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| Technical Liaison Group  Discussion Paper #1 Review of the 800MHz Technical FrameworkTechnology Characteristics, Standard Trading Unit and Minimum Contiguous Bandwidth and Core Conditions of the Technical Framework. |
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Review of the 800MHz Technical Framework 1

Technology Characteristics, Standard Trading Unit and Minimum Contiguous Bandwidth and Core Conditions of the Technical Framework. 1

1. Introduction 1

2. Band Format and Current Usage 3

3. Technology Characteristics 5

4. Standard Trading Unit and Minimum Contiguous Bandwidth 7

5. Non-Spurious Out of Band Emission Limits 9

5.1. Existing Non-Spurious Out of Band Limits of the Technical Framework 9

5.2. A Method for Out of Band Interference Assessment 10

5.3. 890MHz Band Edge Study and Mitigation Requirements 11

*5.3.1.* *Derivation of a New Planned Out of Band Emission Mask* 11

*5.3.2.* *Formal Description of the New Mask* 13

5.4. 870MHz Band Edge Study and Mitigation Requirements 14

*5.4.1.* *Derivation of a New Planned Mask at the 870MHz Band Edge.* 14

*5.4.2.* *Formal Description of the New Mask* 15

5.5. 845MHz Band Edge Study and Mitigation Requirements. 16

*5.5.1.* *Derivation of a New Planned Out of Band Emission Mask* 16

*5.5.2.* *Formal Description of the New Mask* 16

5.6. 825MHz Band Edge Study and Mitigation Requirements. 16

*5.6.1.* *Derivation of a New Planned Out of Band Emission Mask* 16

*5.6.2.* *Formal Description of the New Mask* 16

5.7. Licensed Frequency Band Edge Study and Mitigation Requirements 17

*5.7.1.* *Derivation of a New Planned Out of Band Emission Mask* 19

*5.7.2.* *Formal Description of a New Mask* 20

6. Spurious Emission Limits 21

6.1. Spurious Limits for Transmitters 21

6.2. Spurious Limits for Receivers 23

7. Out of Area Emission Limits 25

8. Information Sought from Technical Liaison Group Participants 27

9. References 28

10. Appendix A 29

11. Appendix B 33

# Introduction

Spectrum licences in the 825-845 / 870-890 MHz (800MHz) band are due to reach their expiry on 17th June 2013. In order to prepare for potential re-issue of spectrum licences in the band a review of the Spectrum Licensing Technical Framework and its conditions is being conducted with the objectives:

* To ensure technology flexibility so that a range of modern technologies can be used in the band, with a particular focus on International Mobile Telecommunications (IMT) technologies.
* To provide conditions that enable continued usage of existing network technologies in the band.
* To provide interference management within the 800MHz band and in adjacent bands.
* To address deficiencies that have come to light during the current licence period.

The Spectrum Licensing Technical framework in the 800MHz band consists of the following components based on Sections within the Radiocommunications Act (RA).

**Core Conditions (in accordance with RA S66) –** including Out of band Non-spurious and Spurious emission limits and an out of area radiated power limit. These core conditions perform the function of managing interference from spectrum licensed transmitters into adjacent frequency bands and adjacent geographical areas.

**Radiocommunications (Unacceptable Levels of Interference – 800MHz Band) Determination 1998 (in accordance with RA S145) -** consisting of instruction on the registration of spectrum licensed devices through a device boundary criteria calculated around a transmitter or receiver. The device boundary criterion is used to ensure that devices operating under a spectrum licence are contained within the boundary of the spectrum licence and to avoid co-frequency interference to receivers in an adjacent area.

**Radiocommunications Advisory Guidelines (in accordance with RA 262) -** for the purpose of:

* Managing interference from spectrum licensed transmitters into adjacent apparatus licensed receivers.
* Managing interference from apparatus licensed transmitters in adjacent frequency bands or adjacent geographic areas.
* Providing information for use by apparatus and spectrum licensees who may need to coordinate with registered spectrum-licensed receivers.

The main purpose of this paper is to outline recommended changes to the Core Conditions of the 800MHz Technical Framework which are to take effect for re-issued spectrum licences in the band and also to present the reasoning behind these recommendations.

The table below provides a summary of the proposed changes to elements of the 800MHz band spectrum licence technical framework covered by this paper. The final section of the paper presents a number of discussion points upon which ACMA seeks comment from members of the Technical Liaison Group.

|  |  |
| --- | --- |
| **Technical Framework Element** | **Proposed Changes** |
| Standard Trading Unit | Removal of the frequency component of the STU (or a change to 1Hz.)  Change of resolution to the geographic component of the STU to 5 minutes on an Australia-wide basis. |
| Minimum Contiguous Bandwidth | In response to submissions to the first release of this paper, the ‘Recommended MCB’ is to be changed to 5MHz. |
| Core Condition: Non-Spurious Out of Band Emission Limits | Changes to the non-spurious out of band emission limits at the:   * 890MHz band edge, * 870MHz band edge, * 845MHz band edge, * 825MHz band edge, and * Licensed frequency band edge.   Inclusion of an isolation example setting out the required attenuation of out-of-band emissions from 800MHz base transmitters to 900Mhz base receivers. |
| Core Condition: Spurious Emission Limits for Transmitters and Receivers | No change. |
| Core Condition: Emission Limits Out of Area | No change. |

Table 1.

# Band Format and Current Usage

In Australia the 800MHz band is key to the delivery of mobile personal communications services (PCS). It was originally allocated for the first generation of mobile networks using the AMPS technology in the early nineties, then re-allocated to the second generation of PCS services in 1997. This next generation technologies were based on CDMA, although some networks have now transferred to WCDMA/HSPA technologies and provide similar services to mobile communications networks in other frequency bands.

The usage of the 800MHz band by such technologies is in accordance with designation of the 806-960MHz frequency range to IMT technologies at WRC-2000. Identification of this range for IMT-2000 is also contained within the Radio Regulations and ITU-R Recommendation M.1036-3, which refers to the bands denoted ‘A1’ where 824-849MHz is used by the mobile transmitters and 869-894MHz is used by the base transmitters. This range has also been identified by a number of IMT-Advanced candidate submissions to the ITU-R as an operational band for these beyond IMT-2000 technologies.

The 800MHz band is divided into upper and lower paired FDD sub-bands; the lower range for base receive and the upper range for base transmit.

* 825-845MHz paired with 870-890MHz (2 x 20MHz) in metropolitan areas,
* 825-845MHz paired with 870-890MHz (2 x 20MHz) in regional and outback areas.

The diagram below shows the set out of the band and the adjacent band services at each of the band edges of 800MHz sub-bands.



