



Recommendation ITU-R M.1076-1
(02/2015)

**Wireless communication systems for
persons with impaired hearing**

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

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BS	Broadcasting service (sound)
BT	Broadcasting service (television)
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P	Radiowave propagation
RA	Radio astronomy
RS	Remote sensing systems
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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R M.1076-1*

Wireless communication systems for persons with impaired hearing

(Question ITU-R 254/5)

(1994-2015)

Scope

This Recommendation provides the technical and operational characteristics for wireless accessibility of hearing aids to public, home and personal audio services operating in the land mobile service.

Keywords

ALD, ALS, assistive listening device, hearing aid, wireless accessibility of hearing aids

Acronyms and abbreviations

ALD	Assistive listening device
ALS	Assistive listening systems
DSP	Digital signal processing
e.r.p.	Effective radiated power
LAN	Local area network

The ITU Radiocommunication Assembly,

considering

- a) that many forms of hearing impairment cannot be satisfactorily improved by audio amplification only;
- b) that a number of means have been used to transfer speech signals to the listener's hearing device. These means include infrared radiation, use of the magnetic induction internal to current loops, including operation at audio frequencies, VHF and UHF radio and the external induction field of a radiating antenna;
- c) that some 10% of people suffer from mild to severe hearing loss;
- d) that users of aids for hearing impaired (hearing aids including assistive listening devices) are found worldwide;
- e) that personal uses include access to mobile phone and personal audio applications;
- f) that home usage includes access to broadcast television, broadcast radio, emergency notification and alarms;
- g) that public usage includes access to points of sales, counters, public address systems in areas such as airports, train stations, religious places, theatres, events and cinemas;
- h) that the practical application of infrared systems and audio frequency induction loops to communicate with persons with impaired hearing should also be considered for some applications,

* The Director, Radiocommunication Bureau, is requested to bring this Recommendation to the attention of the ITU-T Study Group JCA-AHF and the International Electrotechnical Commission (IEC).

recognizing

a) that Resolution 175 (Rev. Busan, 2014) of the Plenipotentiary Conference resolves to take account of persons with disabilities in the work of ITU,

noting

a) that for public use it may be beneficial to have a standardized wireless system, operating on globally harmonized tuning range;

b) that there is a wide divergence in spectrum used around the world for assistive listening devices;

c) that administrations need to carefully consider suitable harmonized frequency ranges *for* the operation of wireless systems for hearing impaired person,

recommends

that the technical and operational characteristics for radiocommunication systems for persons with impaired hearing given in Annexes 1 and 2 should be used.

Annex 1

Operational characteristics of wireless communication systems for persons with impaired hearing

1 System concepts

Historically, hearing aids consisted of little more than basic “miniature audio amplifiers” placed in or behind the ear(s) solely boosting the incoming sounds. As semiconductor technology has evolved and become miniaturised, hearing impaired people enjoy extremely sophisticated digital systems incorporating a range of communication capabilities.

State-of-the-art technology uses specialized digital signal processing (DSP) technology that is advanced enough to fulfil the stringent mechanical (ultra miniature) and power consumption (only one small single cell battery) requirements that are specified for modern hearing aid devices. DSPs manipulate the incoming sound spectrum mathematically, converting it into a digital representation; programmable software then manipulates this digital representation to achieve:

- background noise reduction;
- correction of user specific deficiencies;
- enhancement of sound cues and other listening parameters used by the brain to reconstruct normal hearing.

Hearing aids contribute to user safety, comfort and enjoyable listening experience. However, real life offers an incredible richness in different listening environments in some of which even the most sophisticated hearing instruments show only a limited benefit. Examples of acoustic environments or listening situations where the performance of conventional hearing instruments can substantially be improved by applying additional communication devices are the following:

- reverberant environments such as big churches or lecture halls;
- communication over larger distances, e.g. in a lecture or in a classroom;

- communication on the telephone, especially cell phones.
- situations with large background noise levels (e.g. rooms, halls and areas with multi-talker speech; engine noise inside or outside of trains and busses, etc.).

In these environments the application of assistive listening systems (ALS) based on wireless communication technologies offer substantial additional benefits and significantly improve speech intelligibility. The advent of digital broadcasting is now displacing some of the frequencies where these wireless ALSs have traditionally operated.

In North America and Europe, approximately 1 person in 10 has some form of hearing loss, from mild to severe. Today only 20% of these people are assisted by hearing aid technology. The binaural rate (wearing two hearing aids: one left and one right) is ~75% to 80% in North America, ~60% in Europe and 10% to 12% in the rest of the world. Reasons for such low adoption rates in general vary from negative stigma associated with wearing cosmetically non-appealing devices to high cost and certain types of hearing losses that could not be corrected.

