Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

FUTURE POSSIBILITIES FOR THE DIGITALISATION OF BAND II (87.5 - 108 MHz)

St. Petersburg, May 2010

0 EXECUTIVE SUMMARY

The frequency band 87.5 to 108 MHz, referred to as Band II, is allocated to terrestrial broadcasting services according to the ITU Radio Regulations for ITU Region 1. It is regarded as essential spectrum for FM broadcasting audio programs and is used by administrations and broadcasters throughout Europe in different ways for national, regional or local FM coverage corresponding to the different demands of commercial (private) and public broadcasters. Given the increasing demands on Band II spectrum for broadcasting there is a need to consider measures that could allow Band II services to meet future requirements. This may best be achieved by taking advantage of emerging digital sound broadcasting systems.

There are a number of candidate digital broadcasting systems that might be deployed as a mid or long-term replacement for FM in Band II. This document explores the features that digital technologies, such as DRM+ and HD-Radio, might offer and considers if a transition to digital sound broadcasting would be beneficial in Band II. The Report also includes an overview of current and foreseen usage of Band II in twenty five CEPT countries.

Overall it is concluded that:

- For some of the candidate systems the necessary technical planning parameters are not fully available thus making it difficult to perform a systematic comparative technical analysis at this point in time.
- A supplementary Report (to this Report) will be required to provide the technical elements and parameters needed for the introduction of digital systems in Band II.
- There are issues with spectral bandwidth of some candidate systems relative to the planning provisions of GE84 which will make their use problematic in Band II which is heavily occupied by existing services, and which could necessitate re-planning if these systems were to be widely deployed.
- Administrations do not wish to have another major planning conference to replace the GE84 Agreement for new digital services.
- Administrations do not wish to lose their existing rights under the GE84 Plan. Consequently, there is a need for any incoming system to comply with the provisions of GE84 Agreement.
- There may be program and technical licensing issues on a national basis. For example, an FM program licence may have been granted following an open competitive tender process for an individual single service, and any subsequent changes which would enable a multiplex capability to such an existing licensee could be problematic.
- No universal switch off date for analogue services in Band II can be planned.

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ABBREVIATIONS

AVC	Advanced Video Coding
CEPT	European Conference of Postal and Telecommunications Administrations
COFDM	Code Orthogonal Frequency Division Multiplexing
DAB	Digital Audio Broadcast
DRM	Digital Radio Mondiale
EBU	European Broadcasting Union
EICTA	The Electronics and ICT Association
EPG	Electronic Program(me) Guide
GE84	GE84 Agreement, Geneva 1984 VHF-FM radio
HE-AAC	High Efficiency Advanced Audio Coding
ILS	Instrument Landing System
ISDB	Integrated Services Digital Broadcasting
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
ITU-R	International Telecommunication Union Radiocommunication
MPEG	Motion Picture Expert Group
RAVIS	Realtime Audiovisual Information System
RDS	Radio Data System
SDR	Software Defined Radio
SFN	Single Frequency Network
SMM	Simplified Multiplication Method
TPEG	Transport Protocol Experts Group
UHF	Ultra High Frequency
VHF	Very High Frequency
VOR	VHF Omnidirectional Range

Future Possibilities for the Digitalisation of Band II (87.5 - 108 MHz)

1 BACKGROUND

There are a number of candidate digital broadcasting systems that might be deployed as a long-term replacement for FM in Band II. This document explores the features that these candidate systems might offer.

The frequency band 87.5 to 108 MHz, referred to as Band II, is allocated to terrestrial broadcasting services according to the ITU Radio Regulations for ITU Region 1. To date this band is predominately used for FM services. Given the increasing demands on Band II spectrum for broadcasting there is a need to consider measures that could allow Band II services to meet future demands. Issues relating to the use of Band II include:

- The available spectrum (20.5 MHz) constitutes a limited resource that is used intensively in Europe. In many countries the introduction of new FM services is difficult and may lead to an unacceptable degradation of existing services. Consequently, it is no longer considered possible for some public or private broadcasters to find frequencies to introduce additional new large scale FM services.
- From a technical or systems perspective there are concerns that Band II as a resource may not be used to its full potential. While new digital broadcasting systems are being developed and introduced, cheap and easy to use digital receivers are still not widely available. FM radio is turning into one of the few analogue islands in an almost all-digital radio communication environment. As interoperability between different platforms is increasingly becoming important both for the consumers and broadcasters an isolated analogue service might be considered to be unproductive towards new technology and developments for those broadcasters utilising a wide range of delivery modes. For the smaller scale broadcaster with a single transmitter or a small one-programme network this may not be an issue.
- Commercial reasons may both necessitate or hinder the consideration of a digital replacement of FM broadcasting. FM today, and for the foreseeable future, is the only relevant revenue source for commercial radio broadcasters and the major source of listening amongst all radio services.

Given the issues above it is worth considering if a transition to digital technologies or a hybrid analogue-digital use could be beneficial in Band II. Therefore, administrations and broadcasters should take into account the latest developments and consider the potential for introducing digital services together with the associated regulatory issues that will need to be addressed.

2 THE CURRENT SITUATION IN BAND II

Band II is regarded by most as important spectrum for FM broadcasting audio programs. It is used for national, regional and local broadcasting networks in virtually all European countries. Band II is used by administrations and broadcasters in different ways, in each country for national, regional or local FM coverage corresponding to different demands of commercial (private) / public broadcasters. In practice, this means there are different ways to allocate frequencies to broadcasters. In some countries, for example, segmentation or 'banding' of the spectrum is applied by allocating defined pieces of spectrum to different broadcasters to facilitate planning and ensure the listener is given the easiest way to find those program genres they desire.

Band II is currently the de facto analogue radio broadcasting band, due to its excellent combination of coverage, quality and low cost nature both in terms of current networks available and receivers in the market. It is well suited to local, regional and national programming and has been successfully used for over forty years now. FM receivers are part of our daily lives and millions of them populate our households. FM radios are cheap to manufacture and for the car industry FM still represents the most important medium for audio entertainment. FM also allows for some limited data services using the RDS functionality, making it easier to tune and delivering some traffic services.

The FM spectrum is in many areas overcrowded and may be reaching saturation if the high quality of reception and existing coverages must be retained. This results in FM services increasingly being interference limited by design or otherwise and these higher interference levels may have to be accepted to allow the introduction of many more additional services. Frequency planning in Band II is generally based on the GE84 Agreement, with the planning parameters specified in the Recommendation ITU-R BS.412-9. However, some administrations have already embraced modified planning parameters on a national basis but must still comply with the technical parameters of GE84 for cross border coordination. Alternatively to the GE84 parameters, some administrations have agreed diverging parameters for cross border coordination on a bilateral basis.

Current usage of Band II spectrum by FM transmissions quite often produces interference into other FM services by exceeding the planning standards recommended Recommendation by ITU-R-BS.412-9. Due to modern audio processing levels, compression of the baseband FM signals and non conformity of the allowed peak deviation, the ETSI-FM-spectrum mask (in effect since 2006, EN 302 018) used in Europe is often not respected, and this mask is already a relaxation compared to earlier reference texts. This leads not only to an additional violation of protection ratios but may also lead to additional interference to aeronautical services (VOR and ILS). This is a national enforcement issue, and has been studied recently by WGFM PT22 where proposals have been made for a standard field measurement compliance mask.

An overview of the current and foreseen usage of Band II in CEPT countries is given in Annex 2. Based on this it can be concluded that:

- Band II is heavily used in all European countries,
- for the current situation the FM services are still considered as satisfactory from the point of sound quality but the lack of frequencies hinders further development,
- there are no wide-spread plans or strategies for the introduction of digital broadcasting in Band II and
- no defined final switch-off dates are given so far. Some administrations are renewing currently their FM licences without prohibiting – or even explicitly allowing – a potential usage of the licence for digital broadcasting in Band II in the future.

3 DIGITAL TERRESTRIAL BROADCASTING SYSTEMS FOR BAND II

FM radio is primarily used to deliver linear audio channels; it is not used to deliver any of the additional services or enhancements associated with digital radio, with the exception of very low bit-rate services such as RDS services. Newer digital techniques described below could enhance this.

It is assumed that any digital system that would replace FM radio in the long run must be able to provide comparable coverage, ruggedness and audio quality as that of FM. Such a comparison should be based on the current broadcasting coverage and receiver performance. The issues of audio quality should be considered separately from spectrum usage and interference management.

There may be program and technical licensing issues on a national basis. For example, an FM program licence may have been granted following an open competitive tender process for an individual single service, and any subsequent changes which would enable a multiplex capability to such an existing licensee could be problematic.

Currently there are five digital terrestrial broadcasting systems that could be considered as potential candidates for introduction in Band II in Europe:

1. DRM+,
2. FMeXtra
3. HD Radio
4. RAVIS and
5. T-DAB.

Annex 1 gives an overview on their characteristics. From this Annex it can be seen that there are issues with spectral bandwidth of some candidate systems relative to the planning provisions of GE84 which will make their use problematic in Band II , and which could necessitate re-planning if these systems were to be widely deployed.

There are other systems currently being further developed in other parts of the world, for instance the ISDB-TSB system, which is cross referenced as “Digital System F” in Recommendation ITU-R BS.1114.

4 FUTURE USAGE OF THE BAND II SPECTRUM

The FM band’s ability to provide high-quality stereo audio, the extremely high levels of receiver penetration and the relative scarcity of spectrum in the band combine to make this frequency band extremely valuable for broadcasters. There are various approaches and techniques that could be employed to ensure that maximum benefit is derived from the spectrum in Band II, some of which are outlined below. These concepts are not

necessarily mutually exclusive. Employing digital broadcasting techniques is one possibility for a more efficient use of Band II.

