RALI FX 1

DATE OF EFFECT: 24 June 2019

Radiocommunications Assignment and Licensing Instruction

FREQUENCY ASSIGNMENT REQUIREMENTS FOR NARROWBAND FIXED AND MOBILE SERVICES WITH WIDEBAND FIXED SERVICES IN THE 403-420 MHZ BAND

AUSTRALIAN COMMUNICATIONS AND MEDIA AUTHORITY

SPECTRUM PLANNING AND ENGINEERING BRANCH

Amendment History

Date	Comments
13 August 1992	RALI FX1 (Sequence Number 3), Initial publication
14 December 1992	RALI FX5 (Sequence Number 18)- Narrowband Assignments in the Vicinity of Wideband Fixed Services in the 403-500 MHz Band
1 May 1998	Replaced both RALI FX1 (Sequence Number 3) & RALI FX5 (Sequence Number 18) with RALI FX1 (Sequence Number 130(3)) – entitled "Narrowband Assignments in the vicinity of 400 MHz wideband fixed services"
24 June 2019	Inclusion of a procedure to coordinate wideband transmitters against narrowband receivers, and an update on the assumptions used for coordinating narrowband transmitters against wideband receivers. A bandwidth factor is also introduced. The option of using ITU-R propagation models P.525 + P.526 instead of the modified Longley-Rice model has been introduced. Other minor editorial changes were also made.

Suggestions for improvements to Radiocommunications Assignment and Licensing Instruction FX 1 may be addressed to The Manager, Spectrum Engineering, ACMA at PO Box 78, Belconnen, ACT, 2616, or by e-mail to freqplan@acma.gov.au. Please notify the ACMA of any inaccuracy or ambiguity found in order that the matter may be investigated, and appropriate action taken.

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Frequency assignment requirements for narrowband fixed and mobile services with wideband fixed services in the 403-420 MHz band

1 Purpose

The purpose of this Radiocommunications Assignment and Licensing Instruction (RALI) is to provide information on frequency coordination and licensing arrangements between narrowband fixed & mobile services and wideband fixed point-to-point services operated under apparatus licences in the 403-420 MHz part of the 400 MHz band.

This RALI replaces RALI FX1, dated 1 May 1998, Sequence Number 130(3).

The information in this RALI reflects the ACMA's statement of current policy in relation to frequency assignment requirements between narrowband fixed & mobile services and wideband fixed point-to-point services in the 400 MHz band. In making decisions, Accredited Persons (APs) and the ACMA's officers 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, PO Box 78, Belconnen, ACT, 2616, or by e-mail to freqplan@acma.gov.au.

2 Current Applicability

This RALI applies to inter-service frequency assignment between narrowband services and wideband fixed point-to-point services sharing the 403 – 420 MHz part of the 400 MHz band. In this context "narrowband services" refers to land mobile assignments and fixed point to multipoint assignments.

Current applicability extends to detailing the steps necessary for frequency coordination and licensing for narrowband transmitters against wideband fixed receivers and wideband fixed point-to-point transmitters against fixed and land mobile base and mobile receivers in the 403 – 420 MHz part of the 400 MHz band.

2.1 Grandfathering of Analog (24/60 channel systems with pilot tone)

When first released RALI FX1 was intended to provide procedures for coordinating narrowband services with wideband fixed services in the 403 - 420 MHz part of the 400 MHz band with an analog modulation scheme that supported 24/60 channel capacity with a pilot tone. Often identified with emission designators ending with G7WET, G7WDT, D7WET, according to ACMA licensing records these wideband systems appear to have ceased being assigned in 2008. Later assignments use other forms of digital modulation.

While existing 24/60 channel systems will continue to be coordinated in accordance with the procedures outlined in this RALI, all other wideband systems will be treated as digital systems.

3 Overview

The frequency coordination procedures outlined in this RALI is based on determining the unwanted signal level at the victim receiver (either the narrowband or wideband receiver are appropriate) and comparing the unwanted signal to the specified protection criteria.

