

[PEARLE LOGO]



***Cultural Europe will not survive
a second digital dividend***

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economy at the basis of its existence***

***People experience through events the essential
emotions that everybody needs.***

***These once in a lifetime experiences will be
vastly inferior without PMSE.***

This paper explains the above and provides guidelines for spectrum management

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1. Introduction

For daily productions 96MHz of UHF TV band interleaved spectrum is needed. For "common" major events which take place at least every 3 to 5 times a month per country 270 MHz of interference free interleaved bandwidth is needed. For very big events like the Olympic Games even more spectrum is required. As a consequence of the first Digital Dividend there is only 320 MHz left and as once the DVB-T multiplexes are deducted only 214 MHz till 264 MHz of interleaved spectrum is available. PMSE is already at the limit of its possibilities.

This joint APWPT and PEARLE² strategy paper provides an overview of mid and long term strategy for PMSE (Programme Making and Special Events) audio applications. Given the critical role of PMSE for the production of live and recorded content in the EU, any EU decision will have an immense impact on the cultural and social life of every citizen of the European Union.

2. What is PMSE what are its properties and what are the threats to its existence

PMSE consists of all types of wireless production tools for broadcast production and program making such as professional wireless microphone systems (PWMS), In-Ear –Monitor systems (IEM), wireless video cameras and other wireless video links, audio links, conference systems, etc. The professional event production (concerts, conferences, sports events, elections, entertainment, houses of worship, etc.) require many frequencies (radio spectrum). Today available spectrum becomes scarcer and scarcer. Many new applications are seeking access to the UHF spectrum. The Digital Switch Over has a huge impact on PMSE's spectrum operating environment. Not only are PMSE users being evicted from their dedicated operating channels, they are also about to see the amount of interleaved spectrum available to them significantly reduced. The PMSE community is now seriously concerned about threats to the quality and quantity of spectrum available.

The political definition of the Digital Dividend² suggests that through the Digital Switchover process UHF TV band spectrum can be released. In practice however there is no positive value of a Digital Dividend because the programs broadcasted in DTT, DVB-HD and DVB-T2 and DVB-H will need the

¹ APWPT is the European association promoting the efficient and demand-driven provision and use of production frequencies for PMSE - www.apwpt.org, PEARLE is the European federation of performing arts organisations and enterprises <http://www.pearle.ws/>

² Digital Dividend: We consider the Digital Dividend 790-862MHz.

total UHF TV band. This negative value of the Digital Dividend cumulates due to cross border effects of DTT allotments. In principle it is also strange to validate spectrum only on the basis of the fact that only one radio service (IMT) is able to administer and charge the use per second and by delivered service. Regulators should manage the radio spectrum infrastructure rather than define it as an economic playground.

3. What we demand/ Crucial Challenges

1. Freedom of speech and freedom of news gathering are both highly dependent on PMSE.
2. It must be recognised that the spectrum below 1 GHz is the core spectrum for most PMSE audio applications. For daily audio productions a minimum of 96 MHz of interference free interleaved spectrum is required and this rises to a minimum of 270 MHz for common major events.
3. PMSE usage will continue to grow in the future and will require more spectrum.
4. Additional spectrum between 1 GHz and 2 GHz is needed for PMSE.
5. No further spectrum below 1GHz should be assigned to IMT, as IMT cannot share spectrum with other services.
6. Any further erosion of the UHF TV band spectrum will have a severely negative impact on the production of major events such as national elections, festivals, sport events, etc. and the content production of the Olympic Games will become impossible. (Appendix 1)
7. PMSE spectrum demand for major events should not have an impact on daily basis PMSE production requirements.
8. Because of economies-of-scale it would be preferable to have harmonized PMSE frequencies Europe wide.
9. The EU should mandate a study on PMSE's social and cultural contribution and examine spinoff markets like culture, tourism, etc.
10. Without a long-term regulatory framework, market-based technological development cannot be cited. PMSE manufacturers will not invest in research and development of new PMSE technologies without future regulatory certainty.
11. Most PMSE applications are live (e.g., concert tours, conferences, Electronic Newsgathering, live-broadcast) and need protection in the form of a secure and reliable regulatory status. This is required to ensure that the quality demands of the primary service, for example broadcasters, are fulfilled. (Appendix 1)
12. The VHF-TV band (174-230 MHz) should become available EU-wide for PMSE usage despite the high man-made noise in this band. Due to man-made noise the VHF band cannot be an alternative for the UHF band but the band could be suitable for applications like audio links, talk-back systems and consumer wireless microphones. (Appendix 2)
13. Due to the introduction of new technologies and services in the UHF-TV band, the noise floor is rising severely: the European Union, in concert with national regulators, must develop measures to deal with these noise issues. (Appendix 2)