Recent progress made in binaural hearing health revealed that having for example the right hearing aid being able to communicate with the left hearing aid and vice versa helps achieve another level of breakthrough in restoring someone's hearing. This also directly contributes to the safety of that person's listening environment, for example directionality of sounds can be better perceived, in cases such as an approaching ambulance or fire truck which cannot be seen but only heard, is physically located. In some instances where one ear is totally impaired, sounds captured from that side of the head can be relayed to the other ear and processed such as that person experiences full 360° hearing again.

A major role of allowing the hearing impaired to communicate and also enjoy similar experiences to those with normal hearing has been played by the Telecoil system which is in worldwide use. Unfortunately these are difficult or impossible to install in large public places such as airports and train stations and are both expensive to install and maintain. Also building owners are often reluctant to allow them to be installed. In addition they only supply a single low quality voice channel. This lack of flexibility and cost have given rise to an explosion of radio based systems for most teaching, especially sports coaching¹ and domestic use where multiple channels are required².

Hearing aids can be described as body worn therapeutic medical devices used to provide improved medical treatment of a patient. Therefore, they are subject to the very same constraints as all other body worn medical devices:

- They perform therapeutic tasks aimed at treating, curing, hence bettering patient's lives.
- They are installed/worn in and around the body.
- They are subject to severe power consumption constraints, due to their discreet mechanical size, that commands a very small source of energy (single cell battery).
- A harmonized, worldwide deployable tuning range would facilitate the use of these devices for international travellers in public areas.
- These devices rely on the radio spectrum to be optimized in terms of energy spent for range and link robustness achieved, hence a low noise floor and minimal interference band, where body tissue absorption and spectrum usage density are taken into account.

¹ Football and horse riding are some of the many sports now using this equipment for coaching.

² Many schools require in excess of 25 channels.

- If these devices are exposed to an environment of high emissions the user could experience pain and possible damage³ to the ear drum and/or other physical incapacity.

2 Induction-Loop system (often referred to as Telecoil)

Inductive systems rely on coupling an audio amplifier, e.g. for the microphone of a speaker in a lecture hall or a teacher in a classroom, directly to an induction loop system which basically directly transmits the rather low frequency audio signal as a radiated time varying magnetic field. Induction loop systems use a large coil antenna integrated in the floor of a large room for radiating the magnetic field. Once properly installed, and given that the listener's hearing aids include "T" coils, an IL system is undoubtedly the most convenient and possibly the most cost effective ALS. To hear the audio, all a person has to do is enter the looped area and switch his/her personal hearing aids to the telecoil position. As long as the person's hearing aids include "T" coils, he or she always has an assistive device "receiver" available.

However this technology also has some technical drawbacks which limit the range of application of this technology. The physics of inductive coupling requires the receiving coil (T-Coil) to be perpendicularly oriented to the field of the sending coil or induction loop. This is sometimes difficult to achieve because the orientation of the induction loop is fixed and the orientation of the T-Coil depends on how it is built into the hearing instrument and the person's orientation. Furthermore, the inductive transmission strongly depends on the distance between sender and receiver which sometime results in a weak signal. The receiver also always has to remain within the loop in order to receive a signal. External interferences (from power lines or fluorescent lights, computer monitors copiers, fax machines, cell phones, etc.) creating background noises or distortions in the hearing instrument, are difficult to remove. Next, in school environments, several different systems are required for different classrooms. When applying two different systems in neighbouring classrooms it often is difficult to avoid spill over from one induction loop system to the next although recently technological progress has been made for reducing this problem. Furthermore, induction loop systems are not portable and can only be applied where they have been pre-installed.

3 VHF and UHF systems

Current systems employing VHF and UHF FM (sub 2 000 MHz) radio transmission are capable of providing communication over distances greater than those using the radio induction-field system, as they employ transmission via a radiation field which decays less rapidly with distance than does an induction field. As a consequence, VHF and UHF radio transmission systems require that each transmission in any locale, such as a school classroom and its environs, be assigned a separate frequency channel.

VHF and UHF reception is generally less susceptible to interference from natural and man-made noise than is reception at lower frequencies and systems employing VHF and UHF radio transmission will be useful in many circumstances to avoid local problems of interference which affect the operation of the radio induction-field system.

