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M Series: Mobile, radiodetermination, amateur and related satellite services

Overview of regional and global usage of audio programme making and special events as applications in the mobile service

Foreword

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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
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***Note**: This ITU-R Report was approved in English by the Study Group under the procedure detailed in Resolution ITU-R 1.*

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REPORT ITU-R M.2563-0

Overview of regional and global usage of audio programme making and special events as applications in the mobile service

(2025)

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1 Scope

This Report provides an overview of regional and global usage of audio Programme Making and Special Events (PMSE), which are meant for Services Ancillary to Programme making (SAP) / Services Ancillary to Broadcasting (SAB), including Electronic News Gathering (ENG) as applications in the mobile service, in accordance with *resolves* 1 and 2 of Resolution ITU-R 59-3. The Report is segmented in sections regarding overview, technical characteristics, frequency usage, standardization, application and use of radio spectrum.

2 Background

Resolution ITU-R 59-3 invites studies on availability of frequency bands for worldwide and/or regional harmonization and conditions for their use by terrestrial electronic news gathering systems and resolves:

– to carry out studies regarding possible solutions for global/regional harmonization of frequency bands and tuning ranges for ENG use, focused on bands already allocated, on a primary or secondary basis, to the fixed, mobile or broadcasting services, taking into account;

– that some frequency bands have more favourable properties suitable for ENG use;

– available technologies to maximize efficient and flexible use of spectrum;

– system characteristics and operational practices which facilitate the implementation of these solutions;

– to develop ITU-R Recommendations and/or ITU-R Reports based on the aforementioned studies, as appropriate.

3 Related ITU-R Recommendations and Reports

ITU-R Recommendations

Recommendation ITU-R P.372 – Radio noise

Recommendation ITU-R BS.1116 – Methods for the subjective assessment of small impairments in audio systems

Recommendation ITU-R BS.1283 – Guidance for the selection of the most appropriate ITU-R Recommendation(s) for subjective assessment of sound quality

Recommendation ITU-R BS.1284 – General methods for the subjective assessment of sound quality

Recommendation ITU-R M.1637 – Global cross-border circulation of radiocommunication equipment for use in emergency and disaster relief situations

Recommendation ITU-R M.1767 – Protection of land mobile systems from terrestrial digital video and audio broadcasting systems in the VHF and UHF shared bands allocated on a primary basis

Recommendation ITU-R F.1777 – System characteristics of television outside broadcast, electronic news gathering and electronic field production in the fixed service for use in sharing studies

Recommendation ITU-R M.1824 – System characteristics of television outside broadcast, electronic news gathering and electronic field production in the mobile service for use in sharing studies.

Recommendation ITU-R BT.1868 – User requirements for codecs for transmission of television signals through contribution, primary distribution, and SNG networks

Recommendation ITU-R BT.1871 – User requirements for wireless microphones, in-ear monitoring devices and wireless multi-channel audio systems

Recommendation ITU-R BT.1872 – User requirements for broadcast auxiliary services including digital television outside broadcast, electronic/satellite news gathering and electronic field production

ITU-R Reports

Report ITU-R BT.2069 – Tuning ranges and operational characteristics of terrestrial electronic news gathering (ENG), television outside broadcast (TVOB) and electronic field production (EFP) systems

Report ITU-R BT.2338 – Services ancillary to broadcasting/services ancillary to programme making spectrum use in Region 1 and the implication of a co-primary allocation for the mobile service in the frequency band 694-790 MHz

Report ITU-R BT.2344 – Information on technical parameters, operational characteristics and deployment scenarios of SAB/SAP as utilized in broadcasting

Report ITU-R F.2379 – Sharing and compatibility issues between electronic news gathering and other systems in frequency bands allocated to the fixed, mobile and broadcasting services.

4 List of acronyms and abbreviations

AC	Alternating current
BAS	Broadcast auxiliary systems
CEPT	European Conference of Postal and Telecommunications Administrations
DECT	Digital enhanced cordless telecommunications
ECC	Electronic Communications Committee
ENG	Electronic News Gathering
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
IEM	In-ear monitoring
IMT	International Mobile Telecommunications
IrDA	Infrared direct access
MPX	Multiplexed
NB	Narrow band
OB	Outside broadcasting
PMR	Personal mobile radio
PMSE	Programme making and special events
PSD	Power spectral density
QoS	Quality of service
RF	Radio frequency
SAB	Services ancillary to broadcasting
SAP	Services ancillary to programme making
SNG	Satellite news gathering
SRD	Short range devices
TDD	Time division duplex
TDMA	Time division multiple access
WMAS	Wireless multi-channel audio system

4.1 Terms used in the Report

Audio link: a point-to-point or point-to-multipoint connection, which can carry one dedicated audio channel or multiple audio channels. Note: Examples include left and right channel of stereo or multiple channels of a microphone array.

In-ear monitor (IEM) system: A permanently or temporarily installed transmitter that transmits to one or more portable body-worn receivers that provide audio to an earphone. Note: The transmitter is typically stationary when in use.

Programme making: the creation of content for broadcast, the production of films, presentations, advertisements, audio or video recordings; and the staging or performance of an entertainment, sporting, social or other public/private event.

Special events: occurrences of limited duration, typically from one day to several weeks or longer, which take place in specifically defined locations.

Talkback system: Wired and wireless transceivers that provide unidirectional or bidirectional communication between all involved people in a production team. Note: Examples include presenters, interviewers, cameramen, sound operators, lighting operators.

Tuning range: The spectral interval either in frequency (fmin, fmax) or wavelength (lmin, lmax) over which the operating frequency/wavelength of a tunable device can be adjusted by means of tuning control.

Wireless microphone system: A portable hand-held or body-worn transmitter with integrated or attached microphone which transmits to a permanently or temporarily installed receiver. Note: The receiver is typically stationary.

Wireless multichannel audio system (WMAS): wireless audio transmission system using digital wideband transmission techniques for microphone and IEM applications, and other multichannel audio PMSE use with the ability to support three or more audio channels per MHz.

WMAS base: A unit of a WMAS capable of serving multiple devices for the purpose of audio transmission/reception and device management and control.

WMAS portable: A movable device served by a WMAS base.

5 Overview on PMSE

There are three main broad classifications of PMSE applications:

– audio PMSE: the most commonly used audio PMSE applications are wireless microphones (handheld and body worn), in-ear monitors, intercom, conferencing solutions, audio links and talkback systems – relevant content is provided by this Report;

– video PMSE: the most commonly used video PMSE applications are portable or mobile wireless video links and cordless cameras;

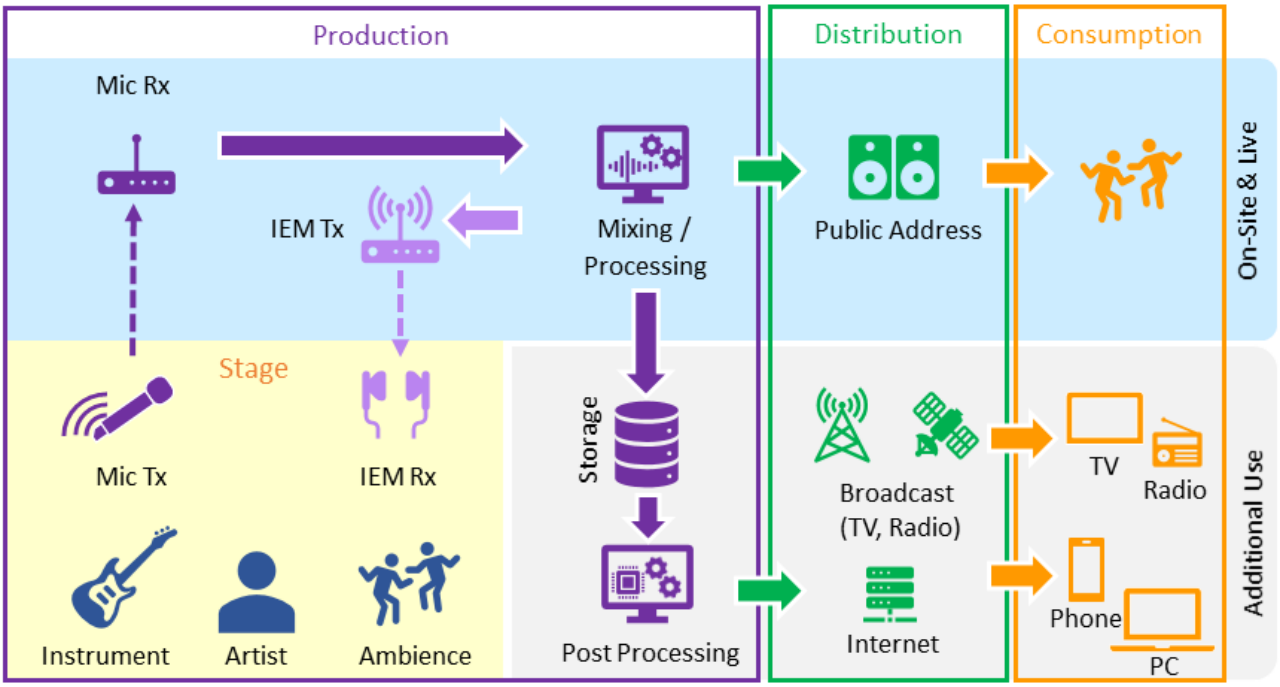
– PMSE service links: PMSE equipment that is used for data transmission for production such as effect and remote control and team connection, including OB, BAS and SNG.