14. All aspects and implications of allocating spectrum to other services need to be investigated and taken into account, including interference to PMSE and broadcast, the costs of changing consumer products, costs for mitigation measures of other services, impact on market value, cost impact on spinoff markets, employment, extra cost of broadcast productions, cancellation of major events, etc. (Appendix 2)
15. APWPT cannot state an opinion on White Space Devices until the results of the ETSI TG17 Special Task Force 386 and the project team C-PMSE cognitive radio technologies for PMSE are considered. A regulatory framework should not be established without taking into account the requirements of the PMSE industry.

4. Explanation of the demands

- PMSE equipment such wireless microphones and in ear monitors are essential entertainment production tools. In modern live entertainment, be it music, theatre, opera or film, flexibility is all important. Spectacular modern production standards owe a great deal to developments in PMSE technology. It is not only on stage and in the public eye that PMSE technologies are invaluable; back stage or on set they ensure greater safety and efficiency for those working in hostile production environments. PMSE is not a luxury, it is essential. Live concerts, theatre, TV shows (most presenters use wireless microphones), major sport events (Grand Slam tennis events, Tour de France, F 1, The UEFA champions league) all rely on using PMSE equipment. Major events such as the Commonwealth and the Olympic Games would be unable to be broadcast in their current form without access to large quantities of interference free interleaved spectrum. PMSE equipment is wide spread across society and is used extensively in the entertainment and installation industry by professional bodies. Those that benefit include musicals, theatres, stage productions, public events, sporting events, program production (including television, multimedia, video, MP3, CD and DVD), broadcasters, houses of worship, museums, exhibition and event centers, schools, universities, education centers and many other professional entities. Whilst the PMSE sector is a disparate and diverse community mostly made up of small businesses and individuals, it brings untold social, economic and cultural benefits to the citizens and consumers of the European Union.
 - PMSE equipment uses many different bands for many different applications. These different applications have differing needs with regard to audio quality, audio latency, transmission range and other factors. For PMSE audio applications the UHF TV band is the core band.
 - The number of wireless microphones deployed within the EU has only been roughly estimated. Due to different license regimes the real number gets masked. A way to estimate the total number is to look at the result of the Dutch Agentschap Telecom survey of a few professional audio distributors in 2010 on the numbers sold in the last decade. They came up with a figure of 250.000 systems (transmitter and receiver) sold. If this number were to be extrapolated over the total number of EU inhabitants one can conclude the total number of channels being deployed is about 10 million and the number of
- PMSE strategy paper_draft_v0.2.1.docx

daily users will be about 8 million. It would require a study to get a real idea of the size of the core market. The real economic value of PMSE to the EU however is in the spinoff that PMSE creates. This should be added to the value of these products. The cultural value of PMSE is therefore immeasurable. PMSE has greatly enhanced certain industries (e.g. musical industry, press conferences) leading to other spinoff markets (for example musicals-tourism in London's West End).

