# Annex G JWG DD Report V1.0 (2011-02)

**Joint CENELEC-ETSI Working Group (JWG) on Digital Dividend Issues**
**Compilation of contributions to the JWG and outputs of sub groups of the JWG**

**Annex G: Cordless Audio (Radio Microphones, Wireless Headphones, Baby Alarms and In-Ear Monitors (IEM)) in the band 863-865 MHz**

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# Introduction

This document covers the input and information presented to the ETSI-CENELEC Joint Working Group on Digital Dividend issues on Cordless Audio and similar devices

# 1 Definitions, symbols and abbreviations

## 1.1 Symbols

For the purposes of the present document, the following symbols apply:

| | |
|---|---|
| dB | decibel |
| dBm | power ratio in dB (decibels) referenced to one milliWatt (mW) |
| kHz | kiloHertz – 1 thousand cycles per second |
| MHz | MegaHertz – 1 million cycles per second |
| mW | milliWatts |

## 1.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

| | |
|---|---|
| CEPT | European Conference of Postal and Telecommunications Administrations |
| EC | European Commission |
| ECC | European Communications Committee |
| ECN | Electronic Communications Network |
| ERP | Effective Radiated Power |
| FDD | Frequency Division Duplex |
| FM | Frequency Modulation |
| GSM | Global System for Mobile communications |
| LTE | Long-Term Evolution |
| QPSK | Quadrature Phase Shift Keying |
| RF | Radio Frequency |
| SC-FDMA | Single Carrier – Frequency Division Multiple Access |

# Annex G: Cordless Audio

## G.1 Executive Summary

A variety of six professional, semi-professional and consumer “cordless audio” devices operating in the license-exempt frequency band 863-865 MHz conforming to the harmonised standards EN 301 357 or EN 300 422 were tested for susceptibility to a 10M Hz bandwidth LTE signal transmitting from 700 MHz to 862 MHz emulating both the base station and terminal unit. The term ‘cordless audio’ covers a range of devices, all of which feature a transmitter with an audio input, and a receiver with an audio output, and includes devices such as radio microphones, wireless headphones and tour guide systems.

- 50% of devices were adversely affected by a simulated Electronic Communications Network (ECN) terminal unit operating at the highest frequency channel (857 MHz);
- A third of devices were susceptible to LTE transmissions below the proposed ‘uplink’ section of the band (below 832 MHz);
- One device out of six was susceptible to LTE transmissions below the lowest edge of the proposed ECN band (below 779 MHz).

ECN terminal units can use up to 316 mW (ECC Decision (09)03 and EC Decision 210/267/EU). Those devices susceptible to interference on the highest planned LTE terminal unit channel, centred at 857 MHz, will start to show interference at powers above 0.15 mW ERP (LTE signal transmitted from a 3 m distance). This is a conservative figure with the cordless audio transmitter and receiver within 1.5 m of each other, whereas normal operating conditions for the cordless audio equipment would probably be in the range 3-5 m.

One unit also showed interference from the base station transmit frequencies, which could well affect a large percentage of existing wireless headphone users.

## G.2 Introduction

The frequency allocation of 863-865 MHz for cordless audio devices has been available since the mid-1990s. It is primarily populated by a mix of consumer and semi-professional equipment which has a life expectancy in excess of nine years and professional equipment whose life expectancy will be greater than twelve years: therefore currently there will be a wide range of equipment in use which will be both analogue and digital. In addition to these devices there is an allocation at 864.8-865 MHz for cordless baby alarms; these have not been tested but are likely to have a poorer immunity as they normally conform to EN 300 220.

Whilst the specific applications vary, the fundamental requirement is to receive audio frequency data (from voice or other source), convert it to RF and transmit to a receiver, where it is demodulated back to audio frequency for onward transmission or use. Transmitters may be built into microphones or have an audio input socket. Receivers may be integrated into headphones or have an audio output socket.