Radiocommunication systems intended only for short-range communication are capable of producing high field strengths at their required working distances, without radiating significant levels of power. Exploitation of the resulting possibilities of shared spectrum usage can result in improved spectrum utilization, and may allow large numbers of channels to be made available, for example to satisfy the

³ <http://www.access-board.gov/research/interference.htm>
<http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/ucm116327.htm>

requirements of large schools for any children with impaired hearing which is increasingly a requirement of national legislation and an objective for children above five weeks old in many countries.

Equipment takes a number of physical forms from add on receivers for behind the ear systems to belt mounted units and necklace units. Currently narrow band FM systems predominate for teaching systems with Bluetooth connectivity for mobile phones and some domestic equipment using radio local area network (LAN) technology for connection to multimedia terminals.

Scarcity of spectrum has meant that the narrowband fixed frequency channel equipment using a 100% duty cycle is not suitable for sharing with other services or short range devices (SRD); therefore development of more spectrum efficient techniques such as frequency hopping and control from a remote database are currently under development. One such system is shown below.

Overview of the system

Wireless audio systems considered here transmit speech or audio from a microphone, over a digital radio link, to a receiver. An assistive listening system for use by the hearing impaired in public spaces such as airports, railway stations, churches and theatres, where the transmitter is connected to the audio programme or public address system and the receiver is worn by deaf users, or integrated into users' hearing aids.

The use of digital technology, e.g. with 4GFSK modulation and low bit-rate audio coding, provides a balance between the need for good audio quality (a requirement to maintain intelligibility and minimise user fatigue), spectrum efficiency and range. These systems can work well between 150 MHz and about 2 GHz.

Depending on available spectrum and coexistence requirements, systems to operate in approximately 200 kHz, 400 kHz and 600 kHz occupied bandwidth are outlined. The transmitter and receiver duty cycle is inversely proportional to the bandwidth, which means that the amount of spectrum resource used is roughly independent of the bandwidth, but the receiver power consumption is proportional to the duty cycle.

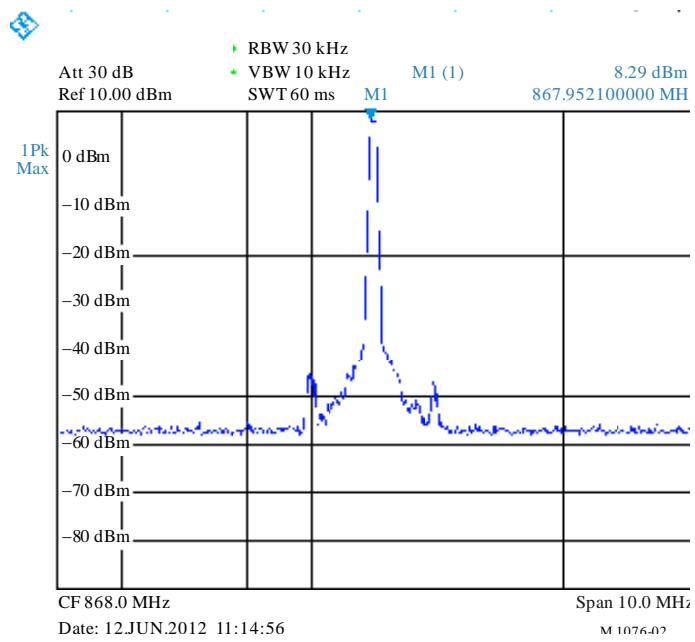
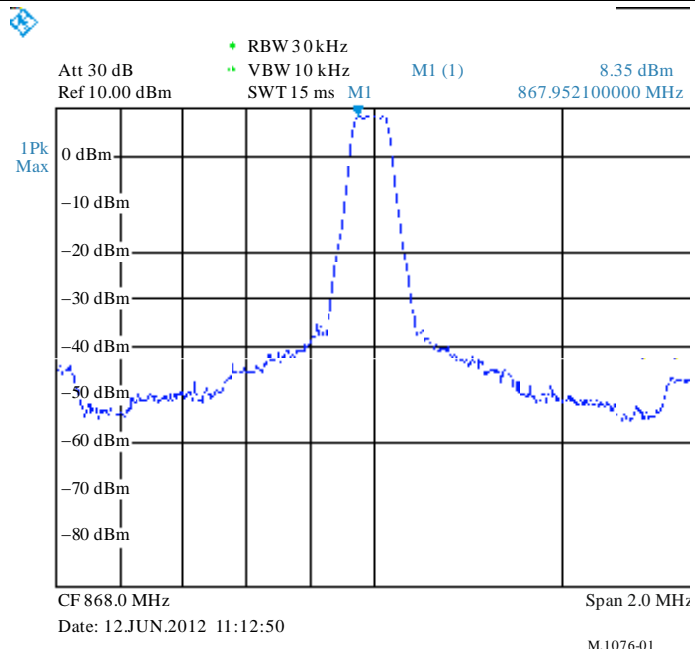
This means that a 600 kHz system would allow receivers to consume approximately 1/3 the power of a 200 kHz system, which is highly beneficial in power-limited applications such as hearing aids. Wider bandwidth also decreases end-to-end delay, which is of benefit to many audio applications where the audio must maintain lip-sync with the talker in order to maximise intelligibility.

