receive threshold[9] the co-channel protection that it can be afforded is reduced. Without such reductions the effective co-channel re-use distance for adjacent services becomes unreasonably large.

Table 1 is to be used to determine the level of co-channel protection that can be afforded to a receiver operating close to its minimum useable sensitivity.

Reduced co-channel protection will apply to:

- a proposed new receiver where its own "wanted" signal will be weaker than - 99 dBm ; or
- any potential victim receiver with a "wanted" signal weaker than - 99 dBm.

"Wanted" Signal Level (WL)	Co-channel protection ratio applying
WL ≥ -99 dBm	= 30 dB;
- 99 > WL > - 129 dBm	= 30 minus "X" dB; where X= (- 99 minus WL)
WL ≤ -129 dBm	No protection.

Table 1: Calculation of co-channel protection ratios applying to SCTF P-P receivers.

4. Frequency Assignment Policy

Successful management of interference in the P-P service requires that all stations operating in the service comply with the planning rules in Section 3.3 of this RALI.

Coordination of P-P services with wide-band fixed services in the 400 MHz band is addressed in RALI FX1. In any other cases, because of the diversity and complexity of sharing situations that may arise, it is not possible to provide rigorous and explicit procedures covering all inter-service coordination requirements. In these cases, coordination should be performed in accordance with good engineering practice based on fundamental interference mitigation principles.

4.1 Application of Planning Rules

SCTF P-P services operating in the 400 MHz and 900 MHz Bands are to comply with the planning rules specified in Section 3.3.

[9] Limited by intrinsic system noise to around - 129 dBm in typical 25 kHz receivers.

4.2 Channelling Arrangements

Frequency assignments for SCTF P-P services may only be made in accordance with the channelling arrangements for SCTF P-P services made in:

- the *400 MHz Plan* (RALI MS22); and
- the *900 MHz Band Plan 1992*.

Frequency assigners are to give full attention to the notes applying in each band plan.

The channelling arrangements for SCTF P-P services, in both the 400 MHz and the 900 MHz Bands are tabulated in Annex A of these instructions.

4.3 Channel loading strategy for SCTF P-P services in the 400 MHz and 900 MHz Bands

A bottom-up vertical channel loading strategy is to be applied to all new SCTF P-P services in the 400 MHz and 900 MHz Bands.

A bottom-up vertical channel loading strategy is one in which the lowest available channel must be assigned.

4.4 Assignment Limit for Co-path Single Channel Links

The Business Operating Procedure "Assignment limit for co-path single-channel links in the VHF and UHF bands" [6] limits the number of single channel links that may be assigned to a particular link operator for co-path use to **five**.

4.5 Inter-service co-ordination procedures

The inter-service co-ordination requirements between narrowband SCTF P-P and wideband P-P services in the 400 MHz Band are specified in RALI FX 1 [5].

4.6 Frequency Coordination Procedure

The following sections propose a coordination procedure for the frequency assignment of SCTF P-P services in the 400 MHz and 900 MHz Bands.

Note: the procedure given below only outlines the general principles that should be applied when selecting and co-ordinating frequencies. It is the responsibility of the assigner to apply sound engineering principles and also take full account of all embargoes, relevant RALIs and Band Plans.

4.6.1 Frequency Selection

After identifying the prospective frequency range(s) meeting the basic engineering requirements for the proposed link the frequency selection process may be carried out in the following 9 general stages:

1. Obtain a current list of licensed services[10] covering the frequency range of interest.

2. Referring to the list, perform a radial cull around the mean position (mid-point) of the proposed service. The cull is carried out in order to exclude services too far away to affect or be affected by the proposed new service. The choice of a suitable cull radius will depend on terrain and the frequency band but should not be less than 200 km.

3. Select the most appropriate site sense arrangements for the proposed service.

Note: assigners should endeavour to follow established transmitter site sense wherever possible. This not only improves the availability of channels later on but also helps to optimise the productivity of prime sites. Rather than mixing site sense assigners should consider using an alternative frequency band. However, as a general guide when it is not possible to avoid mixing site sense, the selected transmission frequency should be at least four channels away from frequencies occupied by receivers nearby. This reduces potential intermodulation problems, which can also affect site productivity.

4. Referring to the list of current embargoes exclude any channels that cannot be used.

5. Carry out necessary engineering assessments to exclude channels that are unavailable due to the potential for interference to wideband P-P Services - see RALI FX 1.

6. Using the parameters specified in Tables 2 and 3 generate a list of wanted-to-unwanted ratios comparing the proposed service to each co-channel service in the cull area.