Well established and accepted broadcast systems are available for the coverage of large areas and a high number of programs in the same area. However, the future use of Band II should also concentrate on small networks and local and regional broadcasters.

The growth of FM frequency assignments over the past forty years or more, along with changes in consumer habits and in the prevailing technical characteristics of the receiver universe, has led to some potential for technical and network improvements. However, almost all receivers present in most households all through Europe are FM-enabled.

A number of countries have considered some re-planning of Band II in the light of modern receiver performance but there are constraints for the broadcasters which include:

- The costs of a network rebuild could be disproportionate to the benefit delivered;
- Issues faced in migrating listeners to the new local frequency arrangements;
- Migrating the audience to modern receivers;
- The international coordination required to gain clearance for new transmitter frequencies could be very lengthy and in some cases not even possible;
- Neighbouring countries may also have to do some frequency rearrangement leading potentially to bi- and multilateral issues.

Under the GE84 Agreement other systems having different characteristics may be used, provided that such use does neither cause greater interference nor demand higher protection than the reference system indicated in the Plan[1]. This is basically similar to the "envelope concept" which has, for example, been adopted as part of the GE06 Agreement. This means that any alternative system should be operated in such a way that across any border it does not exceed the interference criteria and protection ratios in Recommendation ITU-R BS.412-9 as inherent in the GE84 Agreement, unless any local bilateral agreements allow a relaxation.

Given the above it seems unnecessary to consider another major planning conference to revise or replace the GE84 Agreement in order to provide for digital services

However, since Band II is heavily used by the FM services it is important that the introduction of a digital system in Band II has a minimal impact on the current services. In order to ensure the coexistence between FM and digital broadcasting systems in Band II compatibility criteria such as protection ratios need to be defined and adequate migration policies would have to be established.

4.1 Adoption of Modified FM Planning Parameters

The adoption of modified planning parameters could provide spectrum for additional FM services or the introduction of digital services. In a crowded RF environment this inevitably means relaxation in the protection criteria but there are other considerations which can be taken into account.

These include:

- terrain screening due to local geography;
- improved IF filtering in more modern receivers and
- better planning tools.

Further, it is known that FM works well for mobile reception. Any revised planning parameters should take account of this; the original planning parameters refer only to fixed reception with roof antennas. It must, however, be noted that before modified FM planning parameters are adopted, careful analysis of the impact of such modifications on existing FM networks and coverage is essential.

The main possibility for technical consideration could be the simplified multiplication method (SMM[2]) as compared to simple power summation, plus the insistence that all interference signals from all directions north, south, east and west, are taken into account continuously in assessing incoming interference. The interference

[1] Geneva 84, Annex 2, Chapter 3, Section 3.1. Transmission Systems
[2] Geneva 84, Annex 2, Chapter 4. Determination of the usable field strength by the Simplified Multiplication Method

really needs classifying into two categories namely continuous, and longer distance tropospheric or sporadic E. The two main categories can then be assessed separately before assessing the overall likely percentage time effects. The continuous signals may in some cases dominate most of the longer distance interference and a more pragmatic analysis can be undertaken.

Continuous interference by definition is always there and always included in the summation. The other longer distance interference forms are rarely if ever experienced simultaneously from different directions, and probably never from all directions and ranges. Sea paths can result in a wide arc of interference but normally longer distance interference arrives at a particular time from a region or multiple separate regions along smaller individual ranges of bearings and varies with the weather, time of day and season to season.

There is very little information available on the time correlation of these longer distance interference propagation effects between areas to allow suitable changes to be made to moderate the summation to only consider sensibly grouped sets of transmitters simultaneously interfering. A change would be required to start working on the basis of numbers of transmitters in say a 50 km radius of a geographic point, and the calculations may be somewhat different overall but the end result should be a better percentage time estimate.

Stations are protected to a percentage of time and there could be some opportunities to balance the interference potential under statistical SMM summation, or even replace SMM with simple power sum if the statistics are already included in the propagation prediction. This correlation of interference by area is perhaps an area of study which could be undertaken by the propagation experts and could be of some significant value. The effects could be very dependent on geographic location, for example cold sea / warm sea and hot humid climates/desserts/colder northern Europe. To get to 1% time values will require many years of data monitoring.

On a more local basis administrations may have detailed knowledge of propagation conditions to and from their neighbours taking into account all the geographic terrain features allowing them to undertake more relaxed bilateral arrangements for cross border coordination.

If, in addition to modified planning parameters, a partial or full reallocation (for example as done in the Netherlands) of the assigned frequencies is used, the potential for more room for additional FM services will be higher. However, a practical and economical realisation of the frequency reallocation may be difficult or not feasible in many situations, in particular with the high power parts of a network.

4.2 Segmentation of Band II

Segmentation or ‘banding’ of Band II for new services could be achieved from the migration of existing network(s) out of or into smaller contiguous parts of Band II. This may be achievable by re-planning parts of Band II more efficiently using modified planning parameters. This has already been done by some administrations, but if any centralised plan was introduced pre-defining ranges for various purposes it may cause national difficulties because a group of service types could be lost in the process. Consequently, this should only be done on a non-mandatory, voluntary basis by an administration in cooperation with neighbours.

Perhaps, in some situations, it might be possible to create some free spectrum by condensing the existing analogue FM. Condensing in that respect refers to re-organising the spectrum usage in geographical and spectral separation terms. However, this is likely to be expensive and to result in significantly increased levels of FM to FM interference.

4.3 Migration to other Frequency Bands to free the Spectrum in Band II

Some broadcasters offer a variety of different programs to a common coverage area. For these broadcasters there may be advantages in adopting digital systems that utilise a multiplex approach provided that there are no issues with the terms under which current licences were granted. Therefore, it may seem natural to propose in those countries where broadcasters are interested, where licences allow a transition and where spectrum is available, a migration of these services from FM to T-DAB in Band III and/or L-Band in SFN mode. Released Band II frequencies could then be used for new FM services and/or the introduction of digital terrestrial broadcasting systems.

For broadcasters providing a single program a narrow-band digital broadcasting system could be more attractive. Other candidate bands for these systems may be 26 MHz band and Band I in particular for local broadcasting services, although it should be noted that Band I frequently suffers from anomalous interference issues via sporadic E and at parts of the sunspot cycle can have truly global coverage problems. Band I has also been reallocated by many administrations to other services following a local withdrawal of broadcasting many years ago.

4.4 Digital Switch-Over

Within the national laws on sound broadcasting services that control the standardization of the signal and the application to frequencies and services, one approach for the introduction of digital services into Band II could be the replacement of analogue transmissions with digital transmissions. In many parts of Europe this could mean an instantaneous switch to digital.

Currently for most commercially funded broadcasters in Europe such a switch to digital is not feasible because the listener base would be lost until the digital platform gains widespread receiver penetration. Moreover, an extensive period of simulcasting is inevitable to maintain a commercial presence during the transition with its inherent extra costs. The effect on the car industry and the car radios needs to be taken into account too.

Generally, in analogue broadcast planning, it is not possible to co-site adjacent channel transmissions, therefore at every Band II broadcast site the adjacent channel is not used. Digital broadcast systems with suitable characteristics could be introduced on these adjacent frequencies which could provide for a period of simulcasting. This procedure was used for the initial introduction of digital terrestrial television in the UK.

If the simulcast signal is in another band, for example via T-DAB in Band III, then it becomes easier to switch off or convert the Band II transmitters once the audience has migrated or is able to receive in both bands.

As FM in Band II is currently, and for the foreseeable future, the broadcasting system supporting the only viable business model for radio (free-to-air) in most European countries, no universal switch-off date for analogue services in Band II can be considered

4.5 Conversion from Analogue Assignments to Digital Assignments

A conversion procedure, similar to the way digital television had been introduced in UHF before the GE06 Plan was established (i.e. on the basis of Chester 97 Multilateral Coordination Agreement), could be devised to enable introduction of digital broadcasting systems in Band II. A set of operating characteristics would have to be defined to allow digital transmission within the interference constraints of an existing analogue assignment.

In addition, appropriate sharing and compatibility conditions between the digital systems and FM have to be established to facilitate coordination and introduction of new digital services in the predominantly analogue environment.

For this approach to be fully effective there is a need for the incoming digital service characteristics to be able to provide at least a similar coverage area while maintaining an outgoing interference potential which is no more than the original analogue service being replaced.

This spectrum envelope requirement is paramount in this approach. One must not get distracted by secondary considerations of how many programs are being carried which has nothing to do with spectrum efficiency even though it may be an important commercial consideration determining the viability or otherwise of the service.

An advantage of this approach would be a smooth transition from analogue to digital, without disruption of the existing FM services. Furthermore, those broadcasters that have no intention to introduce digital services for the time being would not be adversely affected by others wishing to introduce digital systems either nationally or internationally.

A potential disadvantage is that the spectrum usage would not necessarily be optimised for any of the digital systems.

The current difficulty with this approach is that a large amount of information needed for the technical planning assessment of the candidate digital systems is missing. Until this information becomes available in a technically neutral format and verified in a transparent manner it will not be possible to make an impartial evaluation of the options. Some candidate systems are still closer to a development environment than being ready for commercial deployment which means that it is probably too early to make any decisions.