Below are given technical parameters for wireless communication systems for access of hearing impaired people to public services. The most appropriate channel bandwidth/parameters set should be chosen in accordance with coexistence requirements for the radio frequency band in which such a system would be realized.

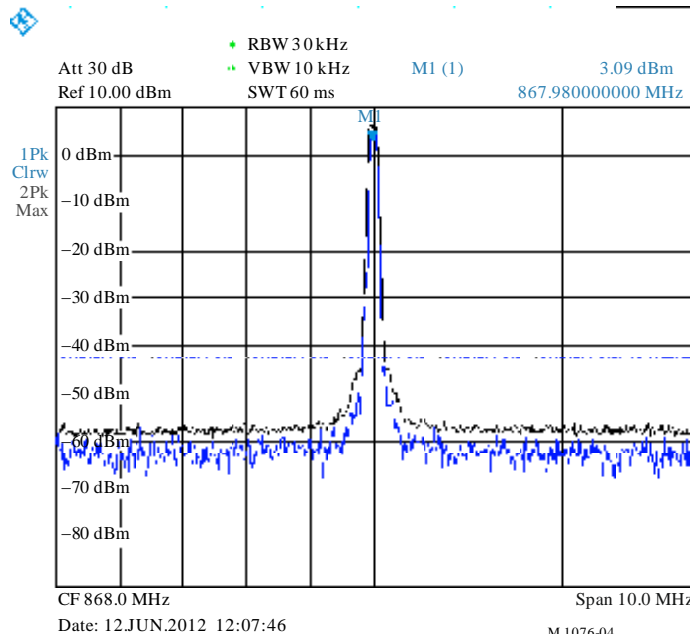
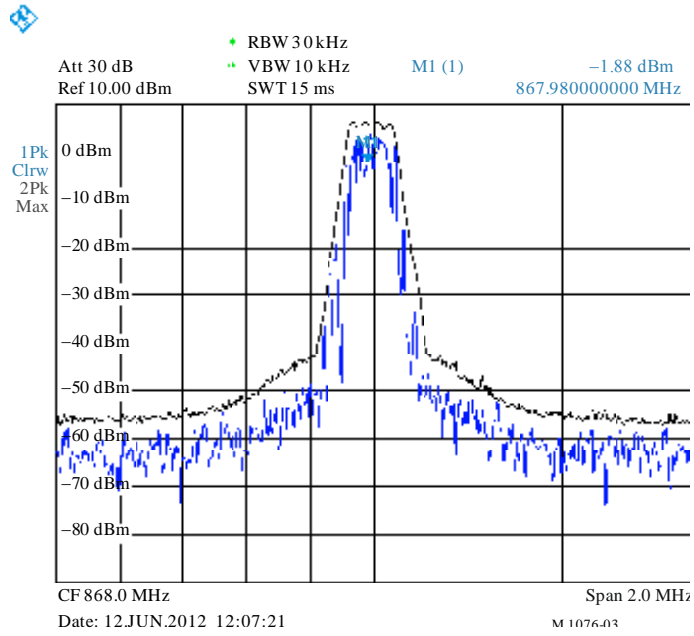
200 kHz system

Channel bandwidth	200 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter effective radiated power (e.r.p.)	10 mW
Transmitter field strength @ 30m	88 dB μ V/m
Transmitter out of band emission @ 30m	70 dB μ V/m, 100 kHz from carrier, narrowband 40 dB μ V/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @ 120 kbit/s, ±40 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	30-50% for one audio channel
Receiver sensitivity, direct inject	-80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

Example transmitter mask (max hold)
(note measurement noise floor at -55 dBm)
Nominal 200 kHz bandwidth