Relative angle off bore-sights	Assumed discrimination
within ±18 degrees	- 15 dB
any other angle	0 dB

Table 2: Assumed cross-polar discrimination for antennas in the 400 MHz and 900 MHz Bands.

Note: the assigner is free to select the antenna polarisation (either horizontal or vertical) that provides the best co-ordination results. However, horizontal polarisation is preferred as additional onsite isolation is then available to and from adjacent vertically polarised land mobile services.

[10] Lists of current frequency assignments are available from the Register of Radiocommunications Licences on the ACMA web site.

Propagation Distance	Path Loss
400 MHz Band	
0.003 to 40 km	Free space loss[11] + 10dB
> 40 km	104 + 0.55*(distance in km)
900 MHz Band	
0.003 to 55 km	Free space loss[12] + 10dB
> 55 km	107 + 0.55*(distance in km)

Table 3: Path loss calculations for SCTF P-P services.

Note: Formulas are derived from the Longley Rice[12] model applied to an unobstructed line-of-sight path.

7. Exclude from the list those channels where the co-channel protection ratio required by Sections 3.5 and 3.6 is not met. Then select the lowest available channel using the bottom-up vertical channel loading strategy described in Section 4.3.

Note: selection of a suitable SCTF P-P channel will require finding a pair of available duplex frequencies.

8. Document the final details of the service for licensing purposes.

9. Complete licensing requirements.

4.7 Local Environment

There may be circumstances where the channel selected using the above mentioned procedure is not the optimal channel to be assigned due to the local environment. Examples are: a large mountain range offering additional propagation loss to/from a service in an adjacent area; a transmitter located on a site at a height much greater than the planning model assumes; or an anomalous propagation mode occurring due to a path over water.

Under such circumstances, propagation path loss may be determined by the use of any appropriate method described in section 4 of ITU-R P.526 (versions 4 through 9). All methods must use a 9 second digital elevation model (such as RadDEM) or better. Other methods for determining the propagation path loss may also be used pending ACMA agreement.

[11] Free Space Loss (FSL) = 32.5+ 20*Log (Distance in km) + 20*Log (Frequency in MHz).

[12] The model estimates loss to a 90% confidence level.

RALI Authorisation

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References

1. The *400 MHz Plan* (RALI MS22).

2. The *900 MHz Band Plan 1992.*

3. Spectrum Planning Report 3/86: "Guidelines for the assignment of frequencies to two frequency single channel services in the 400 MHz and 900 MHz Bands".

4. Spectrum Planning Report 11/92: "Lynx Version 3.0 - Computer assisted frequency assignment for two frequency single channel fixed services in the 150, 400 and 900 MHz Bands".

5. RALI FX 1: "Narrrowband assignments in the vicinity of 400 MHz wideband Fixed Services".

6. BOP Assignment limit for co-path single-channel links in the VHF and UHF bands http://www.acma.gov.au/WEB/STANDARD/pc=PC_2708

Annex A - Channelling arrangements for the Single Channel Two Frequency Point-to-Point Service in the 400 MHz and 900 MHz Bands

Preface

Each SCTF P-P channel comprises of a pair of frequencies with a fixed frequency separation - a duplex pair. Depending on the site sense (see stage 3 of section 4.6.1) one end of every SCTF P-P link must be chosen to transmit on the higher frequency of the duplex pair (i.e. to **Transmit High**). The related receiver at that same end receives on the lower frequency of the pair. The transmitter/receiver at the opposite end of the link operates in complement - transmitting on the lower frequency of the pair (**Transmit Low)** and receiving on the higher frequency. Tables A1 to A5 list the duplex pairs allocated in each band in terms of transmitter frequency. By convention, the higher duplex frequency is denoted as **Transmit High** and the lower duplex frequency is denoted as **Transmit Low**.

A1. 400 MHz Band

Bands 1 and 2

Two groups comprising of 82 channels with 12.5 kHz spacing are provided in the 400 MHz Band. The channel centres are:

- **Band 1**: [403.98125 + n (0.0125)] MHz paired with [413.43125 + n (0.0125)] MHz; and
- **Band 2**: [450.48125 + n (0.0125)] MHz paired with [459.98125 + n (0.0125)] MHz.

  Where n is any integer between 1 and 82 inclusive.

  Channelling arrangements for Bands 1 and 2 are detailed in Tables A1 and A2.