5 REGULATORY ISSUES

There is a family of ETSI Standards, a number of ITU Recommendations and some CEPT documents that regulate FM broadcasting in Band II and these are listed in Annex 3.

ETSI and ITU have adopted several relevant technical and regulatory documents covering the issues of the signal spectrum of an FM Band II transmitter. Unfortunately none of these documents has accurately set an unambiguous standard transmission mask for a correctly operated transmitter. The basis for the technical

compliance compatibility is clearly defined in Recommendation ITU-R BS.412-9 in sets of tables. No actual transmission mask is provided although the data is available in the complementary form of protection ratios which must be met versus frequency offset.

ETSI ETR132 Edition 1 provides the clearest statement of FM Band II transmitter spectral purity requirements considering all the parts of the transmission site as a total system. This report also provides the technical requirements for compatibility with adjacent band mobile and aeronautical systems, together with considerable practical detail on how to set up and correctly configure a broadcast installation together with audio compression and limiting. It also describes how a signal can generate transients of overmodulation if care is not taken during operation.

The first ETSI technical specification covering the FM spectrum mask issues is ETS 300-384 which details the necessary transmission mask together with cross referencing to the earlier ETR132 for more detailed investigations which may be required to ensure compatibility on certain sites into other services.

Finally, the more recent ETSI EN 302-018 includes a relaxed mask compared with ETS 300-384 which is potentially an overload fault condition mask when modulated with pink noise. This mask is the maximum envelope with all the safety limiters fully engaged with potential noise peaks of over-modulation in the input. This is because the input white noise specified in the test procedure has an unknown peak to mean signal level input and may not be dynamically clamped before modulation, and instead may rely on post event levelling in the transmitter. This probably should not be used as the spectrum planning technical compliance reference for correct operation with normal programme input.

Earlier work within CEPT WGFM resulted in ERC/REC 54-01 on the measurement of the modulation deviation of FM transmitters in Band II. The recent measurement campaign carried out WGFM PT22 and a number of CEPT Administrations has revealed that a large number of FM transmitters do not comply with existing standards and there is a need for improved national enforcement. This is especially true as there are safety of life issues if interference gets into aeronautical systems

The spectrum below 87.5 MHz is allocated amongst others to fixed and mobile service while the spectrum range above 108 MHz up to 117.975 MHz is allocated to aeronautical radionavigation and aeronautical mobile services on a primary basis under ITU-R Radio Regulations, Article 5, Footnote 5.197A. The GE84 Agreement contains provisions that cover the adjacent band issues, and these may need to be reviewed with respect to new digital broadcasting services.

The technical consideration with Band II FM transmissions must be carried forward to ensure no intermodulation products causing interference to the safety-of-life services in the aeronautical band from 108 MHz upwards.

Based on the performance of receivers recently introduced in the market several theoretical investigations, laboratory testing and field trials (involving DRM+ and HD-Radio) raised the question of adapting some of the existing ITU-R Recommendations to be in line with a contemporary, real world environment in Band II. The documents that could be reviewed with reference to modern receivers are Recommendations ITU-R BS.704, ITU-R BS.641, ITU- R BS.412-9, ITU-R BS.1114 and ITU-R SM.1140.

6 MARKET RELATED ISSUES

European radio broadcasts programmes free of charge to millions of European citizens., The revenues they earn by means of advertising are an important part of the public sector. These revenues are currently subject to the global economic and business competition issues throughout Europe.

Organising the switchover from FM in Band II to any improved digital broadcasting system will require a significant time. Transition to any improved digital broadcasting system could benefit from an industry wide agreement to move at a faster rate to minimise the long term costs of dual delivery in both old and new formats.

It is essential that free to air digital radio has widely available cheap receivers in order to survive and thrive. It is vital that all countries work together, on behalf of their citizens, to provide them with a viable system for delivering public service and commercial radio stations.

There is little or no incentive for current major FM broadcasters to make the change to digital radio simulcast – if they believe that as a result this will free up Band II spectrum for new competitive entrants. In most countries, it is still unclear who will bear the costs of the digitisation process.

Digital switch over without planning will result in the loss of the whole investment value of the FM broadcast chain and also the loss of audiences until a comparable receiver base has been built. This means that any possible

switch off or switch over should be agreed with broadcasters and is not viable until enough receivers are on the territory. Also the car industry needs to include digital receivers as a standard fit and replacement option on a large product base. Some FM networks, which represent the backbone of today's free to air services, may be amortised only over a long term. This means that the plans for a switch off date are fundamental for the establishment of new business plans and will allow for better strategy planning.

Digital systems being launched at this early stage may compete with each other and existing analogue broadcasts. The risk of creating uncertainty about a migration to digital may result in the loss of any momentum towards one or the other system resulting in long term damage to the radio broadcasting industry as a whole.

6.1 Availability of Receivers

Currently the market penetration of FM receivers is high and most households have several receivers, although there are large differences in their quality and price. Most receivers are inexpensive and appropriate for the intended use. Receivers usually have a high degree of usability and functionality and are of reasonable ergonomic design. Their sensitivity is generally adequate though often not meeting minimum requirements as defined in Recommendation ITU-R BS.704 nor do they necessarily adhere to the planning parameters outlined in the GE84 Agreement. There are both significantly better as well as dramatically worse receivers available[3]. The receivers in use are of all ages from old to new, and an allowance has to be made for a potentially large number of older receivers still in use.

Many FM receivers can offer additional facilities like RDS (information and seamless retuning). Furthermore, they are often combined with other technology ensuring even wider availability of FM. Car manufactures still view FM as their de-facto standard. The current receiver design provides a graceful move from stereo to mono if reception conditions are challenging. The price of receivers is not necessarily an indicator of performance (RF and Audio).

With regard to power consumption, current analogue receivers typically perform better that the digital ones, particularly in a battery powered mode. Some T-DAB receivers use considerably more power than FM analogue receivers and are essentially mains powered, while portable T-DAB receivers are only capable of short term operation on batteries. This situation is already improving with new silicon chips that consume less energy and with improved battery technology. It is also expected that, as the digital receiver markets mature, economies of scale will drive down the prices as long as a large enough scale can be achieved.

Digital receiver sensitivity and dynamic range needs to be improved as well as antenna performance for both portable (indoor) and mobile reception. Both these reception modes represent the predominant use and therefore the receivers need to be optimised in that respect.

6.2 Strengthening the Digital Radio Market

Successful introduction of digital broadcasting in Band II faces several severe issues. In the absence of good quality receivers that are affordable and widely available, there are no incentives for broadcasters to broadcast in digital format, which in turn discourages the investments by receiver manufacturers. Further issues are caused by increasing numbers of available digital standards which may lead to a long term segmentation of the digital radio market.

The first step to resolve the chicken-and-egg situation has been taken by WorldDMB, EICTA (now DIGITALEUROPE) and EBU in a joint effort to define receiver profiles for digital broadcasting receivers[4]. Manufactures agreed to provide receivers according to the specifications given in the three different receiver profiles, while EBU issued a recommendation for its members to implement transmitter networks complying with the features of the digital receiver profiles.

Future sound broadcasting will not be based on only one technology, i.e. future receivers may have to combine existing and new technologies. This is linked to a new user experience (e.g. surround sound, improved program information). It will be very important that receiver power requirements are not an issue for portable or any other use. Software defined radio (SDR) sometimes referred to as 'black box receiver' may be a way forward potentially unleashing a whole new desirability and adaptability. Seen from a user's point of view, this concept should be considered so the consumer does not need a new receiver for every new broadcast technology. This should allow flexibility both for designer/manufacturer/broadcaster and user.

[3] ReceiverSee receiver studies carried out by OFCOM Switzerland (2004) and Nozema NL(1998)
[4] http://www.worlddab.org/public_documents/WorldDMB_Digital_Radio_Receiver_Profiles.pdf

New digital technologies for Band II will be compared with performance standards of FM radio. In that respect it is crucial that sudden ("brickwall") failure of digital receivers must be alleviated or reduced drastically together with the normally experienced audio disturbance. More specifically, it must be noted that many customers in remote areas utilise low quality FM radio reception and also low quality AM radio reception, where the signal is still usable even at a degraded level. These customers may have no service at all with digital delivery, in particular where increasing transmitter powers would not be possible either economically or under national and international interference constraints.

Emerging new digital radio systems should provide significantly enhanced user experience to ensure market success. This must be a new experience and not only a replacement of analogue services.

New digital radio receivers should be included in a personal communicator (e.g. mobile phone) device that also contains existing well established technologies, as they are unlikely to be successful if sold in isolation.

Customers are interested in tuning to a particular station or program. Therefore, it is necessary to provide multi-standard receivers which allow doing so in an intuitive and straightforward manner without the need to select a particular distribution technology.]

In any case, providing appropriate digital broadcasting receivers requires all stakeholders, in particular broadcasters and manufactures, to very closely collaborate. Manufactures need to have a clear indication of what features listed in the receiver profiles are indeed demanded by broadcasters. Vice-versa, broadcasters should know what kind of services they could develop and provide within the foreseen functionality of available receivers.]

7 CONCLUSIONS

There are several candidate digital broadcasting systems that might be deployed as a long-term replacement for FM in Band II. This document explores the features that these candidate systems might offer.