For the wideband receivers the protection criteria specified as a wanted-to-unwanted protection ratio. For narrowband receivers, the protection criterion is specified as a maximum allowed interference threshold.

This section provides information on relevant system characteristics and assumptions that can be considered in applying those criteria.

Wideband digital systems

Transmitting and receiving equipment used for wideband fixed services in the 403 - 420 MHz part of the 400 MHz band is of two broad types: analog 24/60 channel capacity with a pilot tone, or systems using some form of digital modulation. Systems using a pilot tone require different treatment than those without.

The 24/60 channel emission consists of a modulated carrier signal and a pilot tone as shown in Figure 1. The frequencies relevant to the emission are given in Table 1. The pilot tone is generally more sensitive to interference than the carrier signal. The assignment model considers the frequency stability of the carrier and the noise bandwidth of the pilot tone. The frequency stability of the carrier is assumed to be $\pm$ 13.5 kHz for both types of equipment. The noise bandwidth of the pilot tone is assumed to be $\pm$ 12 kHz (for 24 channel equipment) or $\pm$ 30 kHz (for 60 channel equipment).

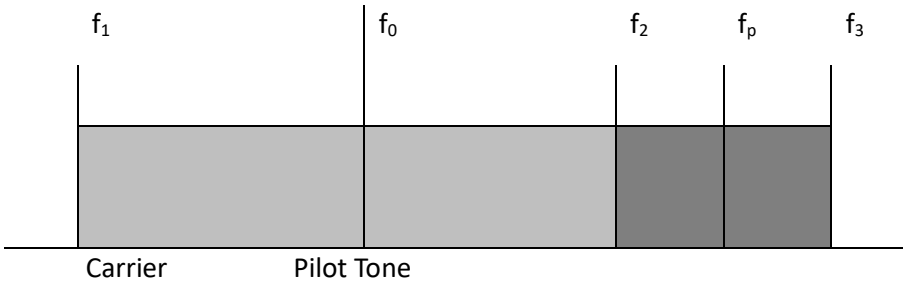

Figure 1: Wideband Emission (24/60 channel with pilot tone)

	24 Channel Equipment	60 Channel Equipment
f_1 =	f_0 - 120.5 kHz	f_0 - 314.5 kHz
f_2 =	f_0 + 93.5 kHz	f_0 + 287.5 kHz
f_3 =	f_0 + 144.5 kHz	f_0 + 374.5 kHz
f_p =	f_0 + 119 kHz	f_0 + 331 kHz

Table 1: Wideband Emission Frequencies

Other forms of emission are assumed to be uniform in power spectral density across their bandwidth, with no part of the emission requiring more protection than any other.

The assignment model assumes a target grade of service of 10% of the noise power in each link hop and with a confidence level of 99%. A protection ratio of 35 dB is assumed to achieve this criterion.

3.1 Protection criteria: 24/60 Channel pilot tone systems

For coordination against systems using a pilot tone, where calculations show a wanted/unwanted ratio of between 35 dB and 60 dB, the narrowband frequency may be assigned. However, if a choice of narrowband frequencies is available, the distribution of signals within the wideband emission should be considered and the narrowband frequency chosen should be the one having the least impact on the wideband service. This is performed by selecting a narrowband frequency in the following priority order:

1. a narrowband frequency[1] that is outside the band f_1 to f_3 ; otherwise
2. a narrowband frequency which is the nearest to f_0 and within the band f_1 to f_2[2]; otherwise
3. a narrowband frequency which is within the band f_2 to f_3.

Note that the frequencies f_0, f_1, f_2 and f_3 are given in Table 1 of this RALI.

3.2 Narrowband systems

Land mobile system models are contained in RALI LM8.

Land mobile antenna heights are to be considered as shown in Table 2 below:

LMS system	Antenna height (m)
LMRS BS Rx	If known use the recorded value, otherwise assume 30
LPMRS BS Rx	If known use the recorded value, otherwise assume 10
Mobile and ambulatory Rx	Assume 1.5

Table 2: LMS receiver heights

3.2.1 Protection criteria narrowband systems

Protection criteria for narrowband systems are based on those specified for land mobile systems in Table 3.