This Report addresses audio PMSE in the mobile service.

Figure 1 provides an overview for a typical audio PMSE usage scenario.

FIGURE 1

Audio PMSE usage scenario from production to consumption



6 Audio PMSE in the mobile service

6.1 Overview

A wide number of applications and components are covered in this Report. The key components are:

– wireless microphones;
– in-ear monitoring systems;
– audio links;
– wireless conference systems;
– talkback systems.

Audio PMSE applications transmit typically with low power, require mission critical low latency audio transmission in an indoor or outdoor service area (e.g. venue, festival location, arena, conference centre, hotel, interviews at arbitrary locations). The scope of audio PMSE use covers ad-hoc, mobile, nomadic use cases as well as stationary locations.

Typical applications are wireless microphones, in-ear monitors (IEMs), Intercom, conferencing solutions, tour guiding and talkback systems.

Traditionally, audio PMSE systems, e.g. wireless microphones and IEM systems, have been unidirectional communications. There are also some talkback systems that allow for bidirectional communication Each audio channel is carried on a dedicated RF channel and consequently, the required resources in radio spectrum scales with the number of audio channels to be employed.

For wireless microphones and IEMs, currently the audio PMSE industry uses analogue and digital technologies employing narrowband modulation techniques with each link typically occupying an RF bandwidth of 200 kHz. Wireless multichannel audio systems (WMAS) can integrate multiple wireless microphones, IEMs and other applications in one broadband RF channel with an RF bandwidth of up to 20 MHz. In WMAS, the base and all portables operate on the same RF channel and all devices are

typically bidirectional supporting audio channel transmissions, management and control functionalities.

For talkback, PMSE uses different technologies depending on the use case. For example, for background communications with band members in a live music scenario a wireless microphone/IEM channel may be used to provide high quality audio and integrate with the performer's IEM. In other scenarios, other mobile technology might be used such as private mobile radio (PMR) or digital enhanced communication telecommunications (DECT)-based systems to communicate between people in the production team.

PMSE events range in size and complexity, which is then reflected in the number of wireless links employed and types of equipment. Large events and productions can have complex setups involving hundreds of microphones, IEMs, intercom, and talkback channels which drives spectrum demand.

The favourable propagation conditions of sub-1-GHz frequencies are employed to support the low power transmission of battery driven portables and to provide sufficient link-budget to overcome wireless channel effects (e.g. fading) and propagation losses by complex stage sets and body absorption loss (handheld and body worn equipment, moving and turning artists).

6.2 Deployment scenarios of audio PMSE applications

Table 1 provides an overview on possible deployment scenarios of audio PMSE for applications. Deployment is distinguished in location (everywhere, dedicated site), type (nomadic, stationary, mobile, air borne – ad-hoc or scheduled) and area of use (indoor or outdoor). Table 1 also provides examples of spectrum requirements per listed deployment scenario. For further explanation and more details regarding the introduced deployment scenarios see Annex 1.

TABLE 1

Mobile service deployment scenarios of audio PMSE and example spectrum requirements

Use		Deployment		
	Required spectrum (example values)	**Location of use**	**Type of use**	**Area of use**
Live event – music, theater – sport, olympics	Small: 20 MHz Medium: 45 MHz Large: 90 MHz Mega: > 150 MHz > 95% in the band 470-694 MHz; Talkback might use DECT technology	Everywhere including dedicated sites or across an extended area, e.g. along a racetrack	Scheduled nomadic or stationary; air-borne possible	Indoor and outdoor
Presentation, conferencing	Small: 8 MHz Medium: 20 MHz Large: 45 MHz Mega: 100 MHz +	Everywhere	Nomadic or stationary	Predominantly indoor, but also outdoor
News gathering: local news, international news	1-2 teams: 5 MHz 10 teams: 20 MHz 50 teams: 50 MHz Mega event: 100 MHz +	Everywhere	Ad-hoc nomadic or mobile, air-borne possible	Predominantly outdoor, but also indoor
Studio – studio production	Small: 20 MHz Medium: 45 MHz Large: 90 MHz	Everywhere including dedicated sites / media villages	Nomadic or Stationary	Predominantly indoor

TABLE 1 (*end*)

Use		Deployment		
	Required spectrum (example values)	**Location of use**	**Type of use**	**Area of use**
Studio – project studio production	10 MHz	Everywhere	Nomadic or Stationary	Predominantly indoor

Note 1: For Mega-events, administrations may make additional spectrum (to what is listed in their national regulations) available for audio PMSE in order to meet demand.

Note 2: The required spectrum in the Table does not consider hot spot areas, where several event places are close to each other. Hot spot areas require a different frequency management setup resulting in higher required spectrum use.

Note 3: Calculation of typical required spectrum in MHz: Audio PMSE manufacturers are offering frequency compatibility calculation tools / frequency management tools. Those tools calculate available frequencies for e.g. wireless microphones and IEM considering:

– Available interference free spectrum:
  - avoiding DTT allocations;
  - considering other audio PMSE devices already in use.
– Technical specifications:
  - Tuning range of the equipment;
  - Intermodulation products;
  - Filter options of antenna systems, receivers and transmitters.

7 Audio PMSE spectrum aspects

7.1 Introduction

Frequency ranges available for audio PMSE use are mainly dependent on national frequency allocations. Some frequency bands are common across ITU-R Regions and countries and, therefore, are the most used frequency ranges for audio PMSE, and are particularly important for cross border use, for example multi-country touring events. Examples of the available frequency ranges for audio PMSE in the mobile service are included in Recommendation ITU-R BT.1871 and Reports ITU-R BT.2344 and ITU-R BT.2069.

A primary task of the engineer in charge of the wireless links is to identify if there is sufficient permitted spectrum available at the event location for the number of audio PMSE equipment specified by the production. Shortage of available spectrum may constrain an event and can, in some cases, mean that a particular location is unable to host the production.

The spectrum available to the individual user depends on:

– the tuning range supported by the audio PMSE equipment used;
– the existing radio spectrum occupancy in the service area (e.g. venue);
– the frequency planning within the service area and the restrictions in place via policies applicable at the venue;
– the applicable license terms and/or the national frequency regulation.

Availability of audio PMSE equipment supporting specific frequency ranges depends on the national regulation, the global or at least regional availability of such tuning ranges and the considered market size.

Users of audio PMSE have to be able to use their equipment in multiple scenarios and environments. A shortage of spectrum resources is frequently part of their daily business. Therefore, manufacturers

of audio PMSE equipment have reacted by offering equipment with selectable operational modes. These modes allow the user to pack more audio channels into a given amount of available radio spectrum, while accepting restrictions on the audio performance and/or operating range. A significant shortage of radio spectrum resources is especially likely for large music events (including nomadic uses), studios, media villages, and venues in densely populated areas, where PMSE is expected to deliver the best audio performance possible. Further, the growing number of content productions, which are becoming larger and more sophisticated in response to audience and consumer expectations, and the demand for a higher resolution audio capture including 3D immersive recordings drive the development of new equipment and radio spectrum demand for audio PMSE.[1]

7.2 Advantages and disadvantages, from a propagation perspective, of the frequency ranges used by audio PMSE

The choice of RF channel for audio PMSE applications largely depends on the propagation characteristics of the frequency range, i.e. the properties of different frequency ranges are better suited to different PMSE applications and use cases.