Figure 1. 800MHz Band and Adjacent Bands

There are currently two spectrum licensees in the band, Telstra and Vodafone Hutchison Pty Ltd with device registrations as set out in the table. There are a limited number of apparatus licences in the band issued to Telstra.

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| Table 2. Existing device registrations and apparatus licences in the 800MHz Lower and Upper Bands – RRL extract from 1st November 2011. | | |
| **800MHz Device Registrations** | | |
|  | Lower Band | Upper Band |
| Total | 29384 | 30433 |
| Telstra Ltd | 23986 | 25034 |
| Vodafone Hutchison Australia Pty Ltd | 5398 | 5399 |
| **800MHz Apparatus Licences** | | |
|  | Lower Band | Upper Band |
| Total | 4 | 5 |
| Telstra Ltd | 4 (PMTS Class B) | 4 (PMTS Class B) |
| Aeromobile AS | - | 1 (PMTS Class C) |
|  | | |

# Technology Characteristics

The development of the revised technical framework conditions has been based on those IMT technologies considered to be likely candidates for licensing and deployment in the 800MHz band. These technologies include:

|  |  |
| --- | --- |
| Technology | Reference Specifications |
| LTE and LTE-Advanced (E-UTRA) | 36.104, 36.101, 36.106, 36.942, 25.814, ITU-R Rec M.1580, ITU-R Rec M.1581. |
| WCDMA, HSDPA/HSUPA, HSPA, HSPA Evolution (UTRA) | 25.104, 25.101, 25.106, 25.201, 36.942, ITU-R Rec M.1580, ITU-R Rec M.1581. |
| CDMA2000, CDMA Multi-Carrier, CDMA HRPD | ITU-R Rep M.2039, ITU-R Rec M.1580, ITU-R Rec M.1581. 3GPP2 specifications. |

Table 3.The main characteristics for each of the technology types listed here are provided in the following tables. It is these characteristics and parameters that have been used in the studies and planning conducted to develop/revise the technical conditions of the framework.

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| --- | --- | --- | --- | --- |
| Table 4. E-UTRA (LTE and LTE-Advanced) Base Station and Mobile Station characteristics. | | | | |
| **Parameter** | **E-UTRA Base Station** | **E-UTRA Mobile Station** | **Reference** |
| **Bandwidth**  **Carrier Spacing** | 5MHz (4.515MHz) | | 36.104, 36.101 |
| **Duplex** | FDD | | 36.104, 36.104 |
| **Access Method** | OFDMA (DL) / SC-FDMA (UL) | | 36.104, 36.101, 25.814 |
| **Carrier Modulation** | QPSK/16QAM/64QAM | | 36.104, 36.101 |
| **Max Transmit Power** | 43dBm/4.515MHz **#** | 24dBm/4.515MHz | For a 5MHz channel, 36.942. |
| **Minimum Output Power** | Dynamic power control range of 13.9dB/symbol (DL). | -40dBm/4.515MHz | 36.104, 36.101 |
| **Base Station Antenna Gain** | 18dBi | 0dBi | 800MHz Notional Receiver Performance |
| **Feeder & Branching Losses** | 5dB | 0dB | 800MHz Notional Receiver Performance |
| **MS Body Loss** | 0dB | 5dB | Presumed |
| **Receiver Noise Figure** | 5dB | 9dB | 36.942 |
| **Receiver Thermal Noise** | -102dBm/4.515MHz | -98dBm/4.515MHz | Calculated. |
| **Interference Threshold** | -108dBm/4.515MHz | -104dBm/4.515MHz | Calculated, I/N = -6dB. |
| **Receiver Sensitivity** | -101.5dBm/4.515MHz, -123.2dBm/30kHz | -98dBm/4.515MHz, -119.8dBm/30kHz | 36.104, 36.101 |
| **#** Note: 36.104 does not state maximum base station output power, so a presumed value has been used here in accordance with typical modern base station power levels. | | | |

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| Table 5. UTRA (UMTS and WCDMA) Base Station and Mobile Station characteristics. | | | | |
| **Parameter** | **UTRA Base Station** | **UTRA Mobile Station** | **Reference** |
| **Bandwidth**  **Carrier Spacing** | 5MHz (3.84MHz) | | 25.104, 25.101 |
| **Duplex** | FDD | | 25.104, 25.101 |
| **Access Method** | WCDMA (DL/UL) | | 25.104, 25.101, 25.201 |
| **Carrier Modulation** | QPSK/16QAM/64QAM | | 25.104, 25.101 |
| **Max Transmit Power** | 43dBm/3.84MHz | 24dBm/3.84MHz | For a 5MHz channel, 36.942. |
| **Minimum Output Power** | Dynamic power control range of >= 18dB (DL). | -50dBm | 25.104, 25.101 |
| **Base Station Antenna Gain** | 18dBi | 0dBi | 800MHz Notional Receiver Performance |
| **Feeder & Branching Losses** | 5dB | 0dB | 800MHz TF Notional Receiver Performance |
| **MS Body Loss** | 0dB | 5dB | Presumed |
| **Receiver Noise Figure** | 5dB | 9dB | 36.942 |
| **Receiver Thermal Noise** | -103dBm/3.84MHz | -99dBm/3.84MHz | Calculated. |
| **Interference Threshold** | -109dBm/3.84MHz. | -105dBm/3.84MHz. | Calculated, I/N = -6dB. |
| **Receiver Sensitivity** | -121dBm/3.84MHz, -143dBm/30kHz | -115dBm/3.84MHz, -136dBm/30kHz | 25.104, 25.101 |

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| Table 6. CDMA2000 (Multi-Carrier) Base Station and Mobile Station characteristics. | | | | |
| **Parameter** | **CDMA2000 Base Station** | **CDMA2000 Mobile Station** | **Reference** |
| **Bandwidth**  **Carrier Spacing** | 3.75MHz Multi Carrier CDMA (3\*1.25MHz) | | M.2039 |
| **Duplex** | FDD | | M.2039 |
| **Access Method** | CDMA Multi-Carrier (DL/UL) | | M.2039 |
| **Carrier Modulation** | BPSK/QPSK | | M.2039 |
| **Max Transmit Power** | 40dBm/3.75MHz | 24dBm/3.75MHz | M.2039 |
| **Minimum Output Power** | - | - |  |
| **Base Station Antenna Gain** | 18dBi | 0dBi | 800MHz Notional Receiver Performance |
| **Feeder & Branching Losses** | 5dB | 0dB | 800MHz Notional Receiver Performance |
| **MS Body Loss** | 0dB | 5dB | Presumed |
| **Receiver Noise Figure** | 5dB | 9dB | M.2039 |
| **Receiver Thermal Noise** | -103dBm/3.75MHz | -99dBm/3.75MHz | M.2039 |
| **Interference Threshold** | -109dBm/3.75MHz | -105dBm/3.75MHz | M.2039, I/N = -6dB |
| **Receiver Sensitivity** | -119dBm/3.75MHz, -139dBm/30kHz | -99dBm/3.75MHz, -119dBm/30kHz | M.2039. |

# Standard Trading Unit and Minimum Contiguous Bandwidth

The Spectrum Licensing Technical Frameworks of the current licence period were designed to use specific parameters to assist in setting the bounds within which spectrum licences could be traded. Specifically the granularity of a trade was set through use of the Standard Trading Unit and the least amount of spectrum that could be licensed in any particular band was set through the Minimum Contiguous Bandwidth. These parameters were usually derived prior to band release from technology characteristics and technical conditions required for licensing of the band.

