
Spectrum Management Handbook



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FOREWORD

The wireless communication technology has been evolving rapidly bringing about an emergence of a wide range of new wireless services and applications. At the corporate level, innovative wireless solutions can greatly enhance the efficiency of a company's operations and lower the operating cost. For the individual, radio devices such as mobile phones and wireless LANs have brought convenience to our daily life. In this information age, the demand for such services will continue to grow as staying connected and having ready access to information anytime, anywhere now becomes a part of our life.

In view of the increasing demand for wireless services and applications, IMDA recognises the need to inform and update the industry of existing frequency assignment policies and procedures. The aim is to facilitate the application process and help to foster the understanding of applicants on the approach and policy adopted by IMDA.

This handbook serves to provide information on Spectrum Management activities, assignment policies and the application procedures for the various radio-communication services including mobile, fixed, satellite, short-range devices and broadcasting services.

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EXECUTIVE SUMMARY

The Radio Frequency (RF) spectrum is a natural resource that can be used to increase the efficiency and productivity of a nation's work force as well as to enhance the quality of life of its people. It is used to provide a wide variety of radio-communication services including personal and corporate communications, radio navigation, aeronautical and maritime radio, broadcasting, public safety and distress operations, radio location and amateur radio.

IMDA is responsible for the management of the radio frequency spectrum. The management tasks call for the planning and coordinating frequency usage at international, regional and sub-regional levels; allocating and assigning the spectrum nationally; and monitoring and resolving radio frequency interference.

This Spectrum Management Handbook describes in detail the various spectrum management activities carried out by IMDA in its effort to achieving efficient and effective spectrum allocation and utilisation.

These activities cover the spectrum allocations, assignment criteria and application procedures for various services including public mobile, private land mobile, terrestrial fixed and broadcasting services. The conditions for the use of Short Range Devices, the application procedures for temporary radio frequencies and information on the spectrum fees are also included in this Handbook. Parties interested to apply for the use of frequency can refer to this Handbook for guidance.

(1) Public Mobile

Public mobile services include the operation of mobile communications systems (e.g. base stations, radio network controllers, mobile switching centres) required to offer public cellular telephony, paging, trunked radio or mobile data services. IMDA's policy is to assign the spectrum allocated for public mobile services to FBOs only.

(2) Private Land Mobile

The private land mobile network is to provide two-way communications between a fixed control point (i.e. base station) and a number of mobile transceiver units (e.g. vehicular or hand-held portable stations). The coverage area of a private land mobile service is either localised (confined area) or island-wide.

The applicant must be a company incorporated in Singapore and hold a Network Licence issued by IMDA. To ensure that the use of the radio spectrum is optimum, the licence may impose conditions requiring the network to be operated on a non-protection, non-interference basis and limiting the operation to specific geographical locations.

(3) *Terrestrial Fixed*

Fixed service is defined in the ITU Radio Regulations as a radio-communication service between specified fixed points that includes point-to-point and point-to-multipoint radio systems used for the transmission of voice, video and data information. Fixed service radio systems generally operate in the microwave region of the spectrum of about 1 to 60 GHz. There are four categories of application that can qualify for the use of microwave frequencies for fixed service links.

Application that does not fall within any of the above categories may be considered and approved by IMDA on a case-by-case basis.

(4) *Broadcasting*

Broadcasting service is a radio-communication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other type of transmissions.

To provide broadcasting services in Singapore, the applicant must obtain a broadcast service licence (e.g. free-to-air licence) and to also apply for a telecommunication infrastructure licence for broadcasting system from IMDA.

(5) *Short Range Devices*

Short Range Devices cover radio transmitters that have a localised area of operation due to their low output power (i.e. generally 100 mW or less). These include radio-communication equipment such as radio microphones, cordless phones, remote control devices, etc.

Short Range devices could be used virtually everywhere and they operate on a wide range of frequencies. Such devices are, however, permitted to operate on a non-interference and non-protection basis. That is, they must share-use the frequencies with other radio applications and they must not cause interference to other radio-communication networks duly authorised by IMDA.

Generally, short range devices are exempted from licensing if the transmitter output power is kept below the maximum approved field strength or power as indicated in Chapter 7 of the Handbook.

(6) *Temporary Use of Radio Frequencies*

IMDA permits the temporary use of radio frequencies for purposes as exhibitions, demonstration and testing of equipment.

Dealers holding valid Telecommunication Dealer's Licence may apply to IMDA for the temporary use of frequencies for occasional needs such as the demonstration of equipment to potential customers at their business premises.

(7) *Spectrum Fees*

Presently, under the administrative allocation approach, IMDA has two charging schemes for the usage of radio spectrum, namely Long Term and Temporary Use of Frequencies. The computation of fees can be based on the charging scheme provided in the handbook.

CONTENTS

CHAPTER 1 - INTRODUCTION	1
CHAPTER 2 - SPECTRUM MANAGEMENT IN SINGAPORE	3
1. Spectrum Planning and Coordination	3
2. National Spectrum Allocation and Assignment	5
3. Spectrum Monitoring and Interference Management	6
CHAPTER 3 - PUBLIC MOBILE SERVICES	7
1. Introduction	7
2. Spectrum Allocations & Band Plan	7
3. Licensing and Application	10
4. Conditions of Operation	11
CHAPTER 4 - PRIVATE LAND MOBILE SERVICES	12
1. Introduction	12
2. Eligibility	12
3. Licensing and Application	12
4. Processing Time	13
5. Frequency Assignment Criteria	13
6. Conditions of Operation	14
7. Frequency Fees	15
CHAPTER 5 – TERRESTRIAL FIXED SERVICES	17
1. Introduction	17
2. Eligibility	17
3. Spectrum Allocations	18
4. Frequency Assignment Criteria	18
5. Licensing and Application	19
6. Installation of Rooftop Antenna and the Microwave Path Clearance	20
7. Frequency Fees	21
CHAPTER 6 - BROADCASTING SERVICES	23
1. Introduction	23
2. Spectrum Allocations	24
3. Broadcasting Services in Singapore	25
4. Licensing and Application	26

CHAPTER 7 - SHORT RANGE DEVICES	27
1. Introduction	27
2. Spectrum Allocations	27
3. Conditions for use and sale of Short Range Devices.....	32
CHAPTER 8 – TEMPORARY USE OF RADIO FREQUENCIES.....	33
1. Introduction	33
2. Eligibility.....	33
3. Frequencies for Equipment Demonstration or Testing.....	33
4. Application Procedures	34
5. Conditions of Operation	34
6. Equipment Registration.....	35
7. Duration of Use	35
8. Frequency Fees	35
9. Exportation of Equipment.....	36
CHAPTER 9 – SPECTRUM FEES	37
1. Introduction	37
2. Fees for Long Term Usage of Radio Frequencies	37
3. Fees for Temporary Usage of Radio Frequencies	40
ANNEX 1 Terminology	
ANNEX 2 Frequency Channelling Plans or Terrestrial Fixed Services	
ANNEX 3 Explanatory Notes for Application of Terrestrial Microwave Station Licence	
ANNEX 4 Document Change History	

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CHAPTER 1 - INTRODUCTION

1. The RF spectrum is a natural resource that can be used to increase the efficiency and productivity of a nation's work force as well as to enhance the quality of life of its people. It is used to provide a wide variety of radio-communication services¹ including personal and corporate communications, radio navigation, aeronautical and maritime radio, broadcasting, public safety and distress operations, radio location and amateur radio.
2. The use of RF spectrum needs to be coordinated to avoid interference problem. Two radio-communication devices operating on the same frequencies, at the same time and at about the same coverage area will produce interference to the receivers. Therefore, the RF spectrum is a limited resource like land and water. It has the property of being conserved if used properly, and wasted if not. As the uses of wireless applications are wide and varied, it is crucial to ensure that the spectrum is efficiently and effectively managed to optimally benefit the society and economy.
3. IMDA is responsible for the management, allocation and assignment of the radio frequency spectrum. The Resource Management & Standards Division of IMDA undertakes the essential activities needed to ensure efficient and effective allocation and use of the spectrum for radio services. These activities include:
 - planning and coordinating frequency usage at international, regional and sub-regional levels;
 - assigning and managing the spectrum nationally; and
 - monitoring and resolving radio frequency interference.
4. Chapter 2 gives an overview of the various spectrum management activities carried out by the Resource Spectrum Management & Standards Division of IMDA to ensure that the goal of efficient and effective spectrum allocation and utilisation is achieved.
5. Chapters 3 to 6 provide details on the spectrum allocations, assignment criteria and application procedures for the individual services including public mobile, private land mobile, terrestrial fixed and broadcasting services. Parties interested to apply for the use of frequency can refer to these chapters for guidance.
6. Conditions for the use of Short Range Devices, the application procedures for temporary radio frequencies and information on the spectrum fees can be found in chapters 7, 8 and 9 respectively.

¹ Definition of various radio-communication services can be found in Annex 1.

7. IMDA will review the frequency assignment policies and application procedures periodically and welcomes comments from all interested parties. For any comments, queries or clarifications, please contact the following:

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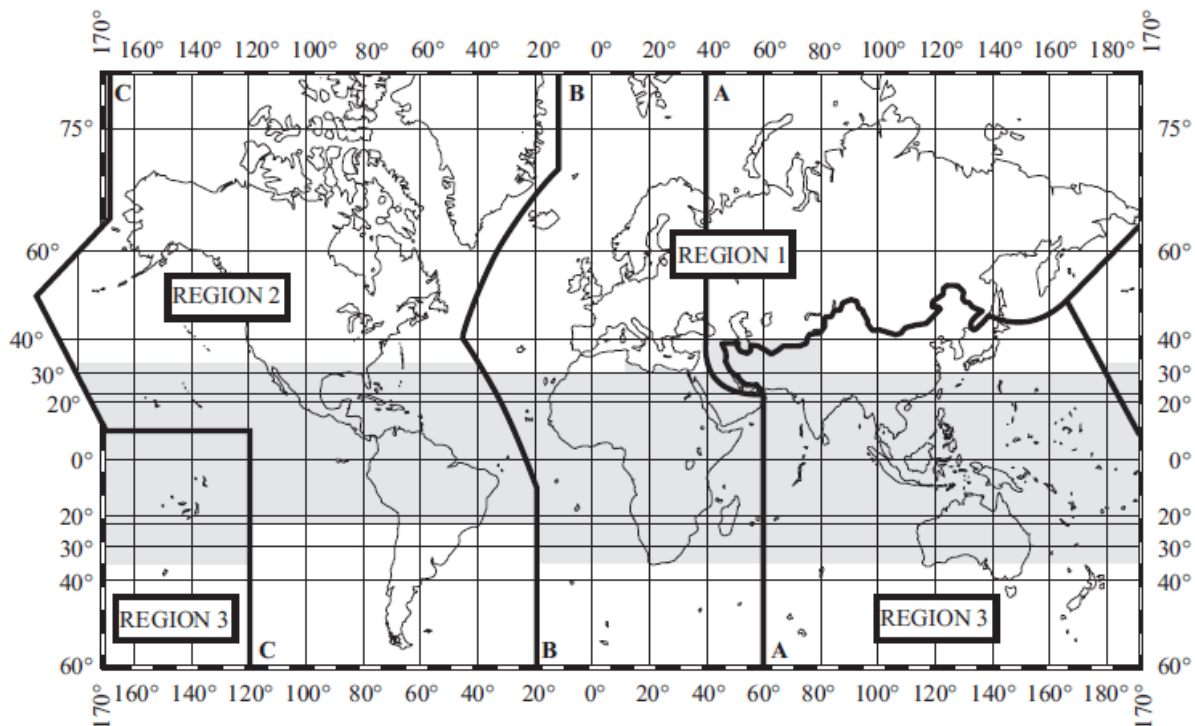
CHAPTER 2 - SPECTRUM MANAGEMENT IN SINGAPORE

1. Spectrum Planning and Coordination

1.1 World Radio-communication Conference

1.1.1 Globally, the use of radio spectrum is regulated by the International Telecommunication Union (ITU). The ITU Radio Regulations form the international framework within which member nations allocate and manage spectrum at a more detailed level. Singapore is a member of the ITU since 1965. As a signatory to the ITU Constitution and Convention, Singapore has the obligation to ensure that the spectrum management activities are in compliance to the ITU Radio Regulations.