Provisions for the use of 25 kHz channels in Bands 1 and 2

The *400 MHz Plan* allows two 12.5 kHz channels to be assigned contiguously where a need exists for 25 kHz operation. Where two 12.5 kHz channels are being assigned contiguously the 25kHz channel centre frequency should be selected as follows:

1. Calculate the centre frequency of each odd numbered channel (where n=1, 3, 5, etc);
2. Next add 6.25 kHz to each calculated centre frequency. This yields the centre frequency of each possible 25 kHz channel (see Table A4); then
3. Consistent with the bottom up channel loading strategy expressed in section 4.3, use the frequency selection process outlined in section 4.6.1 to find the lowest available 25 kHz centre frequency.

Note: the same co-channel protection ratios apply to both 12.5 kHz and 25 kHz channels.

A2. 900 MHz Band

Band 3

One group comprising of 40 channels with 25 kHz spacing is provided in the 900 MHz Band. The channel centres are:

- **Band 3**: [851.9875 + n (0.025)] MHz paired with [927.9875 + n (0.025)] MHz.

  Where n is any integer between 1 and 40 inclusive.

  Channelling arrangements for Band 3 are detailed in Table A3.

Band 4

One group comprising of 40 channels with 12.5 kHz spacing is provided in the 900 MHz Band. The channel centres are:

- **Band 4**: [852.99375 + n (0.0125)] MHz paired with [928.99375 + n (0.0125)] MHz;

  Where n is any integer between 1 and 40 inclusive.

  Channelling arrangements for Band 4 are detailed in Table A4.

  Provisions for the use of 25 kHz channels in Band 4

  The *900MHz Band Plan* allows two 12.5 kHz channels to be assigned contiguously where a demonstrated need exists for 25 kHz operation. However, wherever possible use should be made of regular 25kHz channels in other bands. Where two 12.5 kHz channels are being assigned contiguously the 25kHz channel centre frequency should be selected as follows:

  1. Calculate the centre frequency of each odd numbered channel (where n=1, 3, 5, etc);
  2. Next add 6.25 kHz to each calculated centre frequency. This yields the centre frequency of each possible 25 kHz channel (see Table A5); then
  3. Consistent with the bottom up channel loading strategy expressed in section 4.3, use the frequency selection process outlined in section 4.6.1 to find the lowest available 25 kHz centre frequency.

  Note: the same co-channel protection ratios apply to both 12.5 kHz and 25 kHz channels.

Centre Frequency (MHz)					Centre Frequency (MHz)				
Channel Number	**Transmit Low**		**Transmit High**		**Channel Number**	**Transmit Low**		**Transmit High**	
1	403.99375	404.000	413.44375	413.450	43	404.51875	404.525	413.96875	413.975
2	404.00625		413.45625		44	404.53125		413.98125	
3	404.01875	404.025	413.46875	413.475	45	404.54375	404.550	413.99375	414.000
4	404.03125		413.48125		46	404.55625		414.00625	
5	404.04375	404.050	413.49375	413.500	47	404.56875	404.575	414.01875	414.025
6	404.05625		413.50625		48	404.58125		414.03125	
7	404.06875	404.075	413.51875	413.525	49	404.59375	404.600	414.04375	414.050
8	404.08125		413.53125		50	404.60625		414.05625	
9	404.09375	404.100	413.54375	413.550	51	404.61875	404.625	414.06875	414.075
10	404.10625		413.55625		52	404.63125		414.08125	
11	404.11875	404.125	413.56875	413.575	53	404.64375	404.650	414.09375	414.100
12	404.13125		413.58125		54	404.65625		414.10625	
13	404.14375	404.150	413.59375	413.600	55	404.66875	404.675	414.11875	414.125
14	404.15625		413.60625		56	404.68125		414.13125	
15	404.16875	404.175	413.61875	413.625	57	404.69375	404.700	414.14375	414.150
16	404.18125		413.63125		58	404.70625		414.15625	
17	404.19375	404.200	413.64375	413.650	59	404.71875	404.725	414.16875	414.175
18	404.20625		413.65625		60	404.73125		414.18125	
19	404.21875	404.225	413.66875	413.675	61	404.74375	404.750	414.19375	414.200
20	404.23125		413.68125		62	404.75625		414.20625	
21	404.24375	404.250	413.69375	413.700	63	404.76875	404.775	414.21875	414.225
22	404.25625		413.70625		64	404.78125		414.23125	
23	404.26875	404.275	413.71875	413.725	65	404.79375	404.800	414.24375	414.250
24	404.28125		413.73125		66	404.80625		414.25625	
25	404.29375	404.300	413.74375	413.750	67	404.81875	404.825	414.26875	414.275
26	404.30625		413.75625		68	404.83125		414.28125	
27	404.31875	404.325	413.76875	413.775	69	404.84375	404.850	414.29375	414.300
28	404.33125		413.78125		70	404.85625		414.30625	
29	404.34375	404.350	413.79375	413.800	71	404.86875	404.875	414.31875	414.325
30	404.35625		413.80625		72	404.88125		414.33125	
31	404.36875	404.375	413.81875	413.825	73	404.89375	404.900	414.34375	414.350
32	404.38125		413.83125		74	404.90625		414.35625	
33	404.39375	404.400	413.84375	413.850	75	404.91875	404.925	414.36875	414.375
34	404.40625		413.85625		76	404.93125		414.38125	
35	404.41875	404.425	413.86875	413.875	77	404.94375	404.950	414.39375	414.400
36	404.43125		413.88125		78	404.95625		414.40625	
37	404.44375	404.450	413.89375	413.900	79	404.96875	404.975	414.41875	414.425
38	404.45625		413.90625		80	404.98125		414.43125	
39	404.46875	404.475	413.91875	413.925	81	404.99375	405.000	414.44375	414.450
40	404.48125		413.93125		82	405.00625		414.45625	
41	404.49375	404.500	413.94375	413.950					
42	404.50625		413.95625						