Key considerations for audio PMSE include the quality and reliability of the (reproduced) audio signal; range/distance of operation; form-factor of equipment (for example antenna size) and environment of use. These will be different for different classes of equipment and their intended use, for example, talkback and intercom systems have different requirements to a microphone used in a live concert; conference systems will have different requirements to IEMs; and wideband systems respond differently to fading and reflections than narrowband systems.

The factors that are considered when assessing the preferred frequency range for audio PMSE applications include:

– range / distance of operation;
– RF fading, reflection and shielding;
– building loss;
– body loss/body absorption;
– RF interference/noise (natural and man-made);
– antenna size.

The advantages and disadvantages, from a propagation perspective, of the frequency bands that are typically used for audio PMSE are shown in Table 2. Additional information can be found in ECC Report 204 [6].

[1] ECC Report 204: "*Spectrum use and future requirements for PMSE*" [6] and Copyright Industries in the U.S. Economy: The 2024 Report by Jéssica Dutra, Ph.D. and Robert Stoner, Ph.D. prepared for the International Intellectual Property Alliance® (IIPA®) February 2025 [16]

TABLE 2

Advantages and disadvantages, from a propagation perspective, of the frequency ranges used by audio PMSE

Frequency range	Propagation characteristics	Comments
VHF	– Good range / long distance of operation – Minimum building loss, reflection, and diffraction – Larger antenna needed – Higher levels of natural and man-made noise – Low body loss	Typical applications include talkback, audio links and low-end wireless mics. Large antenna size makes the band unsuitable for body worn equipment and equipment where size is a factor, e.g. IEMs
UHF (below 1 GHz)	– Good range / long distance of operation – Higher levels of building loss, reflection, and diffraction than VHF – Acceptable antenna size for a range of applications – Lower levels of natural and man-made noise than VHF – Medium level of body loss	The propagation characteristics of this frequency band are optimal for all audio PMSE applications, including narrowband and wideband (WMAS) systems.
UHF (above 1 GHz)	– Acceptable range / distance of operation – High levels of building loss, reflection, and diffraction – Small antennas possible – Low levels of natural and man-made noise – Increased level of body loss	Increased losses (particularly body loss) may constrain some applications, e.g. body worn and narrowband equipment. However, systems might benefit from increased reflections. Shielding may benefit frequency reuse and system performance can be optimized by use of directional antennas.

7.2.1 Usage scenarios for audio PMSE

The spectrum demand for PMSE is dependent on the usage scenario as shown in Table 1. It should be noted that the deployment scenarios in § 6.2 might coexist in the same location at the same time.

The density and deployment of audio PMSE equipment is higher in urban areas and areas where production facilities are located (studios and media villages) than in rural areas, although in rural areas, periodic very high-density use is common at festivals and in film/TV productions when productions are on location. In these hot spot areas, stationary deployments have a high probability of use. The actual use is dependent on the work/ rehearsal / performance schedule of the event, when the frequencies would be occupied at 100%, and to a certain extent the use and activity of audio PMSE use can be planned and coordinated.

Regular large events

In many cases where an event is known in advance, planning and coordination of spectrum use can take place. Depending on the requirement of the event, some administrations may facilitate temporarily access to additional spectrum available beyond what is listed in their allocation to audio PMSE. However, such additional spectrum would need to be supported by equipment available to the market. Examples of such events are Formula 1, G8, as well as extraordinary events such as the Olympics.

Hot spot scenarios

The events in Table 1 can occur in the same area and same time. Such cases are considered as hot spot scenarios. There is a cumulative demand for spectrum. The spectrum demand will vary depending on the time of day and other factors. Studios and media villages show an almost permanent use of audio PMSE applications such as wireless microphones, in-ear monitors, and intercoms as content production and contribution happens daily, almost 24 h / 7 days per week.

Other scenarios have a lower demand for spectrum

The demand may vary depending on the application, time of day and other factors. There are situations where only 1 to 2 wireless microphones are used in combination with a small loudspeaker system for presentation or speech purposes.

Peak demand scenarios

While assessing the spectrum requirements for PMSE, the normal regular demand for spectrum should be distinguished from the "peak demand". "Peak demand" may be temporarily or geographically limited (see CEPT Report 32 [3]).

– The geographical peaks are triggered by long-term use at event and production locations in certain geographical areas where there is a continuous heavy demand (typically multi-equipment, multi-channel users), thus most of the available UHF spectrum will be needed to satisfy this demand. Every country has geographical peaks these in a number of locations.

– The temporary peaks are triggered by special events of a short-term nature (large concerts, festivals etc.). When temporary events are staged at existing geographical peak locations, they result in a complex spectrum demand requiring detailed intervention by a spectrum manager or the administration, as this results in a "double overload." Spectrum planning using all available techniques, including building attenuation between outdoor and indoor use along with geographical shielding and temporary access to additional spectrum, is then employed.

It should be noted that the scenarios of peak demand are most often triggered by professional users. Additional details are given in CEPT Report 32 Annexes 3 and 4 [3].

Spectrum demand is heaviest for large-scale, professional productions, and for touring musicals and rock concerts, and it is these areas on which the following discussion concentrates. Typically, these usage scenarios will be most prominent in the locations with highest density of professional theatres, e.g. the West End in London.

7.2.2 Introduction of temporary event-specific solutions

Mega events (see Table 1) and increasingly other large events might require every single available and suitable piece of spectrum that is usually not allocated to PMSE so that the required wireless microphones, IEM's, talkbacks, etc. can operate reliably. The required quality of service of PMSE equipment before and during these events is very high. In some cases, it is thus necessary to access spectrum in other bands that usually are not intended for use by PMSE on a national basis, for a limited time period. These spectrum sharing arrangements require careful professional planning far in advance. Only such an "all hands-on board approach" will make it possible that the users who attend these events, such as news crews and teams, are able to work with their own PMSE equipment. Such users typically bring along and expect to use their own equipment for the event from other countries or regions, which the regulators would not allow to be deployed at the event location under usual circumstances.

7.3 Frequencies used by audio PMSE

7.3.1 Introduction

Only a limited number of spectrum bands are available for audio-PMSE and are harmonized in availability and access methods at least in a region.

PMSE has always shared spectrum with other services and to manage use, individual licenses can be issued for a specific use on a specific date and at a specific location. The available spectrum in any particular country is determined on a national basis; each frequency band may be wholly, partially or might be not available on a given day, in a given location.

7.3.2 Efficient use of spectrum for audio PMSE

Audio PMSE as a local area low power application specially designed to operate on a free tuning basis is able to integrate well in a channel raster predominant due to incumbent use. Spectrum sharing is for example globally practiced since decades with terrestrial television in a common audio PMSE tuning range for ad-hoc, nomadic and installed deployments of audio PMSE uses.

Spectrum sharing is especially technically viable for audio PMSE if the incumbent use at a given geographic location is not coincident with the audio PMSE use (in time and frequency range) and thus leaves sufficient suitable spectrum resources unused at the geographic location. Interference and receiver blocking due to adjacent incumbent use or other uses might limit the suitability of spectrum for audio PMSE use.

In the perspective of audio PMSE users, the spectrum use by the existing users in general has to be:

– observable, e.g. by spectrum scanning procedures or other information means;
– projectable, which means that it has tobe stable in its operational times and frequency occupancy for a reasonable duration at the geographic location of audio PMSE use.

7.3.3 Spectrum planning for audio PMSE use

Audio PMSE equipment typically operates on a free tuning concept to accommodate specific spectrum deployment conditions and to account for existing spectrum occupancy within their service area. Further, standards like ETSI EN 300 422 and other audio PMSE related ETSI standards define transmit spectrum masks, which are tailored to foster multi-link, multi-vendor uses of the available frequency bands.

Many different licensing schemes are implemented on national level. Those schemes can vary from license free usage to a restricted use limited to a set of specific frequencies limited on time and location.

Examples of implementation in Region 1 (in various countries):

– Option 1: no license required (e.g. general licence regime).
– Option 2: users have to register.
– Option 3: users have to apply for a use license, which allows them to use a specific number of devices.
– Option 4: license required, frequency authority defines a list of individual frequencies.
– Option 5: license required, specific frequencies for a given time and location.