1.1.2 The ITU Radio Regulations and the Table of Frequency Allocations are revised at the World Radio-communication Conference (WRC) held once every few years. In preparation for the WRC, each regional Administration attempts to align their position within the region. The ITU has defined three separate regions as shown below:



1.1.3 In the Asia Pacific Region (Region 3), the Asia Pacific Telecommunity (APT) organises Preparatory Group meetings (APG) to formulate common positions among members for consideration at the WRC.

1.2 Border Coordination

1.2.1 Radio waves propagate in space with no regard for national boundaries. In any border area between two countries, the allocation of frequency bands to new radio technologies requires close coordination between the two countries to pre-empt any harmful interference. This is particularly critical for high power and wide coverage systems.

1.2.2 In Singapore, the frequency coordination is achieved via the following fora:

- Frequency Assignment Committee of Singapore, Malaysia And Brunei Darussalam (FACSMAB);
- Trilateral Coordination Meeting between Singapore, Malaysia and Indonesia; and
- Border Communication Coordination Meeting (BCCM) between Singapore and Indonesia.

1.2.3 The FACSMAB was set up in the 1940s by the then British Forces for frequency coordination in the region. FACSMAB comprises of members from the Singapore, Malaysia and Brunei Darussalam. The aim of the FACSMAB is to ensure effective, equitable and efficient allocation of frequencies in the border areas. Through FACSMAB, members formulate spectrum plans for services that may otherwise cause interference along the bordering area. Also, members keep each other informed of any new frequency assignment and seek concurrence from each other to make sure that the new frequency assignment would not cause harmful interference to licensee's networks and licensed radio stations and services.

1.2.4 The Trilateral Coordination Meeting and Border Communication Coordination Meeting were set up to provide a forum for discussion of technical matters relating to telecommunications in the participating countries. Both meetings are held annually, to discuss matters related to:

- Radio frequency coordination along border areas;
- Coordination of future planned radio-communication services; and
- Resolution of radio frequency interference along border areas.

2. National Spectrum Allocation and Assignment

2.1 *Table of Frequency Allocations*

2.1.1 IMDA charts the present and future utilisation of the radio frequency spectrum. IMDA monitors the trends and developments of new wireless technologies and reviews the frequency allocations whenever there is a demand for spectrum. This is to keep the industry and interested parties abreast of the availability of spectrum in the coming years, the technological trends in the use of spectrum and IMDA's policy direction with regard to spectrum allocation and re-allocation for public communication networks.

2.2 *Spectrum Allocation Band Plan*

2.2.1 From the ITU Radio Regulation Table of Frequency Allocations for Region 3, IMDA decides for each frequency band which service(s) to adopt based on the national requirements and priority.

2.2.2 IMDA determines the band plan to adopt for each service based on technical considerations such as the bandwidth, duplex separation, etc. Other crucial considerations for deciding the band plan to adopt are the technology development and radio equipment availability.

2.2.3 For the purpose of assignment, the band plan is further divided into a number of channels to give the channelling plan. Once the necessary border co-ordination has been successfully carried out, the frequencies can then be assigned to eligible users.

2.3 *Frequency Assignment*

2.3.1 IMDA develops the policies, rules and regulations for the assignment of radio frequency spectrum. In the past, the spectrum was administratively allocated. However, in the liberalised environment, administrative allocation may not be the most objective, efficient and transparent means of ensuring the spectrum is put to its most effective use. An alternative approach is to adopt market-based approach such as an auction process, where competing services in common bands cannot effectively share the same spectrum. IMDA has adopted auction process for allocating spectrum for certain services such as the 2G, 3G and 4G.

2.3.2 The general categorisation of frequency assignment is as follows:

Long Term	Exclusive*	For networks providing island-wide coverage	Public cellular, trunked radio and mobile data networks
Long Term	Shared Use	For localised coverage	Private mobile radio and short range devices such as radio telemetry equipment, cordless telephones, etc.
Short Term	Shared Use	For a period of less than 90 days	Telecom exhibitions and trade shows; system trials and testing, etc.

* The term "Exclusive" used in this table means that sharing the use of frequencies among the high power island-wide networks stated in the last column is not feasible because of potential of interference. IMDA reserves the right to assign these frequencies for shared use with other low power or localised coverage networks where these networks will not cause harmful interference to the island-wide networks in the last column.

2.4 Spectrum Engineering

2.4.1 For frequency assignment based on the administrative allocation approach, IMDA formulates the frequency assignment criteria for each service.

2.4.2 For the use of frequency, IMDA sets the technical regulations to be imposed such as the sharing criteria, power limit, standards and specifications, etc as part of the licensing conditions.

2.4.3 The frequency assignment criteria and licensing criteria for the various services are detailed in the chapters to follow.

3. Spectrum Monitoring and Interference Management

3.1 The management of spectrum includes the responsibility of investigating and resolving complaints from radio users who experience interference in their radio-communication operations. IMDA carries out routine frequency monitoring and tracing of unauthorised transmissions. This ensures an interference free environment for licensed radio frequency users in Singapore.

3.2 When a radio station is licensed, IMDA may conduct radio monitoring to ensure that the licensee complies with the licensed operating conditions such as RF output power, modulation, and frequency accuracy.

CHAPTER 3 - PUBLIC MOBILE SERVICES

1. Introduction

- 1.1 Public mobile services include the operation of mobile communications systems (e.g. base stations, mobile switching centres) required to offer public cellular telephony, paging, trunked radio and mobile data services.
- 1.2 There are currently four cellular operators viz. M1, Singtel Mobile, StarHub Mobile and TPG Telecom Pte Ltd. IMDA has made available spectrum in the 700 MHz Frequency Division Duplex (FDD), 900 MHz (FDD), 1800 MHz (FDD), 2100 MHz (FDD), 2.3 GHz Time Division Duplex (TDD), 2.5 GHz (FDD) and 2.5 GHz (TDD) frequency bands for the provision of public mobile services.
- 1.3 The trunked radio features have not been replaced by cellular services. For example, the ability to make one-to-many group calls using trunked radio is a feature in which cellular networks have yet to offer. One-to-many group calls are crucial for operations that require information to be verbally communicated to all field staff in different locations simultaneously. Today, GRID Communications and CitiCall Communications are the operators offering the public trunked radio services.
- 1.4 The following is the list of FBOs offering public mobile services in Singapore:

Operator	Type of Services Offered		
	3G Cellular Service	4G or more advanced Cellular Service	Trunked Radio Service
M1	√	√	
Singtel Mobile	√	√	
StarHub Mobile	√	√	
TPG Telecom Pte Ltd		√	
GRID Communications			√
CitiCall Communications			√

2. Spectrum Allocations & Band Plan

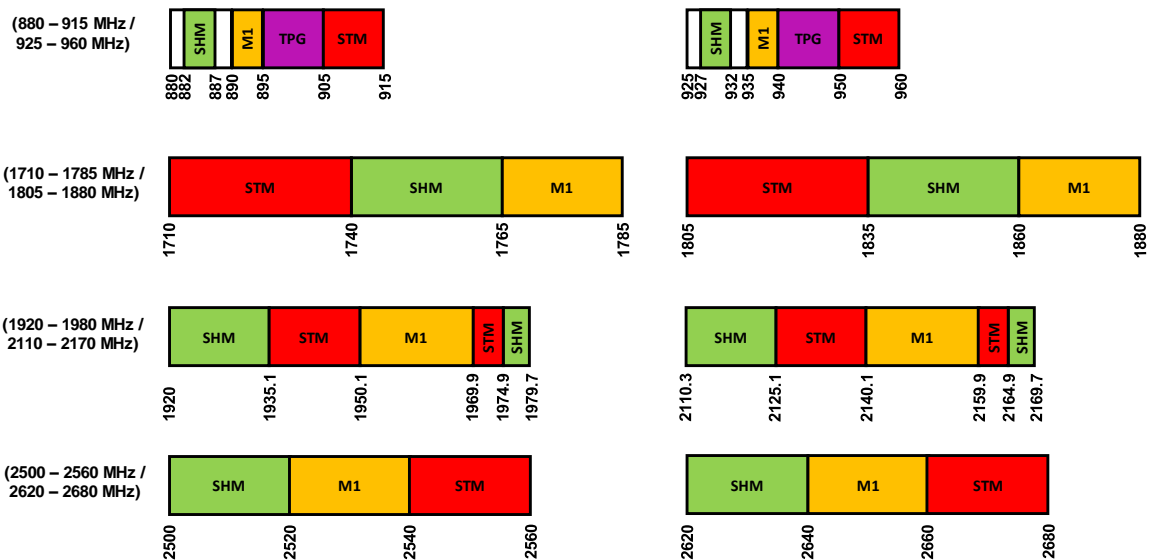
- 2.1 The spectrum allocations for public mobile services are based largely on the systems that have been harmonised internationally.

(i) **Public Cellular Mobile Services**

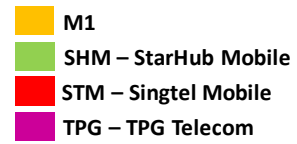
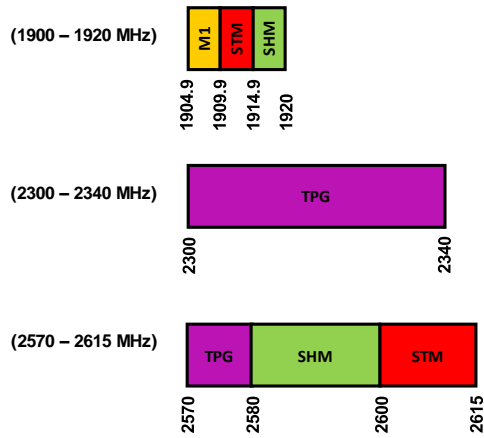
Frequency Range	Existing/Planned Systems	Status
703-748 MHz/758-803 MHz	FDD	Pending assignment
880-890 MHz/925-935 MHz	FDD	Partially assigned
890-915 MHz/935-960 MHz	FDD	Fully assigned
1710-1785 MHz/1805-1880 MHz	FDD	Fully assigned
1880-1900 MHz	Cordless Systems	Currently used by DECT
1900-1904.9 MHz	TDD	Not assigned
1904.9-1920 MHz	TDD	Fully assigned
1920-1969.9 MHz/ 2110.3-2159.9 MHz	FDD	Fully assigned
1969.9-1979.7 MHz/ 2159.9-2169.7 MHz	FDD	Fully assigned
2010-2025 MHz	TDD	Not assigned
2300-2400 MHz	TDD	Partially assigned
2500-2570 MHz/ 2620-2690 MHz	FDD	Partially assigned
2570-2620 MHz	TDD	Partially assigned

Spectrum Assignment for Cellular Systems

FDD Bands



TDD Bands



(ii) Public Trunked Radio Services

Frequency Range	Existing/Planned Systems	Main User
410-430 MHz/ 440-450 MHz	Trunked radio	CitiCall Communications
806-821 MHz/ 851-866 MHz	Trunked radio	GRID Communication

3. Licensing and Application

- 3.1 IMDA's policy is to assign the spectrum allocated for public mobile services to FBOs only. The guideline for the application of a [FBO licence](#) is available at IMDA website.
- 3.2 Traditionally, spectrum for public mobile services is allocated administratively based on the merit of the proposal submitted by an operator. However, IMDA has decided to consider applying market-based approach where there are competing demands over the same or similar spectrum bands and where competing services in common bands cannot effectively share the spectrum.
- 3.3 To date, IMDA has adopted the market-based approach (i.e. auction) for 3G, 2G and 4G spectrum allocations. As for other services such as trunked radio, fixed links, and etc, the administrative-based approach will continue to be applied till such time when there are competing demands for the spectrum.
- 3.4 As for other services such as paging, trunked radio, fixed links, etc, the administrative-based approach will continue to be applied till such time when there are competing demands for the spectrum.
- 3.5 For spectrum to be administratively allocated, IMDA requires the applicant to furnish the following information:

- (i) Network Facilities

The planned locations and technical details of radio base station sites and other equipment to be installed and frequency spectrum to be used.