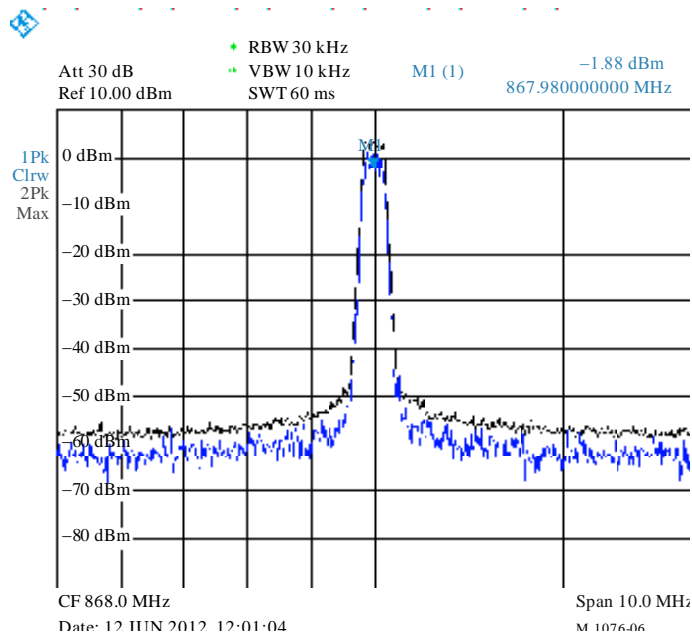
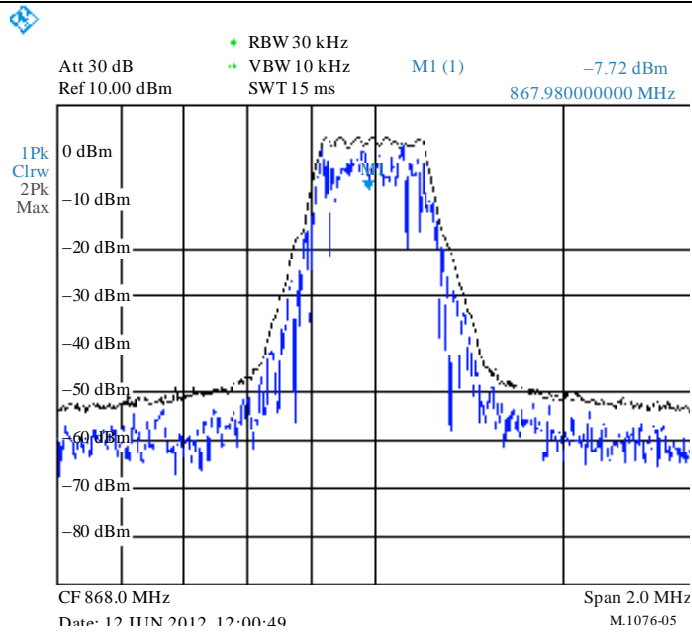
Example transmitter mask (average and max hold)
(note measurement noise floor at -55 dBm)
Nominal 200 kHz bandwidth



400 kHz system

Channel bandwidth	400 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter e.r.p.	10 mW
Transmitter field strength @30m	88 dB μ V/m
Transmitter out of band emission @30m	70 dB μ V/m, 200 kHz from carrier, narrowband 40 dB μ V/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @250 kbit/s, ±80 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	15-25% for one audio channel
Receiver sensitivity, direct inject	-80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