The information and technical specification of the Electronic Communications Networks (ECN) systems will be found in CEPT Report 30 and ECC Decision (09)03. Information sources used within this document can be found in the ETSI docbox at:

http://docbox.etsi.org/Etsi_Cenelec/PUBLIC%20FOLDER%20on%20DD/

## G.3 Cordless audio devices found in the 863-865 MHz band

Cordless audio devices intended for use by consumers or professionals are available in a wide variety of application-specific forms. Audio quality and receiver performance will vary greatly between consumer and professional equipment. Common uses include:

- Wireless headphones for consumer markets. These will commonly be plugged into the headphone outlet of televisions, radios, Hi-Fi systems, games consoles and similar devices;
- Consumer radio microphones, used with karaoke systems, camcorders and similar devices;
- Radio microphones for semi-professional markets;
- Radio microphones for professional markets;
- Portable wireless microphone and receiver for professional markets;
- Butt transmitters, these are plug-on units for existing audio microphones;
- In Ear Monitoring systems (IEM) enable performers to hear the combined audio output of other musicians or singers;
- Tour guide systems. These systems allow a tour guide to provide a commentary on the subject of the tour. In some cases there will be more than one frequency in use to allow additional languages to be used; a voice quality 7 kHz audio bandwidth is common in these devices;
- Baby Alarms consisting of a sensitive microphone in the vicinity of a baby with the receiver adjacent to parents or other adults.

These devices may use FM or digital modulation with an output power below 10 mW. The receivers are capable of receiving signals in the 863-865 MHz band.

# G.4 Test setup

The objective was to determine if ECNs operating in the reallocated band 790-862 MHz using LTE modulation will cause interference to incumbent devices transmitting and receiving in the 863-865 MHz band. As the cordless audio devices consists of two parts (a transmitter that broadcasts to a receiver or receivers in the vicinity), it was necessary for both components to be operating normally in the presence of an interfering signal in the 790-862 MHz band to determine if there is potential for interference to the transmitter and/or the receiver.

ECNs are primarily a data service, unlike the existing GSM systems which are primarily voice orientated. Initial offerings of ECNs using LTE modulation schemes are likely to include data dongles which may well be in close proximity to domestic equipment. Various tests have been carried out within Europe and ECN terminal units have been shown to cause interference up to 4m from the terminal unit, this means that terminal units in adjacent flats or rooms may well generate interference into domestic setups. As these devices migrate into 'mobile phones' the possibility of these being in close proximity to radio microphones or even on the user of the cordless audio device will increase.

The cordless audio devices were set up in the anechoic chamber at a 3m separation distance from the interferer antenna. Initially the cordless audio transmitter was located centrally and held stationary whilst the output of the receive unit was monitored as it was being moved around in proximity to the cordless audio transmitter. The locations were exchanged, and testing repeated. Moving the cordless audio units enables the impact of any nulls or peaks in the transmit power of both the LTE and cordless audio signals to be overcome.

The devices were either mains-powered or powered by fully-charged or new batteries.

A 1 kHz audio tone was supplied to the transmit device, and the output of the receive device monitored on headphones in every case.

The interferer was a 316 mW ERP LTE signal transmitted in a 10 MHz bandwidth, using a Frequency Division Duplex scheme. The characteristics of the signal are contained in Table 1.

| Radio format | Bandwidth | Standard rev | Access technique | Modulation | Waveform name |
|---|---|---|---|---|---|
| FDD Uplink | 10 MHz | 2008-09 | SC-FDMA | Full-filled QPSK | LTE_FDD_UL_10 |

**Table 1: LTE modulation parameters**

The field strength was monitored by a NARDA probe, which can be seen in Figure 2 below.