- (ii) Network Coverage, Capacity and Improvement

The planned geographical coverage of the network upon launch of services and the network capacity expansion plans for the first 5 years of operation; and commitments for improvements to infrastructure facilities for the next 5 years.

- (iii) Technology and System Parameters

Technologies employed and the rationale for the choice of technology selected and the system parameters for the technology chosen as listed below:

Frequency channelling plan	<ol style="list-style-type: none"> 1. Operating frequency range 2. Channel Spacing 3. Duplex separation
Transmission parameters	<ol style="list-style-type: none"> 1. Antenna gain 2. Maximum power output 3. EIRP/ERP 4. Multiple Access Technique 5. Spectrum mask 6. Receiver threshold 7. C/I ratio
Capacity of network	<ol style="list-style-type: none"> 1. Data rate 2. Projected number of subscribers able to support with the frequency required

(iv) Any other relevant information

The applicant may submit any information not specified above which it considers supportive of its application.

4. Conditions of Operation

(i) Effective Radiating Power

The effective radiating power (ERP) limit is as follows:

System	Effective Radiating Power (ERP) limits
Cellular	100W
Paging	50W
Trunked Radio	25W

(ii) Co-ordination

The operator should assist IMDA in co-ordinating with other countries on the use of frequencies assigned. Operator should also co-ordinate the use of frequencies in the border area.

CHAPTER 4 - PRIVATE LAND MOBILE SERVICES

1. Introduction

- 1.1 The private land mobile network is to provide two-way communications between a fixed control point (i.e. base station) and a number of mobile transceiver units (e.g. vehicular or hand-held portable stations). The coverage area of a private land mobile service is either localised (confined area) or island-wide.
- 1.2 The following paragraphs provide information and advice on frequency assignment policy for single and two frequency(s) private land mobile networks operating in the VHF and UHF bands using 6.25 kHz, 12.5 kHz and 25 kHz channel spacing.
- 1.3 In a single frequency private land mobile network, the portable radio stations transmit and receive on the same frequency. Normally, no base station is involved and the coverage is limited within a few kilometres.
- 1.4 In a two frequencies private land mobile network, the base station transmits and receives at different frequencies. The frequencies at base station transmit at higher power to provide wider area radio coverage.

2. Eligibility

- 2.1 The applicant must be a company incorporated in Singapore and hold a Network Licence issued by IMDA. To ensure that the use of the radio spectrum is optimum, the licence may impose conditions requiring the network to be operated on a non-protection, non-interference basis and limiting the operation to specific geographical locations.

3. Licensing and Application

- 3.1 Interested parties who wish to apply to IMDA for a new private land mobile network are to complete and submit the online Network Licence application form available on IMDA's website ([Online Licence Application](#)).
- 3.2 The following information is also required and must be attached to the online application form:
 - (i) Justification for the need of the network, i.e. the purpose for the network and any other information to support the need for the proposed network;
 - (ii) Network description, including technical and operational details;

- (iii) Tuneable frequency range(s);
 - (iv) The number of mobile or portable units to be served after start of operation of the network; and
 - (v) Implementation plans for the proposed network in terms of expected dates for start and completion of construction.
- 3.3 For existing land mobile network that require additional frequency channels, the applicant is required to state the change(s) in the original application submitted to IMDA and provide other relevant information which helps to justify the need for additional frequency channels.
- 3.4 Applicants are advised to supply complete information at the time of the application. Failure to do so may result in delays in the processing of the application.
- 3.5 Applicants must use their best efforts to ensure that the information submitted in their applications is accurate in all aspects. Any change in the information contained in the application form must be notified immediately to IMDA.
- 3.6 When the frequency(s) has been assigned subject to certain licence conditions, the applicant is required to indicate his/her acceptance of the frequency(s) and remit the appropriate licence and frequency fee within 14 days before proceeding to acquire the radio equipment. The radio equipment must be registered with IMDA and the applicant shall submit declaration form to IMDA.

4. Processing Time

- 4.1 All applications will be processed on a first-come-first-served basis, depending on the availability of frequencies for the proposed service.
- 4.2 Successful applicants will be granted approval within 14 working days of application submission, provided that the applicants have submitted all the necessary information and clarification requested by IMDA for evaluation purposes.

5. Frequency Assignment Criteria

- 5.1 Where a user is eligible for frequency assignment for a private land mobile network, IMDA will consider the requirement submitted by the user and assign either a single frequency or two frequency radio channel(s) in the most appropriate segment of the available frequency bands. Also, all equipment shall incorporate CTCSS tone frequency.

- 5.2 Single frequency channel is assigned for low power (i.e. transmitted power of 5 watts ERP or less) private land mobile networks for handheld-to-handheld portable communications in a confined area (e.g. within a building compound or a manufacturing plant site).
- 5.3 Two frequency channels are usually assigned for high power transmitted power (i.e. max. of 25 watts ERP) private land mobile networks where the intended service coverage is large. Repeater mode of operation may be allowed on a two-frequency network.
- 5.4 The private land mobile frequencies will be assigned from the VHF (i.e. 137 – 174 MHz) and UHF (i.e. 400 – 450 MHz) bands. In general, the criteria for assigning are based on the number of mobile/portable units, specifically:

Type of Private Land Mobile Network	Minimum Number of Portable Units	Maximum Allowable Transmit Power	Nature of Frequency Assignment
Single frequency	5	1 watts ERP	Shared-use
Single frequency	30	5 watts ERP	Shared-use
Two frequency	50	25 watts ERP	Exclusive use

- 5.5 Two-frequency channels are also assigned for Taxis radio-communication network with a minimum of 1 base station and 150 mobile stations. Mobile to mobile communication is not permitted. Before submitting the application to IMDA, the applicant must first obtain an endorsement from the Public Transport Regulation Department of Land Transport Authority of Singapore (LTA).

6. Conditions of Operation

- 6.1 The operation of private land mobile radio stations shall be subject to the following conditions:
- (i) The height of the antenna of a radio base station shall not exceed 10m for localised coverage and 50m for island-wide coverage; and
 - (ii) Users of private land mobile radio stations operating on shared-use frequencies must ensure that no interference is caused to the existing radio-communication services. In the event of radio interference, the user has to resolve the interference promptly. IMDA reserved the right to withdraw the assigned frequency if the interference is not resolved satisfactorily.

7. Frequency Fees

7.1 The fees payable for the long term usage of radio frequencies comprises of two main components, namely, the Application & Processing Fee and the Frequency Management Fee.

7.2 The details of the Application & Processing Fee and Frequency Management Fee are given as follows:

- i) Application & Processing Fee – this is a one-time charge payable upon the approval of frequency(s) assignment. The application & processing fee covers the cost of the initial activities performed in assessing the suitability of the frequency to be used for the intended application. Any changes in the technical parameters shall be deemed as a new application.

Application & Processing Fee Payable Per Frequency: \$300*

* *Excluding GST*

- ii) Annual Frequency Management Fee – this is a recurrent fee payable annually to cover the cost of the activities performed to safeguard the use of the frequency(s).

Fees for the use of a radio frequency on an exclusive basis:

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Private Mobile Radio	All Frequency Bands	$X \leq 25 \text{ kHz}$	\$400
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$500
		$500 \text{ kHz} < X \leq 10 \text{ MHz}$	\$9,200
		$10 \text{ MHz} < X \leq 20 \text{ MHz}$	\$29,800
		$X > 20 \text{ MHz}$	\$44,500

Fees for the use of a radio frequency on a shared basis

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Private Mobile Radio	All Frequency Bands	$X \leq 25 \text{ kHz}$	\$300
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$400
		$500 \text{ kHz} < X \leq 10 \text{ MHz}$	\$2,500
		$10 \text{ MHz} < X \leq 20 \text{ MHz}$	\$7,600
		$X > 20 \text{ MHz}$	\$11,300

* *Excluding GST*

7.3 Applicants should note that frequency fees are separately payable to IMDA for the allocation and management of frequencies, apart from the station licence fees.

CHAPTER 5 – TERRESTRIAL FIXED SERVICES

1. Introduction

- 1.1 Fixed service is defined in the ITU Radio Regulations as “a radio-communication service between specified fixed points” that includes point-to-point and point-to-multipoint radio systems used for the transmission of voice, video and data information. Fixed service radio systems generally operate in the microwave region of the spectrum of about 1 to 60 GHz. The microwave frequency bands below 12 GHz have traditionally been preferred for long haul radio-relay applications due to their favourable propagation characteristics. In addition, the frequency bands in the 1 - 3 GHz are increasingly being used and earmarked for terrestrial and satellite mobile communications (e.g. IMT-2000). As such, IMDA generally does not assign frequencies in the 1 - 3 GHz band for terrestrial fixed service.
- 1.2 In accordance to the ITU recommendations, the frequencies in the E-band (i.e. 71 – 76 GHz paired with 81 – 86 GHz) are considered for radio frequency channel arrangement for fixed wireless system. IMDA will monitor market and technology developments of the E-band, and take into consideration the World Radiocommunication Conference 2019 recommendations before allocating the frequencies in this band beyond 2020. In the meantime, IMDA has made available the E-band for short-term commercial use of up to 12 months until 31 December 2019. Interested applicants may apply for short-term commercial use of this band where the applicable frequency fee is gazetted in the First Schedule of the Telecommunications (Radio-communication) Regulations under the shared use of radio frequency². Any request for renewal shall be subject to IMDA’s approval.
- 1.3 The following paragraphs provide information on the application procedure, assignment criteria and the conditions for the operating of a fixed service links.

2. Eligibility

- 2.1 Microwave frequencies for fixed service links are assigned for the following categories:
- Back-up backbone links for FBOs, between major exchanges or to link Singapore to off-shore islands or border areas of neighbouring countries;
 - Links for local access networks to be provided by FBOs;
 - Studio-to-transmitter and outside broadcast links for broadcasters; and
 - Links for use by government agencies.

² <https://www.imda.gov.sg/~media/imda/files/industry-development/acts-and-regulations/telecomregulation2016.pdf?la=en>

2.2 Application that does not fall within any of the above categories may be considered and approved by IMDA on a case-by-case basis. Such application shall include the following information:

- A detailed explanation for not being able to obtain such service from existing FBOs/licensed carriers; and
- An assessment of alternative systems and the reasons/justifications for considering the proposed system.

3. Spectrum Allocations

3.1 IMDA allocates the spectrum for microwave fixed service links in conformity with ITU Radio Regulation. The spectrum band plans for these fixed service links are inline with the ITU recommended channelling arrangements. This is to accommodate readily available radio-communication equipment in the market. Table 1 shows the spectrum bands allocated and the corresponding channelling plans. It should be noted that some of the frequency bands are currently shared with Satellite services.

Table 1

Frequency Range	Channelling Plan ³	Channel Width (MHz)	Min. Path Length
5925-6425 MHz	ITU-R F. 383-8	29.65	20km
6425-7125 MHz	ITU-R F. 384-10	20	20km
7125-7725 MHz	ITU-R F. 385-9	7	20km
7725-8500 MHz	ITU-R F. 386-8	29.65	20km
10.5-10.68 GHz	ITU-R F. 747-0	7/14	15km
10.7-11.7 GHz	ITU-R F. 387-11	20	15km
12.2-12.7 GHz	ITU-R F. 746-9	20	15km
12.75-13.25 GHz	ITU-R F. 497-7	28	15km
14.4-15.35GHz	ITU-R F. 636-3	7/14/28	10km
17.7-19.7 GHz	ITU-R F. 595-9	27.5/55	5km
21.2-23.6 GHz	ITU-R F. 637-3	3.5/7/14/28	2km

4. Frequency Assignment Criteria

4.1 Frequency assignment for microwave fixed service links is subject to spectrum availability and successful frequency co-ordination with the bordering countries.