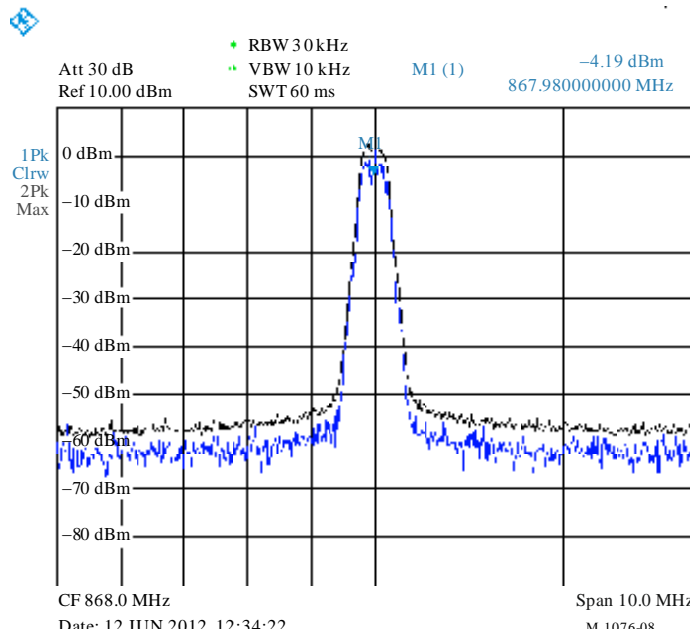
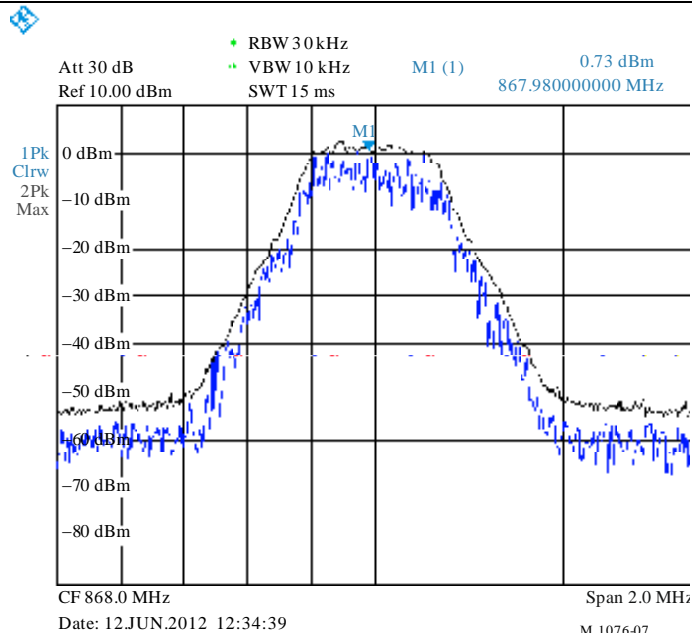
Example transmitter mask (average and max hold)
(note measurement noise floor at -55 dBm)
Nominal 400 kHz bandwidth



600 kHz system

Channel bandwidth	600 kHz
Frequency tolerance	±0.005% (transmitter) ±0.005% (receiver)
Transmitter e.r.p.	10 mW
Transmitter field strength @30m	88 dB μ V/m
Transmitter out of band emission @30m	70 dB μ V/m, 300 kHz from carrier, narrowband 40 dB μ V/m, 1 MHz from carrier, wideband
Transmitter modulation (indicative)	4GFSK @500 kbit/s, ±120 kHz maximum deviation (outer symbols), BT = 0.5
Transmitter duty cycle (indicative)	10-20% for one audio channel
Receiver sensitivity, direct inject	-80 dBm or better
Receiver selectivity	30 dB minimum, adjacent channel 40 dB minimum, alternate channel, image channel and above
Receiver blocking rejection	50 dB minimum, ±2 MHz separation

Example transmitter mask (average and max hold)
(note measurement noise floor at -55 dBm)
Nominal 600 kHz bandwidth



Annex 2

Technical characteristics of wireless communication systems for persons with impaired hearing

1 LF and MF radio systems

1.1 30~190 kHz (China)

Magnetic field strength limits @10 m:

for 30~50 kHz:	72 dB μ A/m (quasi-peak value)
for 50~190 kHz:	72 dB μ A/m (–3 dB/octave) (quasi-peak value).

1.2 315 kHz~1 MHz (China)

Magnetic field strength limits @10 m: \leq mn dBmn/m (quasi-peak value)

1.3 1.7~2.1 MHz, 2.2~3.0 MHz (China)

Magnetic field strength limits @10 m:	\leq 9 dB μ A/m (quasi-peak value)
Frequency tolerance:	0.0001
Chanel bandwidth (6 dB):	\leq 200 kHz

1.4 1~3 MHz except the frequencies listed in § 1.3 (China)

Magnetic field strength limits @10 m: \leq –15 dB μ A/m (quasi-peak value)

2 HF radio systems

2.1 3-11 MHz (not implemented in all regions)

Channel bandwidth	300-400 kHz
Frequency tolerance	$< \pm 1\%$
Transmitter field strength @10 m	< -20 dB μ A/m
Transmitter modulation (indicative)	FSK @300 kbit/s
Transmitter duty cycle (indicative)	30-50% for one audio channel

2.2 3.1~4.1 MHz, 4.2~5.6 MHz, 5.7~6.2 MHz, 7.3~8.3 MHz, 8.4~9.9 MHz (China)

Magnetic field strength limits @10 m:	\leq 9 dB μ A/m (quasi-peak value)
Frequency tolerance:	0.0001
Chanel bandwidth (6 dB):	\leq 200 kHz.