**Figure 2: A tour guide system comprising of transmitter (square black device) and receiver (blue headphones with integral receiver) during test preparation. The 1 kHz tone generator can be seen behind the transmitter, and a NARDA field strength probe can be seen behind that.**

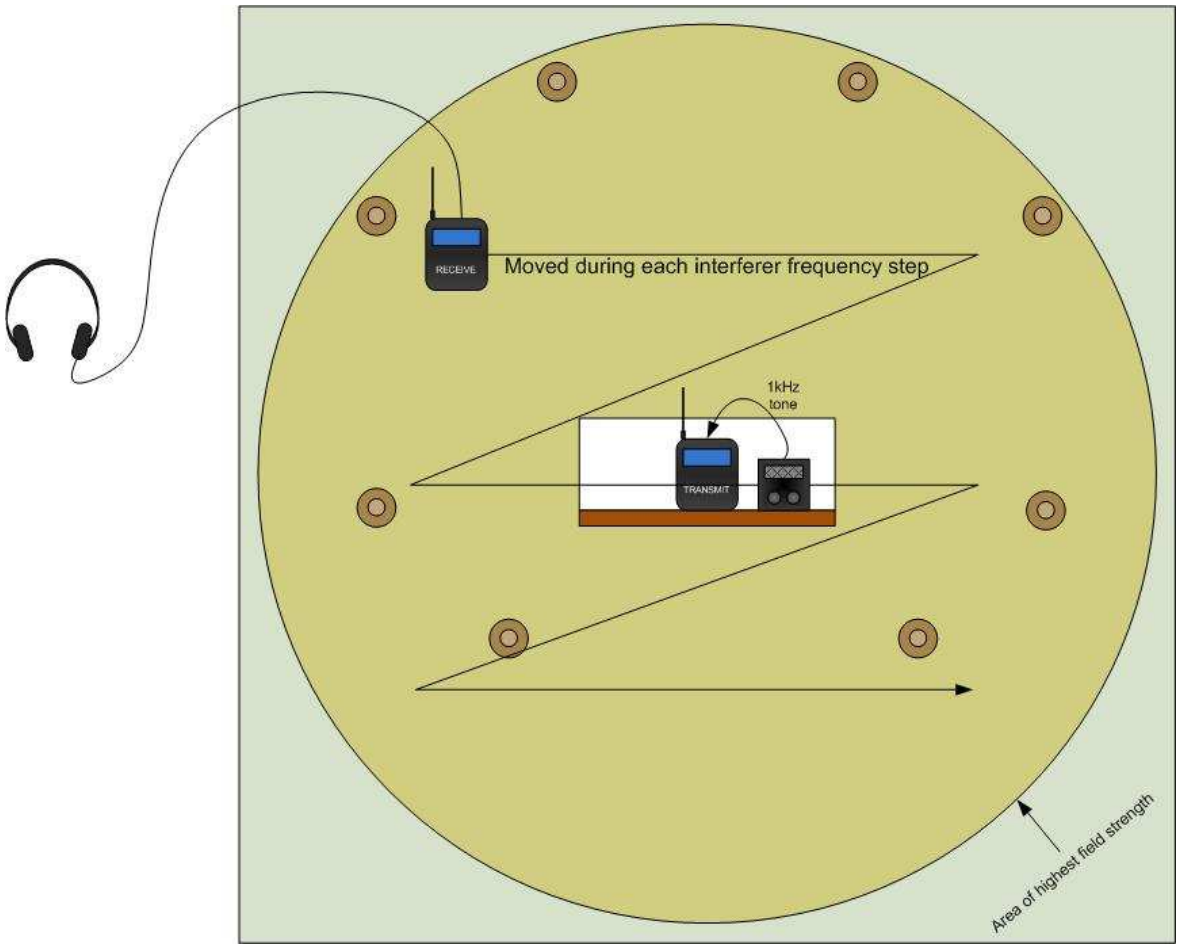


**Figure 3: Test support board layout. In this example a portable transmitter broadcasts from a central location and a portable receiver is moved around the board.**