4.2 A point-to-point fixed service link is highly directional and the frequency assigned to such link often can be re-assigned for another link with sufficient

³ See Annex 2 for details of the various frequency channelling plans.

spatial separation. As such, IMDA generally assigns frequencies for point-to-point fixed service links on a shared-use basis. Use of exclusive frequency assignment is discouraged. For the request for exclusive frequency assignment, the applicant will be required to provide justifications and only usage that warrant such assignment will be approved.

- 4.3 IMDA allows a mean propagation availability of 99.9% for the overall link budget calculation. IMDA encourages the use of hot standby and space diversity for backbone links to improve the service availability. To ensure the efficient usage of frequency, frequency diversity is generally not permitted. For the use of frequency diversity, applicant will be required to provide justification and IMDA will consider on a case-by-case basis.
- 4.4 The lower frequency bands are known to have propagation characteristics suitable for longer links. To ensure the efficient use of frequencies in these bands, IMDA will decide the choice of frequency band based on the path length of the fixed service link. As a general rule, the request for a frequency in any band should satisfy the minimum path length as stipulated in Table 1.

5. Licensing and Application

- 5.1 IMDA does not guarantee the availability of the frequencies for any length of time. Usage of each frequency shall be renewed on an annual basis. However, taking into account the need for continued operation of the service and lead time required for migration, IMDA will endeavour to give notice as early as possible if there is a change in the spectrum plans.
- 5.2 All frequency applications will require co-ordinations with our neighbouring countries through FACSMAB. Upon approval, IMDA may at its own discretion conduct site inspections on the transmitting radio station.
- 5.3 All applications must be completed and submitted online at IMDA's website ([Telecoms Licensing System](#)) under the General Radio-Com Station (Fixed Link Or Relay Station) Licence. Please refer to the [guidelines](#) for more information. Annex 3 provides an explanation on the information required in the application form.
- 5.4 In addition to the information submitted in the online application form, the applicant should provide the following information:
 - i) The purpose of the link and any other information to support the need for the proposed link. For cross border links, applicant should indicate the overseas operator it is partnering with;
 - ii) Description of the link, which should include the link capacity, traffic volume and the type of data carried; and

- iii) Implementation plans for the proposed link and the expected date of operation.

6. Installation of Rooftop Antenna and the Microwave Path Clearance

- 6.1 The installation of telecommunication equipment on rooftop requires height clearance from Ministry of Defence and Civil Aviation Authority of Singapore (CAAS). For height clearance, please contact the following:

Manager (Landuse Management)
Building and Infrastructure
Defence Science & Technology Agency
Defence Technology Tower A
1 Depot Road #12-05
Singapore 109679
Fax: 6273 5836

Operations Manager (Navigation Services)
Operations Division
Civil Aviation Authority of Singapore
Singapore Changi Airport P O Box 1
Singapore 918141
Fax: 6545 6516

- 6.2 A planning permission is required for installation of equipment on rooftop of buildings from the Urban Redevelopment Authority of Singapore (URA). However, such permission is not required if the following conditions are met:
- i) The equipment is not covered and there is no additional Gross Floor Area (GFA) involved;
 - ii) If the equipment is mounted on a pole, it does not exceed 3m in height; and
 - iii) No height restrictions would be imposed on surrounding existing and future developments.
- 6.3 Line-of-sight is critical for the use of microwave fixed service links. The applicant should, therefore, conduct the necessary field surveys to ensure that this is achieved for the proposed link.
- 6.4 The Singapore landscape changes rapidly with new high-rise buildings springing up across the island. Hence, the applicant must accept and undertake the responsibility of relocating the microwave link at its own expense in the event that the link is obstructed by structures/buildings due to new land developments.

- 6.5 The URA offers a registration service to provide advance notification of any new development proposals that could affect the microwave paths. This will enable the microwave users to make early arrangements to divert the microwave paths. To obtain more details about or to apply for the registration service, please contact the following:

Information & Customer Service
 Physical Planning Division
 Urban Redevelopment Authority
 45 Maxwell Road, The URA Centre
 Singapore 069 118

7. Frequency Fees

- i) Application and Processing Fee (one-time fee)

Application & Processing Fee Payable Per Frequency: \$300*

* Excluding GST

- ii) Annual Frequency Management Fee

Fees for the use of a radio frequency on an exclusive basis:

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Fixed	All Frequency Bands	$X \leq 25 \text{ kHz}$	\$400
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$1,100
		$500 \text{ kHz} < X \leq 10 \text{ MHz}$	\$2,900
		$10 \text{ MHz} < X \leq 20 \text{ MHz}$	\$7,700
		$X > 20 \text{ MHz}$	\$10,700

Fees for the use of a radio frequency on a shared basis (where the occupied bandwidth falls within two or more categories of radio frequency bands, the fees payable in respect of the lower radio frequency band will apply)

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Fixed	Below 10 GHz	$X \leq 25 \text{ kHz}$	\$300
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$400
		$500 \text{ kHz} < X \leq 10 \text{ MHz}$	\$800
		$10 \text{ MHz} < X \leq 20 \text{ MHz}$	\$1,800
		$X > 20 \text{ MHz}$	\$2,400
	10 GHz – 15.7 GHz	$X \leq 25 \text{ kHz}$	\$300
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$400

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
		500 kHz < X ≤ 10 MHz	\$500
		10 MHz < X ≤ 20 MHz	\$900
		X > 20 MHz	\$1,200
	15.7 GHz – 21.2 GHz	X ≤ 25 kHz	\$300
		25 kHz < X ≤ 500 kHz	\$400
		500 kHz < X ≤ 10 MHz	\$500
		10 MHz < X ≤ 20 MHz	\$700
		X > 20 MHz	\$900
	Above 21.2 GHz	X ≤ 25 kHz	\$300
		25 kHz < X ≤ 500 kHz	\$400
		500 kHz < X ≤ 10 MHz	\$500
		10 MHz < X ≤ 20 MHz	\$600
		X > 20 MHz	\$700

* Excluding GST

For more information on Frequency Fees, please refer to chapter 9.

CHAPTER 6 - BROADCASTING SERVICES

1. Introduction

- 1.1 Broadcasting service is defined in the ITU Radio Regulations as “a radio-communication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other type of transmissions”.
- 1.2 The broadcasting service is a one-way communication service and has a long history of radio spectrum usage. It is used for dissemination of cultural and educational programs, and the provision of entertainment and events reporting through the airwaves. It has in many ways influenced the life of many people.
- 1.3 Sound broadcasting was implemented in Singapore in the late 1940s with Amplitude Modulated (AM) signal on Medium Wave (MW) and Short Wave (SW). As technology evolves, FM stereo was introduced in the late 1960s to enhance the sound quality and to add extra features to the service to be comparable to home hi-fi system. Also, the radio data services were added within the FM bandwidth to provide radio text and automatic tuning.
- 1.4 The Digital Audio Broadcasting (DAB) develop in the 1990s to replace the existing AM and FM audio broadcast services, and main purpose is to offer radio at CD-high quality.
- 1.5 TV was introduced in the 1960s, starting with black and white and has progressed to colour in the mid 1970s. In Singapore, with the Digital Video Broadcasting (DVB), Singaporeans are able to tune to digital TV programmes that offer high definition picture using a specialised set top box. Digital broadcasting has also made possible interactive TV services. Furthermore with the development of DVB Terrestrial 2nd Generation (DVB-T2) which incorporates the latest developments in modulation and error-protection to increase the bit-rate capacity and improve signal robustness, that provide a better reception conditions in the future.

2. Spectrum Allocations

- 2.1 The planning and channelling of the broadcasting spectrum is carried out at the international level (ITU), regional level (Asia-Pacific Broadcasting Union, ABU) and bilateral level (i.e. border coordination). As Broadcasting services are intended for high power and wide coverage, the use of spectrum requires close coordination with the neighbouring countries. As such, there are only a selected number of channels in each broadcasting bands that can be used in Singapore.
- 2.2 The usage plans for broadcasting services has been established. With the advent of digital broadcasting, IMDA has also planned the spectrum allocations for both digital audio and digital video broadcasting services.
- 2.3 The broadcasting bands in Singapore are shown in Table 2.

Table 2

Service	Band (MHz)	Bandwidth (kHz)
MW	0.5265 – 1.6065	10
SW	5.95 – 6.20	10
	7.0 – 7.3	10
	9.5 – 9.9	10
	11.60 – 12.10	10
	13.6 – 13.8	10
	15.1 – 15.8	10
	17.55 – 17.90	10
	21.45 – 21.85	10
FM	88 – 108	180 or 300
TV and DAB	174 – 230	TV –7000; DAB -1536
TV and DVB	494 – 790	8000
Direct Broadcasting Sat	11700 – 12200	27000
Feeder Links	17300 - 18000	27000

3. Broadcasting Services in Singapore

3.1 The tables below show the broadcasting services currently available in Singapore:

Babcock Communications

Band (MHz)	Broadcasting Frequency (kHz)							
3	3915							
5	5845	5890	5905	5975				
6	6195							
7	7395	7410	7465	7485				
9	9410	9505	9510	9540	9585	9605	9650	9705
	9740	9780	9790	9810	9855	9890	9900	
11	11675	11685	11695	11700	11730	11740	11750	11790
	11795	11825	11850	11890	11895	11910	11945	11955
	11965	11995						
12	12010	12025	12035	12045	12065	12070	12075	12095
13	13725	13730						
15	15270	15285	15310	15335	15470	15510	15595	15620
	15640	15755						
17	17510	17720	17760	17790	17845	17860	17870	
21	21660	21715						

FM Radio

Frequency (MHz)	Station	Frequency (MHz)	Station
88.3	883Jia FM	94.2	Warna 94.2FM
88.9	BBC Radio	95.0	Class 95FM
89.7	Ria 89.7	95.8	Capital 95.8FM
90.5	Gold 90.5FM	96.8	Oli 96.8FM
91.3	One FM 91.3	97.2	Love 97.2FM
92.0	Kiss 92 FM	98.0	Power 98 FM
92.4	Symphony 92.4FM	98.7	987FM
93.3	Y.E.S. 93.3FM	99.5	Lush 99.5FM
93.8	938LIVE	100.3	UFM 100.3

Analogue TV

Channel	Carrier Frequency (MHz)				System	Station
	Video	Colour	Sound	Nicam		
5	175.25	179.68	180.75	181.1	PAL-B	Channel 5
8	196.25	200.68	201.75	202.1	PAL-B	Channel 8
12	224.25	228.68	229.75	203.1	PAL-B	Suria
24	495.25	499.68	500.75	501.1	PAL-G	Vasantham
28	527.25	531.68	532.75	533.1	PAL-G	Channel U
30	543.25	547.68	548.75	549.1	PAL-G	OKTO
32	559.25	563.68	564.75	565.1	PAL-G	Channel NewsAsia

Digital TV – DVB-T/T2

CH	Centre Frequency	System
29	538 MHz	DVB-T2
31	554 MHz	DVB-T2
33	570 MHz	DVB-T2
35	586 MHz	DVB-T2
38	610 MHz	DVB-T

4. Licensing and Application

- 4.1 To provide broadcasting services in Singapore, the applicant must obtain a broadcast service licence (e.g. free-to-air licence) and is also required to apply for a Broadcasting Station Licence from the IMDA. The approval of the Broadcasting Station licence is subject to electromagnetic compatibility studies.
-

CHAPTER 7 - SHORT RANGE DEVICES

1. Introduction

- 1.1 The term “Short Range Devices” (SRD) is intended to cover radio transmitters that have a localised area of operation due to their low output power (i.e. generally 100 mW or less). These include radio-communication equipment such as radio microphones, cordless phones, remote control devices, etc.
- 1.2 Short Range devices could be used virtually everywhere and they operate on a wide range of frequencies. Such devices are, however, permitted to operate on a non-interference and non-protection basis. That is, they must share-use the frequencies with other radio applications and they must not cause interference to other radio-communication networks duly authorised by IMDA.
- 1.3 The following paragraphs illustrate the common spectrum allocation for individual applications and the general operating conditions as well as the specific conditions for Short Range Devices.