- CEPT report 32, noted:
"PMSE demand for spectrum is expected to continue to rise in the medium term. Even if there was no reduction in the quantity of interleaved spectrum available for PMSE, users would eventually face increasing constraints in spectrum supply and the need to change the way that they used it. Interleaved channels/white spaces in the UHF band are the principal spectrum for wide band audio applications. Therefore, the 470 MHz to 790 MHz range should be maintained for PMSE allowing them to operate on a temporary basis in areas where broadcasting is not used."
- It is commonly agreed that PMSE is an important service and critical PMSE applications need better protection against other secondary services. (E.g. CEPT Report 32)
- The Analysis/ Mason 2009 EU Report: this study discusses SAB/SAP as part of PMSE (for example on p. 324) and states that SAB/SAP use by wireless microphones and talkback is "of tremendous value" to society (p. 186). It is a pity the authors do not consider the situation of PMSE within the EU strategy.
- The amount of allocated spectrum below 1 GHz to IMT must be limited to the current DD. IMT cannot coexist with other radio services and therefore sharing with other radio services is impossible and as a consequence is spectrum inefficient. The predicted future growth of data demand of IMT services below 1 GHz cannot be proven. In many cases this data demand can be offloaded to more suitable frequencies for high data rates (above 2 GHz) and to WSD technologies (e.g. femto and pico cells). Data transmission is not latency critical. IMT should be challenged to innovate LTE and become more spectrum efficient within the currently allocated IMT bands. The use of current allocated UMTS frequencies should be maximised till 100%.
- PMSE equipment operation relies on interference-free access to spectrum. Access to the spectrum is on an opportunistic basis – at the time at which the frequency is needed it has to be available free of interference.
In direct contradiction to that, PMSE equipment belongs to SRD family, i.e. from the EC Decision on SRD and the ITU perspective with no rights of protection from interference. PMSE applications need protection in the form of a secure and reliable status from other secondary applications because of the high audio quality required by the primary service provider.

- The EU should not follow US RF spectrum policy, as it is currently being discussed, as there are too many differences between US and EU spectrum usage and management.
 - a. The DTT allotments in the EU are more dense and vary widely per country due to different languages and broadcast schedules.
 - b. The DTT and Digital Radio technical standards differ resulting in different sorts of interference.
 - c. In the EU complications arise due to different national licensing schemes for PMSE.
 - d. Geographically urban areas are closer to each other compared to US.

5. PMSE technology - present and future

Quality of Service

Most PMSE applications are live and need protection because of the high audio quality and reliability required by the producers and the audience. Many PMSE applications differ in quality of service (QoS) requirements. In critical applications (e.g. broadcast, musicals, theatre, music shows...) the expected QoS is very high; e.g., no latency and no degradation in audio quality. By contrast, consumer applications can live with some degree of audio latency and require an audio quality, which provides merely a high level of speech intelligibility.

Interleaved spectrum below 1 GHz is the core spectrum for most PMSE audio applications.

The vast majority of PMSE audio applications are critical applications that need a highly reliable RF connection and because of the required propagation properties need to operate below 1 GHz.

The German Federal Network Agency study of October 2008 concluded that in urban centres PMSE audio applications require at least 96 MHz of spectrum for average daily productions. Measurements show that for major events (Eurovision Song Contest, Champions League Final, regional elections in Germany, etc) 270 MHz is needed. This spectrum must be available in addition to the DVB-T spectrum already in use locally.

Efficient use of Spectrum

- Manufacturers are working on wireless microphones that use spectrum more efficiently.
- Regarding high audio quality and reliability, digital modulation schemes are presently not more efficient in using spectrum compared to analogue. Compression of the audio would lead to latency or irreversible artefacts.

Because the wired audio chain from microphone to sound system/OB van is already digitised there is a primary interest in having digital wireless microphones.

(Insert: Mathematical example)