The existing formalised definitions of these parameters are as follows:

***Standard Trading Unit*** *means a parcel of spectrum space that consists of a geographic area equal to a cell of the spectrum map grid and a frequency band having lower and upper frequency limits defined by:*

*(i) 825 + n \* 1 MHz and 825 + (n+1) \* 1 MHz respectively: or*

*(ii) 870 + n \* 1 MHz and 870 + (n+1) \* 1 MHz respectively;*

*where n is an integer from 0 to 19 (inclusive).*

***Minimum Contiguous Bandwidth*** *means the least amount of spectrum that may be licensed in a spectrum licensing band typically representing the bandwidth suitable for delivery of a basic service.*

Recent changes to ACMA policy regarding spectrum trading has seen the removal of the frequency component of the Standard Trading Unit because of the potential restrictions it places on spectrum trading and the potential that the STU raster could be incompatible with technology channelisation.

The geographic component provides the terrestrial dimension of the STU and is the basic unit used to define subdivided portions of an original geographic licence area. The geographic STU is based on cells of the Australian Spectrum Map Grid (ASMG) defined for Outback/Remote, Rural and Metro/Regional population density areas. Up until this time the ASMG (and hence the geographic STU) has used coordinates based on the AGD66 datum. ACMA plans to transition the coordinate system of the ASMG used for spectrum licensing technical frameworks to a newer and more compatible coordinate system based on the GDA94 datum.

This transition is expected to address the transform of device registration coordinates and a re-definition of the ASMG to a higher resolution of 5 minute grid cells on an Australia-wide basis. The use of a higher resolution geographic STU will assist in resolving problems around the inefficiencies and restrictions to spectrum trading in Outback/Remote and Rural areas where licensees may only wish to provide a radiocommunications service in smaller licence areas. ACMA will release full details of the transition GDA94 coordinates for the ASMG and radiocommunications licensing during a future planned public consultation.

The recent policy changes also result in a re-definition of the existing MCB parameter used in spectrum licensing frameworks. A ‘recommended MCB’ will still set the minimum amount of spectrum that should be licensed and it will perform the same functions as the original parameter in controlling band fragmentation and maintaining consistency in the band. Adherence to the ‘recommended MCB’, however, is now not mandatory. Lesser bandwidths than the MCB may be licensed upon approval from ACMA’s Spectrum Infrastructure Branch. Applications will be considered on a case by case basis.

It is planned that the ‘recommended MCB’ will use a new bandwidth of 5MHz.

***It is proposed:***

***that the frequency component of the standard trading unit is to be removed (or set to 1Hz by default),***

***that the geographic component of the standard trading unit is to be set to 5 minutes on an Australia-wide basis,***

***that the MCB parameter be changed to a ‘Recommended MCB’ with a bandwidth of 5MHz.***

# Non-Spurious Out of Band Emission Limits

In this section, the existing non-spurious out of band emission limits are defined at each of the spectrum band edges. These existing limits are compared to the out of band levels of new technologies and a series of interference evaluations is described; one at each of the spectrum band edges to determine the potential increase in interference that would arise through use of a new technology spectral mask at the transmitter in comparison to a spectral mask that adheres to the existing limits. From the results of these studies new out of band limits have been derived for implementation at the 800MHz band edges.

## Existing Non-Spurious Out of Band Limits of the Technical Framework

Schedule 8 of the *Radiocommunications Spectrum Marketing Plan (800 MHz and 1.8 GHz Bands) 1998* sets out the existing non-spurious out of band emission levels that apply at the frequency edges 800MHz spectrum bands. They are described as:

* Non-Spurious Out of band Emissions offset from the 890MHz frequency edge.
* Non-Spurious Out of band Emissions offset from the 825MHz, 845MHz and 870MHz frequency edges.
* Non-Spurious Out of band Emissions offset from the upper and lower limits of the licensed frequency band.

The following plot displays each of the masks currently defined for the 800MHz band as applied to a typical 5MHz transmitter and offset from the channel centre. The on-channel radiated power used here is in accordance with the standard transmit power from the parameters set out in the Technology Characteristics section combined with an antenna gain of 18dBi less 5dB of line losses and converted to a 30kHz bandwidth.

Figure 2.

## A Method for Out of Band Interference Assessment

At each of the band edges of the 800MHz band where spectrum licensed transmitters are immediately adjacent to either an apparatus licensed service or another spectrum licensed service, it is necessary to determine the potential for interference due to the out of band emissions from new technologies in comparison to the existing technical framework limits. An increase in the transmitted emission level results in a lessening of the frequency dependent rejection (FDR) as calculated for offsets between the IMT channel and the receiver channel centre frequency.

A number of deterministic studies have been performed where the additional mitigation required to offset the interference increase from 800MHz IMT base transmitters to adjacent service receivers is calculated. Received interference power is calculated through the standard link budget equation.

## 890MHz Band Edge Study and Mitigation Requirements

At the 890MHz band edge, base transmitters deployed in the 870-890MHz band are directly adjacent to GSM base receivers deployed in the lower channels of the 890-915MHz (900 MHz) band. Previously, the limits at this band edge were quite stringent to better enable sharing with GSM base receivers. Now that new IMT technologies can and have been deployed in the 800MHz band it is timely to review the out of band limits for suitability to these technologies and to determine whether there is any potential for additional interference. This is a high-site to high-site interference path with potentially direct line of sight between stations.

In the plot below the out of band emissions for new technologies are compared with the existing limits.

Figure 3.

Key results of this study are set out in Table A1 of Appendix A. For small offsets from the channel edge there is a net additional mitigation requirement, whilst for large offsets it is assumed that adherence to the existing limits will ensure that no additional mitigation is required.