- For some of the candidate systems the necessary technical planning parameters are not publicly available or independently verified thus making it impossible to perform a systematic comparative technical analysis at this point in time.
- A supplementary Report (to this Report) will be required to provide the technical elements and parameters needed for the introduction of digital systems in Band II.
- There are issues with spectral bandwidth of some candidate systems relative to the planning provisions of GE84 Agreement which will make their use problematic in Band II which is heavily occupied by existing services, and which could necessitate re-planning if these systems were to be widely deployed.
- Administrations do not wish to have another major planning conference to replace the GE84 Agreement for new digital services.
- Administrations also do not wish to lose their existing rights under the GE84 Plan. Consequently, there is a need for any incoming system to comply with the provisions of GE84 Agreement.
- There may be program and technical licensing issues on a national basis. For example, an FM program licence may have been granted following an open competitive tender process for an individual single service, and any subsequent changes which would enable a multiplex capability to such an existing licensee could be problematic.
- No universal switch-off date for analogue services in Band II can be planned

ANNEX 1: CANDIDATE DIGITAL TERRESTRIAL BROADCASTING SYSTEMS FOR BAND II

Five digital terrestrial broadcasting systems are currently proposed for use in Band II: DRM+[5], HD-Radio[6], FMeXtra[7] RAVIS and T-DAB.

A1.1 Digital Radio Mondiale Mode E – DRM+

A1.1.1 System Summary

DRM, Digital Radio Mondiale, is a digital radio standard, approved by the DRM consortium in 1998. The consortium developed this digital transmission system for AM-band, i.e. for long-, medium- and short waves (up to 30 MHz, DRM 30 Mode A-D) and launched this system worldwide. The extension of the DRM system family to upper frequency bands up to 174 MHz, called DRM+ (DRM Mode E) is standardized under ETSI ES 201980 V3.1.1 (2009-02-16). DRM+ is a spectrum efficient system with a bit rate capacity up to 186 kbps at only 96 kHz bandwidth. The COFDM modulation techniques combined with the appropriate use of a guard interval enables single frequency network (SFN) operation, and robust mobile reception up to 300 km/h also in multipath environments.

For use in Band II DRM+, as part of the DRM optimised configurations across all bands, offers the following:

- Compatibility with the existing European raster based on 200 kHz channels for FM. At 100 kHz the DRM + sits comfortably in the allocation and can be placed where there is space within this spectrum allocation
- Efficiency. DRM+ is extremely efficient because within each 200 kHz channel it can carry up to 8 stereo programmes
- Flexibility. Using DRM+ we can trade quality against bandwidth and transmission power for coverage.
- Flexibility Plus. DRM+ allows for new possibilities and supports features like surround sound and advanced data applications
- Interoperability. DRM+ like the whole DRM system is interoperable with the World DMB family, linking to each other across services and sharing these with the DAB platform in a seamless fashion for the listener
- SFN. DRM+ enables SFN for larger area coverage

The data services, multiplexing and signalling schemes are the same as in the earlier established part of the DRM standard. A wide range of possible data rates from 37 to 186 kbit/s allows for a flexible use of the multiplex with respect to the number and type of programs (audio, data, video) adjusted to the broadcasters' requirements and preferences. Up to four radio services with excellent sound quality (MPEG4 HE-AAC v2.0) including 5.1 surround sound can be transmitted within a single the DRM+ signal. In addition to the audio services several kinds of service information like MOT, TPEG, EPG, Journaline, text messages etc. can be transmitted. Many of the multimedia services are also standardised in DAB/DAB+ and DRM. DRM+ can be perfectly combined with the existing FM/DRM/DAB/DAB+ transmission networks and ensures switching (also seamless) between different programs at the receiver side.

The DRM System is an open standard. Due to its small bandwidth it fits very well into the European FM raster.

A1.1.2 Laboratory and field measurements

The evaluation tests of DRM+ system show the following results in addition to the main DRM+ properties:

- DRM+ fulfills the transmitter mask defined for ITU Region 1 and it fully complies with the European 100 kHz frequency raster.
- DRM+ can be used to migrate existing analogue VHF FM stations as well as to introduce new digital stations in the VHF FM broadcasting scenario.

[5] For additional information on DRM+ see: www.drm.org
[6] For additional information on HD-Radio see: www.hd-radio.ch/en/index.html and www.ibiquity.com/index.php
[7] For additional information on FMeXtra see www.dreinc.com

- The radio services of the public authorities and organizations with security tasks, which use the frequency range just below the VHF FM band, is not interfered by DRM+. Also, the aeronautical radio navigation devices, operating in the frequency band right above the VHF FM band, are not affected.
- DRM+ SFNs can be introduced in the actual FM band in a compatible way and exhibit high coverage reliability even at lower TX powers than FM. Furthermore, frequencies can be freed, which then become available for other broadcasters.

All these benefits of DRM+ facilitate the soft analogue to digital switch-over.

A1.1.2 Combined Transmission of DRM+ and FM Signals

A close placement of DRM+ signal to an FM signal is possible and can be flexibly configured depending on the existing use of spectrum. In this way, DRM+ may be introduced into the FM frequency bands.

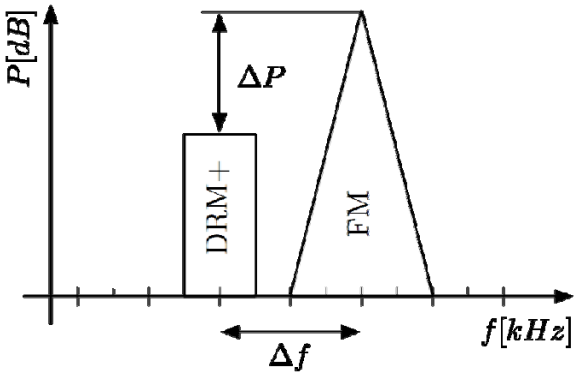

Figure A1-1: Example configuration for DRM robustness mode E and FM signal

Figure A1-1 shows that the DRM+ signal can be placed closely above or below the existing FM signal. To guarantee the respective protection levels and audio quality of the FM signal, the carrier frequency distance Δf and the power level difference ΔP of the FM and the DRM+ signals can be planned accordingly. Δf can be chosen according to a 50 kHz channel raster. Δf >= 150 kHz is recommended. ΔP can be varied flexibly; however, a ΔP > 20dB is recommended for the minimum Δf = 150kHz.

Two transmission configurations are possible: the analogue (FM) and digital (DRM+) signals can be combined and transmitted via the same antenna; or the two signals can be transmitted from different antennas.

Different configurations for the DRM+ signal are possible. The DRM+ signal can have the same program as the FM service, a different program or the same program as well as additional programs. If the same program is available via DRM+ and FM, alternative frequency switching (AFS) flag should be sent in the service description channel (SDC) of the transmission multiplex allowing for a support of heterogeneous networks. Figure A1-2 shows some example configurations.

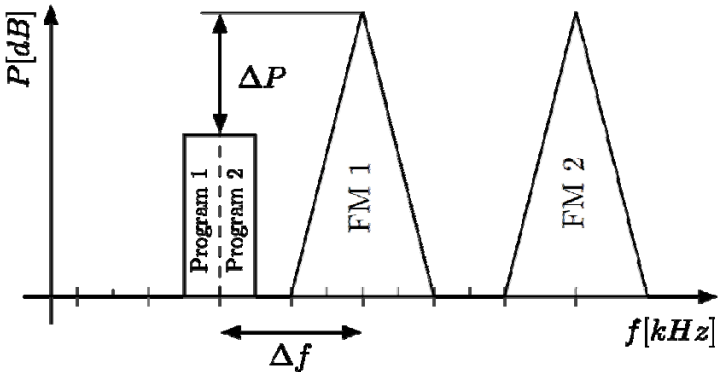

Figure A1-2: Example configuration with 2 FM Stations and DRM robustness mode E

A1.2 FM HD Radio™

A1.2.1 System Summary

iBiquity Digital's HD Radio™ technology offers a digital upgrade path to broadcasters in VHF FM (88 – 108 MHz) Band II. By employing the composition of signals offered by HD Radio, broadcasters are able to transmit multiple configurations of digital signals along with the analogue FM signals . Figures A1-3 and A1-4 represent, one configuration of VHF HD Radio waveforms for hybrid operation (where digital and analogue signals are broadcast together) one configuration of and the full-digital system, once the analogue has been turned off, respectively. Other configurations allow broadcasting only one digital band (Upper or Lower) along with the analogue FM signal, and broadcasting the digital bands each at a different power.

The advantages of this approach include: 1) the ability to support new digital receivers while retaining backward compatibility with existing analogue receivers,

2) affordable conversions that utilize much of a radio station's existing equipment and infrastructure,

3) retention of brand equity and dial position,

4) a conversion path that is gradual for radio stations and seamless to listeners, and

5) a potential migration to all-digital services when conditions are favourable (e.g. when digital receiver penetration is sufficient).

In FM Hybrid Mode HD Radio signals may occupy from one band of 70 kHz and up to two bands of 100 kHz each, in addition to the existing analogue signal (see Figure A1-3).