2.3 6.765~6.795 MHz, 13.553~13.567 MHz, 26.957~27.283 MHz (China)

Magnetic field strength limits @10 m:	\leq 42 dB μ A/m (quasi-peak value)
Frequency tolerance:	0.0001
Spurious emissions (transmitter):	

For equipment operated in frequency band 13.553-13.567 MHz, the magnetic field strength limit for offset within 140 kHz at both ends of this frequency band is 9 dB μ A/m(@10 m, quasi-peak value).

2.4 3~30 MHz except the frequencies listed in §§ 2.2 and 2.3 (China)

Magnetic field strength limits @10 m: ≤ -15 dB μ A/m (quasi-peak value).

3 VHF and UHF radio systems

In some parts of the world, systems have successfully shared various frequency bands in the range 169-220 MHz for many years, with the type of radio services to which these frequency bands are allocated by the Radio Regulations. With the introduction of assistive listening device (ALD) systems for public spaces which can be controlled from a database better sharing with broadcast services could be expected.

3.1 40.66-40.70 MHz (China)

FM fixed channel system with 100% duty cycle

Transmitter e.r.p.:	10 mW
Frequency tolerance:	± 0.0001
Spurious emissions (transmitter):	
	27 dB μ A/m@10 m (9-150 kHz, measurement bandwidth: 200 Hz)
	27 dB μ A/m@10 m (150 kHz-10 MHz, measurement bandwidth: 9 kHz)
	-3.5 dB μ A/m@10 m (10-30 MHz, measurement bandwidth: 9 kHz)
	250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)
	4 nW (48.5~72.5, 76-108, 167-223, 470-566, 606-798 MHz, measurement bandwidth: 100 kHz).

3.2 72-76 MHz (not implemented in all regions)

Antenna length and man-made noise are an issue.

Channel bandwidth:	50 kHz for a narrow-band device 200 kHz for a wideband device
Frequency tolerance:	0.005% (transmitter)
Frequency stability:	0.005% (receiver)
Field strength produced at 30 m:	Not to exceed 8 000 μ V/m
Transmitter e.r.p.:	1 170 μ W (calculated from above)
Modulation requirements for FM:	20 kHz maximum (narrow-band) 75 kHz maximum (wideband)
Out-of-band emissions:	± 25 kHz or more from carrier, no more than 150 μ V/m at 30 m for narrow-band ± 150 kHz or more from carrier, no more than 150 μ V/m at 30 m for wideband
Receiver selectivity:	40 dB minimum, adjacent channel
Receiver image rejection:	40 dB minimum.

3.3 75.4-76 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 200 KHz
Transmitter e.r.p.:	10 mW
Frequency tolerance:	0.0001
Spurious emissions (transmitter):	
27 dB μ A/m@10 m (9-150 kHz, measurement bandwidth: 200 Hz)	
27 dB μ A/m@10 m (150 kHz-10 MHz, measurement bandwidth: 9 kHz)	
-3.5 dB μ A/m@10 m (10-30 MHz, measurement bandwidth: 9 kHz)	
250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)	
4 nW (48.5~72.5, 76-108, 167-223, 470-566, 606-798 MHz, measurement bandwidth: 100 kHz).	

3.4 84-87 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 200 KHz
Transmitter e.r.p.:	10 mW
Frequency tolerance:	0.0001
Spurious emissions (transmitter):	
27 dB μ A/m@10 m (9-150 kHz, measurement bandwidth: 200 Hz)	
27 dB μ A/m@10 m (150 kHz-10 MHz, measurement bandwidth: 9 kHz)	
-3.5 dB μ A/m@10 m (10-30 MHz, measurement bandwidth: 9 kHz)	
250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)	
4 nW (48.5~72.5, 76-108, 167-223, 470-566, 606-798 MHz, measurement bandwidth: 100 kHz).	

3.5 87-108 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 200 KHz
Transmitter e.r.p.:	3 mW
Frequency tolerance:	0.0001
Spurious emissions (transmitter):	
27 dB μ A/m@10 m (9-150 kHz, measurement bandwidth: 200 Hz)	
27 dB μ A/m@10 m (150 kHz-10 MHz, measurement bandwidth: 9 kHz)	
-3.5 dB μ A/m@10 m (10-30 MHz, measurement bandwidth: 9 kHz)	
250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)	
1 000 nW (1 000 MHz-10 th harmonics, measurement bandwidth: 1 MHz)	
4 nW (48.5~72.5, 167-223, 470-566, 606-798 MHz, measurement bandwidth: 100 kHz).	

3.6 169 MHz band (Europe and Japan)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 50 kHz
Transmitter e.r.p.:	10 mW or <500 mW public systems (Europe only), individual licence required
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz).