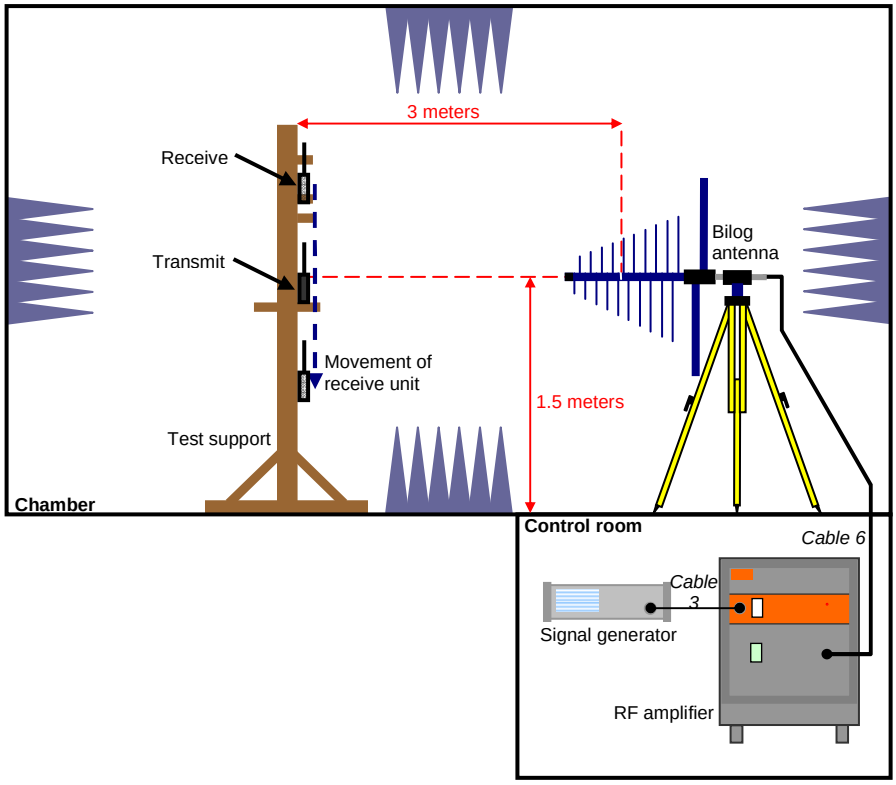


**Figure 4: Test environment and arrangement of equipment**

# G.5 Observations

These results were obtained from 4th-12th May 2010.

| LTE generator centre frequency (1 MHz steps) | FM Wireless headphones | Semi-professional radio microphone | Professional radio microphone system 1 | Professional radio microphone system 2 | Professional portable wireless microphone and receiver | Tour guide system |
|---|---|---|---|---|---|---|
| 700-769 | | | | | | |
| 770-779 | * | | | | | |
| 780-789 | ** | | | | | |
| 790-799 | ** | | | | | |
| 800-809 | ** | | | | | |
| 810-819 | * | | | | | |
| 820-829 | * | * | | | | |
| 830-839 | ** | ** | | | | |
| 840-849 | ** | * | | | | |
| 850-856 | ** | ** | | | | |
| **857 - highest potential 10 MHz LTE Centre Frequency** | ** | ** | *** | | | |

Key:

| | |
|---|---|
| * | Mild LTE noise present |
| ** | Moderate LTE noise present |
| *** | Strong LTE noise present |

**Table 2: Cordless audio devices operating in 863-865 MHz. Susceptibility to LTE operating from 700 – 857 MHz.**

When listening to high quality music over a system any noise or interference is unacceptable. Where a radio microphone is in use, any interference will ruin a production or cause the audio amplification to overload with possible harm to the audience.

System susceptibility varied dependant on the physical location of the receiver relative to both the interfering transmission antenna and the cordless audio transmitter: nulls and peaks were detected during lateral movement around the 3m separation point, which in most cases had a reasonable or dramatic effect on the scale of the interference.