Frequency Bands

- Frequency spectrum is a scarce resource. This resource has to be managed in an efficient and appropriate manner serving all European Union citizens.
- At present PMSE operates on non-primary, non-protected basis, however PMSE requires interference free use of radio spectrum at the site of operation. This is because there must be no interruption to audio quality (100 % AF duty cycle is needed to achieve this).
- Consideration should be given to establishing a (European) license exempt harmonized band for PMSE to better facilitate cross border operation of professional wireless microphone systems and to increase economies-of-scale in production.
- PMSE applications in the 470 – 790 MHz band should primarily be the application that should receive protection (i.e. “Critical use”). This may be achieved by “controlled” access to spectrum. The “controlled” access may improve the frequency re-use of the band. This could be achieved by administrations through an individual licensing regime (see ERC/REC 70-03 annex 10) or by specifying the type of equipment that is allowed to operate in this band. In most cases, it would provide sufficient spectrum for daily productions and in some cases for major events.
- Two kinds of bands could be made available to PMSE in addition to 470 – 790 MHz:
 1. For “less critical” uses which can tolerate higher interference levels or which cannot operate in the band 470 – 790 MHz, frequency bands should be identified without “controlled” access to the spectrum.
 2. Where interleaved channels are insufficient for “critical” PMSE use in the band 470-790 MHz to satisfy peak demand, new frequency bands need to be identified, where “critical” PMSE use can ensure the protection of services such as broadcasting. This may be achieved by a “controlled” access to this new spectrum.
- Bands to be considered could be the VHF band (174 – 230 MHz), the L band (1452 – 1518 MHz), 1785-1805 MHz, and available spectrum in 790-862 MHz (e.g. LTE duplex gap 821 – 832 MHz).
- The bands 863-865 and 821-832 MHz are already available in most CEPT countries for audio applications (including wireless microphones according ERC/REC 70-03 annex 10 and 13 of 02-2011). Due to out of band emissions from LTE these bands are very likely to be severely disrupted by interference. Therefore the EU should mandate a study on this matter and undertake appropriate measures.

EU Harmonized bands

Beside the required 96 MHz for daily productions and the 270 MHz of interleaved spectrum for common major events, EU harmonised bands are needed for touring applications. EU member states have different licensing schemes with different application procedures. In many countries application details are available in the national language only and this is a burden to the usage of PMSE equipment touring within the EU. Therefore, we propose to identify harmonised frequency bands with

harmonised access for PMSE usage. We suggest as the main bands for PMSE users touring within the EU without regulatory burdens the following harmonized bands: .

TV-Channels 39-41 (for touring applications)

821 – 832 MHz (should be exclusively allocated to PMSE usage but it should be noted that this band may be unusable as a result of out of band interference from neighbouring LTE downlink and uplink blocks)

863 – 865 MHz (existing EU harmonized audio band but has a high potential of being interfered by LTE uplink block and also other consumer audio applications)

Interleaved UHF-TV spectrum 470 – 790 MHz

Large major events require all interleaved spectrum in UHF-TV band that is currently available and beyond.

Interleaved spectrum is needed to allow frequencies used in fixed installations to be separated from mobile PMSE users.

Frequency bands under discussion

The bands above 1 GHz will not be sufficient to meet any alternative bandwidth requirements to compensate for the total spectrum loss below 1 GHz. The 1,8 GHz wireless audio band should be retained for PMSE as the band could be used for certain applications. It would be worthwhile to enlarge the band to 1805 MHz. Extra tuning ranges should be identified in the L Band frequency range (1452 – 1518 MHz) for use by PMSE (including professional conference applications).

It is not favourable to have dedicated IMT bands in the UHF TV band; as IMT bands cannot share spectrum with other services (inflexibility=inefficient use of scarce spectrum). Additional capacity for IMT broadband services should be sought above 2 GHz as these frequencies are far more appropriate.

PMSE regulation

Without a long-term regulatory framework, market-based technological development cannot be cited. PMSE manufacturers will not invest in research and development of new PMSE technologies without future regulatory certainty.

As an example the regulation on maximum RF occupied bandwidth does not stimulate innovative digital wireless microphone technologies.

ITU Activities

The EU should urge the national regulators to provide harmonized channels for PMSE and endorse a PMSE Agenda Item for WRC 2016. The ITU *Report ITU-R BT.2069-4 (11/2009) Tuning ranges and operational characteristics of terrestrial electronic news gathering (ENG)*,³ and some recommendations like *ITU-R.F1777* and *ITU-R.F1824* are good starts, but more work needs to be done to establish PMSE (SAB/SAP) as a term recognized worldwide for content production activities that go far beyond ENG.