2. Spectrum Allocations

- 2.1 IMDA allocates the spectrum for short range devices based on ITU-R Radio Regulations, the availability of equipment in the market and any international standards. The frequency bands made available for short range devices are indicated in Table 3 below.

Table 3

Examples of SRD Applications	Authorised Frequency Bands/Frequencies	RF Output Power	Field Strength
Induction loop system IMDA TS SRD	16 – 150 kHz		≤ 66 dBμA/m @ 10m
	150 – 5000 kHz		≤ 13.5 dBμA/m @ 10m
	6765 – 6795 kHz		≤ 42 dBμA/m @ 10m
	7400 – 8800 kHz		≤ 9 dBμA/m @ 10m
Radio detection, alarm system IMDA TS SRD	0.016 – 0.150 MHz		≤ 100 dBμV/m @ 3m
	13.553 – 13.567 MHz		≤ 94 dBμV/m @ 10m
	146.35 – 146.50 MHz 240.150 – 240.30 MHz	≤ 100 mW ERP	

Examples of SRD Applications	Authorised Frequency Bands/Frequencies	RF Output Power	Field Strength
	300.00 – 300.30 MHz 312.00 – 316.00 MHz 444.40 – 444.80 MHz		
Wireless Microphone IMDA TS SRD	0.51 – 1.60 MHz		≤ 57 dBμV/m @ 3m
	40.66 – 40.70 MHz		≤ 65 dBμV/m @ 10m
	88.00 – 108.00 MHz		≤ 60 dBμV/m @ 10m
	470.00 – 806.00 MHz	≤ 10 mW ERP	
Wireless Microphone, Hearing/Audio assistance aids IMDA TS SRD	169.40 – 175.00 MHz	≤ 500 mW ERP	
	180.00 – 200.00 MHz 487.00 – 507.00 MHz		≤ 112 dBμV/m @ 10m
Remote control of garage door, camera and toys and miscellaneous devices IMDA TS SRD	26.96 – 27.28 MHz 34.995 – 35.225 MHz	≤ 100mW ERP	
	40.665 – 40.695 MHz 40.77 – 40.83 MHz 72.13 – 72.21 MHz	≤ 500mW ERP	
Remote control of aircraft and glider models and machines, telemetry and alarm systems IMDA TS SRD	26.96 – 27.28 MHz 29.70 – 30.00 MHz	≤ 500 mW ERP	
Medical and biological telemetry IMDA TS SRD	0.009 – 0.315 MHz		≤ 30 dBμA/m @ 10m
	40.500 – 41.000 MHz	≤ 0.01 mW ERP	
	216.00 – 217.00 MHz	> 25 μW ERP ≤ 100 mW ERP	
	454.000 – 454.500 MHz	≤ 2 mW ERP	
	1427.00 – 1432.00 MHz	> 25 μW ERP ≤ 100 mW ERP	
	All frequencies	≤ 25 μW ERP	

Examples of SRD Applications	Authorised Frequency Bands/Frequencies	RF Output Power	Field Strength
Remote control of cranes and loading arms IMDA TS SRD	170.275 MHz ⁴ 170.375 MHz ⁴ 173.575 MHz ⁴ 173.675 MHz ⁴ 451.750 MHz ⁴ 452.000 MHz ⁴ 452.050 MHz ⁴ 452.325 MHz ⁴	≤ 1000 mW ERP	
On-site radio paging system IMDA TS SRD	26.96 – 27.28 MHz 40.66 – 40.70 MHz	≤ 500 mW ERP	
	26.96 – 27.28 MHz ⁴ 40.66 – 40.70 MHz ⁴	> 500 mW ERP ≤ 3000 mW ERP	
	151.125 MHz 151.150 MHz	≤ 1000 mW ERP	
	151.125 MHz ⁴ 151.150 MHz ⁴	> 1000 mW ERP ≤ 3000 mW ERP	
Wireless modem, data communication system IMDA TS SRD	72.080 MHz 72.200 MHz 72.400 MHz 72.600 MHz 158.275/162.875 MHz 158.325/162.925 MHz 453.7250/458.7250 MHz 453.7375/458.7375 MHz 453.7500/458.7500 MHz 453.7625/458.7625 MHz	≤ 1000 mW ERP	
Short range radar systems such as automatic cruise control and collision warning systems for vehicle IMDA TS SRD	76 – 77 GHz	≤ 37 dBm EIRP when vehicle is in motion ≤ 23.5 dBm EIRP when vehicle is stationary	
Radio telemetry, telecommand system IMDA TS SRD	433.05 – 434.79 MHz	≤ 10 mW ERP	

⁴ SRDs required approval for operation

Examples of SRD Applications	Authorised Frequency Bands/Frequencies	RF Output Power	Field Strength
Radio telemetry, telecommand, RFID system IMDA TS SRD	866 – 869 MHz 920 – 925 MHz	≤ 500 mW ERP	
	920 – 925 MHz ⁴	> 500 mW ERP ≤ 2000 mW ERP	
Wireless video transmitter and other SRD applications IMDA TS SRD	2.4000 – 2.4835 GHz	≤ 100 mW EIRP	
	10.500 – 10.550 GHz	-	≤ 117 dBµV/m @ 10m
	24.000 – 24.250 GHz	≤ 100 mW EIRP	
Bluetooth IMDA TS SSRD	2.4000 – 2.4835 GHz	≤ 100 mW EIRP	
Wireless LAN only IMDA TS SRD	2.4000 – 2.4835 GHz	≤ 200 mW EIRP	
SRD application IMDA TS SRD	5.725 – 5.850 GHz	≤ 100 mW EIRP	
Wireless LAN and broadband access only IMDA TS SRD	5.725 – 5.850 GHz	≤ 1000 mW EIRP	
	5.725 – 5.850 GHz ⁴	> 1000 mW EIRP ≤ 4000 mW EIRP	
Wireless LAN IMDA TS SRD	5.150 – 5.350 GHz	> 100 mW EIRP ≤ 200 mW EIRP	
	5.150 – 5.350 GHz	≤ 100 mW EIRP	
Wireless LAN and broadband access IMDA TS SRD	5.470 – 5.725 GHz	≤ 1000 mW EIRP	
	57 – 66 GHz	≤ 10 W EIRP	

2.2 The following provides a general description of the various categories of SRDs:

1	<i>Induction Loop – IMDA TS SRD</i>
<p>An induction loop communication system is a system in which the radio frequency energy is conducted or guided along wires or in cables (e.g. Induction loop paging) and the field radiated by wire or cable is limited, giving a typical range between cable and receiving equipment of 30 meters.</p> <p>Induction loop communication systems may be used in a building or limited area of a factory site which is under the control of the system user.</p>	
2	<i>Radio Detection and Alarm Systems – IMDA TS SRD</i>
<p>Radio detection system (e.g. field disturbance sensor) is a movement detection device which is used to give warning of intrusion by activating an alarm or sending a coded signal to a receiving device to identify the source of emission.</p>	

	Radio alarm system (e.g. short range fire detection & alarm system, anti-theft alarm device) is an alarm system which uses radio signals to generate or indicate an alarm condition or to set or unset the system.
3	<i>Wireless Microphones – IMDA TS SRD</i>
	Radio microphone is defined as a microphone that uses a radio link to convey speech or music to a remote receiver.
4	<i>Radio Telemetry and Telecommand Equipment – IMDA TS SRD</i>
	Telemetry – The use of telecommunication for automatically indicating or recording measurements at a distance from the measuring instrument. Telecommand– The use of telecommunication for the transmission of signals to initiate, modify or terminate functions of equipment at a distance (e.g. radio control of models, automatic garage door openers, etc).
5	<i>Medical and Biological Telemetry Devices – IMDA TS SRD</i>
	A medical and biological device shall include a transmitter and its associated receiving equipment, which is used to transmit, within a restricted area, via radio frequency field, measurements of either human or animal biomedical phenomena to a receiver.
6	<i>On-site Paging Service – IMDA TS SRD</i>
	On-site paging service is a one-way selective signalling system, which may incorporate tone paging or combined speech/tone paging. On-site paging service means the radio signals emitted from the transmitter must be restricted within the confine of the licensee’s compound or in specific area or site as may be approved by the licensing authority.
7	<i>VHF On-site Paging System – IMDA TS SRD</i>
	On-site paging service means the radio signals emitted from the transmitter must be restricted within the confine of the licensee’s compound or in specific area or site as may be approved by the licensing authority.
8	<i>Wireless Video Transmitter – IMDA TS SRD</i>
	It is mainly to be used for controlling or monitoring purposes.
9	<i>Wireless Data Communication Systems – IMDA TS SRD</i>
	A wireless data communication (e.g. wireless LAN) is a radio-communication system used for transmission of data between computers installed within a building.
10	<i>Wireless Modem – IMDA TS SRD</i>
	A wireless data communication system (e.g. wireless modem and LAN) is a radiocommunication system used for transmission of data from a computer to remote terminals installed within a building.

11	<i>Spread Spectrum System – IMDA TS SRD</i>
A spread spectrum system is defined as a radiocommunication system used for transmission of data/voice within a building using spread spectrum techniques.	
12	<i>Radio Equipment and Devices – IMDA TS SRD</i>
The radio equipment shall transmit and/or receive within the designated band and be used within a building.	
13	<i>Short Range Radar System – IMDA TS SRD</i>
A short range radar system is a movement and position detection device which is used to give a warning of collision by identifying the delay between a transmitted pulse and a return pulse.	

2.3 The Technical Specification for Short Range Devices can be downloaded from the IMDA website ([standards](#)).

2.4 The development of spectrum allocations for short range devices is an ongoing policy review process. IMDA will revise and update its frequency allocations for short range devices as new technologies emerge.

3. Conditions for use and sale of Short Range Devices

3.1 Generally, short range devices are exempted from licensing if the transmitter output power is below the maximum approved field strength or power as indicated in Table 3; and the uses of these devices are localised.

3.2 Short range devices have to be registered with IMDA before they can be used or put on sale in Singapore. Companies seeking equipment registration must also have a local presence and possess a Telecommunication Dealer's Licence issued by IMDA.

CHAPTER 8 – TEMPORARY USE OF RADIO FREQUENCIES

1. Introduction

- 1.1 This chapter furnishes information on the available frequencies, operating conditions and fees payable for the temporary or occasional use of frequencies. This usage is typically necessitated by such purpose as exhibitions, demonstration and testing of equipment. IMDA shall decide, at its discretion, the circumstances in which the temporary or occasional use of frequencies will be permitted.

2. Eligibility

- 2.1 Any person may apply for the temporary use of frequencies for occasional needs such as the demonstration of equipment to potential customers at their business premises for a period not exceeding 90 days, subject to availability of the spectrum.

3. Frequencies for Equipment Demonstration or Testing

- 3.1 The following are assigned for temporary or occasional use:

	Frequency	Bandwidth
i)	25 273 kHz	16 kHz
ii)	71.575 MHz	16 kHz
iii)	83.875/87.875 MHz	16 kHz
iv)	137.175/141.775 MHz	16 kHz
v)	161.450 MHz	16 kHz
vi)	433.05 – 434.79 MHz	Low power devcies of 10 mW ERP
vii)	866 – 869 MHz	Low power devices of 500 mW ERP
viii)	920 – 925 MHz	Low power devices of 500 mW ERP
ix)	1 525 – 1 559 MHz	Satellite Receive Band
x)	1 880 – 1 900 MHz	Low power devices of 100 mW EIRP
xi)	2 400 – 2 483.5 MHz	Low power devices of 100 mW EIRP
xii)	3 400 – 4 200 MHz	Satellite Receive Band
xiii)	5 150 – 5 350 MHz	Low power devices of 100 mW EIRP
xiv)	5 725 – 5 850 MHz	Low power devices of 1 W EIRP
xv)	10.7 – 11.7 GHz	Satellite Receive Band
xvi)	12.2 – 12.75 GHz	Satellite Receive Band

The above list may be amended from time to time as a result of changes in international/national frequency allocations.