### *Derivation of a New Planned Out of Band Emission Mask*

A new planned mask is derived from these results. It is based on a combination of relaxation of the mask over the frequency range 200kHz to 5MHz offset from the 890MHz band edge and the existing requirements beyond this frequency range. Relaxation of the existing requirement is made considering the increased out of band levels of new OFDM modulations schemes due to subcarrier superposition. The slope of the mask here is a 12dB reduction from the gradient of the 36.104 levels – which represents worst case. The new planned mask over this range results in a net additional mitigation amount of 6dB which is not expected to cause significant degradation to GSM receivers operating within the vicinity, however, GSM licensees can improve the rejection of this interference by implementation of additional filtering on base station receivers. Isolation requirements for the protection of GSM receivers are contained within a new Compatibility Evaluation Report to be released at the time of the Technical Liaison Group process. Alternatively, licensees may implement a guard band at the 890MHz band edge which will ensure that there is no interference increase in GSM receivers.

Beyond the frequency offset of 5MHz the new planned mask conforms to the existing requirement – which addresses the larger mitigation amounts.

Figure 4. Planned New Mask at the 890MHz Band Edge.

### *Formal Description of the New Mask*

**The proposed limits on non-spurious out of band emissions offset from the 890MHz band edge for a transmitter operated under an 800MHz band spectrum licence are:**

For radio emission that is:

(a) not a spurious emission; and

(b) caused by a transmitter operating under a spectrum licence issued for the 800 MHz band; and

(c) at frequencies outside the frequency band 870 MHz to 890 MHz; and

(d) offset from 890 MHz;

the emission limits outside the band are for frequency bands containing frequencies that have offsets:

(e) within the range 0 kHz to 200 kHz — a radiated maximum true mean power of 2.5 dBm EIRP per 30 kHz; and

(f) within the range 200 kHz to 5 MHz – a radiated maximum true mean power of x dBm EIRP per 30kHz, where

where f\_offset is the offset frequency from the 890MHz band edge to the centre frequency of the measuring filter; and

(g) within the range 5 MHz to 10 MHz — a radiated maximum true mean power of -21.5 dBm EIRP per 30 kHz; and

(h) greater than 10 MHz — a radiated maximum true mean power of -30 dBm EIRP per 30 kHz.

***It is proposed:***

***that new non-spurious out of band emission limits be implemented at the 890MHz band edges to accommodate increased emissions levels for new technologies whilst limiting potential interference to services in adjacent spectra.***

## 870MHz Band Edge Study and Mitigation Requirements

At the 870MHz band edge there is potential for out of band interference from IMT base station transmitters to Land Mobile handset receivers operating in the band 865-870MHz. This is a high-site to low-site unwanted path over which standard mobile propagation conditions have been assumed to apply. The same method as used previously of calculation of received interference power at Land Mobile handset receivers was used to determine any increase in interference through use of new technology masks. Full results for these studies comprising the required additional mitigation results are contained in Table A2 of Appendix A.

### *Derivation of a New Planned Mask at the 870MHz Band Edge.*

A planned new mask is proposed for control of non-spurious out of band emissions at the 870MHz band edge. The mask follows the existing requirement within the first 1MHz offset from the band edge; hence transmitters that adhere to the existing out of band limits will also adhere to the new mask. It then follows the gradient of the 36.104 technology mask for frequency offsets from 1MHz to 5MHz out of band with an 8dB reduction. From this point the new mask adheres to the existing limits outside the 870MHz band edge.

Figure 5. Planned new mask at the 870MHz band edge.

### *Formal Description of the New Mask*

**The proposed limits on non-spurious out of band emissions offset from the 825MHz, 845MHz or 870MHz band edge for a transmitter operated under an 800MHz band spectrum licence are:**

For radio emission that is:

(a) not a spurious emission; and

(b) caused by a transmitter operating under a spectrum licence issued for the 800 MHz band; and

(c) at frequencies outside the frequency bands 825 MHz to 845 MHz and 870 MHz to 890 MHz; and

(d) offset from 825 MHz, 845 MHz and 870 MHz;

the emission limits outside the band are for frequency bands containing frequencies that have offsets:

(e) within the range 0 kHz to 30 kHz — a radiated maximum true mean power of 3 dBm EIRP per 30 kHz; and

(f) within the range 30 kHz to 1 MHz — a radiated maximum true mean power of -7 dBm EIRP per 30kHz; and

(g) within the range 1 MHz to 5 MHz – a radiated maximum true mean power of x dBm EIRP per 30kHz, where

where f\_offset is the offset from the 825 MHz, 845 MHz or 870 MHz band edge to the centre frequency of the measuring filter; and

(h) within the range 5 MHz to 10 MHz — a radiated maximum true mean power of -15 dBm EIRP per 30 kHz; and

(i) greater than 10 MHz — a radiated maximum true mean power of

-30 dBm EIRP per 30 kHz.

## 845MHz Band Edge Study and Mitigation Requirements.

Over the 845 MHz band edge there are two interference scenarios. Firstly, interference from IMT mobile stations, and secondly interference from IMT repeater stations operating in the 825-845MHz band to Fixed Service STL/SOB receivers deployed in the 845-852MHz band. The fixed service here is used by Studio Transmitter Links and Sound Outside Broadcast links with bandwidths ranging from 25kHz up to 400kHz. Interference evaluations were conducted for both cases using the same method as at the previous band edge.

Full results of these studies setting out the required additional mitigation amounts are contained in Table A3 of Appendix A.

### *Derivation of a New Planned Out of Band Emission Mask*

To control interference from emissions outside the band transmitted by spectrum licensed stations operating at the 845MHz band edge, it is recommended that the new mask described and plotted in section 5.4.1 be applied at the 845MHz band edge.

### *Formal Description of the New Mask*

The mask for application at the 845MHz band edge is the same as that described in Section 5.4.2.

## 825MHz Band Edge Study and Mitigation Requirements.

At the 825MHz edge which immediate adjoins the Land-Mobile base receive band from 820-825MHz there are two interference scenarios for which to account. Firstly, IMT mobile transmit stations to Land-Mobile base receivers, and secondly, IMT repeater transmit stations to Land-Mobile base receivers. Again the same method was used in determination of received interference power over this frequency boundary to Land-Mobile receivers.

Full results of the study setting out the additional mitigation requirements are contained in Table A4 in Appendix A.

### *Derivation of a New Planned Out of Band Emission Mask*

To control interference from emissions outside the band transmitted by spectrum licensed stations operating at the 825MHz band edge, it is recommended that the new mask described and plotted in section 5.4.1 be applied at the 825MHz band edge.

### *Formal Description of the New Mask*

The mask for application at the 825MHz band edge is the same as that described in Section 5.4.2.

***It is proposed:***

***that new non-spurious out of band emission limits be implemented at the 870MHz, 845MHz & 825MHz band edges to accommodate increased emissions levels for new technologies whilst limiting potential interference to services in adjacent spectra.***

## Licensed Frequency Band Edge Study and Mitigation Requirements

Together with the non-spurious out of band limits that apply at the upper and lower edges of spectrum licensing FDD bands, there are also non-spurious emission limits that apply at the edges of the frequency band of a spectrum licence. These limits prescribe total emissions into adjacent in-band services; which may be adjacent channel IMT receivers or other existing services in the case where the licensed band is at the edges of the spectrum band.