Planning certainty and frequency stability for PMSE users / applications can only be established by giving PMSE a higher reliable status compared to the current 'secondary user' status that PMSE currently has. Therefore, the APWPT encourages the RSPG and RSC to work with other EU bodies so that PMSE will obtain "a more protected" status in certain spectrum bands as early as possible. (highest priority: 470 – 790 MHz)⁴

6. Conclusions

1. Cultural Europe will not survive a second digital dividend
2. Any further erosion of the UHF TV band is unacceptable and will hurt the cultural economy at the basis of its existence
3. People experience through events the essential emotions that everybody needs. These once in a lifetime experiences will be vastly inferior without PMSE
4. Given the critical role of PMSE for the production of live and recorded content in the EU, any EU decision will have an immense impact on the cultural and social life of every citizen of the European Union.

³ http://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2069-4-2009-PDF-E.pdf

⁴ See already APWPT comments on CD:

http://rspg.groups.eu.int/_documents/consultations/comments_cognitiv_20091113_1227/cpi_cogtec_apwpt.pdf

Appendix 1: Eurovision Song Contest

Spectrum usage at the Eurovision Song Contest

Measurement of the DKE, the German commission for Electrical, Electronic and Information technology within DIN (German Standard Institute) and VDE (the Association for Electrical, Electronic & Information Technologies)

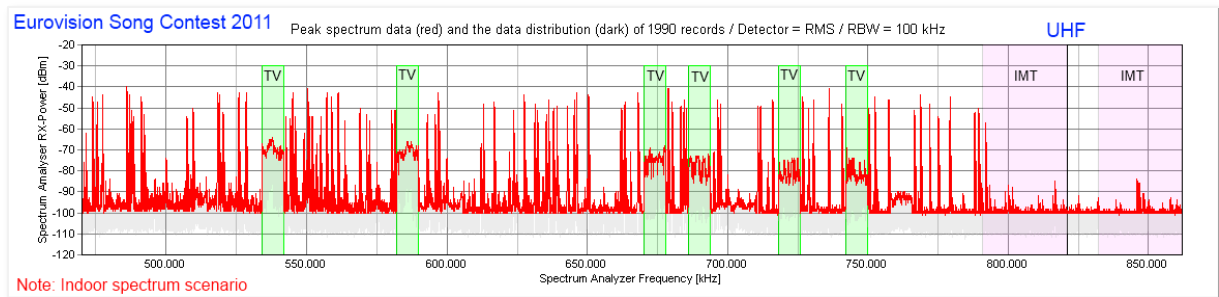


Fig 1: measurements taken during the event

Note: Light green blocks are local active DVB-T transmitter

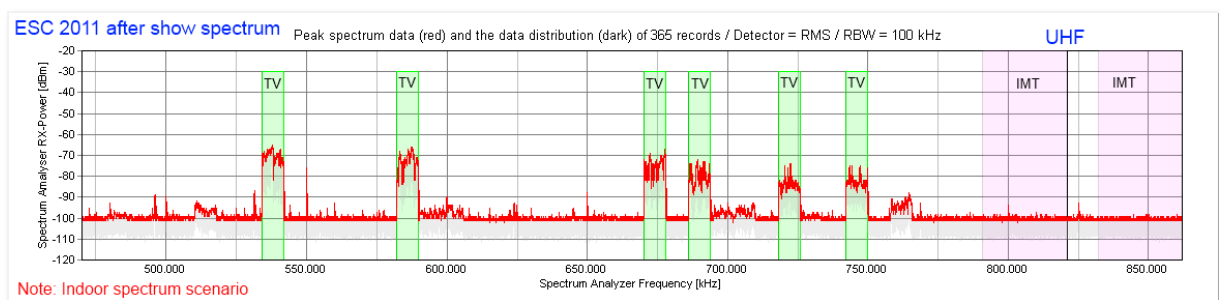


Fig 2: measurements taken after the event.