In case of Options 1 to 3, the frequency planning is performed on site. The planning is managed by the user with the help of available planning tools from the manufacturers of the equipment or in case of large events with national interest with governance by the frequency administration.

The time parallel operation of PMSE applications, e.g. wireless microphones, IEM and/or WMAS in the same service area require suitable frequency coordination.

Frequency planning and coordination in the service area are assisted by spectrum scanning procedures and frequency management software tools including the support for mixed vendor deployments. This also supports the possible ad-hoc and nomadic deployments of audio PMSE in service areas where audio PMSE or other services are already in use.

7.4 Frequency bands and/or tuning ranges for possible global/regional harmonization for use by audio PMSE

National and/or regional information about the available frequency bands or frequency ranges for the use of audio PMSE in the mobile service can be found in Annex 2.

NOTE – Working Party (WP) 6A is currently developing an Electronic News Gathering (ENG) / Programme Making and Special Events (PMSE) database as suggested by Resolution ITU-R 59-3. The database is located at the Software and Databases page in the ITU-R site (https://www.itu.int/pub/R-SOFT/en).

7.4.1 Commonly available frequency ranges

Frequency ranges commonly available on a global scale, based on Annex 2, are given below.

Portions of the 470-698 MHz frequency range

Annex 2 shows that most countries make spectrum available for audio PMSE in portions of the frequency range 470-698 MHz.

This is why this frequency range is considered as a tuning range for audio PMSE; however, several countries focus on the lower portion of the band with the introduction of new services/systems in the upper part of that frequency range.

National conditions may impose certain restrictions due to applications of other services including TV broadcast and other mobile applications including IMT, so the whole frequency range may not be available for audio PMSE.

This frequency range is the most widely utilized for audio PMSE worldwide and serves as a crucial resource for such applications. Currently, in some countries, access to this range for audio PMSE is managed on a geographically interleaved basis with Digital Terrestrial Television (DTT) services.

Portions of the 1-2 GHz frequency range

2 GHz is considered the upper limit for audio PMSE due to propagation and body absorption effects as noted in Reports ITU-R BT.2344, ITU-R BT.2069 and ITU-R BT.2338.

Within the frequency range 1 to 2 GHz, some administrations have made spectrum available for use by audio PMSE (see Annex 2). In order to satisfy the objective in Resolution ITU-R 59-3, to harmonise frequency bands/tuning ranges for PMSE, administrations could consider these bands, or parts thereof, for adoption for audio PMSE in their national regulations if not currently available. Such action (to harmonise these bands as far as possible) would benefit PMSE users conducting cross-border events and provide economies of scale for manufacturers for equipment development and production.

8 Technical and operational characteristics of audio PMSE systems

8.1 Description of systems employing audio PMSE-specific technology

8.1.1 Overview

The ETSI standard EN 300 422-1 [1] describes the following three radio interfaces:

a) Narrow-band analogue – discrete frequency per audio channel;

b) Narrow-band digital – discrete frequency per audio channel; and

c) Wireless multichannel audio system (WMAS) – multiplexed channel system serving N portable transceivers.

Multi-audio channel installations based on Narrow-band equipment form complex systems with e.g. microphone receivers and IEM transmitters being mounted to separate racks to avoid receiver blocking. Each link requires its own dedicated working frequency, i.e. its own RF channel.

Figure 2 shows the radio interface for narrow-band equipment. The radio interface can employ analogue or digital modulation techniques for the audio plane, while the control plane is realized with an additional SRD link or IrDA interface.

FIGURE 2

Radio interface for narrow-band equipment

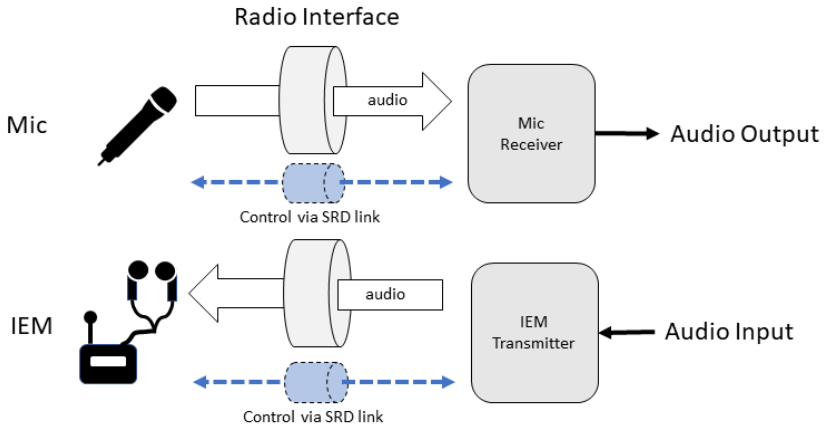
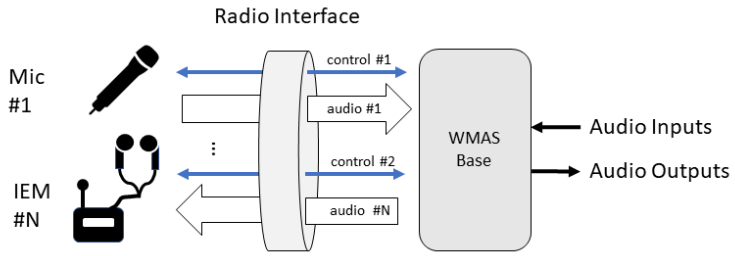


Figure 3 outlines the radio interface of a WMAS that offers multiple audio and control planes integrated in a single wideband radio interface. The direction of each dedicated audio plane is defined by the portable type connected. WMAS can support up to N devices.

FIGURE 3

Radio interface WMAS for #N portables



8.1.2 Narrow-band analogue

This is defined as an audio PMSE radio interface employing analogue modulation techniques (as summarized in Table 3) with a dedicated transmitter-receiver pair for a single audio link transmission on a dedicated operating frequency. The audio content plane is unidirectional carrying a Mono or MPX-Stereo signal. Additional audio links are established via deployment of additional, unique RF channels.

TABLE 3

Parameters audio PMSE narrow-band analogue

Parameter	Description	Notes
Application	Audio PMSE Dedicated transmitter-receiver pair for a single audio link	
Channel bandwidth / Channel spacing	Typical 200 kHz / Free tuning, placement on non-equidistant grid to account for transmitter intermodulation products.	1
Modulation	Analogue: frequency modulation	
Direction	Audio plane: uni-directional Control data plane: employing separate SRD radio interface	2
Transmit power / PSD	Typical: max. 50 mW e.r.p. below 1 GHz max. 50 mW e.i.r.p. above 1 GHz	3
Transmit spectrum mask	ETSI EN 300 422/ EN 301 357 / EN 300 454	
Channel access and occupation	Constant duty cycle, up to 100% occupancy in time	
Frequency planning assumptions		4 5
Relevant standard	ETSI EN 300 422/ EN 301 357 / EN 300 454	

Note 1: ETSI EN 300 422 enables certain other channel bandwidths within the range 50 kHz to 600 kHz.

Note 2: Configuration of portables via IrDA and/or a control plane is established via additional other radio interface operating in a different frequency band.

Note 3: The maximum transmit power is defined in national radio regulations and interface descriptions. Higher maximum transmit power may be allowed by licensing terms / special permits.

Note 4: Audio PMSE, being a low latency critical application, does not allow co-channel operation by other radio interface technologies.

Note 5: Frequency planning assisted by spectrum scanning procedures and frequency management software includes support for mixed vendor deployments. Time parallel operation of radio microphones, IEM and/or WMAS in same coverage area require suitable frequency separation/coordination.

8.1.3 Narrow-band digital

This is an audio PMSE radio interface employing digital modulation techniques (as summarized in Table 4) with a dedicated transmitter-receiver pair for a single audio link transmission on a dedicated centre frequency. The audio stream is Mono or Stereo signal. Additional audio links are established via deployment of additional, unique RF channels.