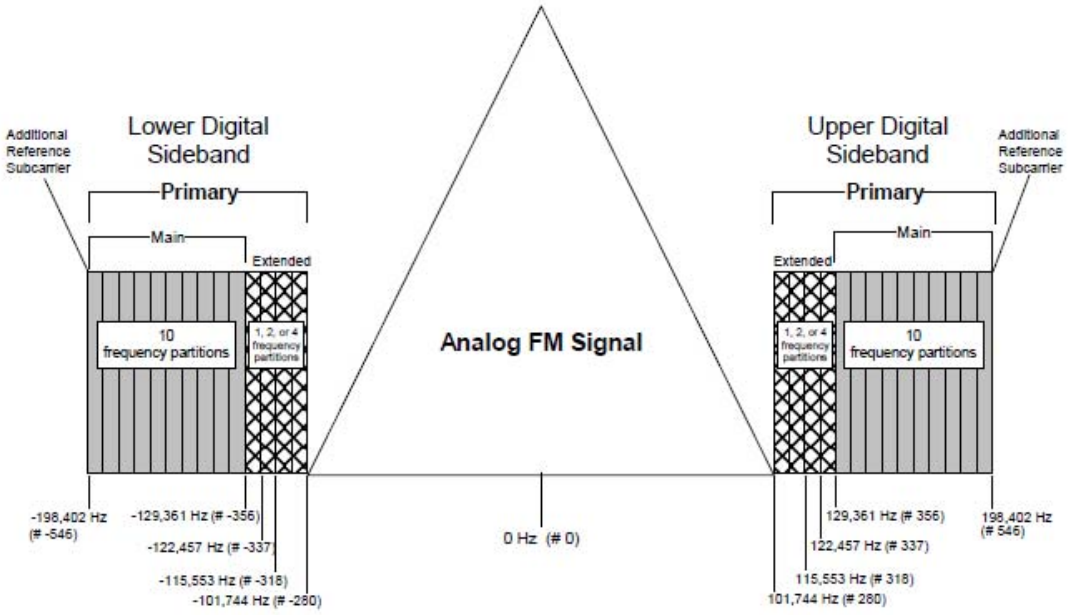

Figure A1-3: The graph indicates the extended-hybrid mode (MP11) configuration. A different hybrid configuration can be used in the same example, using MP1 mode by eliminating the Extended Hybrid carriers. (see Figure A1-5)

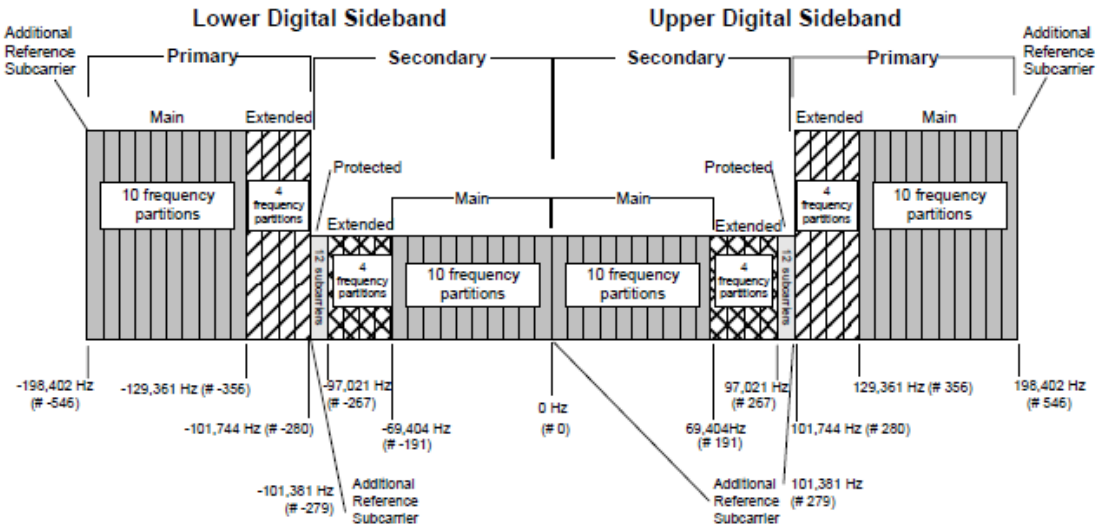

Figure A1-4: The graph represents one configuration of the all-digital operation. See Figure A.1-5 for throughput options

The technology presently supports eight HD Radio audio channels, utilizing the HD Radio operating mode MP3[8] (see Figure A1-5), in addition to multiple data services. The system architecture supports more than eight digital audio channels (in the all-digital mode) in addition to multiple data services. The technology supports Single Frequency Network (SFN) operation.

A1.2.2 Receivers

Currently (April 2010), there are approximately two and a half million receivers in use, with over one hundred different models certified by approximately sixty manufacturers to receive the signals of approximately 2000 HD-Radio stations, globally. There are various types of receivers including table top units, automobile aftermarket, automobile original-equipment-manufacturers (OEM), component units for high-end use, and portable. .

A1.2.3 Regulatory Aspects

HD Radio system employs a composition of signals. It may include the existing analogue signal and it may include digital bands, at specific allocations, as allowed by GE84. Each signal complies with the spectral emission mask defined by ITU.

ITU has designated the FM HD Radio system as Digital System C, a recommended system for digital sound broadcasting in the VHF bands (Recommendation ITU-R BS.1114). iBiquity, along with EHDRA (European HD Radio Alliance) is also currently working with both ECC and ETSI. To support this, numerous successful field trials have taken place in Europe with published results including Germany and Switzerland[9]. As part of this work, iBiquity is contemplating some additional operating modes specifically intended for use in Europe and were filed as part of an ETSI System Reference Document (SRDoc).

[8] Not be confused with MPEG 1 audio layer 3 commonly known as MP3.
[9] See www.ehdra.eu for more information.

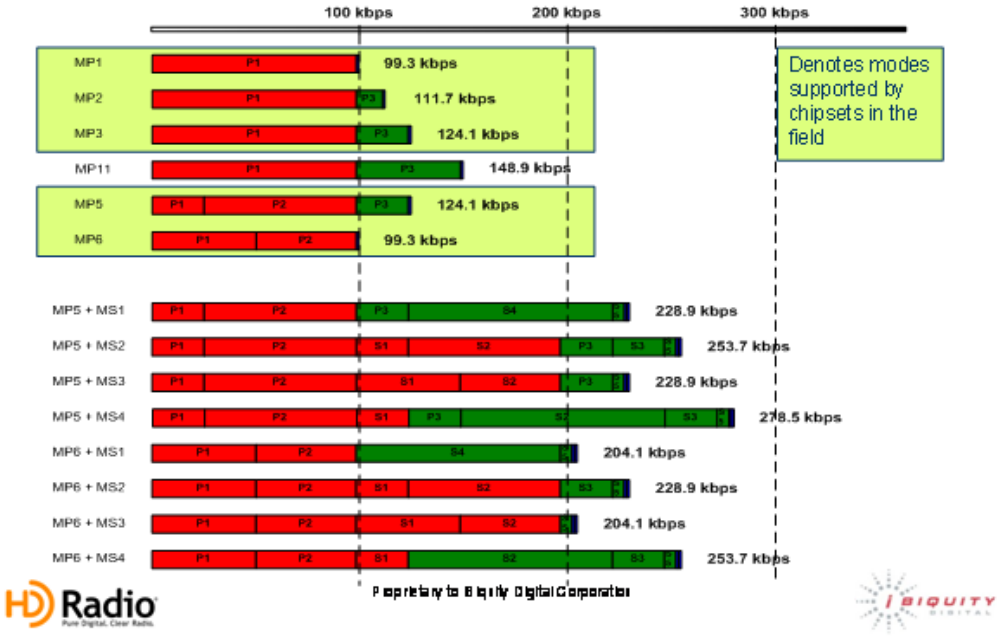

Figure A1-5: The graph indicates the various operating modes and their bit-rate throughputs. These modes are user selectable, and may be changed at any time desired

Note: some future modes are shown, but not commercially supported at this time.

A1.3 FMeXtra

FMeXtra differs significantly from systems above in that a digital signal is incorporated into the FM multiplex signal. A base band signal is generated which contains the FM stereo signal, RDS and a digital multi-carrier part. This multiplex signal is then modulated onto the RF carrier in the standard FM manner with a maximum data rate of 50 kbits/sec. The advantage of this type of digital signal is that it fits very well into the European FM raster. No SFN operation is possible with the FMeXtra system.

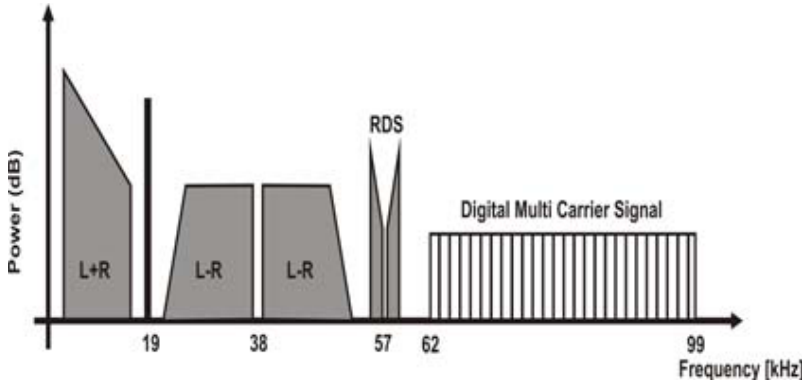

Figure A1-6: FMeXtra

A1.4 T-DAB

Information on T-DAB can be found in the ETSI Specification EN 302 077 together with the associated documentation in the original Wiesbaden '95 Planning Conference[10] which is now also available in the technical annexes of the GE06 Agreement.