Where the operating frequency could be selected, 861.3 MHz was set as the frequency of transmission/reception for the cordless audio unit. Where selection could not be made, transmission was within the 863-865 MHz band.

A 10MHz bandwidth LTE signal with a centre frequency of 857 MHz will occupy the range 852-862MHz.

## G.5.1 Immunity level of cordless audio against an 857 MHz LTE signal

Three of the six devices tested are susceptible to signals radiated within the proposed 790-862MHz band. ECC Decision 09/03 provides for a terminal unit power of 23dBm +/- 2dB. For the purposes of testing a 25dBm signal has been used and stepped down where interference was observed, in an attempt to discern the power boundary where interference ceases. Table 3 shows the signal levels where interference to the cordless audio equipment starts to be observed.

| | Radiated power (ERP, dBm) | Radiated power (ERP, mW) |
|---|---|---|
| **FM Wireless headphones** | 13.96 | 24.88 |
| **Semi-professional radio microphone** | 15.3 | 33.88 |
| **Professional radio microphone system 1** | -8.14 | 0.15 |

**Table 3: Maximum 10 MHz bandwidth LTE signal power**

In addition whilst the base station out-of-band emissions are stringent at -49.5 dBm EIRP, there is the possibility of interference from base stations under some circumstances, especially with the older cordless audio and baby alarm systems. The slide below reproduced by kind permission of UK Ofcom provides a graphic view of the energy dispersion over the band; this is obtained from the block edge mask contained in CEPT Report 30.

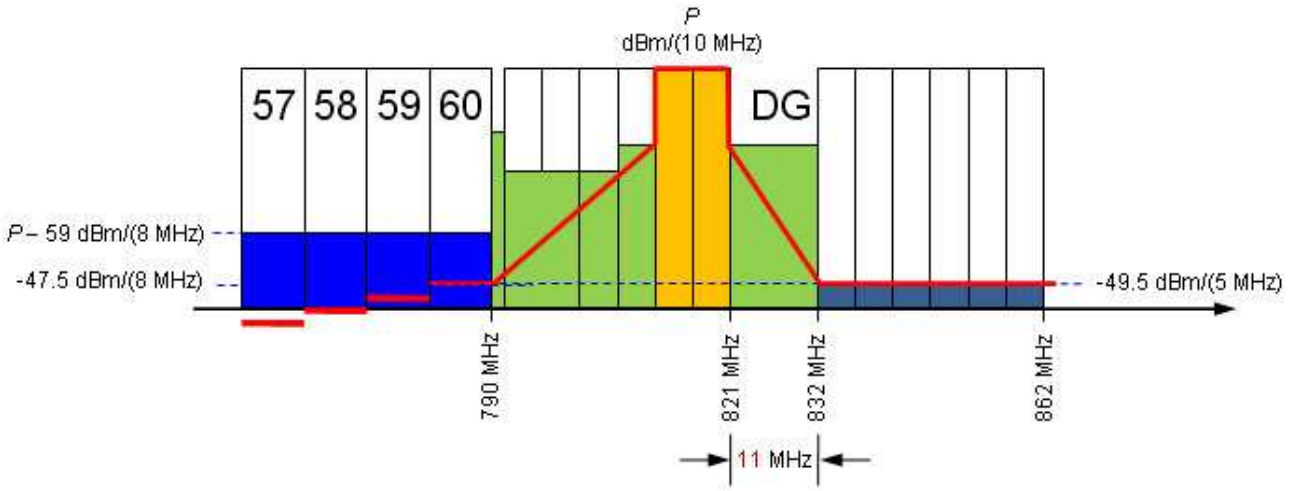


**Figure 1: Excerpt from presentation "MFCN base station emission limits for different 800 MHz licensees", UK Ofcom.**

# History

| Document history | | |
|---|---|---|
| V1.0 | February 2010 | Document creation following JWG consultation and February meeting |