The figure shows on the horizontal axis the frequency range 470 to 865 MHz and on the vertical axis the measured level of the different spectrum users. Clearly visible are the DVB-T carriers. 7 of them were recorded inside the venue and the one on the far right had a low level as a consequence of wall attenuation. The frequencies of the radio microphones and the IEM's used at this event are nicely arranged between the DVB-T carriers. As the bandwidth of these systems is much smaller in comparison to the DVB-T carrier the systems appear as lines and not as a clearly visible DVB-T block. The figure shows that the white spaces in the range of 470 to 790 MHz are almost completely filled with transmissions. It should be noted that at the location of the measurement antenna not all PMSE systems in use could be measured.

Above 790 MHz the spectrum is allocated to IMT services as a result of the Digital Dividend. The producers of this event would not take the risk of interference to this production by operating above 790 MHz. The detected signals above 790 MHz are most likely audio or talk-back links as they are not as critical as wireless microphones to broadcast content.

It should be noted the measurements took place on the evening of the event itself. All of the equipment was active approximately 4 weeks prior to the main event due to the number of rehearsals that were required. From a viewing perspective the Eurovision Song Contest is the second largest live broadcast event in the world (with a tremendous turnover for IMT on SMS services as a consequence). It is surpassed only by the FIFA world cup final at which very significant quantities of PMSE equipment are also used.

We enjoyed a great European event



(Photo: APWPT)

Fig 3: Eurovision Song Contest 2011 Düsseldorf Germany

**Appendix 2:
Uncontrolled emissions causing interference in the VHF and UHF bands**

Example of interference in the UHF-TV band caused by video walls

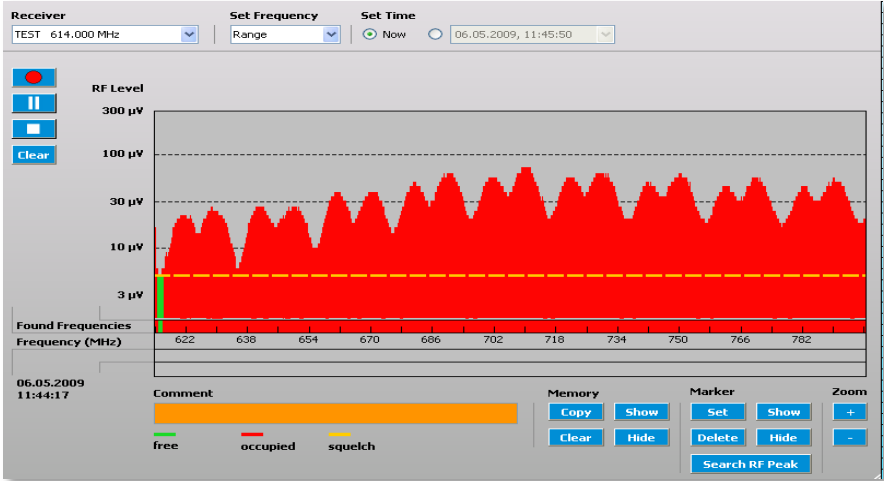


Fig 4: Manmade noise levels measured at radio microphone receiver

The picture shows the UHF range 614 to 800 MHz on the horizontal axis and on the vertical axis the level measured by a radio microphone receiver used at the venue (Eurovision Song Contest, Moscow, 2009). This clearly shows the high interference level caused by the video wall. The noise level was measured between 5 and 80 μV . At these noise levels, the use of wireless microphones is not free of interference, even at short distances.

During the event a variety of video walls were used and the picture below gives an impression of the size.



Fig 5: Eurovision Song Contest 2009, Moscow

Example of interference in the VHF TV band

The following measurement was made during regional elections in 2010 in Bremen, Germany. The picture gives an impression of man-made noise levels.