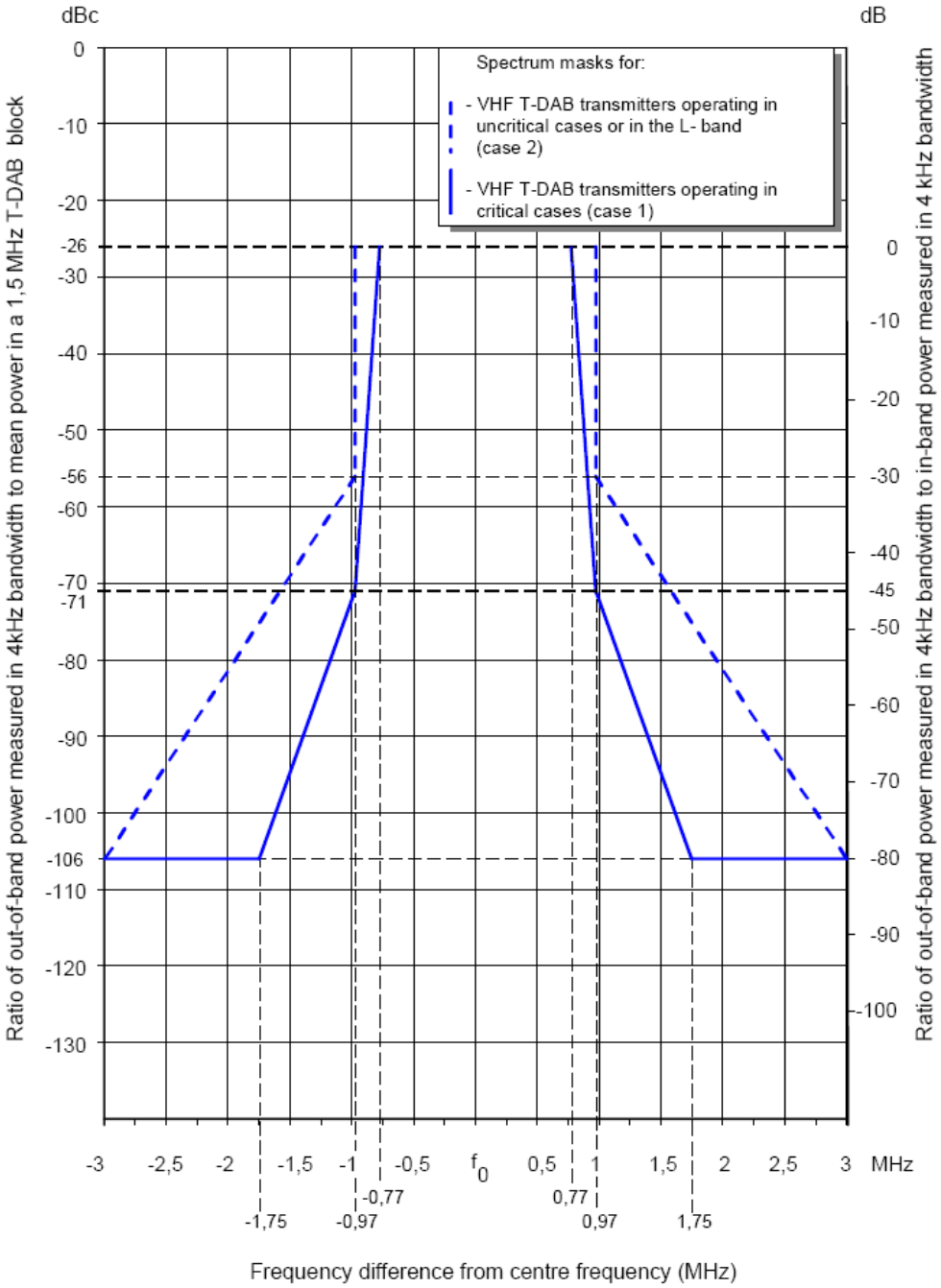

Figure A1-7: Spectrum masks for T-DAB out-of-band emissions (case 1 and case 2)

Case 1 - VHF T-DAB transmitters operating in areas critical for adjacent channel T-DAB to T-DAB interference, and in any case when it is necessary to protect other services operating on adjacent frequencies on a primary basis

Case 2 - VHF T-DAB transmitters in other cases and to 1.5 GHz T-DAB transmitters

[10] http://www.ero.dk/tdab

A1.5 RAVIS

Digital mobile narrowband multimedia terrestrial broadcasting system RAVIS (Realtime AudioVisual Information System, former AVIS) have been developed for the purpose of efficiency enhancement of utilization of spectrum bands used now for audio FM broadcasting, i.e. VHF Bands I and II.

RAVIS allows to deliver digital data with bit rates from 150 to 900 kbps through one 200 or 250 kHz bandwidth radiofrequency channel. Thus, it is possible to transmit over one channel more than 10 stereophonic audio programs, or video program with several audio channels. In this case audio program quality will be not worse than quality of analogue audio FM broadcasting.

RAVIS provides for steady mobile reception (up to 250 km/h) in urban environment, in the districts with difficult topography, in mountainous and dense forested areas, in water areas, that is under conditions characterized by multipath propagation, without direct visibility of transmitting antenna and so forth.

The advanced technologies are used for video and audio information encoding such as MPEG-4 AVC (ISO/IEC 14496-10) and MPEG-4 HE-AAC (ISO/IEC 14496-3) standards. Advanced channel encoding combined with COFDM modulation provided for high spectrum efficiency.

Flexible choice of channel encoding and modulation parameters (forward error correction encoding rate, constellation pattern, guard interval length) provides possibility for steady broadcasting in various conditions (big or small city, countryside etc.), including single-frequency networks (SFN) implementation.

Within the limits of available bitrate it is possible to choose various configurations of transmitted services, including audio programs, video programs, still images, text messages and other additional data.

The channel bandwidth used by the system allows to deploy it using frequency arrangements of European FM broadcasting, particularly simultaneously with analogue FM broadcasting or with other narrowband digital terrestrial broadcasting systems.

General description of the system can be found also in the ITU-R Report BT.2049-2 (Appendix 5 – Digital narrowband multimedia broadcasting system AVIS).

The system has passed laboratory and field trials. In 2009-2010 the experimental broadcasting will be organized in the Russian Federation.

ANNEX 2: CURRENT AND FORESEEN FUTURE USE OF BAND II FOR BROADCASTING

Austria (01/09):

In the current situation Band II in Austria is used for analogue FM transmissions only. Band II is used intensively for analogue radio and at the moment there are no intentions to use Band II for digital radio transmissions in the future.

Belgium (01/09):

In Belgium the three Communities based on the language (i.e. the Flemish, French and German-speaking Communities) are competent for broadcasting (the federal authority is responsible for the programs of broadcasting which cannot be considered as belonging exclusively to one Community in the Region of Brussels). The situation in band II in the different Belgian Communities is as follows.

In the Flemish community band II is heavily used for analogue FM radio broadcasting by public and private broadcasters. The Flemish public broadcaster VRT has 5 different programmes in band II. As far as the private broadcasters are concerned licences have been awarded for 'national' (i.e. the Flemish Community) (2), 'regional' (5) and 'local' (293) broadcasters. The future use and the potential prolongation of the 'analogue' licences in band II will be studied.

On a similar way, in the French Speaking Community, the band II is also heavily used for analogue FM radio broadcasting:

- 5 programmes are allocated to the public broadcaster RTBF
- 4+2 programmes to the private/commercial broadcasters
- 5 provincial networks to the private/commercial broadcasters
- 84 local programmes to the private/commercial broadcasters

The digitalization's date of the band II and the norms used are not yet decided.

In the German Speaking community band II is used for analogue FM radio broadcasting by public and private broadcasters. The German Speaking public broadcaster BRF has 3 different programmes in band II. For the private broadcasters, licences have been awarded for 2 regional and 4 local broadcasters and will be in the future also for networks covering the whole community. The future uses in band II haven't been studied yet.

Croatia (01/09):

Band II is used for FM sound broadcasting and SRD devices, highly congested, for public and commercial broadcasters on state, regional, city or lower level of coverage.

Czech Republic (01/09):

Band II is used for FM radio according to GE84 Plan. Utilization is very intensive; there is strong demand for further frequencies that are not possible to satisfy because of fully occupied spectrum.

There are 522 transmitters in operation in total:

ERP 10 – 100 kW	- 90 transmitters
ERP 1 – 9.99 kW	- 156 transmitters
ERP up to 999 W	- 276 transmitters

Public service – 139 transmitters in total:

Three nation-wide networks	- 84 transmitters
Regional networks	- 55 transmitters

Commercial service – 383 transmitters in total:

Two nation-wide networks	- 50 transmitters
Regional networks	- 333 transmitters

Germany (01/09):

Currently Band II is used for analogue FM radio on regular operation, about 250 Million analogue receivers are supposed to be in the German market.

Several trials with different digital systems (DRM+, HD-Radio™, FMeXtra) have been taken place in Germany (Hannover, Heidelberg, Kaiserslautern).

]Nevertheless up to now no decisions have been made regarding switch-off scenarios neither for the short nor the medium time frame.

Denmark (01/09):

Band II is used for analogue radio broadcasting and there has not been any decision to digitalize it or switch analogue radio off.

Estonia (04/09):

The frequency range 87.5-108 MHz (Band II) is allocated for FM-broadcasting in Estonia. The band is heavily utilized - there are 159 FM radio stations in operation. In most of regions there is no free resource available at all for farther development of FM radio. At the moment there are no plans to switch off the analogue radio or digitalize it.

Finland (01/09):

In Finland Band II is allocated for FM sound broadcasting and the whole band is used according to the Geneva 84 agreement for FM radio. Currently there are no plans to switch off the analogue radio.