In evaluating the effect of potential interference from IMT base stations to IMT mobile stations operating on adjacent channels within the 800MHz band, the analysis may be simplified through the use of the frequency dependent rejection (FDR) method alone. Previous studies indicated that the additional mitigation amount required to offset interference from an increase in transmitter out of band interference is essentially equal to the difference between the FDR calculated using the new technology masks and the FDR calculated using the existing emission limits.

Each of the following scenarios was considered in this evaluation.

* Existing 800MHz frequency licensed band emission limits to 36.101 mobile station receiver.
* 36.104 base station transmitter to 36.101 mobile station receiver.
* 25.104 base station transmitter to 36.101 mobile station receiver.
* Existing 800MHz frequency licensed band emission limits to 25.101 mobile station receiver.
* 36.104 base station transmitter to 25.101 mobile station receiver.
* 25.104 base station transmitter to 25.101 mobile station receiver.

The plots here set out the FDR between the adjacent channel offsets of 5MHz, 10MHz, 15MHz and 20MHz.

Figure 6. FDR Comparison Plot for 36.101 (E-UTRA) Receiver

Figure 7. FDR Comparison Plot for 25.101 (UTRA) Receiver.

The plots here show only a marginal decrease in FDR values at frequency separations of 5MHz and 10MHz for use of new technologies. In the worst case the FDR decrease by no more than 10dB at a separation of 15MHz.

### *Derivation of a New Planned Out of Band Emission Mask*

From these results it is proposed that a new mask be implemented at the licensed frequency band edge. The same principles as previously stated have been used to derive this mask which follows the slope of the 36.104 requirement with a 6dB reduction at offset frequencies immediately outside the band out to 5MHz from the band edge. For frequencies beyond this point, the new mask adheres to the existing requirement. The plots above display that there is insignificant additional mitigation required for use of the proposed band edge mask at the frequency licence band edge.

Figure 8. Planned new mask at the frequency licence band edges.

### *Formal Description of a New Mask*

**Proposed limits on non-spurious out of band emissions offset from the frequency licensed band edge for a transmitter operated under an 800MHz band spectrum licence are:**

For radio emission that is:

(a) not a spurious emission; and

(b) caused by a transmitter operating under a spectrum licence issued for the 800 MHz band and

(c) at frequencies outside the frequency band of the licence; and

(d) Offset from the upper and lower limits of the frequency band;

the emission limits outside the band are for frequency bands containing frequencies that have offsets:

(e) within the range 0 kHz to 30 kHz — a radiated maximum true mean power of 24 dBm EIRP per 30 kHz; and

(f) within the range 30 kHz to 60 kHz — a radiated maximum true mean power of 5 dBm EIRP per 30 kHz; and

(g) within the range 60 kHz to 5 MHz – a radiated maximum true mean power of x dBm EIRP per 30kHz, where

where f\_offset is the offset from frequency from the band edge of the licensed frequency band to the centre frequency of the measuring filter; and

(h) within the range 5 MHz to 10 MHz — a radiated maximum true mean power of -14 dBm EIRP per 30 kHz; and

(i) greater than 10 MHz — a radiated maximum true mean power of -30 dBm EIRP per 30 kHz.

***It is proposed:***

***that a new non-spurious out of band emission mask be implemented for transmitters operating on channels within the 870-890MHz for frequency offsets from the frequency licence band edge. The proposed mask provides some accommodation for increased emissions levels for new technologies whilst limiting potential interference to mobile station receivers operating on an adjacent 5MHz channel.***

# Spurious Emission Limits

## Spurious Limits for Transmitters

Spurious emission limits for transmitters operating the 800MHz band are set out in Schedule 8 of the *Radiocommunications Spectrum Marketing Plan (800MHz and 1800MHz) 1998*. These conditions are designed to reduce interference that arises due to:

* Intermodulation Products: as generated due to non-linearities in radio equipment or in the mixing of signals.
* Parasitic Signals: which are emissions generated at frequencies which are independent of the carrier frequency and of the frequencies of any oscillations that arise due to generation of the carrier.
* Harmonic: which are emissions generated at frequencies which are integer multiples of the carrier frequency.
* Frequency-Conversion Products: which are spurious signals (not including harmonic emissions) generated at integer multiples, or at sums and differences of integer multiples of any oscillator generated through the production of the carrier frequency.

In assessing the potential for interference from such spurious signals, it is necessary to make a comparison between the existing requirements levels of the 800MHz technical framework and those that might arise due to use of the new technologies. Consequently, the 800MHz band requirements and those of new technology specifications are plotted in the graph below.

The technology levels in these graphs are on the basis of radiated transmitter output power (EIRP). The levels of the new technology specifications in 36.104, 25.104 and ITU-R Rec M1580 have been converted to a radiated power through the addition of the notional antenna gain of 18dBi less 5dB of lines losses in feeders and branching units.

Figure 9. Existing 800MHz Technical Framework spurious requirements compared to new technology spurious levels of 36.104, 25.104 and CDMA2000 technologies.

For this evaluation of the spurious emissions from new IMT technologies, it is the Category B requirements that most closely resembles the existing limits of the 800MHz Technical Framework and hence are most suitable to the Australian environment.

For 36.104, 25.104 and CDMA2000 technologies the spurious levels are mostly contained within the existing requirements over the frequency range 550MHz to 1650MHz. The elevated level over the range 859MHz to 904MHz which is 10Mhz on either side of the transmit band corresponds to a transition zone from the non-spurious region to the spurious region as defined in specifications and ITU-R Rec SM.399. This elevated level is deemed not to apply for comparison of the spurious levels.

For frequencies below 550MHz and above 1650MHz, the new technology spurious levels will exceed the technical framework requirements. Hence, for these frequency ranges licensees will be required to ensure that there is sufficient filtering in place on base station transmitters so that emitted spurious signals is maintain below the existing 800MHz technical framework requirement.

***It is proposed:***

***that the existing transmitter spurious emission limits of the 800MHz technical framework remain unchanged. Licensees implementing new technologies will be required to implement filtering on base stations below 550MHz and above 1650MHz, or at any other frequency where transmitter spurious emissions do meet the existing limits.***

## Spurious Limits for Receivers

Existing receiver spurious emissions requirements for the 800MHz band are specified in Schedule 8 of the *Radiocommunications Spectrum Marketing Plan (800MHz and 1800MHz Band) 1998*. These levels are defined in terms of a radiated power per reference bandwidth.