- 3.2 Frequencies not listed above may be approved on a case-by-case basis.

4. Application Procedures

- 4.1 All applications must be made on the online form which is available at IMDA website ([Telecoms Licensing System](#)) under Temporary Use Of Frequency. Please refer to the [guidelines](#) for more information. For demonstration or testing of equipment, applications must be submitted 3 weeks before the scheduled date for demonstration or testing.
- 4.2 For short-term use of satellite frequencies for uplink/downlink of broadcasting programmes, where the applicant already possesses an uplink/downlink licence from IMDA, separate application guidelines are available.
- 4.3 The following information is required and must be attached to the application:
- i) a brief description of the equipment and its functions;
 - ii) a copy of the equipment's technical specifications, which shall include the frequency range, the desired frequency(ies), the necessary bandwidth, emission characteristics, antenna gain, bandwidths and effective radiated power;
 - iii) alternative frequencies or frequency ranges, if the desired frequencies/frequency ranges are not available;
 - iv) for VSAT or earth station, the station location in Singapore and documentary evidence of permission to access the satellite system (including the name and location of satellite);
 - v) approval from Media Division of the Ministry of Communications and Information (MCI) must first be obtained for all transient satellite news gathering;
 - vi) location and period of demonstration; and
 - vii) name and telephone number of the person to contact in case of radio interference.

5. Conditions of Operation

- 5.1 Frequencies approved for temporary use will be subject to the following conditions of operation:
- i) frequencies are operated on a shared-use basis;
 - ii) frequencies are operated on a non-protection basis;

- iii) usage of frequencies shall not cause interference to other radiocommunication networks duly authorised by IMDA;
- iv) usage is confined to the location indicated by the applicant and transmission is allowed only during the approved period;
- v) RF output power shall not exceed 0.5 W ERP and height of external antenna should not exceed 10 meter above ground. Exception may be allowed on justifiable grounds; and
- vi) Other conditions may apply when deem appropriate on case-by-case basis.

6. Equipment Registration

- 6.1 Unless otherwise specified by IMDA, all equipment operated by a licensed dealer for demonstration purpose must be registered with IMDA.
- 6.2 Equipment intended for temporary use, for example, by an exhibitor or an equipment manufacturer/supplier who takes part in an exhibition, may be exempted from registration. However, equipment that is unable to meet IMDA's technical specifications may not be operated unless the applicant prove to IMDA that its operation will not cause harmful interference to the operation of other radio-communication networks and equipment.

7. Duration of Use

- 7.1 The duration of temporary use typically ranges from a few hours to a few days; up to a maximum period of 90 days. For occasional use of frequencies by licensed Telecommunication Dealers, the period during which the occasional usage allowed is 12 months and may be renewed upon the renewal of the Telecommunication Dealer's Licence.

8. Frequency Fees

- 8.1 A fee of \$100 is payable for a frequency selected from the pool of demonstrating frequencies listed in paragraph 3.1.
- 8.2 Where a frequency not from the pool of frequencies in paragraph 3.1 is approved for use, the fee payable shall be as follows:

<i>Bandwidth (x)</i>	<i>Fee (Excluding GST)</i>	
	10 days or less	11 – 90 days
$x \leq 25$ kHz	\$100	\$175
$25 < x < 500$ kHz	\$150	\$275
$500 \text{ kHz} \leq x < 1$ MHz	\$450	\$825
$1 \leq x < 20$ MHz	\$900	\$1,625
$x \geq 20$ MHz	\$1,550	\$2,800

- 8.3 Unless otherwise determined by IMDA, a fee of \$100 is payable for a frequency mentioned in paragraph 8.2, if the period is less than a day or the cumulative hours of operation are less than 24 hours.
- 8.4 Unless otherwise determined by IMDA, the station licence fee of the radio-communication equipment is waived.

9. Exportation of Equipment

- 9.1 Any non-registered equipment shall be exported out of Singapore immediately after operation. Documentation showing proof of export must be submitted to IMDA.
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CHAPTER 9 – SPECTRUM FEES

1. Introduction

- 1.1 The Telecommunications (Radio-communication) Regulations 2001 empowers the Authority to grant any person the right to use any specified part of the radio frequency spectrum upon payment of the charges determined by the Authority.
- 1.2 Presently, under the administrative allocation approach, IMDA has two charging schemes for the usage of radio spectrum, namely Long Term (frequency assignment based on annual renewal) and Temporary Use of Frequencies. The nature of each charging scheme is detailed in the following paragraphs.

2. Fees for Long Term Usage of Radio Frequencies

- 2.1 The long term usage of radio frequencies is usually intended for the operation of radio-communication networks. The fee structure for such usage comprises two main components namely, the Application & Processing Fee and the Frequency Management Fee. The details of each component are given below:
- i) Application and Processing Fee - this is a one-time charge payable upon the approval of frequency(s) assignment. The application & processing fee covers the cost of the initial activities performed in assessing the suitability of the frequency to be used for the intended application. Any changes in the technical parameters shall be deemed as a new application.
 - ii) Frequency Management Fee - this is a recurrent fee payable annually to cover the cost of the activities performed to safeguard the use of the frequency(s).
- 2.2 The fee schedule for long term usage of radio frequency fees is as follows:
- i) Application and Processing Fee

<i>Category</i>	<i>Fee payable per frequency*</i>
1. Commonly Assigned Frequencies (for temporary or occasional use)	\$100
2. All Other Frequencies (including satellite downlink frequencies)	\$300

* Excluding GST

ii) Annual Frequency Management Fee

1. Fees for the use of a radio frequency on an exclusive basis:

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Broadcasting	All Frequency Bands	$X \leq 25$ kHz	\$400
		25 kHz $< X \leq 500$ kHz	\$800
		500 kHz $< X \leq 10$ MHz	\$12,100
Fixed	All Frequency Bands	$X \leq 25$ kHz	\$400
		25 kHz $< X \leq 500$ kHz	\$1,100
		500 kHz $< X \leq 10$ MHz	\$2,900
		10 MHz $< X \leq 20$ MHz	\$7,700
		$X > 20$ MHz	\$10,700
Private Mobile Radio	All Frequency Bands	$X \leq 25$ kHz	\$400
		25 kHz $< X \leq 500$ kHz	\$500
		500 kHz $< X \leq 10$ MHz	\$9,200
		10 MHz $< X \leq 20$ MHz	\$29,800
		$X > 20$ MHz	\$44,500
Public Mobile Radio	All Frequency Bands	per 5MHz of occupied bandwidth or part thereof	\$7,700
Others	All Frequency Bands	$X \leq 25$ kHz	\$400
		25 kHz $< X \leq 500$ kHz	\$1,100
		500 kHz $< X \leq 10$ MHz	\$15,100
		10 MHz $< X \leq 20$ MHz	\$29,800
		$X > 20$ MHz	\$44,500

2. Fees for the use of a radio frequency on a shared basis (where the occupied bandwidth falls within two or more categories of radio frequency bands, the fees payable in respect of the lower radio frequency band will apply):

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Fixed	Below 10 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$800
		10 MHz $< X \leq 20$ MHz	\$1,800
		$X > 20$ MHz	\$2,400
	10 GHz – 15.7 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$500
		10 MHz $< X \leq 20$ MHz	\$900
		$X > 20$ MHz	\$1,200

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
	15.7 GHz – 21.2 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$500
		10 MHz $< X \leq 20$ MHz	\$700
		$X > 20$ MHz	\$900
	Above 21.2 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$500
		10 MHz $< X \leq 20$ MHz	\$600
		$X > 20$ MHz	\$700
Radiodetermination (Non- Aeronautical)	Below 3 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$1,800
		10 MHz $< X \leq 20$ MHz	\$3,200
		$X > 20$ MHz	\$4,700
	3 GHz - 5.85 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$1,000
		10 MHz $< X \leq 20$ MHz	\$1,800
		$X > 20$ MHz	\$2,500
	Above 5.85 GHz	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$700
		10 MHz $< X \leq 20$ MHz	\$1,000
		$X > 20$ MHz	\$1,400
Satellite (GeoStationary Orbit)	All Frequency Bands	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$700
		10 MHz $< X \leq 20$ MHz	\$1,000
		$X > 20$ MHz	\$1,600
Satellite (Non-GeoStationary Orbit)	All Frequency Bands	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$1,500
		10 MHz $< X \leq 20$ MHz	\$2,800
		$X > 20$ MHz	\$4,700
Private Mobile Radio	All Frequency Bands	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$2,500
		10 MHz $< X \leq 20$ MHz	\$7,600
		$X > 20$ MHz	\$11,300
Radiodetermination (Aeronautical)	All Frequency Bands	$X \leq 25$ kHz	\$300
		25 kHz $< X \leq 500$ kHz	\$400
		500 kHz $< X \leq 10$ MHz	\$2,100
		10 MHz $< X \leq 20$ MHz	\$4,000
		$X > 20$ MHz	\$5,800

Radiocommunication Service	Radio Frequency Bands	Occupied Bandwidth (X)	Fee payable per frequency per annum*
Others	All Frequency Bands	$X \leq 25 \text{ kHz}$	\$300
		$25 \text{ kHz} < X \leq 500 \text{ kHz}$	\$500
		$500 \text{ kHz} < X \leq 10 \text{ MHz}$	\$4,000
		$10 \text{ MHz} < X \leq 20 \text{ MHz}$	\$7,700
		$X > 20 \text{ MHz}$	\$11,300

<i>Radio Frequency Spectrum</i>	<i>Fee payable per frequency per annum*</i>	
	<i>ISM Band</i>	<i>Non ISM Band</i>
Common Frequencies for In-building or On-site Wireless Systems —		
(a) bandwidth of 20 MHz or less	\$50	\$100
(b) bandwidth of more than 20 MHz but not exceeding 50 MHz	\$100	\$200
(c) bandwidth of more than 50 MHz	\$150	\$300
Block of Assigned Frequencies for Multi-channel Radio Communication Networks and Systems	\$15	

* *Excluding GST*

3. Fees for Temporary Usage of Radio Frequencies

- 3.1 The temporary usage of radio frequencies (typically ranges from a few hours to a few days, and up to a maximum period of 90 days) is necessitated by purposes such as exhibitions, product demonstration and the testing of equipment. In general, the frequency fee payable depends on the period of usage, the bandwidth and the frequency band used.

3.2 The fee schedule for the temporary usage of radio frequencies is show below.

Fees for the temporary use of radio frequencies

<i>Bandwidth (x)</i>	<i>Fee (Excluding GST)</i>	
	10 days or less*	11 - 90 days
1. $x \leq 25$ kHz	\$100	\$175
2. $25 < x < 500$ kHz	\$150	\$275
3. $500 \text{ kHz} \leq x < 1$ MHz	\$450	\$825
4. $1 \text{ MHz} \leq x < 20$ MHz	\$900	\$1,625
5. $x \geq 20$ MHz	\$1,550	\$2,800

* Unless otherwise determined by the Authority, a fee of \$100 is payable for the use of any of the above radio frequencies if the period of usage or cumulative period of usage is less than 24 hours.

ANNEXES

ANNEX 1**Section I – Definition of Service**

1. *radiocommunication service* – A service as defined in this Section involving the transmission, emission and/or reception of radio waves for specific telecommunication purposes.
2. *fixed service* – A radiocommunication service between specified fixed points.
3. *fixed-satellite service* – A radiocommunication service between earth stations at given positions, when one or more satellites are used; the given position may be a specified fixed point or any fixed point within specified areas; in some cases this service includes satellite-to-satellite links, which may also be operated in the inter-satellite service; the fixed-satellite service may also include feeder links for other space radiocommunication services.
4. *mobile services* – A radiocommunication service between mobile and land stations, or between mobile stations (CV).
5. *mobile-satellite service* – A radiocommunication service:
 - between mobile earth stations and one or more space stations, or between space stations used by this service; or
 - between mobile earth stations by means of one or more space stations.