Table A1: Band 1 Channel Arrangements.

Centre Frequency (MHz)					Centre Frequency (MHz)				
Channel Number	Transmit Low		Transmit High		Channel Number	Transmit Low		Transmit High	
1	450.49375	450.500	459.99375	460.000	43	451.01875	451.025	460.51875	460.525
2	450.50625		460.00625		44	451.03125		460.53125	
3	450.51875	450.525	460.01875	460.025	45	451.04375	451.050	460.54375	460.550
4	450.53125		460.03125		46	451.05625		460.55625	
5	450.54375	450.550	460.04375	460.050	47	451.06875	451.075	460.56875	460.575
6	450.55625		460.05625		48	451.08125		460.58125	
7	450.56875	450.575	460.06875	460.075	49	451.09375	451.100	460.59375	460.600
8	450.58125		460.08125		50	451.10625		460.60625	
9	450.59375	450.600	460.09375	460.100	51	451.11875	451.125	460.61875	460.625
10	450.60625		460.10625		52	451.13125		460.63125	
11	450.61875	450.625	460.11875	460.125	53	451.14375	451.150	460.64375	460.650
12	450.63125		460.13125		54	451.15625		460.65625	
13	450.64375	450.650	460.14375	460.150	55	451.16875	451.175	460.66875	460.675
14	450.65625		460.15625		56	451.18125		460.68125	
15	450.66875	450.675	460.16875	460.175	57	451.19375	451.200	460.69375	460.700
16	450.68125		460.18125		58	451.20625		460.70625	
17	450.69375	450.700	460.19375	460.200	59	451.21875	451.225	460.71875	460.725
18	450.70625		460.20625		60	451.23125		460.73125	
19	450.71875	450.725	460.21875	460.225	61	451.24375	451.250	460.74375	460.750
20	450.73125		460.23125		62	451.25625		460.75625	
21	450.74375	450.750	460.24375	460.250	63	451.26875	451.275	460.76875	460.775
22	450.75625		460.25625		64	451.28125		460.78125	
23	450.76875	450.775	460.26875	460.275	65	451.29375	451.300	460.79375	460.800
24	450.78125		460.28125		66	451.30625		460.80625	
25	450.79375	450.800	460.29375	460.300	67	451.31875	451.325	460.81875	460.825
26	450.80625		460.30625		68	451.33125		460.83125	
27	450.81875	450.825	460.31875	460.325	69	451.34375	451.350	460.84375	460.850
28	450.83125		460.33125		70	451.35625		460.85625	
29	450.84375	450.850	460.34375	460.350	71	451.36875	451.375	460.86875	460.875
30	450.85625		460.35625		72	451.38125		460.88125	
31	450.86875	450.875	460.36875	460.375	73	451.39375	451.400	460.89375	460.900
32	450.88125		460.38125		74	451.40625		460.90625	
33	450.89375	450.900	460.39375	460.400	75	451.41875	451.425	460.91875	460.925
34	450.90625		460.40625		76	451.43125		460.93125	
35	450.91875	450.925	460.41875	460.425	77	451.44375	451.450	460.94375	460.950
36	450.93125		460.43125		78	451.45625		460.95625	
37	450.94375	450.950	460.44375	460.450	79	451.46875	451.475	460.96875	460.975
38	450.95625		460.45625		80	451.48125		460.98125	
39	450.96875	450.975	460.46875	460.475	81	451.49375	451.500	460.99375	461.000
40	450.98125		460.48125		82	451.50625		461.00625	
41	450.99375	451.000	460.49375	460.500					
42	451.00625		460.50625						

Table A2: Band 2 Channel Arrangements.