[1] The occupied bandwidth of the narrowband emission should be taken into consideration. It is assumed to be the narrowband channel width. This takes into consideration the necessary bandwidth and frequency tolerance of the narrowband transmitter.

[2] A narrowband emission at a frequency f_1 or f_2 has a higher potential to cause interference than at a frequency closer to the carrier frequency, f_0.

LMS channel bandwidth (kHz)	Maximum unwanted signal level (dBm) (Interference threshold for base or mobile)
6.25	-124
12.5	-121
25	-121

Table 3: Narrowband receiver maximum interference levels

3.3 Propagation Models

	Wanted signal	Unwanted signal
Narrowband Tx to Wideband RX	ITU-R P.526 along with ITU-R P.525, or Modified Longley-Rice	ITU-R P.526 along with ITU-R P.525
Wideband Tx to LMRS Rx (LPMRS)	NA	Base: ITU-R P.526 along with ITU-R P.525, or Modified Longley-Rice Mobile: ITU-R P.526 along with ITU-R P.525

Table 4 – Propagation models used in the calculations

Modified Longley-Rice: The Modified Longley-Rice propagation loss model may be used to calculate the wanted signal level at a wideband receiver. The model estimates propagation loss to a 90% confidence level and assumes a terrain irregularity of 90 metres. Parameter values used in the model are detailed in Table 5 below.

Distance (km)	Path Loss (dB)
0 < distance <= 0.003	45
0.003 < distance <= 40	FSL + 10
distance > 40	104 + (0.55 x distance)

Table 5: Modified Longley-Rice Propagation Model

Note: FSL (Free Space Loss) = 32.45 + 20 log [distance(km)] + 20 log [frequency (MHz)] dB

3.4 Antenna Cross-Polarisation

A 10 dB cross-polarisation discrimination may be assumed to exist between wideband systems with horizontally polarised antennas and narrowband land mobile and point-to-multipoint systems using standard vertically polarised omnidirectional antennas.

For narrowband point-to-point transmitters, a discrimination of 15 dB should be assumed when the wideband receiver antenna and the narrowband antenna are cross-polarised and are each directed to within an angle of 18 degrees of the other. Otherwise, no cross-polarisation discrimination factor should be assumed.

3.5 Assignment priority

Wideband fixed point to point services:

A maximum isolation/horizontal loading strategy should be employed to minimise the likelihood of narrowband transmitters causing harmful interference to wideband receivers. Under this strategy, frequencies that pass the frequency coordination procedure by the greatest margin are assigned.

Narrowband services: Nil (refer to LM8)

4 Frequency Coordination Procedure

The frequency coordination procedures outlined below are based on determining the unwanted signal level at the victim receiver (either the narrowband or wideband receiver) and comparing the unwanted signal to the specified protection criteria.

For wideband receivers the protection criteria specified as a wanted-to-unwanted protection ratio. For narrowband receivers, the protection criterion is specified as a maximum allowed interference threshold.

The model assumes certain wideband equipment characteristics and, where appropriate, recognises the distribution of signals within the wideband transmissions. The model also includes antenna characteristics and cross polarisation discrimination, to aid in improving spectrum productivity.

For mobile stations the separation distance is taken to be from the closest edge of the service area to the station that it is being coordinated against.

4.1 Identification of potentially affected services

Services within the following frequency and distance culls are considered:

Distance cull: 160 km of the proposed new service.

Frequency cull: Any service where the licence bandwidth overlaps that of the proposed new service.

Notes:

1. Both base and mobile transmit frequencies shall be considered. The mobile station's location is taken to be the point where the base station is located
2. When considering assessing against mobile and ambulatory receivers the cull distance is taken to be from the location of the base or centre of the service area

4.2 Narrowband to wideband fixed Point-to-Point services

4.2.1 Frequency Coordination Procedure

The following section details a coordination procedure that may be applied for a proposed narrowband transmitter within 160 km and wholly or partially within the licensed bandwidth of a wideband receiver in the 403 - 420 MHz portion of the 400 MHz band. Alternative frequency coordination procedures may be used to assess the scenario.