In making a comparison between the existing spurious limits of the technical framework and those of new technologies it is first necessary to perform a conversion from receiver output power to radiated power (EIRP). This conversion is the simple addition of a notional antenna gain of 18dBi less 5dB of losses in feeders and branching units. Thus they may be compared on the same basis.

In the plot here it can be seen that over the frequency range 550MHz through to 1650MHz the levels of the new technologies; 36.104, 25.104 and CDMA2000 are maintained below the framework spurious level requirements and so for these frequencies there is to be no change to these existing requirements. For frequencies less than 550MHz and greater than 1650MHz licensees should ensure that sufficient filtering is implemented on base stations so that actual receiver spurious emissions meet the existing requirements.

Figure 10. Existing 800MHz Technical Framework spurious requirements for receivers compared to new technology spurious levels of 36.104, 25.104 and CDMA2000 (ITU-R M.1580).

***It is proposed:***

***that the existing receiver spurious emissions limits of the framework remain unchanged. Licensees implementing new technologies will be required to implement filtering below 550MHz and above 1650MHz, or at any other frequency at which receiver spurious emissions do not meet the existing limits.***

# Out of Area Emission Limits

**Out of area Core Condition for Transmitters**

The out of area emission limits is a core condition that sets a limit on the transmitted horizontal radiated power from spectrum licensed devices in the 800MHz band. The effect is to prevent co-frequency interference into adjacent geographic licence areas; so new base stations operating under a spectrum licence must comply with this EIRP limit. In accordance with the current technical framework requirements this limit is calculated from the function P.

P = 70-k (d) (dBm)

Where d is the distance measured in km, that a device is inside the boundary of the geographic area of the licence under which the device operates; and

k(d) is the power conversion function defined:

* For a spectrum licence issued for the 800MHz band as k(d) = 11 for d ≥ 0.

For the 800MHz band the EIRP limit is evaluated as 59dBm/30kHz. It is recommended;

* To simplify the definition of the out of area constraint by replacing the equation definition of P with the numeric values of EIRP. The Spectrum Marketing Plan and licensing documentation to be updated accordingly.
* To retain the existing maximum EIRP level for transmitting device operating in the 800MHz bands at 59dBm/30kHz (or 74dBm/1MHz).

In the table below (Table 7) the expected EIRP levels for new technologies operating in the 800MHz bands are listed. It can be seen from this data that the existing out of area limit is sufficient to enable operation of each of these new technologies. On this basis there is no requirement to change this existing constraint.

|  |
| --- |
| Table 7. Comparison of transmitter parameters. |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | | Transmitter Parameter | 800MHz TF Transmitter Requirements | 36.104 E-UTRA Rx Parameter | 25.104 UTRA Rx Parameters | CDMA2000 Rx Parameters (ITU-R M.2039 & CS.0011) | | Radiated Power  Core Condition – Out of area | P = 70- k(d)  P = 70-11  =59dBm/30kHz  (74dBm/1MHz) | 43dBm/4.515MHz + 18dBi  =39.2dBm/30kHz  (54.4dBm/1MHz) | 43dBm/3.840MHz + 18dBi  =39.9dBm/30kHz  (55.1dBm/1MHz) | 40dBm/3.750MHz + 18dBi  =37.0dBm/30kHz  (52.2dBm/1MHz) | |

***It is proposed:***

***that the existing out of area EIRP limit of the 800MHz Technical Framework remain unchanged,***

***that these EIRP limits apply to base stations operating in the 870-890MHz band and repeater stations operating in the 825-845MHz and 870-890MHz bands,***

***that the equation used to define the out of area core condition in the Radiocommunications Spectrum Marketing Plan and licensing documentation should be replaced with the actual numeric values of the EIRP limit.***

# Information Sought from Technical Liaison Group Participants

***Discussion Points***

Please provide comment on the proposed non-spurious emission limits for the;

* 890MHz band edge;
* 870MHz, 845MHz and 825MHz band edge, and
* Frequency Licence band edge.

In particular the ACMA is interested to know:

* Whether members consider that the non-spurious emission levels defined in Chapter 5 are appropriate out of band emission levels.
* In particular, whether members consider that the proposed emission levels at the 890 MHz band edge provide sufficient reduction in out of band levels so as to not unreasonably restrict use of the adjacent 890-915 / 935-960 MHz band.

Please provide comment on the proposed transmitter and receiver non-spurious emission limits. In particular the ACMA is interested to know:

* Whether members foresee any difficulties in implementing suitable filtering to ensure that spurious emissions from 800MHz transmitters and receiver adhere to the existing requirements. This could be with regard to the realisation of suitable filtering, cost of manufacture and implementation as well as the practicality of installation.
* Whether members seek any modification to the Spurious Emissions requirements for transmitters and receivers operating in the 800MHz bands.

***Comment Period***

Technical Liaison Group participants are requested to submit comments and suggestions to the 800MHz TLG SharePoint discussion pages prior to the closure of the comment period on 5th August 2011.

# References

**800MHz Technical Framework Documents:**

1. *Radiocommunications Spectrum Marketing Plan (800MHz and 1.8GHz Bands) 1998.* Office of Legislative Drafting and Publishing, Attorney-General’s Department, October 2005.

**3GPP Specifications:**

1. 3GPP TS 25.104 V8.0.0, *Technical Specification Group Radio Access Network; Base Station (BS) radio transmission and reception (FDD) (Release 8)*, September 2009.
2. 3GPP TS 25.101 V8.0.0, *Technical Specification Group Radio Access Network; User Equipment (UE) radio transmission and reception (FDD) (Release 8)*, September 2009.
3. 3GPP TS 25.201 V10.0.0, *Technical Specification Group Radio Access Network; Physical Layer; General Description (Release 10)*, March 2011.
4. 3GPP TR 25.814 V.7.1.0, *Technical Specification Group Radio Access Network; Physical Layer Aspects for Evolved Universal Terrestrial Radio Access (UTRA) (Release 7)*, September 2006.
5. 3GPP TS 36.104 V9.2.0, *Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (FDD) (Release 9)*, December 2009.
6. 3GPP TS 36.101 V9.2.0, *Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (FDD) (Release 9)*, December 2009.
7. 3GPP TS 36.942 V9.0.1, *LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios (Release 9)*, April 2010.

**ITU-R Documents:**

1. ITU-R Recommendation M.1580-3. *Generic Unwanted Emission Characteristics of Base Stations Using the Terrestrial Radio Interfaces of IMT-2000.* Working Party 5D, International Telecommunications Union, June 2009.
2. ITU-Rec SM.329-10. Unwanted Emissions in the Spurious Domain. International Telecommunications Union, 2003.
3. ITU-R Report M.2039 *Characteristics of Terrestrial IMT-2000 Systems for Frequency Sharing/Interference Analysis.* International Telecommunications Union, 2004.
4. ITU-R Recommendation M.1036-3. *Frequency arrangements for implementation of the terrestrial component of IMT-2000 in the bands 806-960MHz, 1710-2025MHz, 2110-2200MHz and 2500-2690MHz.* International Telecommunications Union, 2007.
5. IMT-Advanced Technology Candidate Submissions (Numbers 4-9) Working Party 5D, International Telecommunications Union, 2009.
6. ITU-R Resolution 224, *Frequency Bands for the terrestrial component of International Mobile Telecommunications below 1GHz.* International Telecommunications Union, 2007.