Centre Frequency (MHz)			Centre Frequency (MHz)		
Channel Number	**Transmit Low**	**Transmit High**	**Channel Number**	**Transmit Low**	**Transmit High**
1	852.0125	928.0125	21	852.5125	928.5125
2	852.0375	928.0375	22	852.5375	928.5375
3	852.0625	928.0625	23	852.5625	928.5625
4	852.0875	928.0875	24	852.5875	928.5875
5	852.1125	928.1125	25	852.6125	928.6125
6	852.1375	928.1375	26	852.6375	928.6375
7	852.1625	928.1625	27	852.6625	928.6625
8	852.1875	928.1875	28	852.6875	928.6875
9	852.2125	928.2125	29	852.7125	928.7125
10	852.2375	928.2375	30	852.7375	928.7375
11	852.2625	928.2625	31	852.7625	928.7625
12	852.2875	928.2875	32	852.7875	928.7875
13	852.3125	928.3125	33	852.8125	928.8125
14	852.3375	928.3375	34	852.8375	928.8375
15	852.3625	928.3625	35	852.8625	928.8625
16	852.3875	928.3875	36	852.8875	928.8875
17	852.4125	928.4125	37	852.9125	928.9125
18	852.4375	928.4375	38	852.9375	928.9375
19	852.4625	928.4625	39	852.9625	928.9625
20	852.4875	928.4875	40	852.9875	928.9875

Table A3: Band 3 Channel Arrangements

Centre Frequency (MHz)			Centre Frequency (MHz)		
Channel Number	**Transmit Low**	**Transmit High**	**Channel Number**	**Transmit Low**	**Transmit High**
1	853.00625	929.00625	21	853.25625	929.25625
2	853.01875	929.01875	22	853.26875	929.26875
3	853.03125	929.03125	23	853.28125	929.28125
4	853.04375	929.04375	24	853.29375	929.29375
5	853.05625	929.05625	25	853.30625	929.30625
6	853.06875	929.06875	26	853.31875	929.31875
7	853.08125	929.08125	27	853.33125	929.33125
8	853.09375	929.09375	28	853.34375	929.34375
9	853.10625	929.10625	29	853.35625	929.35625
10	853.11875	929.11875	30	853.36875	929.36875
11	853.13125	929.13125	31	853.38125	929.38125
12	853.14375	929.14375	32	853.39375	929.39375
13	853.15625	929.15625	33	853.40625	929.40625
14	853.16875	929.16875	34	853.41875	929.41875
15	853.18125	929.18125	35	853.43125	929.43125
16	853.19375	929.19375	36	853.44375	929.44375
17	853.20625	929.20625	37	853.45625	929.45625
18	853.21875	929.21875	38	853.46875	929.46875
19	853.23125	929.23125	39	853.48125	929.48125
20	853.24375	929.24375	40	853.49375	929.49375

Table A4: Band 4 Channel Arrangements (12.5 kHz raster).

Centre Frequency (MHz)			Centre Frequency (MHz)		
Channel Number	**Transmit Low**	**Transmit High**	**Channel Number**	**Transmit Low**	**Transmit High**
1	853.0125	929.0125	11	853.2625	929.2625
2	853.0375	929.0375	12	853.2875	929.2875
3	853.0625	929.0625	13	853.3125	929.3125
4	853.0875	929.0875	14	853.3375	929.3375
5	853.1125	929.1125	15	853.3625	929.3625
6	853.1375	929.1375	16	853.3875	929.3875
7	853.1625	929.1625	17	853.4125	929.4125
8	853.1875	929.1875	18	853.4375	929.4375
9	853.2125	929.2125	19	853.4625	929.4625
10	853.2375	929.2375	20	853.4875	929.4875

Table A5: Band 4 Channel Arrangements (25 kHz raster).

Note: See the section *"Provisions for the use of 25 kHz channels in Band 4"* above before assigning 25 kHz channels in Band 4.