TABLE 4

Parameters audio PMSE narrow-band digital

Parameter	Description	Notes
Application	Audio PMSE Dedicated transmitter-receiver pair for a single audio link	
Channel bandwidth / channel spacing	Typical 200 kHz Free tuning, allowing equidistant grid, placement with typical 200 kHz to 600 kHz channel separation.	1
Modulation	Digital modulation	
Direction	Audio plane: Uni-directional Control data plane: Employing separate SRD radio interface	2
Transmit power / PSD	Typical: Max. 50 mW e.r.p. below 1 GHz Max. 50 mW e.i.r.p. above 1 GHz	3
Transmit spectrum mask	ETSI EN 300 422/ EN 301 357 / EN 300 454	
Channel access and occupation	Constant duty cycle, up to 100% occupancy in time.	
Frequency planning assumptions		4 5
Relevant standard	ETSI EN 300 422/ EN 301 357 / EN 300 454	

Note 1: ETSI EN 300 422 enables certain other channel bandwidths within the range 50 kHz to 600 kHz.

Note 2: Configuration of portables via IrDA and/or a control plane is established via additional other radio interface operating in a different frequency band.

Note 3: The maximum transmit power is defined in national radio regulations and interface descriptions. Higher maximum transmit power may be allowed by licensing terms / special permits.

Note 4: Audio PMSE, being a low latency critical application with high QoS requirements, does not allow co-channel operation by other radio interface technologies.

Note 5: Frequency Planning assisted by spectrum scanning procedures and software includes support for mixed vendor deployments. Time parallel operation of radio microphones, IEM and/or WMAS in same coverage area require suitable frequency separation/coordination.

8.1.4 Wireless multi-channel audio system (WMAS)

WMAS is an audio PMSE radio interface establishing a multiplexed approach (as summarized in Table 5) for audio applications serving e.g. microphone, IEM and talkback in a single RF wideband channel. Additional scaling of capacity (e.g. adding more audio channels as supported by a single WMAS base) via deployment in additional RF channels is possible. WMAS allows a flexible configuration of each audio channel regarding direction and use (e.g. IEM, Microphone or talkback transceivers), mapping of audio channels to a device, latency, audio quality and link reliability.

TABLE 5

Parameters audio PMSE WMAS

Parameter	Description	Notes
Application	Audio PMSE – multiplexed system	
Channel bandwidth / channel spacing	Typical {6,7,8} MHz (international DTT channel grid) or 10 MHz Free tuning but accommodating predominant channel raster of incumbent.	1
Modulation	Digital modulation	
Direction	Multiple audio planes, bi-directional Multiple control data planes, bi-directional	2
Transmit power / power spectral density (PSD)	Typical: (country and frequency band depended) 100 mW e.r.p.	3 4
Transmit spectrum mask	ETSI EN 300 422	
Channel access and occupation	Typical TDD TDMA Constant duty cycle, up to 100% occupancy in time	5
Frequency planning assumptions	ETSI TR 103 450	6 7
Relevant standard	ETSI EN 300 422	

Note 1: ETSI EN 300 422 enables a channel bandwidth of up to 20 MHz for WMAS. However, based on practical considerations, WMAS is likely to be utilized with smaller bandwidth and might follow the channel grid employed by an incumbent service (e.g. broadcasting or other). ETSI EN 300 422 requires WMAS to support at least one mode supporting in minimum three audio channels / MHz.

Note 2: Bi-directional control data plane is available, enabling permanent control and reconfiguration of all portables. This enables dynamic resource allocation at run-time to other portables.

Note 3: The maximum transmit power is defined in national radio regulations and interface descriptions. Higher maximum transmit power may be allowed by licensing terms / special permits. Larger occupied bandwidth results in lower PSD because maximum transmit power is per device. Example: PSD of an 8 MHz-wide WMAS is 16 dB lower than the one of a single 200 kHz link.

Note 4: In systems employing TDMA, the total transmit power in a given RF channel is not scaled with the number of WMAS devices deployed because each device only transmits in a short time slot and is limited to the maximum transmit power.

Note 5: ETSI TR 103 450 also envisions other duplex and multiple access schemes.

Note 6: Audio PMSE, being a low latency critical application with high QoS requirements, does not allow co-channel operation by other radio interface technologies.

Note 7: Frequency planning assisted by spectrum scanning procedures and software includes support for mixed vendor deployments. Time parallel operation of radio microphones, IEM and/or WMAS in the same coverage area require suitable frequency separation.

9 Summary

The possible global tuning range for audio Programme Making and Special Events (audio PMSE) is 470-698 MHz. This range is the most widely used for audio PMSE worldwide and serves as an important resource for such applications; however, several countries focus on the lower portion of the band with the introduction of new services/systems in the upper part of that frequency range.

Although the frequency range 1-2 GHz is less available for audio PMSE on a global scale, there is potential to harmonize bands within this frequency range. This would allow equipment capable of supporting this range to tune to the specific frequencies required by national regulations.

Table 6 provides some criteria for spectrum suitable for audio PMSE.

In assessing likely candidate bands for harmonisation several criteria should be determined whether spectrum is both viable for and meets the needs of audio PMSE. Importantly, this includes long term stability in terms of access and the possibility of harmonisation internationally.

Manufacturers of audio PMSE equipment recognize the importance of both these issues when considering the development of new equipment. Fragmented spectrum supply is very challenging for PMSE users.

The current industry consensus is that higher frequencies are inappropriate for PMSE applications due to their propagation and body absorption characteristics. Such studies can be found in Reports ITU-R BT.2344, ITU-R BT.2069 and ITU-R BT.2338.

TABLE 6

Some criteria for spectrum suitable for audio PMSE

Criteria	Rationale
Compatibility with current and planned services/systems	Due to the typical pattern of spectrum use and deployment by mobile networks, sharing with such networks would be challenging and only possible with separation by distance. In light of this evolving RF landscape, some administrations have made alternate suitable bands below 2 GHz available to support the growing demand for PMSE operations.
The existing use is the same in other major markets	Leading to flexibility for professionals conducting cross-border events as well as economies of scale for manufacturers, both in terms of equipment production and of distribution.
Provides a substantial block of contiguous spectrum (i.e. a range of spectrum that could be realistically accommodated in the tuning range of equipment)	Fragmented spectrum supply would be very challenging for PMSE users.
Below 2 GHz	The current industry consensus is that higher frequencies are inappropriate for PMSE applications due to their propagation and body absorption characteristics (reference Report ITU-R BT.2338).

10 References

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[9] ECC/DEC/(15)01 of 6 March 2015 on Harmonised technical conditions for mobile/fixed communications networks (MFCN) in the band 694-790 MHz including a paired frequency arrangement (Frequency Division Duplex 2x30 MHz) and an optional unpaired frequency arrangement (Supplemental Downlink), https://docdb.cept.org/download/1502

[10] 2013/752/EU: Commission Implementing Decision of 11 December 2013 amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2005/928/EC (notified under document C(2013) 8776) Text with EEA relevance, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D0752

[11] ECC Report 245: "Compatibility studies between a PMSE and other systems / services in the band 1350-1400 MHz", https://docdb.cept.org/download/1242

[12] ECC Report 253: "Compatibility studies for audio PMSE at 1 492-1 518 MHz and 1 518-1 525 MHz, https://docdb.cept.org/download/1272

[13] Commission Implementing Decision of 1 September 2014 on harmonised technical conditions of radio spectrum use by wireless audio programme making and special events equipment in the Union – (notified under document C(2014) 6011) – (2014/641/EU), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014D0641

[14] ERC Report 42: "Handbook on radio equipment and systems radio microphones and simple wide band audio links", https://docdb.cept.org/download/67b0287c-5ada/REP042.PDF

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Annex 1

Examples of audio PMSE use

This Annex is not intended to give a full overview on all deployment scenarios of audio PMSE use in the field but gives an overview on typical and regularly occurring uses.

The field of audio PMSE can be separated into the following major use case areas:

1) Live event (music, theatre), sport, Olympics
2) Presentation, conferencing
3) News gathering: local news, international news
4) Studio – studio production
5) Studio – project studio production

Calculation of typical required spectrum in MHz

Audio PMSE manufacturers are offering frequency compatibility calculation tools/frequency management tools. Those tools calculate available frequencies for e.g. wireless microphones and IEM considering:

– Available interference free spectrum:
  - Avoiding DTT allocations
  - Considering other audio PMSE devices already in use
– Technical specifications:
  - Tuning range of the equipment
  - Intermodulation products
  - Filter options of antenna systems, receivers and transmitters

The required spectrum listed in the below sections provides a typical number in MHz.

1 Live event

The band 470-694 MHz is the primary used band for audio-PMSE in live events. Talkbacks are using the DECT technology (e.g. 1 880-1 900 MHz in Region 1) as well.