**Other Reports:**

1. ERC Report 101, *A Comparison of the Minimum Coupling Loss Method, Enhanced Coupling Loss Method, and the Monte Carlo Simulation*, CEPT 1999.

# Appendix A

***890MHz Band Edge Study Characteristics and Results***

* IMT base transmit stations to GSM base receive stations.

The following characteristics were utilised:

* 800MHz base station characteristics as defined in Tables 2-4 with a height of 30m above ground level.
* 800MHz transmit spectral masks from the 36.104 (Category B Wide Area Base Station), 25.104 (Macro Base Station) and M1580 (Macro Base Station) specifications.
* GSM Base Receiver characteristics from specification 3GPP TS 05.05 V8.20.0.
* GSM channelised on the standard raster of 200kHz.
* Frequency dependent rejection was calculated using the IMT transmitter mask and the GSM receiver mask for frequency offsets outside the transmit band edge at 890MHz. Frequency offsets were selected at 200kHz to coincide with the first 10 adjacent GSM channels. Beyond this range increments of 5MHz were used out to 20MHz.
* The received power at the GSM station was calculated assuming Smooth Earth propagation for a ‘high-site to high-site’ scenario in accordance with a standard link budget equation.
* Inclusion of 5dB of line losses (i.e. feeder and branching) in both base transmitter and base receiver.

|  |  |
| --- | --- |
| Differences in Required Mitigation to the 890MHz Tx Mask for separations of 0.2km. | |
| Offset Frequency | New Technology Tx Mask |
| 1st Adjacent Channel | 0.7dB |
| 10th Adjacent Channel | 11.3dB |
| 10MHz | 12.6dB |
| 15MHz | 15.8dB |
| 20MHz | 15.1dB |

Table A1.

Where the offset frequency is the difference between the upper 5MHz IMT channel in the 870-890MHz band and the GSM frequencies in the 890-915MHz range.

***870MHz Band Edge Study Characteristics and Results***

* IMT base transmit stations to Land Mobile handset receive stations

The characteristics of the scenario are as follows:

* 800MHz base station characteristics from 3GPP specifications 36.104, 25.104 and from the Radiocommunications Advisory Guidelines (Managing Interference from AL Transmitters – 800MHz Band) 1998, with a height of 30m.
* 800MHz transmit spectral mask from 36.104(Category B Wide Area BS) , 25.104 (Macro BS) and M1580 (Macro BS) specifications.
* Land mobile handset receive characteristics from ACMA’s Rali LM-08 coordination document.
* Land mobile receiver masks from the published standard AS/NZ 4295 for 25kHz channelling.
* Modified Hata propagation for Open Area from ERC Report 068 used for *high-site to low-site* scenario.
* Frequency dependent rejection is calculated from the transmit and receiver masks corresponding to frequency separation increments of 25kHz for the first 20 adjacent land mobile channels as specified in the 900MHz Band Plan and Rali LM-08.
* Inclusion of 5dB feeder and branching losses.
* Frequency separations over the range 2.5125MHz through to 2.9875MHz for the first 20 adjacent land mobile channels.

|  |  |  |
| --- | --- | --- |
| Differences in Required Mitigation to the 870MHz Tx Mask for separations of 0.2km (dB) using Modified Hata propagation. | | |
| Offset Frequency MHz | Adjacent Channel | New Technology Tx Mask |
| 2.5125 | 1st Adjacent Channel | 22.0 |
| 2.5375 | 2nd Adjacent Channel | 13.5 |
| 2.6125 | 5th Adjacent Channel | 7.6 |
| 2.7375 | 10th Adjacent Channel | 7.5 |
| 2.9875 | 20th Adjacent Channel | 7.1 |

Table A2.

Where the offset frequency is the difference between the centre frequency of the lower 5MHz IMT channel in the 870-890MHz band and the centre frequency of each of the Land-Mobile mobile receive channels in the 865-870MHz band. Results for the first 10 adjacent channel and the 20th adjacent channel are listed.

***845MHz Band Edge Study Characteristics and Results***

* IMT mobile transmit stations to Fixed STL & SOB
* IMT repeater stations to Fixed STL & SOB

Characteristics utilised in the studies are as listed:

* 800MHz mobile stations with characteristics as defined above and at a height of 1.5m.
* 800MHz repeater stations with characteristics as defined above and at a height of 10m corresponding to the maximum transmitter height in the 825-845MHz band.
* 800MHz mobile transmit spectral mask from 36.101, 25.101 and M1581 specifications.
* 800MHz repeater transmit spectral mask from 36.106, 25.106 and M1580 specifications.
* Fixed Service STL/SOB receiver characteristics from Rali FX-11 and ITU-R Rec F.758 and operating at a notional height of 30m.
* Fixed Service STL/SOB receiver masks based on the PMP mask from Rali FX-16 using the method of ETSI EN301390 and TR101854.
* Modified Hata propagation for Open Area from ERC Report 068 used for *low-site to high-site* IMT MS to Fixed Service receiver scenario; and Smooth Earth propagation from Rali FX-3 for *high-site to high-site* for the IMT Repeater to Fixed Service receiver scenario.
* Frequency dependent rejection is calculated from the transmit and receiver masks corresponding to frequency separation increments of 400kHz for 17 adjacent channel as specified in the 900MHz Band Plan and in Rali FX-11.
* Inclusion of 5dB feeder and branching losses.
* Frequency separations over the range 2.9MHz through to 9.3MHz offset from the centre frequency of the mobile station bandwidth for the first 17 adjacent fixed service channels.

*Additional Mitigation Requirements - Mobile Station to Fixed Station STL & SOB.*

Study results indicated no additional interference from IMT mobile stations to STL/SOB receivers in the 17 adjacent channels of the 845-852MHz band.

*Additional Mitigation Requirements - Repeater Station to Fixed Station STL & SOB.*

|  |  |  |
| --- | --- | --- |
| Differences in Required Mitigation to the 845MHz Tx Mask for separations of 0.2km using Smooth Earth propagation. | | |
| Offset Frequency MHz | Adjacent Channel | New Technology Tx Mask |
| 2.9 | 1st Adjacent Channel | 7.2dB |
| 3.3 | 2nd Adjacent Channel | 6.7dB |
| 3.7 | 3rd Adjacent Channel | 14.1dB |
| 4.1 | 4th Adjacent Channel | 13.6dB |
| 4.5 | 5th Adjacent Channel | 13.0dB |
| 6.5 | 10th Adjacent Channel | 10.2dB |
| 9.3 | 17th Adjacent Channel | 8.8dB |

Table A3.