France (01/09):

6580 frequency assignments to FM sound broadcasting stations are recorded in the GE 84 plan or coordinated by the French Administration with the administrations concerned. As the previous FM licences were arriving to an end, the CSA ("Conseil Supérieur de l'Audiovisuel", i.e. the French Broadcasting regulatory Authority) decided to launch a re-farming process with the participation of public and private broadcasters and editors. During the past 4 years, 15 calls for tenders have been launched in France, including overseas regions, and enabling the use of more than 1000 new frequencies. The licences are given for 15 years. Moreover, an extra 5 year bonus will be given for analogue broadcasting to those editors which will get a digital licence in Band III or in Band L. Therefore, there is no plan of analogue switch off in the neither short nor medium term for Band II.

It must be noted that due to the demand, CSA has adopted for Ile de France area, which includes Paris, a raster of 200 kHz for planning. In this are, that represents 12 012 km² (approximately 60 km radius) and accounts 11 694 000 inhabitants (in 2008), 211 stations are broadcasting FM services, as independent stations or part of a national network of broadcasting transmitters (which can broadcast local contents).

Hungary (04/10):

The migration of FM stations from band 66 – 73 MHz to the band 87,5 – 108 MHz finished by 1st January 2007. The band 87,5 -108 MHz is extensively used, 3 national radio networks providing public service programs, 2 national commercial radio networks and a great number of regional, local and small community level broadcasting stations are operating.

There is demand for further FM stations, however the band is very congested and the international coordination of new frequencies is very difficult. It is assumed that, on longer term, the introduction of digital radio systems could give solution, but there are no plans for the digitalization of Band II in the near future.

Italy (12/09)

With reference to the future possibilities for the digitalisation of Band II, Italian administration communicates that in Italy the whole Band II is allocated for FM analogue sound broadcasting and currently there are no plans to implement digital radio in this Frequency Band.

Netherlands (09/09):

Currently band II is used for the following FM-services:

- 4 nationwide public radio services
- 12 regional public radio services
- 4 public local minority radio services
- Approx. 300 public local radio stations (104.9 MHz – 107.9 MHz)
- 9 (nearly) nationwide commercial (private) radio services
- 38 regional commercial (private) radio services
- 3 local military radio services.

In September 2011 all current licenses for band II will expire. The current political plans are that all licenses will continue to be granted to the existing licensees for 6 more years (i.e. until 2017). In order to speed up the digitalisation of radio the existing FM-licensees will also get a license for transmitting DAB(+) in band III.

These new FM-licenses, which include a DAB(+) license for band III, will be granted to the existing licensees under the condition that they will start to invest in digital radio via DAB(+). The licensees have to make sure that by September 2015 at least 80% of The Netherlands (geographically) will be able to receive radio via DAB(+).

If existing (band II) licensees do not want to invest in digital radio via DAB(+) their license will be revoked and will be granted to a new broadcaster either by auction or by beauty contest.

In 2016, a year before the new licenses expire, the success of digital radio via DAB+ will be evaluated. If DAB(+) is successful (i.e. more than 50% of the Dutch population has an DAB(+) receiver) a switch off date for analogue FM will be set . In this case the existing licenses will again be prolonged for a maximum of 6 years (i.e. until 2023). If DAB (+) is not successful and a switch off date is not set, the new licenses will be granted to new broadcasters either by auction or beauty contest.

Ireland (01/09):

The use of Band II (87.5 – 108 MHz, also called 'FM radio') is licensed, under broadcasting legislation, in Ireland to either RTÉ (Radio Telefís Éireann) the public sector broadcaster or the BCI (Broadcasting Commission of Ireland). The BCI is an independent statutory body responsible for a number of key areas of activity with regard to television and radio services in Ireland. In relation to radio in Ireland, the BCI are responsible for regulating independent radio services.

The Irish public sector broadcaster, RTÉ, operates four national radio services in FM. In addition to this, the BCI regulates 57 independent sound broadcasting services in the FM band, which breakdown as follows:

- 1 National Independent Commercial Radio Station - Today FM
- 1 Quasi National Commercial Radio Station – Newstalk
- 1 Multi City Commercial Radio Station – 4FM
- 4 Regional Commercial Stations
- 26 Local Independent Commercial Radio Stations
- 1 Special Interest Station (Dublin)
- 18 Community / Community of Interest Radio Station
- 5 Institutional Stations (2 Dublin, 1 Clonmel, 1 Limerick, 1 Cork).

The BCI issues occasional short term sound-broadcasting contracts (up to 30 day duration) to provide coverage of special events. The medium of broadcast radio in FM remains predominant in terms of consumer reach in Ireland. For instance, the Joint National Listenership Reach survey figures for analogue FM services in the period April 2007 to March 2008 indicated that 85% of the adult population were listening to a daily mix of national, regional and local radio throughout the country (www.bci.ie). Independent commercial analogue radio in Ireland, which is advertiser led, continues to be buoyant. In addition, new commercial analogue radio stations have been licensed by the BCI in 2008 and further commercial stations are expected to be launched in 2009.

In terms of digital radio technologies for radio services in Ireland, initially services will become available on T-DAB in Band III. Testing of T-DAB technology in the Irish market has been ongoing in 2007 and 2008. RTÉ has begun a DAB service in Band III at the end of 2008 in the North East of the country and in some of the major cities. It is expected that FM analogue radio services will continue to operate for the foreseeable future, depending on the demand for such services in the particular franchise areas. Irish legislation has been updated in 2007 to facilitate the introduction of digital sound broadcasting services. Ireland is keeping an open mind at present regarding any future digitisation of Band II, in light of the ever increasing development of radio services in this band.

Lithuania (04/09):

Band II is wholly planned for analogue FM radio broadcasting in Lithuania and the band is nearly fully utilized. At the same time a high power TV station on channel R4 in Vilnius is in service and the usage of the shared spectrum for radio broadcasting is therefore restricted in the relevant geographical area until this TV station is closed down. There also are some protected TV stations on both channels R4 and R5 in the neighbouring (non-EU) countries so there are some additional international restrictions of today's spectrum usage for FM radio broadcasting.

The whole FM radio broadcasting network covers 88% of the area of Lithuania in terms of given technical criteria for reliable reception and 95% of population is able to listen to radio broadcasts according to the same technical criteria. Current receivers are able to receive FM radio broadcasting in nearly whole country. 10 nationwide networks are in operation that carry 3 programs of Lithuanian National Radio and programs of commercial broadcasters. There are almost 80 regional and local stations and almost 230 FM radio broadcasting stations in total in service in Lithuania while additional frequencies are demanded by broadcasters.

Assignment and usage of radio frequencies for broadcasting is regulated by the Law on Electronic Communications. The Communications Regulatory Authority of the Republic of Lithuania which regulates electronic communications and postal activities assigns radio frequencies to the network providers or broadcasters holding a license awarded by the Lithuanian Radio and Television Commission which is a regulator for programmes in Lithuania.

Latvia (01/09):

250 frequency assignments to FM sound broadcasting stations are recorded in the GE 84 plan or coordinated by Latvian Administration with the administrations concerned. 135 stations are brought into use by this time:

30 stations, e.r.p. below 30 dBW;

105 stations, e.r.p. 30 dBW and more.

All frequency assignments currently available in places of high interest – in the capital Riga (23 stations) and in some other biggest cities - are in use. A backlog of demand characterizes these places. In spite of high interest to develop FM stations a number of frequencies remain unused. The reason for that is, from one side, lower interest in some areas (rural) and from other side – restrictions caused by TV stations operating in Band II in accordance with the Stockholm 61 plan.

These restrictions apply to a number of FM assignments pertaining to the frequency range 87.5 MHz to 100 MHz, located in areas bordering with some countries (Russian Federation, Lithuania). Restrictions are caused by the need to protect system "D" TV stations in operation or planned in the mentioned countries, channels 4 and 5. They may be removed step by step and at least by the end of the transition period, June 2015, and use of the released frequencies for new FM stations can be expected.

Some other bordering countries, Estonia and Republic Belarus, do not impose restrictions to the use of the Band II in full for FM broadcasting.

Norway (01/09):

In Norway there are, as of January 2009, no political plans of altering the current exclusive use of analogue FM broadcasting in Band II. Today Norway count approximately 3000 operational FM transmitters.

Poland (01/09):

Band II is being extensively used by FM radio broadcasting stations; there is no plan of switching off the analogue FM transmissions in the near future.

Portugal (01/09):

Actually Band II is being extensively used by FM radio broadcasting stations, and there are some regions where no frequency is available at all.

Romania (01/09):

Band II is extensively use for FM broadcasting (approx. 850 stations) and the request for new FM stations is still high, especially in large cities. Romania has according to GE84 Plan 4 FM broadcasting networks with national coverage: 2 of them are owned by the public broadcaster and the other two are owned by two private broadcasters (approx. 40 stations each).

Russian Federation (04/09):

In the 76 – 100 MHz frequency band, the analogue TV stations (more than 2000) are operating in the territory of the whole country. These channels are mainly used for national TV programs.

The 87.5 – 108 MHz frequency band is actively used for analogue FM sound broadcasting (more than 2500 stations). In some areas the frequency resource for sound broadcasting is practically exhausted. The limitations to use some frequencies are set because of the necessity to ensure electromagnetic compatibility with existing TV stations in Channels 4 and 5.

According to Decision dated 1999 of State Commission for Radio Frequencies of the Russian Federation, the new licenses for television broadcasting in 87.5 – 100 MHz, which is currently shared by sound and television broadcasting, are not given, with the purpose to use this band for VHF FM sound broadcasting.