3.7 173-175 MHz (in some European countries)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 50 kHz
Frequency tolerance:	± 5 kHz
Transmitter e.r.p.:	2-10 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)
Spurious emissions (receiver):	2 nW (100 kHz-1 000 MHz) 20 nW (1 000-4 000 MHz).

3.8 173.3-174.0 MHz (Korea)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 200 kHz
Frequency tolerance:	$\pm 0.002\%$
Transmitter e.r.p.:	< 10 mW
Spurious emissions (transmitter):	250 nW (-36 dBm) (below 1 000 MHz with reference bandwidth of 100 kHz) 1 μ W (-30 dBm) (above 1 000 MHz with reference bandwidth of 1 MHz)
Spurious emissions (receiver):	4 nW (-54 dBm) (above 9 kHz).

3.9 174-216 MHz (in some European countries)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth:	< 50 kHz
Frequency tolerance:	± 5 kHz
Transmitter e.r.p.:	10-50 mW
Spurious emissions (transmitter):	4 nW (41-68, 87.5-118, 162-230, 470-872 MHz) (250 nW elsewhere below 1 000 MHz) 20 nW (above 1 000 MHz)

Spurious emissions (receiver): 2 nW (100 kHz-1 000 MHz)
20 nW (1 000-4 000 MHz).

3.10 216-217 MHz (USA)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth: < 50 kHz
 Frequency tolerance: ± 5 kHz
 Transmitter e.r.p.: 100 mW
 Spurious emissions (transmitter): 4 nW (41-68, 87.5-118, 162-230, 470-872 MHz)
 (250 nW elsewhere below 1 000 MHz)
 20 nW (above 1 000 MHz)
 Spurious emissions (receiver): 2 nW (100 kHz-1 000 MHz)
 20 nW (1 000-4 000 MHz).

3.11 216-217 MHz (Korea)

Analogue FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 kHz
 Frequency tolerance: $\pm 0.002\%$
 Transmitter e.r.p.: < 10 mW
 Spurious emissions (transmitter): 250 nW (-36 dBm) (below 1 000 MHz with
 reference bandwidth of 100 kHz)
 1 μ W (-30 dBm) (above 1 000 MHz with reference
 bandwidth of 1 MHz)
 Spurious emissions (receiver): 4 nW (-54 dBm) (above 9 kHz).

3.12 189.9~223.0 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 kHz
 Transmitter e.r.p.: 10 mW
 Frequency tolerance: 0.0001
 Spurious emissions (transmitter):
 4 nW (48.5~72.5, 76-108, 470-566, 606-798 MHz, measurement bandwidth: 100 kHz)
 250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)
 1 000 nW (1 000 MHz-10th harmonics, measurement bandwidth: 1 MHz)

3.13 470~510 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 KHz
 Transmitter e.r.p.: 50 mW
 Frequency tolerance: 0.0001
 Spurious emissions (transmitter):

4 nW (48.5~72.5, 76-108, 167~223, 510~566, 606-798 MHz, measurement bandwidth: 100 kHz)

250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)

1 000 nW (1 000 MHz-10th harmonics, measurement bandwidth: 1 MHz)

3.14 630~787 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 KHz

Transmitter e.r.p.: 50 mW

Frequency tolerance: 0.0001

Spurious emissions (transmitter):

4 nW (48.5~72.5, 76-108, 167~223, 470~566 MHz, measurement bandwidth: 100 kHz)

250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)

1 000 nW (1 000 MHz-12.5 GHz, measurement bandwidth: 1 MHz)

3.15 863-865 MHz (Europe)

Specification ETSI EN 301 357

FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 KHz

Transmitter radiated power: 10 mW

Spurious emissions (transmitter): 4 nW (41-68, 87.5-118, 162-230, 470-872 MHz)
(250 nW elsewhere below 1 000 MHz)
20 nW (above 1 000 MHz)

Spurious emissions (receiver): 2 nW (100 kHz-1 000 MHz)
20 nW (1 000-4 000 MHz)

3.16 2 400~2 483.5 MHz (China)

FM fixed channel system with 100% duty cycle

Channel bandwidth: < 200 KHz

Transmitter e.r.p.: 10 mW

Frequency tolerance: 75 kHz

Spurious emissions (transmitter):

4 nW (48.5~72.5, 76-108, 167~223, 470~566, 606-798 MHz, measurement bandwidth: 100 kHz)

250 nW (30-1 000 MHz, measurement bandwidth: 100 kHz)

1 000 nW (1 000 MHz-12.5 GHz, measurement bandwidth: 1 MHz)