Where the offset frequency is the difference between the centre frequency of the upper IMT channel in the 825-845MHz band and the fixed link channel frequency in the 845-852MHz band.

***825MHz Band Edge Study Characteristics and Results***

* IMT mobile transmit stations to Land Mobile base receive stations.
* IMT repeater stations to Land Mobile base receive stations.

Characteristics utilised in the studies are as listed:

* 800MHz mobile station with characteristics as defined above and at a height of 1.5m.
* 800MHz repeater station with characteristics as defined above and at a height of 10m corresponding to the maximum transmitter height in the 825-845MHz band.
* 800MHz mobile transmit spectral mask from 36.101, 25.101 and M1581 specifications.
* 800MHz repeater transmit spectral mask from 36.106, 25.106 and M1580 specifications.
* Land Mobile receiver characteristics from Rali LM-08 and operating at a notional height of 30m.
* Land Mobile receiver masks in accordance with the standard AS/NZ 4295 for 25kHz radio channels.
* Modified Hata propagation for Open Area from ERC Report 068 used for *low-site to high-site* IMT MS to Land Mobile base receive scenario; and Smooth Earth propagation from Rali FX-3 for *high-site to high-site* for the IMT Repeater to Land Mobile base receive scenario.
* Frequency dependent rejection is calculated from the transmit and receiver masks corresponding to frequency separation increments of 25kHz for the first 10 adjacent channel as specified in the 900MHz Band Plan and in Rali LM-08.
* Inclusion of 5dB feeder and branching losses.
* Frequency separations over the range 2.5125MHz through to 2.7375MHz offset from the centre frequency of the IMT channel out to the first 10 adjacent land mobile channels.

*Additional Mitigation Requirements – IMT Mobile Stations to Land Mobile Receiver Stations.*

Study results indicated no additional interference from IMT mobile stations to Land Mobile base receivers in the first 10 channels of the 820-825MHz band.

*Additional Mitigation Requirements – IMT Repeater Stations to Land Mobile Receiver Stations.*

|  |  |  |
| --- | --- | --- |
| Differences in Required Mitigation to the 825Mhz Tx Mask for separations of 0.2km using Smooth Earth propagation. | | |
| Offset Frequency MHz | Adjacent Channel | New Technology  Tx Mask |
| 2.5125 | 1st Adjacent Channel | 22.0dB |
| 2.5375 | 2nd Adjacent Channel | 13.5dB |
| 2.6125 | 5th Adjacent Channel | 7.7dB |
| 2.7375 | 10th Adjacent Channel | 7.5dB |

Table A4.

Where the offset frequency is the difference between the centre frequency of the lower IMT channel in the 825-845MHz band and the Land Mobile receive channel in the 820-825MHz band.

# Appendix B

*Isolation Example for Out-of-Band Emissions into 900MHz GSM Base Receivers*

The new proposed mask to apply at the 890MHz band edge represents a relaxation of the existing requirement over the range 0.2MHz to 5MHz. In some situations this may result in an increase in noise that appears in the passband of a 900MHz GSM receiver. This section calculates the total required isolation in order avoid excessive degradation in the receiver sensitivity due to this noise.

The enhanced minimum coupling loss method from ERC Report 101 is applied with use of the following equation.

P\_int: maximum interferer carrier power.

dB\_BW: bandwidth conversion factor.

MC\_int: multi carrier margin to take account of numerous carriers transmitted by the base station.

G\_vict: victim receiver antenna gain less line losses.

G\_int: interferer receiver antenna gain less line losses.

S\_vict: receiver sensitivity

C/I\_vict: receiver carrier to interference ratio requirement.

f(dBc, P\_int): function of relative attenuation (dBc) of transmitter carrier power with offset frequency, where the offset frequency is defined as the difference between centre frequencies of the transmitted and received channel.

Where the values of these parameters are as follows:

|  |  |
| --- | --- |
| P\_int | 43dBm/5MHz |
| dB\_BW | 10\*Log10(200kHz/5000kHz) = -13.98dB |
| MC\_int | 0dB |
| G\_vict | 18dBi-5dB = 13dBi |
| G\_int | 18dBi-5dB = 13dBi |
| S\_vict | -104dBm/200kHz |
| C/I\_vict | 9dB |
| f(dBc, P\_int) | Transmit mask relative attenuation (dB) |

Table B1.

The plot below displays the required isolation between an 800MHz base transmitter and a 900MHz GSM base receiver assuming co-sited operation and an antenna coupling loss of 30dB. Isolation is displayed for use of the existing out-of-band mask, for use of the new proposed band edge mask, and for use of the new mask with additional transmit side filtering. The numerical values of these latter cases are shown in Table B2 that follows, where the first value of interest is for an offset of 2.7MHz corresponding to the first adjacent GSM receive channel. It is considered likely that in most cases the antenna separation values will exceed this figure of 30dB in actual deployments due to additional antenna discrimination through pointing an orientation. Transmitter filters available for installation on 800MHz base transmitters are available with very sharp roll-off outside the 890MHz band edge; one in particular can achieve 86dB within 1.6MHz. Application of such filtering drastically reduces the isolation requirement outside of this frequency separation. For non-co-sited cases inclusion of path loss will also reduce any additional isolation required.

Figure B1.

|  |  |  |
| --- | --- | --- |
| Frequency offset between Centre Frequencies (MHz) | Isolation less antenna coupling (30dB) for use of new mask (dB) | Isolation less antenna coupling (30dB) for use of new mask with additional filtering (dB). |
| 2.5 | 130.3 | 130.3 |
| 2.7 | 87.8 | 87.8 |
| 2.9 | 87.6 | 87.6 |
| 3.1 | 87.3 | 87.3 |
| 3.3 | 87.0 | 87.0 |
| 3.5 | 86.7 | 86.7 |
| 3.7 | 86.4 | 86.4 |
| 3.9 | 86.2 | 86.2 |
| 4.1 | 85.9 | 47.3 |
| 4.3 | 85.6 | 47.3 |
| 4.5 | 85.3 | 47.3 |
| 4.7 | 85.0 | 47.3 |
| 4.9 | 84.8 | 47.3 |
| 5.1 | 84.5 | 47.3 |
| 5.3 | 84.2 | 47.3 |
| 5.5 | 83.9 | 47.3 |
| 6.5 | 82.5 | 47.3 |
| 7.5 | 81.1 | 47.3 |
| 12.5 | 77.8 | 47.3 |

Table B2.