The plans for digitalization of Band II haven't been approved; at the same time, the possibility to use Digital Mobile Narrowband Multimedia Broadcasting System RAVIS (Realtime Audiovisual Information System) developed in Russia for Band II (87,5 – 108 MHz) and Band I (66 – 74 MHz) is considering. Experimental and field tests of the system model was carried out in 2006. The information about RAVIS (former AVIS) was introduced at ITU-R Study Group 6 meetings in contributions from the Russian Federation (ITU-R Doc. 6E/336, March 2006, and 6M/150, August 2006). The information about RAVIS is contained in ITU-R Report BT.2049-2 **"**Broadcasting of multimedia and data applications for mobile reception". Experimental broadcasting is planned for 2009 - 2010.

Sweden (01/09):

According to the Swedish Frequency Plan the Band II is used for the analogue FM radio. The latest official report on the commercial radio (October 2008), made on the request of the Swedish government, estimates that the analogue FM radio is going to be in operation in Sweden for at least the next 10-15 years.

Slovenia (01/09):

In the Republic of Slovenia Band II is fully used by FM radio broadcasting stations.

Switzerland (12/09):

Band II is used intensively for analogue FM-radio.

The Swiss Federal Council decided on the 4th November 2009, that Swiss Broadcasters are permitted to send their program in addition to analogue also in digital format. The Council decided thereby for no dedicated technology. The transmission of additional digital programs is permitted only on a non-interference / non-protection base and must ensure that no intermodulation products causing interference to services operating in adjacent frequency bands. Each transmission must be submitted for accordance.

The association of private radio operators has announced in a press release, that at least five radios intend to start a commercial HD-Radio operation by 1st of November 2010.

It is Ofcom's duty to follow closely technical developments and to facilitate the introduction of new systems where appropriate. Therefore Ofcom is "open minded" in considering any application for test licences, regardless for which system.

Since three years, a field trial with HD-Radio is in operation in the central part of Switzerland. Extensive measurement campaigns showed the general compatibility of the system. No complaints of the public or the listeners are reported so far.

Switzerland has not set a switch-off date for the analogue FM and there is no plan to set such a date. Switzerland intends digital FM as a local to regional complement to DAB+ in Band III.

Slovak Republic (01/09):

In the Slovak Republic 262 stations are in operation, which are recorded in the GE 84 plan or coordinated with the administrations concerned.

30dBW and below 30dBW: 157 stations

40dBW and below 40dBW: 78 stations

More then 40dBW: 27 stations.

There is a high demand for using of all available and new frequencies, which characterizes the current situation in the Slovak republic. The Slovak public sector broadcaster (Slovensky Rozhlas) operates four national services in FM. In addition to this The Council for Broadcasting and Retransmission regulates 33 private providers with license for multiregional (9), regional (15) and local (9) areas.

It is expected that FM analogue radio services will continue to operate depending on the demand for such services. Any future digitisation of Band II in the Slovak republic is open due to increasing development of radio services in this band.

United Kingdom (01/09):

Within the United Kingdom the whole of Band II is currently used exclusively for FM radio broadcasting. There are around 2500 UK FM radio stations in Band II. These range from the National coverage networks through to small coverage community and temporary (28 day) radio services. The planning of the band is segmented into varying types of service. The original BBC national networks are in the lower part of the band and the newer services, both national and local radio, tend to be in the middle and higher end of the band.

The planning is partly constrained by the in band local oscillator issue, plus image problems with aeronautical services in the spectrum immediately above.

Ukraine (04/09):

809 FM stations broadcast in Ukraine in BAND II according to Agreement GE84 and also 41 transmitters of analogue TV broadcast according to Agreement ST61.

At present time there are no approved plans to switch off the analogue broadcasting in BAND II. Since 2006 a hybrid HD Radio technology broadcasting is tested in Ukraine. In 2008, the possibility of coexistence of HD Radio system with analogue FM stations has been studied. Results of studies are the following:

- Usage of protection ratios of Recommendation ITU-R BS.412-9 shows that there are potential interference for FM reception with HD Radio introduction and it is theoretically required some increasing of territorial separation for FM stations working with 200 kHz frequency separation;
- Practical investigation of FM station analogue reception with 200 kHz frequency separation from HD Radio transmitter and 70 km of territorial separation between transmitters have shown the absence of subjective deterioration of received analogue signal quality while the interference from digital HD Radio subcarriers have been expected. Thus, the main problem of HD Radio technology implementation is not the technical problem of planning. It is the regulatory problem of discrepancy of HD Radio signal raster and ETSI EN 302 018 raster that was approved for FM broadcasting planning in Europe;
- According to studies results it is recommended to reconsider the protection ratios that are defined in Recommendation ITU-R BS.412-9;
- HD Radio technology system can be implemented in Ukraine in case of development and approval of appropriate criteria for planning of digital and hybrid systems.
- State Administration of Communications of Ukraine, which is a subdivision of the Ministry of Transport and Communications of Ukraine, hasn't made a final decision yet as far as transition to digital sound broadcasting in BAND II is concerned. Currently they are busy with the comparative analysis of all the

standards for switching over to digital technologies. Among these digital technologies there are two main candidates: DRM+ and HD-Radio. Among the obstacles on the way to adoption of HD Radio Standard are the problems of cross border coordination and the enlargement of bandwidth in a hybrid mode.

- The 3 - year studies and experiments on the practical usage of HD Radio in Ukraine showed the possibility of coexistence of analog and digital broadcasting even in the most complicated conditions in terms of interference. The experiments and studies were carried out by the state enterprise Ukrainian Scientific Research Institute of Radio and Television which is subject to the Ministry of Transport and Communications of Ukraine. The same Institute has worked out the norms of frequency and territorial separation for radio - electronic devices using HD Radio considering protection ratios.
- At the moment State Standards for using HD Radio are being worked out in Ukraine
- HD Radio Implementation is supported by the Association of Television and Radio Broadcasting of Ukraine.

ANNEX 3: REFERENCES

Recommendation ITU-R BS.412-9	Planning standards for terrestrial FM sound broadcasting at VHF
Recommendation ITU-R BS.415-2	Minimum performance specifications for low-cost sound broadcasting receivers
Recommendation ITU-R BS.450-3	Transmission standards for FM sound broadcasting at VHF
Recommendation ITU-R BS.467	Technical characteristics to be checked for frequency-modulation stereophonic broadcasting
Recommendation ITU-R BS.641	Determination of radio-frequency protection ratios for frequency modulated sound broadcasting
Recommendation ITU-R BS.642-1	Limiters for high-quality sound-programme signals
Recommendation ITU-R BS.704	Characteristics of FM sound broadcasting reference receivers for planning purposes
Recommendation ITU-R BS.1114-6	Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz
Recommendation ITU-R BS.1596	Guide to ITU-R Recommendations for broadcast sound production
Recommendation ITU-R BS.1660-3	Technical basis for planning of terrestrial digital sound broadcasting in the VHF band
Recommendation ITU-R P.1546-3	Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz
Recommendation ITU-R SM.1009-1	Compatibility between the sound-broadcasting service in the band of about 87-108 MHz and the aeronautical services in the band 108-137 MHz
Recommendation ITU-R SM.1140	Test procedures for measuring aeronautical receiver characteristics used for determining compatibility between the sound-broadcasting service in the band of about 87-108 MHz and the aeronautical services in the band 108-118 MHz
Recommendation ITU-R SM.1268-1	Method of measuring the maximum frequency deviation of FM broadcast emissions at monitoring stations
Report ITU-R BT.2049-2	Broadcasting of multimedia and data applications for mobile reception
EN 301 489-11 V1.3.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 11: Specific conditions for terrestrial sound broadcasting service transmitters
EN 302 018-1 V1.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound broadcasting service; Part 1: Technical characteristics and test methods
EN 302 018-2 V1.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Frequency Modulated (FM) sound broadcasting service; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive
EN 302 077-1 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Terrestrial - Digital Audio Broadcasting (T-DAB) service; Part 1: Technical characteristics and test methods

EN 302 077-2 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Terrestrial - Digital Audio Broadcasting (T-DAB) service; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive
EN 302 245-1 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Digital Radio Mondiale (DRM) broadcasting service Part 1: Technical characteristics and test methods
EN 302 245-2 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Digital Radio Mondiale (DRM) broadcasting service Part 2: Harmonized EN under article 3.2 of the R&TTE Directive
ETR 132	Radio broadcasting systems; Code of practice for site engineering; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters
ETS 300 384	Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters
ETS 300 384 A1	Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters
ETS 300 447	Radio Equipment and Systems (RES); Electro Magnetic Compatibility (EMC) standard for VHF FM broadcasting transmitters
ETS 300 750	Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters in the 66 to 73 MHz band
ES 201 980 V3.1.1	Digital Radio Mondiale (DRM); System Specification
ERC REC/54-01	Method of measuring the maximum frequency deviation of FM broadcast emissions in the band 87.5 MHz to 108 MHz at monitoring stations
Geneva 2006 (GE-06)	Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06) http://www.itu.int/publ/R-ACT-RRC.14-2006/en
Geneva 1984	Final Acts of the Regional Administrative Radio Conference for the Planning of the VHF Sound Broadcasting (Region 1 and part of Region 3**)** http://www.itu.int/publ/R-ACT-RRC.5-1984/en
WI95revCO07	The Wiesbaden, 1995, Special Arrangement, as revised in Constanţa 2007 http://www.ero.dk/52677CE0-D00C-427D-895B-1AF1DFC4A3C2?frames=no&