For so called mega-events spectrum sharing with government agencies has occurred, but these spectrum resources may no longer be available for sharing as the available spectrum has been allocated to other services.

1.1 Music event

Doing business in the music industry has significantly changed over the years. In the past, media (albums, DVD) was the predominant income source of the artists beside touring. As of today, music events and touring are the predominant source of income for artists. Notably, audio streaming platforms have only delivered low payouts per play and so far, all existing audio streaming platforms are not earning money with their service (see https://www.digitalmusicnews.com/2018/12/25/streaming-music-services-pay-2019/).

FIGURE A1-1

Typical concert venue

Latency requirement

– Latency from audio input (microphone used by artist) to audio output (IEM with fold back mix used by same artist) needs to be below 4 ms.

Typical events, venue or locations

Eurovision Song Contest, live concerts… event locations up to large halls, sport stadiums, indoor and outdoor

Typical audio channel count

– Small event, e.g. local distribution: Wireless microphones 16 or more; in-ear monitors 4-8+

  (typical required spectrum ~ 20 MHz)

– Medium event, e.g. regional distribution: Wireless microphones 24 or more; in-ear monitors 8-16+

  (typical required spectrum ~ 45 MHz)

– Large event, e.g. national festivals: Wireless Microphones 64 or more; in-ear monitors 16-24+

  (typical required spectrum ~ 90 MHz)

– Mega event with international distribution: wireless microphones 192 or more (sometimes over 1 000); in-ear monitors 44+

  (typical required spectrum >150 MHz).

The above channel counts are for the productions themselves. Large national or international events will also call for broadcast crews requiring roaming wireless microphone use for interviews, camera video-links, live-broadcasting of the event.

Other PMSE use

– Light and effect control
– Multiple stationary, mobile, line or flying video cameras to capture stage, backstage, audience
– Large Intercom setup for event direction and security.

1.2 Theater, musicals

Typical event, venue or location

Dedicated buildings with installations but also touring at indoor and outdoor event locations.

Typical audio channel count

– Small event, e.g. school: 16 or more
(typical required spectrum ~ 8 MHz)
– Medium event, e.g. regional theatre: 24 or more
(typical required spectrum ~ 20 MHz)
– Large event, e.g. national tours, New York Broadway, London WestEnd: 62 or more, sometimes over 100
(typical required spectrum > 60 MHz).

1.3 Sports event

Sporting events require individual audio content by multiple reporters from various countries.

Moreover, it is becoming increasingly common for officials at sporting events to also use wireless microphones and in-ear monitor solutions to talk to remote services. E.g. Video-assisted referees (Premier League and Bundesliga), Television Match Officials (Rugby Union). For redundancy purposes, each official typically uses two wireless transmitters and one in-ear monitor system.

Match officials: 8+ wireless microphones, 4+ in-ear monitors

Broadcasters and leagues are also working to make sports television more interactive, and this new approach includes attaching microphones to the players themselves. The U.S. National Basketball Association (NBA), for instance, currently uses wireless microphones on each player to capture on-court audio.

The PGA European Tour is investigating adding wireless microphones to professional golfers to capture on-course dialogue for broadcast. See https://www.bbc.co.uk/sport/golf/52841949

Cases, where the PMSE service area is moving along with the athletes (e.g. Tour de France: bicycle race; U.S. Super Bowl; Olympics).

Formula 1 represents one of the most complex and high-stakes environments for audio PMSE applications. Wireless microphones and in-ear monitor (IEM) systems are critical to ensuring seamless communication among race officials, engineers, pit crews and broadcasters across the circuit. These systems are used extensively for live interviews, team communications, media coverage, and ensuring safe and efficient pit operations. The reliability and quality of PMSE audio systems are therefore not only essential for broadcast production, but also play a vital role in the safety of the race.

Olympics and other sport events of national or global interest.

Mega events (see Table 1) might require every single available piece of spectrum. In some cases, it is necessary to lease spectrum from other allocations, applying PMSE technology typically used in other

countries or regions, which would not be allowed to be deployed at the event location under normal circumstances.

Typical audio channel count: 190 and more (sometimes over 1 000).

2 Presentation, conferencing

This scenario covers person(s) giving a presentation, speech, lecture, sermon, moderation employing handheld or body-worn wireless microphones. Free movement of equipped person(s) during use.

Additional handheld wireless microphones might be in use to pick-up questions from the auditorium and for podium discussions involving multiple persons.

Additional IEM-like devices might be in use for hearing assist, especially in schools and universities.

Audio is immediately distributed via the public address (PA) system, but also available for recording or live streaming to the Internet.

Person(s) might be equipped with earphones (IEM) to receive instructions from event direction or security.

Latency requirement

– Latency of play back via PA needs to be low enough, so that the presenter(s) and audience are not distracted.

Typical Venue or Locations

– Dimension: board room, Larger Rooms, Hall, Lecture Theatre
– Deployments include schools, universities, conference centers, hotels, trade fairs, shopping centers, restaurants, churches, multi-purpose halls, press conference, political event areas and public places including streets and parks.

Typical wireless audio channel count

– Small event, e.g. local outreach: 4 or more
  (typical spectrum requirement ~ 8 MHz)
– Medium event, e.g. regional outreach: 12 or more
  (typical spectrum requirement ~ 20 MHz)
– Large event, e.g. national: 24 or more
  (typical spectrum requirement ~ 45 MHz)
– Mega event with international outreach: 48 and more, plus multiple interpretation channel
  (typical spectrum requirement > 60 MHz, 100 MHz +).

Other PMSE use

– Light control
– Multiple video cameras
– Intercom for event direction and security
– Wireless voting
– Interpretation, multi-language transmission.

3 Electronic news gathering

Focus is on news.

Wireless audio link between video camera and wireless microphone handheld or body worn.
Video camera might provide remote link.
Audio and video (remote or OB van) are typically linked to the production facilities.

FIGURE A1-2
Typical ENG situation

Typical wireless audio channel count:

– 1-2 ENG teams: 1-4 or more
(typical spectrum requirement 2-5 MHz)
– 10 ENG teams: 12 or more
(typical spectrum requirement ~ 20 MHz)
– 50 teams: 25 or more
(typical spectrum requirement ~ 50 MHz)
– Mega news event: 48 and more, plus multiple interpretation channels
(typical spectrum requirement ~ 90 MHz +).

4 Studio – studio production

4.1 Local news

Each market area generally has several independent news crews that provide information to local residents.

4.2 National / international news

ENG team follow the news event so that cross border use is routine.

Huddle of multiple ENG teams in one news event location, if event is of major importance. Wireless audio channel count can reach well over 100 (national) and more than 300 if international.

4.3 Video blogger

– Streaming or new media portals, e.g. YouTube.
– Video bloggers have discovered that wireless audio provides significant improvements in audio quality and flexibility in deployment, while producing content in daily routine.

Besides sharing specific community news. Video bloggers deliver content like product testimonials, advertising and entertainment: 2-5 audio PMSE channels.

5 Studio

5.1 Studio production

Production facilities in media villages or at broadcaster sites including mobile studios.

Studio production might be nomadic to event venues.

5.2 Project studio production

There has been a business shift from studio-based audio production to project studio audio productions by musicians and sound engineers, so that more geographic locations and more stakeholders are involved. Such studios demand very high audio standards as well.

5.3 Movie production sound recording

Significantly more entities in addition to traditional broadcasters and movie studios are now producing content, e.g. video streaming platform providers, independent film makers and project studios.

Action scenes require high mobility and reliability in audio transmission as the number of film shoots are limited due to cost and safety reasons.

Sound recordists typically carry 4+ channels of wireless microphones for capturing dialogue on a set. They also have additional wireless transmitters for camera-links and fold-back to the directors and producers on set. A large movie set may have 30+ channels of wireless.

Typical wireless audio channel count:

– Project studio: 10
  (typical spectrum requirement ~ 20 MHz)
– Small studio production: 12 and more
  (typical spectrum requirement ~ 20 MHz)
– Medium studio production: 25 or more

(typical spectrum requirement ~ 45 MHz)

– Large studio production: 48 and more
(typical spectrum requirement ~ 90 MHz).

Annex 2

Spectrum for audio PMSE

National and/or regional information about the available frequency bands or frequency ranges for the use of audio PMSE in the mobile service is provided in this Annex.