This service may also include feeder links necessary for its operation.
6. *land mobile service* – A mobile service between base stations and land mobile stations, or between land mobile stations
7. *land mobile-satellite service* – A mobile-satellite service in which mobile earth stations are located on land.
8. *maritime mobile service* – A mobile service between coast stations and ship stations, or between ship stations, or between associated on-board communication stations; survival craft stations and emergency position-indicating radio beacon stations may also participate in this service.
9. *maritime mobile-satellite service* – A mobile-satellite service in which mobile earth stations are located on board ships; survival craft stations and emergency position-indicating radio beacon stations may also participate in this service.

10. *aeronautical mobile service* – A mobile service between aeronautical stations and aircraft stations, or between aircraft stations, in which survival craft stations may participate; emergency position-indicating radio beacon stations may also participate in this service on designated distress and emergency frequencies.
11. *aeronautical mobile (R)* service* – An aeronautical mobile service reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes.
12. *aeronautical mobile (OR)** service* – An aeronautical mobile service intended for communications, including those relating to flight coordination, primarily outside national or international civil air routes.
13. *aeronautical mobile-satellite service* – A mobile-satellite service in which mobile earth stations are located on board aircraft; survival craft stations and emergency position-indicating radiobeacon stations may also participate in this service.
14. *aeronautical mobile-satellite (R)* service* – An aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.
15. *aeronautical mobile-satellite (OR)** service* – An aeronautical mobile-satellite service intended for communications, including those relating to flight coordination, primarily outside national and international civil air routes.
16. *broadcasting service* – A radiocommunication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other types of transmission (CS).
17. *broadcasting-satellite service* – A radiocommunication service in which signals transmitted or retransmitted by space stations are intended for direct reception by the general public.

In the broadcasting-satellite service, the term “direct reception” shall encompass both individual reception and community reception.

* (R): route

** (OR): off-route

18. *radiodetermination service* – A radiocommunication service for the purpose of radiodetermination.

19. *radiodetermination-satellite service* – A radiocommunication service for the purpose of radiodetermination involving the use of one or more space stations.

This service may also include feeder links necessary for its own operation.

20. *radionavigation service* – A radiodetermination service for the purpose of radionavigation.

21. *radionavigation-satellite service* – A radiodetermination-satellite service used for the purpose of radionavigation.

This service may also include feeder links necessary for its operation.

22. *maritime radionavigation service* – A radionavigation service intended for the benefit and for the safe operation of ships.

23. *maritime radionavigation-satellite service* - A radionavigation-satellite service in which earth stations are located on board ships.

24. *aeronautical radionavigation service* – A radionavigation service intended for the benefit and for the safe operation of aircraft.

25. *aeronautical radionavigation-satellite service* – A radionavigation-satellite service in which earth stations are located on board aircraft.

26. *radiolocation service* – A radiodetermination service for the purpose of radiolocation.

27. *radiolocation-satellite service* – A radiodetermination-satellite service used for the purpose of radiolocation.

This service may also include the feeder links necessary for its operation.

28. *meteorological aids service* – A radiocommunication service used for meteorological, including hydrological, observations and exploration.

29. *earth exploration-satellite service* – A radiocommunication service between earth stations and one or more space stations, which may include links between space stations, in which:

- information relating to the characteristics of the Earth and its

natural phenomena, including data relating to the state of the environment, is obtained from active sensors or passive sensors on Earth satellites;

- similar information may be distributed to earth stations within the system concerned;
- platform interrogation may be included.

This service may also include feeder links necessary for its operation.

30. *meteorological-satellite service* – An earth exploration-satellite service for meteorological purposes.
31. *standard frequency and time signal service* – A radiocommunication service for scientific, technical and other purposes, providing the transmission of specified frequencies, time signals, or both, of stated high precision, intended for general reception.
32. *standard frequency and time signal-satellite service* – A radiocommunication service using space stations on earth satellites for the same purposes as those of the standard frequency and time signal service.

This service may also include feeder links necessary for its operation.

33. *space research service* – A radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes.
34. *amateur service* – A radiocommunication service for the purpose of self-training, intercommunication and technical investigations carried out by amateurs, that is, by duly authorised persons interested in radio technique solely with a personal aim and without pecuniary interest.
35. *amateur-satellite service* – A radiocommunication service using space stations on earth satellites for the same purposes as those of the amateur service.
36. *radio astronomy service* – A service involving the use of radio astronomy.
37. *safety service* – Any radiocommunication service used permanently or temporarily for the safeguarding of human life and property.
38. *special service* – A radiocommunication service, not otherwise defined in this Section, carried on exclusively for specific needs of general utility, and not open to public correspondence.

39. *industrial, scientific and medical (ISM)* – Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunication.

Section II – General Terms

1. *out-of-band emission* – Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions.
2. *spurious emission* – Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.
3. *unwanted emissions* – Consist of spurious emissions and out-of-band emissions.
4. *assigned frequency band* – The frequency band within which the emission of a station is authorized; the width of the band equals the necessary bandwidth plus twice the absolute value of the frequency tolerance. Where space stations are concerned, the assigned frequency band includes twice the maximum Doppler shift that may occur in relation to any point of the Earth's surface.
5. *assigned frequency* – The centre of the frequency band assigned to a station.
6. *reference frequency* – A frequency having a fixed and specified position with respect to the assigned frequency. The displacement of this frequency with respect to the assigned frequency has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the centre of the frequency band occupied by the emission.
7. *frequency tolerance* – The maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency or, by the characteristic frequency of an emission from the reference frequency.

The frequency tolerance is expressed in parts in 10^6 or in hertz.
8. *necessary bandwidth* – For a given class of emission, the width of the

frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.

9. *occupied bandwidth* – The width of a frequency band such that, below the lower *and above the upper* frequency limits, the mean powers emitted are each equal to a specified percentage $\beta/2$ of the total mean power of a given emission.

Unless otherwise specified in an ITU-R Recommendation for the appropriate class of emission, the value of $\beta/2$ should be taken as 0.5%.

10. *power* – Whenever the power of a radio transmitter, etc. is referred to it shall be expressed in one of the following forms, according to the class of emission, using the arbitrary symbols indicated:
- *peak envelope power* (PX or pX);
 - *mean power* (PY or pY);
 - *carrier power* (PZ or pZ).

For different classes of emission, the relationships between peak envelope power, mean power and carrier power, under the conditions of normal operation and of no modulation, are contained in ITU-R Recommendations which may be used as a guide.

For use in formulae, the symbol p denotes power expressed in watts and the symbol P denotes power expressed in decibels relative to a reference level.

11. *peak envelope power* (of a radio transmitter) – The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions.
12. *carrier power* (of a radio transmitter) – The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle taken under the condition of no modulation.
13. *gain of an antenna* – The ratio, usually expressed in decibels, of the power required at the input of a loss-free reference antenna to the power supplied to the input of the given antenna to produce, in a given direction, the same field strength or the same power flux-density at the same distance. When not specified otherwise, the gain refers to the direction of maximum *radiation*. The gain may be considered for a specified polarization.

- Depending on the choice of the reference antenna a distinction is made between:
- i) absolute or isotropic gain (G_i), when the reference antenna is an isotropic antenna isolated in space;
 - ii) gain relative to a half-wave dipole (G_d), when the reference antenna is a half-wave dipole isolated in space whose equatorial plane contains the given direction; and
 - iii) gain relative to a short vertical antenna (G_v), when the reference antenna is a linear conductor, much shorter than one quarter of the wavelength, normal to the surface of a perfectly conducting plane which contains the given direction.
14. *equivalent isotropically radiated power (EIRP)* – The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).
 15. *effective radiated power (ERP)* (in a given direction) – The product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction.
 16. *interference* – The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radiocommunication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.
 17. *harmful interference* – Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with Radio Regulations (CS).
 18. *protection ratio (R.F.)* – The minimum value of the wanted-to-unwanted signal ratio, usually expressed in decibels, at the receiver input, determined under specified conditions such that a specified reception quality of the wanted signal is achieved at the receiver output.

ANNEX 2

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
5925-6425 MHz	ITU-R F. 383-8	29.65	<p>lower half of the band: $f_n = f_o - 259.45 + 29.65n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o - 7.41 + 29.65n$ MHz</p> <p>where: $n = 1, 2, 3, 4, 5, 6, 7$ or 8;</p> <p>$f_o = 6175$ MHz</p>
6425-7125 MHz	ITU-R F. 384-10	20/30/40	<p>lower half of the band: $f_n = f_o - 350 + 20n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o - 10 + 20n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 15, 16$;</p> <p>$f_o = 6770$ MHz</p> <p>lower half of the band: $f_n = f_o - 340 + 30n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 30n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 10$;</p> <p>$f_o = 6770$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
			<p>lower half of the band: $f_n = f_o - 350 + 40n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o - 10 + 40n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 8;$</p> <p>$f_o = 6770$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
7125-7425 MHz	ITU-R F. 385-9	7/14/28	<p>lower half of the band: $f_n = f_o - 154 + 7n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 7 + 7n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 20$;</p> <p>$f_o = 7275$ MHz</p> <p>lower half of the band: $f_n = f_o - 157.5 + 14n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 3.5 + 14n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 10$;</p> <p>$f_o = 7275$ MHz</p> <p>lower half of the band: $f_n = f_o - 164.5 + 28n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o - 3.5 + 28n$ MHz</p> <p>where: $n = 1, 2, 3, 4$ or 5;</p> <p>$f_o = 7275$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
7425 – 7725 MHz	ITU-R F. 385-9	7/14/28	<p>lower half of the band: $f_n = f_o - 154 + 7n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 7 + 7n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 20$;</p> <p>$f_o = 7575$ MHz</p> <p>lower half of the band: $f_n = f_o - 157.5 + 14n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 3.5 + 14n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 10$;</p> <p>$f_o = 7575$ MHz</p> <p>lower half of the band: $f_n = f_o - 164.5 + 28n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o - 3.5 + 28n$ MHz</p> <p>where: $n = 1, 2, 3, 4$ or 5;</p> <p>$f_o = 7575$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
7725-8500 MHz	ITU-R F. 386-8	29.65	<p>lower half of the band: $f_n = f_o - 281.95 + 29.65n$ MHz</p> <p>upper half of the band: $f_n' = f_o + 29.37 + 29.65n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 8;$</p> <p>$f_o = 8000$ MHz</p>
10.5-10.68 GHz	ITU-R F. 747-0	7	<p>lower half of the band: $f_n = f_o - 1204 + 7n$ MHz</p> <p>upper half of the band: $f_n' = f_o - 1113 + 7n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 12;$</p> <p>$f_o = 11701$ MHz</p>
10.7-11.7 GHz	ITU-R F. 387-11	20	<p>lower half of the band: $f_n = f_o - 505 + 20n$ MHz</p> <p>upper half of the band: $f_n' = f_o + 25 + 20n$ MHz</p> <p>where: $n = 1, 2, 3, \dots 23;$</p> <p>$f_o = 11200$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
12.75-13.25 GHz	ITU-R F. 497-7	28	<p>lower half of the band: $f_n = f_0 - 259 + 28n$ MHz</p> <p>upper half of the band: $f_{n'} = f_0 + 7 + 28n$ MHz</p> <p>where: $n = 1, 2, 3, \dots, 8;$</p> <p>$f_0 = 12996$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
14.4-15.35GHz	ITU-R F. 636-3 (with interleaved channel)	7/14/28	<p>lower half of the band: $f_n = f_o + 2670.5 + 28n + 7m$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 3608.5 - 28(N-n) + 7m$ MHz</p> <p>where: $n = 1, 2, 3, \dots, N$; where $N \leq 16$</p> <p>$m = 1, 2, 3, \text{ or } 4$</p> <p>$f_o = 11701$ MHz</p> <p>lower half of the band: $f_n = f_o + 2702 + 14n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 3640 - 14(N-n)$ MHz</p> <p>where: $n = 1, 2, 3, \dots, N$; where $N \leq 16$</p> <p>$f_o = 11701$ MHz</p> <p>lower half of the band: $f_n = f_o + 2688 + 28n$ MHz</p> <p>upper half of the band: $f_{n'} = f_o + 3626 - 28(N-n)$ MHz</p> <p>where: $n = 1, 2, 3, \dots, N$; where $N \leq 16$</p> <p>$f_o = 11701$ MHz</p>

Frequency Range	Channelling Plan	Channel Width (MHz)	Derivation
17.7-19.7 GHz	ITU-R F. 595-9 (with interleaved channel for 220 and 110 MHz spacings)	27.5	lower half of the band: $f_n = f_0 - 1000 + 27.5 n$ MHz upper half of the band: $f_{n'} = f_0 + 10 + 27.5 n$ MHz where: $n = 1, 2, 3, \dots, 35$; $f_0 = 18700$ MHz
21.2-23.6 GHz	ITU-R F. 637-3 (with interleaved channel)	3.5/7/14/28	$f_p = f_0 + 3.5 + 3.5 p$ $1 \leq p \leq 685$ $f_0 = 21196$ MHz

ANNEX 3

Explanatory Notes for Application for Terrestrial Microwave Station Licence

This document is designed to provide applicants with guidelines and instructions to assist them in properly completing the APPLICATION FOR TERRESTRIAL MICROWAVE STATION LICENCE application form.