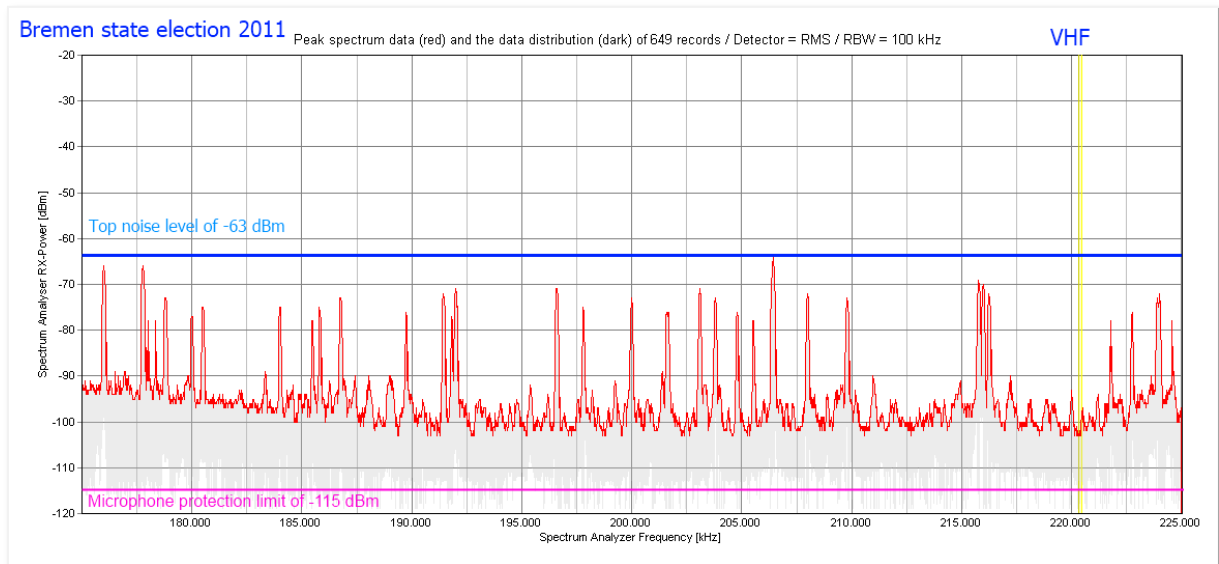


Fig 6: Measured noise level in the VHF TV band.

On the horizontal axis the monitored spectrum between 175 to 225 MHz is shown. On the vertical axis the RF level at the measurement antenna is shown in dBm (-70dBm equals 70 μ V). The pink line indicates the maximum sensitivity of the radio microphone receiver at the level of -115 dBm. From the identified levels the conclusion can be drawn that the noise exceeds the -115 dBm threshold by about 30 dB typically with peaks of up to 50 dB. The red line on the peaks shows the measured noise levels. With such a high noise level at the receiving antenna of a radio microphone system, the noise will overload the signal from the radio microphone and will become clearly audible.

The reliable interference free deployment of wireless microphones cannot be guaranteed. This is the main reason why VHF systems are seldom used today and most manufacturers do not have VHF systems in their product portfolios anymore.

In order to prevent the same fate befalling the UHF band as has befallen the VHF band. Due to the introduction of new technologies and services in the UHF-TV band, the noise floor will inevitably rise. The European Union, in concert with national regulators, must develop measures to deal with these noise issues. In order to prevent the same fate befalling the UHF band as has befallen the VHF band.

This position paper was issued by the following organizations:

APWPT is an international non-profit organisation, which is representing the needs of all users of the Programme Making & Special Event ("PMSE") sector.

Members of APWPT include PMSE organisations, users and manufacturers. The APWPT directly and indirectly represents far over 25,000 members of the PMSE community in Europe and beyond. PMSE is crucial on a daily basis for the production of content that has received world-wide acclaim and continues to attract a global audience. A vast array of organisations are reliant on radio spectrum for the production of content for Performing Arts, Broadcasting, News Gathering, Independent Film and TV Production, Corporate Events, Concerts, Night Venues, Sports Events, Churches, etc. In addition, other sectors that utilise the current UHF spectrum include the Health Service, Education, Local Government, Political Programming and Conferencing.

For more information about the goals and achievements of the APWPT please visit our website at www.apwpt.org or contact us at

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PEARLE (Performing Arts League Europe) Created in 1991, Pearle is the European trade federation of performing arts organisations and enterprises.....

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