1 Region 1

1.1 Spectrum for audio PMSE in CEPT countries

For the CEPT countries in Region 1, ERC REC 25-10 recommends the frequencies listed in Table 3 for audio-PMSE use. ERC REC 70-03 provides technical conditions for audio PMSE frequencies. Further information of recommended frequency ranges for PMSE can be found in the ECO (European Communications Office) Frequency Information System at https://efis.cept.org/views2/pmserec2510.jsp

NOTE – "The bands identified for PMSE use are predominantly shared with other services. The use of the band by these other services can reduce the amount of spectrum available for PMSE at a given location. The extent of the reduction is dependent on local conditions and can be significant." ERC-REC 25-10 [8]

TABLE 7

Frequency ranges for use by audio PMSE applications in CEPT countries

Application	Frequency range (MHz)	Technical information	Background information
Radio microphones and In-ear monitors	29.7-47.0	See ERC/REC 70-03 Annex 10 [5]	Non-professional PMSE use. Legacy systems still in use. No broadcast quality equipment available. Shared use. ETSI EN 300 422 [1]
Radio microphones and In-ear monitors	174-216 (Radio microphones)	See ERC/REC 70-03 Annex 10 [5]	Shared use. EN 300 422 [1]
Radio microphones and In-ear monitors	470-694 (Radio microphones)	See ERC/REC 70-03 Annex 10 [5]	Currently a core band for professional PMSE use. Changes to the band will limit its utility for PMSE. The extent of the impact is dependent on national decisions (see ECC/DEC (15)01 [9]). Shared use. EN 300 422 [1]

TABLE 7 (*end*)

Application	Frequency range (MHz)	Technical information	Background information
Radio microphones and In-ear monitors	823-832	See ERC/REC 70-03 Annex 10 [5] and EC Decision 2014/641/EU [13]	Risk of out of band emissions from adjacent mobile services means there is limited utility for broadcast quality audio Harmonised (within EU member states). EN 300 422 [1]
Radio microphones and In-ear monitors	863-865	See ERC/REC 70-03 Annex 10 [5] and EC Decision 2013/752/EU [10].	Risk of out of band emissions from adjacent mobile services and other short-range devices means there is very limited utility for broadcast quality audio. Shared use (1) EN 300 422 [1] and EN 301 357 [4]
Radio microphones and In-ear monitors	1 350-1 400	See ECC Report 245 [11] and ERC/REC 70-03 Annex 10 [5]	Newly recommended tuning range in 2016. Shared use EN 300 422 [1]
Radio microphones and In-ear monitors	1 518-1 525	ECC Report 253 [12] and ERC/REC 70-03 Annex 10 [5]	Newly recommended tuning range in 2016. Individual license required and restricted to indoor use. Shared use EN 300 422 [1]
Radio microphones and In-ear monitors	1 785-1 805	See ERC/REC 70-03 Annex 10 [5] and EC Decision 2014/641/EU [13]	Harmonised (within EU member states). EN 300 422 [1]
Portable audio links, Mobile audio links and Temporary point-to-point audio links (2), Talkback and Production communications (3)	174-216 (Audio links)	ERC Report 42 [14]	Shared use. EN 300 454 [7]
Portable audio links, Mobile audio links and Temporary point-to-point audio links (2), Talkback and production communications (3)	470-694 (Audio links)	ERC Report 42 [14]	Shared use. EN 300 422 [1] and EN 300 454
Portable audio links, Mobile audio links and Temporary point-to-point audio links (2), Talkback and production communications (3)	694-790 (Audio links)	ERC Report 42 [14]	Changes to the band will limit its utility for PMSE. The extent of the impact is dependent on national decisions. Shared use. EN 300 422 and EN 300 454

(1) The band 863-865 MHz is available for radio microphones; however due note should be taken that it is used also for non-professional and consumer radio applications (cordless audio, etc.).

(2) Depending on application scenario, channel width and required transmitter power, the portable, mobile and temporary point-to-point audio links may be accommodated either in the frequency bands 174-216 MHz/470-694/694-790 MHz identified for professional radio microphones (typically for low power/wideband applications) or in other VHF/UHF bands, including Private Mobile Radio (PMR) bands (typically for high power/narrowband applications).

(3) These applications are service links that operate in the audio PMSE bands.

For the frequency band 470 MHz to 694 MHz one should note that in the countries listed in RR No. **5.296.**

UK – additional information

"UK Interface Requirement 2038 Programme Making and Special Events (PMSE)" contains the requirements for the licensing and use of radio equipment for Programme Making and Special Events in the specified frequency bands available in the United Kingdom and is available on the Ofcom UK website in UK IR2038:

https://www.ofcom.org.uk/siteassets/resources/documents/spectrum/interface-requirements/ir-2038---978-mhz-update.pdf?v=392362

United Arab Emirates

List of frequency bands permitted for wireless microphone operation with mobile allocations in the United Arab Emirates

Table 8 gives guidance on frequency ranges for PMSE wireless audio equipment, their use and applicable usage conditions. The wireless equipment which conforms to short range devices will require class authorization. All other wireless equipment as per the Table will require an individual authorization.

TABLE 8

List of frequency bands permitted for wireless microphone operation with mobile allocations in the United Arab Emirates

Application	Frequency range (MHz)	Usage conditions	Background information
Radio microphones	66.0-74.8	Maximum 10 mW e.r.p.	Wireless microphone authorization Above 73 MHz indoor only
Talkback	138-156	Maximum 1 W e.r.p.	Wireless microphone authorization
Radio microphones	174-230	Maximum 100 mW e.r.p.	Wireless microphone authorization
Talkback	406.1-450	Maximum 1 W e.r.p.	Wireless microphone authorization
Radio microphones, Talkback and IEM	470-614	Maximum 100 mW e.r.p.	Wireless microphone authorization
Radio microphones and IEM	823-826	Maximum 20 mW e.i.r.p.	Class authorization

TABLE 8 (*end*)

Application	Frequency range (MHz)	Usage conditions	Background information
Radio microphones and IEM	826 – 832	Maximum 100 mW e.i.r.p.	Class authorization
Radio microphones and IEM	863-870	Maximum 50 mW e.i.r.p.	Class authorization
Radio microphones and IEM	1 350-1 400	As authorized	Wireless microphone authorization
Radio microphones and IEM	1 785-1 804.8	Maximum 20 mW e.i.r.p. (handheld) and 50 mW e.i.r.p. (body worn)	Class authorization
Radio microphones	1 880-1 900	Maximum 250 mW e.i.r.p.	Class authorization using DECT technology only

2 Region 2

2.1 United States of America

List of frequency bands with mobile allocations in the United States of America permitted for wireless microphone operation

The following frequency bands with mobile allocations are currently permitted for licensed wireless microphone operation (FCC Part 74H) in the United States. License-exempt operation is permitted in the bands that are allocated to mobile service as indicated in the background information.

TABLE 9

List of frequency bands with mobile allocations in the United States of America permitted for wireless microphone operation

Application	Frequency range (MHz)	Technical information	Background information
Wireless microphone	161.625-161.775	FCC Part 74H	licensed wireless microphone operation; (except in Puerto Rico and the Virgin Islands)
Wireless microphone	169-172	FCC Part 74H, FCC Part 90	licensed wireless microphone operation; specific frequencies, licensed under FCC Part 90
Wireless microphone	450-451	FCC Part 74H	licensed wireless microphone operation
Wireless microphone	455-456	FCC Part 74H	licensed wireless microphone operation
Wireless microphone	470-488	FCC Part 74H / Part 15	licensed wireless microphone operation; license-exempt operation

TABLE 9 (*end*)

Application	Frequency range (MHz)	Technical information	Background information
Wireless microphone	488-494	FCC Part 74H / Part 15	licensed wireless microphone operation; license-exempt operation; except Hawaii
Wireless microphone	494-512	FCC Part 74H / Part 15	licensed wireless microphone operation; license-exempt operation
Wireless microphone	614-616	FCC Part 74H / Part 15	licensed wireless microphone operation; license-exempt operation; shared with licensed exempt mics without priority
Wireless microphone	653-657	FCC Part 74H	licensed wireless microphone operation
Wireless microphone	657-663	FCC Part 74H / Part 15	licensed wireless microphone operation; license-exempt operation; shared with licensed exempt mics without priority
Wireless microphone	1 435-1 525	FCC Part 74H	licensed wireless microphone operation; requires prior coordination and approval before use[2]
Wireless microphone	6 875-6 900	FCC Part 74H	licensed wireless microphone operation
Wireless microphone	7 100-7 125	FCC Part 74H	licensed wireless microphone operation

It is noteworthy that licensed and license-exempt wireless microphone operation is also permitted in frequency bands allocated in the USA for broadcasting, including 174-216 MHz and 512-608 MHz. Licensed operation is permitted in portions of the 941.5-960 MHz band (i.e. 941.500-944.000 MHz; 944.000-952.000 MHz; 952.850-956.250 MHz; and 956.450-959.850 MHz, harmonized in large part with some countries in Region 2) that is allocated in the USA for fixed services. These bands have mobile allocations in many countries outside the United States.