The Application for Terrestrial Microwave Station Licence application form is to be completed by the applicant and submitted to the Licensing Authority.

An Application may be submitted for one or more stations. This application form can be used to describe up to four stations and the applicant may make additional copies of the pages of the form if required. For each station described on pages 2 & 3, a complete set of pages 4 to 6 should be completed.

Each completed application should consist of:

- Section 1 for applicant information,
- Section 2 for general description,
- one or more sections for station information,
- one or more Frequency and Link sections cross-referenced to station,
- one or more sections for Radio Equipment, Antenna and Filter equipment information,
- a section for the applicant's certification and signature as well as Company stamp and certification date.

The information in each of these sections is required to properly analyse the application. The applicant should print all responses clearly. Failure to complete all portions of the application could result in a delay in the issuance of a licence.

Section 1 - Applicant Information

This section requests particular information about the applicant, either a Company or individual.

If the applicant is on behalf of a Company, the name should be the Name of the Company under whose name the licence will be issued. Please also indicate its Business Registration Number and type of Business. Because the Licensing Authority may need to contact the applicant for more information, the Name of Contact Person and his/her Designation & Department should also be entered.

If it is an individual applying, as opposed to a Company, the name should be the Name of the Individual under whose name the licence will be issued. The Nationality and Passport or NRIC number are required.

Two separate addresses are indicated: a correspondence address where all licences and other correspondence, except for invoices will be sent; and a billing address where the invoices and any correspondence regarding billing will be sent. If both addresses are the same then only the correspondence address needs to be completed. Because the Licensing Authority may need to contact the applicant for more information, the applicant is requested to indicate a telephone number and if available, a fax and/or telex number.

Section 2 - General Description

Provide a description of the system, its network configuration and its proposed use.

Sections 3,4,5,6 Station Information

The information requested in this section pertains to the actual station site.

Station Name

The applicant should indicate the Callsign of the Station if available, or a name by which the station can be identified.

Location / Station Address

The station location should also be indicated. An address should be provided if appropriate.

Co-ordinates

The Latitude and Longitude of the building or structure to which the antenna is attached should be provided. The accuracy of this location should be to the second and a further refinement (in metres) will be required in section 10. under 'Antenna Displacement'

The above information is required to accurately locate the antenna relative to that location for technical calculations. If the station can be moved, then the applicant should indicate that it is transportable and they should further indicate the radius of operation from the coordinates provided.

Site Elevation

Site Elevation in metres above mean sea level

Building Height

If the antenna is to be mounted on top of a building, give the height of the building in metres.

Antenna Structure Height

Antenna Structure Height in metres.

Section 7 - Frequency Information

The applicant should indicate which station the information is being provided for. The station applies to frequency as well as other information contained in section 8 through 12 on the same form.

Usage Period

State any specific period when station will be in operation else indicate H24 for 24 hour operation.

Desired Frequency Range / Carrier Frequency

Indicate a preferred or desired transmit / receive frequency range. The applicant should be aware that it may not be possible to accommodate the request and an alternate frequency may be assigned.

Feeder Information

If a feeder is provided in the system's configuration, its length, type of line or cable used and loss should also be included.

Necessary Bandwidth

Necessary Bandwidth is defined as for a given class of emission, the width of a frequency band which is just sufficient to ensure the transmission/reception of information at the rate and quality required under specified conditions.

Emission

Set of characteristics of an emission, designated by standard symbols set by ITU (Appendix S1 of the Radio Regulations) e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics. May leave blank if not sure.

Polarisation

The type of polarisation such as Linear or Circular.

BER

For digital systems include the Bit Error Rate (BER) of transmission and reception in Megabits/second. The BER measures the average number of bit errors caused by noise. The value is designated as the negative exponent to the base 10.

Baseband Noise / Power Ratio

For analog systems include Baseband Noise/Power Ratio in dB for transmit and receive. Baseband Noise/Power Ratio is the ratio between the noise (unwanted signal) and the power (wanted signal).

Modulation Scheme / Type / Multiplexing Method

The modulation scheme is a description of how the information carried by the signal is encoded onto the carrier frequency. The modulation type is either analog or digital. For digital modulation include the modulation factor.

Section 8 - Link Information

The coverage/link section is used to describe either the reception point(s) for the proposed transmitting station or in the case of a proposed receiving station, its source transmission point(s).

The following description is intended to guide the applicant in determining which fields to complete for specific situations.

Link to Station

Used for a transmitting station where the intended recipient is another fixed station. The applicant should enter the callsign or name of station (cross-reference to Page 2 & 3). If alternate stations can be reached then they should be identified in the same way with the auxiliary links.

Used for a receiving station where the source of the transmission is another fixed station. The applicant should enter the callsign or name of station and coordinates of that specific transmitting station. If alternate stations can transmit to the proposed station then they should be identified in the same way with the auxiliary links.

Link to Geographical Point

Used for a transmitting station where the intended recipient is a fixed point. The applicant should enter the coordinates of the specific point.

Used for a receiving station where the source of the transmission is a fixed point. The applicant should enter the coordinates of the specific transmitting location.

Section 9 - Radio Equipment Information

This section requests the applicant to provide the Licensing Authority with information on the equipment to be used at the station. The applicant should ensure that the equipment, antenna and filter information are related to the correct station by indicating the station name in this section.

Equipment Identification

The applicant must provide for each type of equipment and associated frequency, the manufacturer and model. The serial number for the transmitter and/or receiver should also be provided, if available.

Frequency Range

The operating Frequency Range in MHz for transmitter and receiver.

Equipment Capacity

Indicate the capacity of the equipment. For digital systems indicate the Bit Rate in Mb/s. For analog systems indicate the number of voice channels.

Equipment Output

For a transmitter, the output Rated Power in dBm should be provided.

Frequency Stability

Frequency Stability in Hz is the ability of radio apparatus to stabilize or remained tuned to a specified tolerance.

Effective Isotropic Radiated Power (EIRP)

This value is the output power by the Antenna.

Reliability

Reliability of the equipment in percentage

LongTerm C/I (dB)

This is the value of the wanted-to-unwanted signal ratio at the receiver input with reference to the Minimum Receive Level of the receiver, such that a specified reception quality of the wanted signal is achieved at the receiver output.

Short Term C/I (dB)

This is the value of the wanted-to-unwanted signal ratio at the receiver input with reference to signal level at the receiver produced by the associated transmitted, such that a specified reception quality of the wanted signal is achieved at the receiver output.

Receiver Threshold Level

For receiver indicate the Minimum Acceptable Received Signal Level in dBm.

Section 10 - Antenna Information

This section requests the applicant to provide the Licensing Authority with information on the antenna equipment to be used at the station.

Antenna Identification

Indicate the manufacturer and model and type (eg parabolic or non parabolic) of antenna and its diameter.

Frequency Range

The operating transmit and receive Frequency Range in MHz.

Antenna Height above ground

The height of the antenna above the ground, measured from the ground level of the antenna site to the centre of radiation.

Antenna Gain

The gain is the ratio of the maximum radiation (in a given direction) to that of a reference antenna (in the same direction) for equal power input. For microwave stations, the reference antenna is an isotropic dipole.

3dB Beamwidth

Indicate the 3dB beamwidth measured in degrees.

Connector/Branching Loss

Indicate the loss in dB

Elevation Angle

Elevation Angle is the angle in the vertical plane between the horizontal plane and the direction in which the antenna points.

Antenna Displacement

North Latitude Displacement is the latitudinal displacement in metres from the exact station coordinates to the actual antenna location, measured from north to south. East Longitude Displacement is the longitudinal displacement in metre from the exact station coordinates to the actual antenna, measured from east to west.

The displacement is the antenna's location expressed as +/- metres from the station coordinates. Positive offsets indicate an increase in latitude or longitude and negative offsets indicate a decrease.

Section 11 - Transmit/Receive RF Filter Information

This section requests the applicant to provide the Licensing Authority with information on the filter equipment (if any) to be used at the station.

Filter Identification

Indicate the manufacturer, model and type of RF filter such as band pass band reject etc.

Total Loss

Total Filter Loss in dB. Insertion Loss is defined as the loss of signal level in dB caused by the insertion of the filter into a signal path. Isolation A is the amount of isolation loss provided by certain types of filters (eg Isolators, Circulator and Band Reject Duplexer) for a given frequency or frequency range. Isolation A is the isolation from the transmitter on the receive side. Isolation B is the amount of isolation loss provided by certain types of filters (eg Band Reject Duplexer) for a given frequency or frequency range. Isolation B is the isolation from the receiver on the transmitter side.

Section 12 - Technical Documents

One set each of the Antenna Radiation Diagram (Copolar & Crosspolar), Transmitter Spectrum Mask / Diagram and Receive Filter Mask / Diagram are to be submitted.

Certification and Signature

The applicant is requested to carefully read the certification and sign and date the form where indicated. If the application is made on behalf of a company then the company stamp should be provided in the space indicated.

ANNEX 4

Document Change History		
Document Name:		Spectrum Management Handbook
Version	Date	Key Changes
1.0	2 February 2006	Baseline copy
2.0	25 April 2011	Amendment to company address, contact, email and fax numbers, DDG name, and SBA name Amendments to information of border coordination in No. 1.2 of Chapter 2 Amendment to information in No. 1 and 2 of Chapter 3 Amendment to information of FM Radio and Analogue tables in Chapter 6 Alignment amendments
2.1	March 2012	Amendment to WBA services
2.2	May 2012	Amendment to broadcasting services in Singapore, SRD information, frequencies for equipment demonstration, and paging service
2.3	September 2013	Amendment to Public Mobile services
2.4	January 2014	Amendment to WBA and Trunked Radio services
2.5	August 2014	Amendment to Mobile services
2.6	February 2015	Updated all hyperlinks and amendments to information in: No. 2.1 and 3.2 of Chapter 2 No. 3.5 (iii) of Chapter 3 No. 3.1, 3.2 (iii), 3.6 and 4.2 of Chapter 4 No. 5.3 of Chapter 5 No. 3.1 DVB - DVB-T table of Chapter 6 No. 2.3 and 3.2 of Chapter 7 No. 3.1, 4.1, 6 and 9.1 of Chapter 8.
2.7	April 2016	Amendment to information in: Chapter 3 No. 7 of Chapter 4 No. 7 of Chapter 5 Table 2 and No. 3.1 of Chapter 6 No. 2.2 of Chapter 9
2.8	December 2016	Updated all related information from IDA to IMDA Amendment to information in: No. 3.1 of Chapter 6
2.9	July 2017	Amendment to information in No. 1.2, 1.4 and 2 of Chapter 3 Added 1.2 of Chapter 5