STEP 1: WANTED/UNWANTED SIGNAL RATIO

The wanted/unwanted signal ratio is calculated by subtracting the Unwanted Signal Level from the Wanted Signal Level. A bandwidth scaling factor is included in the Unwanted Signal Level:

Wanted Wideband Signal Level (dBm) = 10 log (Tx Power(mW))

+ Tx Antenna Gain (dBi)

- Propagation Loss (dB) [see Table 4 of this RALI]

+ Rx Antenna Gain (dBi)

- 2 dB[3]

Note that for unobstructed paths, regardless of path length, the propagation loss should be calculated as follows:

Propagation Loss (dB) = [32.5 + 20 log (Freq (MHz)) + 20 log (dist (km))] + 10

Unwanted Narrowband Signal Level (dBm) = 10 log (Unwanted Tx Power(mW))

+ Unwanted Narrowband Tx Antenna Gain (dBi)

- Propagation Loss (dB) [see Table 4 of this RALI]

+ Wanted Wideband Rx Antenna Gain (dBi)

- 10 log (wideband signal bandwidth/narrowband signal bandwidth)[4]

STEP 2: THE ASSIGNMENT

Where calculations are carried out in accordance with the model described in this instruction and the resulting wanted/unwanted ratio is less than 35 dB, the proposed narrowband frequency fails coordination and cannot be assigned.

For coordination against systems using a pilot tone[5], where calculations show a wanted/unwanted ratio of between 35 dB and 60 dB, the narrowband frequency may be assigned. However, if a choice of narrowband frequencies is available, the distribution of signals within the wideband emission should be considered and the narrowband frequency chosen should be the one having the least

[3] This is the assumed system loss.

[4] Bandwidth adjustment to protection ratio as emission of narrowband signal only occupies a portion of the wideband signal bandwidth

[5] As described in 3.1.2 and often identified with emission designators ending with G7WET, G7WDT, D7WET. These systems appear to have ceased being assigned in 2008.

impact on the wideband service. This is performed by selecting a narrowband frequency in the following priority order:

1. a narrowband frequency[6] that is outside the band f_1 to f_3; otherwise
2. a narrowband frequency which is the nearest to f_0 and within the band f_1 to f_2[7]; otherwise
3. a narrowband frequency which is within the band f_2 to f_3.

Note that the frequencies f_0, f_1, f_2 and f_3 are given in Table 1 of this RALI.

4.3 Frequency Assignment and Coordination Procedure for wideband fixed point-to-point transmitters into land mobile or point-to-multipoint receivers

The following section details a coordination procedure that may be applied for wideband fixed point-to-point transmitters within 160 km and wholly or partially within the licensed bandwidth of land mobile and point-to-point receivers in the 403 - 420 MHz portion of the 400 MHz band. Alternative frequency coordination procedures may be used provided that they achieve the same results.

The proposed assignment fails coordination if the unwanted power at the victim receiver is below the desired interference threshold as per Table 3. The level of unwanted power at each receiver identified by the frequency and distance culls is to be calculated as per below.

Unwanted Signal Level (dBm) = 10 log (wideband Tx power (mW))

+ Wideband Tx antenna gain in the direction of the victim receiver (dBi)

- Propagation Loss (dB) (see section 3.3 of this RALI)

- Cross polarisation discrimination (dB) (see section 3.4 of this RALI)
+ 10 log (narrowband receiver bandwidth/wideband transmitter bandwidth) [8].

[6] The occupied bandwidth of the narrowband emission should be taken into consideration. It is assumed to be the narrowband channel width. This takes into consideration the necessary bandwidth and frequency tolerance of the narrowband transmitter.

[7] A narrowband emission at a frequency f_1 or f_2 has a higher potential to cause interference than at a frequency closer to the carrier frequency, f_0.

[8] Conversion of wideband signal to power received in narrowband channel bandwidth. This assumes a uniform wideband emission. If this is not the case use the PSD for the frequency bandwidth of the relevant narrowband receiver

RALI Authorisation

[Signed] 24 June 2019

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