2.2 Canada

List of frequency bands for wireless microphone operation with mobile allocations in Canada

Licensed (RSS-123) operation is permitted in the following bands allocated to mobile services as indicated in the background information column.

License-exempt (RSS-210 and RSS-247) operation is permitted in the following bands allocated to mobile services as indicated in the background information column.

[2] License and use is on a secondary basis and advance coordination is required with Aerospace and Flight Test Radio Coordinating Council, Inc. (AFTRCC), see: https://aftrcc.org/coordination/

TABLE 10

List of frequency bands for wireless microphone operation with mobile allocations in Canada

Application	Frequency range (MHz)	Technical information	Background information
Wireless microphone	26.10-26.48	RSS-123	Portions; licensed operation
Wireless microphone	54-72	RSS-210 and RSS 247	license-exempt
Wireless microphone	72-73	RSS-210 and RSS 247	license-exempt
Wireless microphone	74.6-74.8	RSS-210 and RSS 247	license-exempt
Wireless microphone	75.2-76	RSS-210 and RSS 247	license-exempt
Wireless microphone	76-88	RSS-210 and RSS 247	license-exempt
Wireless microphone	150-174	RSS-123	portions; licensed operation
Wireless microphone	174-216	RSS-210 and RSS 247	license-exempt
Wireless microphone	450-451	RSS-123	licensed operation
Wireless microphone	455-456	RSS-123	licensed operation
Wireless microphone	470-608	RSS-210 and RSS 247	license-exempt
Wireless microphone	614-616	RSS-210 and RSS 247	license-exempt
Wireless microphone	653-663	RSS-210 and RSS 247	license-exempt
Wireless microphone	902-928	RSS-210 and RSS 247	license-exempt
Wireless microphone	941.5-952	RSS-123	licensed operation
Wireless microphone	953-959.85	RSS-123	licensed operation
Wireless microphone	2 400-2 483.5	RSS-210 and RSS 247	license-exempt
Wireless microphone	6 930-6 955	RSS-123	licensed operation
Wireless microphone	7 100-7 125	RSS-123	licensed operation

3 Region 3

For the Asia Pacific countries, an APT Report APT/AWG/REP-138, “PMSE frequency usage in the 470-806 MHz band in Asia Pacific Region” [15] was released in September 2024.

The APT Report provides current status of frequency usage for PMSE in the 470-806 MHz band in APT countries and relevant issues/incumbents need to be considered when using PMSE in the 470-806 MHz band in APT countries.

Based on current status and possible implementation of radiocommunication systems in the frequency band 470-806 MHz in Asia Pacific region, especially the IMT systems and DTV broadcastings, APT countries are encouraged to identify possible frequency bands for the use of PMSE, whether dedicated bands or low power shared bands (e.g. class license).

To enable device circulation and long-term operation in Asia Pacific region, PMSE manufacturers may need to use this information to comply with technical specifications in each respective APT country.

TABLE 11

Frequency ranges for use by audio PMSE applications in 470-806 MHz band in some countries in Region 3

Applications	Frequency range (MHz)	Country	Background information
PMSE	470-610	Bhutan (Kingdom of)	
PMSE	610-698		
PMSE	698-806		
PMSE	470-610	Nepal (Federal Democratic Republic of)	
PMSE	610-698		
PMSE	698-806		
PMSE	470-610	Thailand (Kingdom of)	
PMSE	694-703		Wireless microphone
PMSE	748-758		
PMSE	803-806		
PMSE	470-714	Japan	Radio Microphone (licensed) and Digital Radio Microphone (licensed)
PMSE	None	Palau (Republic of)	
PMSE	470-694	Malaysia	Wireless Microphone Device (Class Assignment/Unlicensed)
PMSE	487-694	Indonesia (Republic of)	Wireless microphone, licensed under Class License
PMSE	470-610	Viet Nam (Socialist Republic of)	Wireless microphone (470-694 MHz)
PMSE	610-698		
PMSE	698-806		
PMSE	470-610	Sri Lanka (Democratic Socialist Republic of)	
PMSE	610-698		
PMSE	698-806		
PMSE	470-610	Brunei Darussalam	Wireless microphone
PMSE	610-698		
PMSE	698-806		
PMSE	470-610	Nepal (Federal Democratic Republic of)	
PMSE	610-698		
PMSE	698-806		
PMSE	502-606	New Zealand	Radio microphones, Wireless In-Ear Monitoring (IEM) and Audio links

TABLE 11 (*end*)

Applications	Frequency range (MHz)	Country	Background information
PMSE	622-698		Radio microphones, Wireless In-Ear Monitoring (IEM) and Audio links
PMSE	1 785-1 805		Radio microphones, Wireless In-Ear Monitoring (IEM) & Audio links
PMSE	1 880-1 900		Radio microphones (DECT Technology) and Wireless Intercom
PMSE	470-610	China (People's Republic of)	
PMSE	610-698		
PMSE	698-806		
PMSE	470-698	Korea (Republic of)	This band is for PMSE applications (Radio microphones and Audio links) as the secondary use (Broadcasting Service is the primary use)
PMSE	470-610	Philippines (Republic of the)	Wireless microphone
PMSE	610-698		Wireless microphone
PMSE	698-806		Wireless microphone/Wireless Video Transmitter

NOTE – The information for Korea (Republic of) is included additionally and does not come from APT/AWG Report 138 [15].

Table 12 lists additional frequency ranges for use by audio PMSE application in Region 3.

TABLE 12

Frequency ranges for use by audio PMSE applications in some countries in Region 3 outside of 470-806 MHz

Country	Frequency range (MHz)	Licensing arrangement(s)	Note
Australia	VHF Band III – 174-230	Class license permits up to 3 mW e.i.r.p. (note an increase to 50 mW e.i.r.p. is under consideration) Australian standard AS/NZS 4268(1) on short-range devices specifies 0.1 µW for spurious emission level into an adjacent channel	

TABLE 12 (*cont.*)

Country	Frequency range (MHz)	Licensing arrangement(s)	Note
Australia	1 785-1 800	The maximum e.i.r.p. is 100 mW Transmitters must not be operated on frequencies within 1 MHz of 1 785 MHz and transmitters using frequencies below 1 790 MHz must only be used indoors. These proposed limitations on 4 MHz of the proposed additional permitted operating frequency band are to provide for co-existence with adjacent services. Australian standard AS/NZS 4268(1) on short-range devices specifies 0.1 μW for spurious emission level into an adjacent channel	
Japan (2)	74.58-74.76	Maximum antenna input power: 10 mW (for analogue systems) Unlicensed Coordination not required.	IEM
	322.025-322.150 322.250-322.400	Maximum antenna input power: 1 mW (for analogue systems) Unlicensed Coordination not required.	Wireless microphone IEM
	806.125-809.750	Maximum antenna input power: 10 mW (for analogue/ digital systems) Unlicensed Coordination not required.	Wireless microphone IEM
	1 895.616-1 904.256	Maximum antenna input power: 240 mW (for digital systems) Unlicensed Coordination not required.	IEM

TABLE 12 (*end*)

Country	Frequency range (MHz)	Licensing arrangement(s)	Note
Korea	72.610-73.910, 74.000-74.800, 75.620-75.790	10 mW e.r.p. and BW up to 60 kHz	
	173.020-173.280, 217.250-220.110, 223.000-225.000	10 mW e.r.p. and BW up to 200 kHz	
	925.000-937.500	10 mW e.r.p. and BW up to 200 kHz	

(1) AS/NZS 4268:2012 Radio equipment and systems: Short-range devices – Limits and methods of measurement.

(2) 1 240-1 252 MHz and 1 253-1 260 MHz are assigned for wireless microphones as General Service.