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Public Consultation On The Technical Specification For The Integrated Receiver Decoder For Use  
With The Second Generation Digital Terrestrial TV Broadcasting System (DVB-T2).

Consultation Response from Dolby Laboratories Singapore

**To:**

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## 1. Executive Summary

Dolby welcomes the opportunity to provide comments in the Industry Dialogue on the Singapore DVB-T2 Draft Technical specification (**Draft IDA TS IRD-T2**).

Dolby feels honored and privileged regarding the inclusion of Enhanced AC-3 (E AC-3) as part of the specification for multichannel audio codecs. We remain committed to working with the Media Development Authority, iDA Singapore, and local stakeholders to ensure that content creators and broadcasters receive our full breadth of technical and commercial support. We remain assured that with the inclusion of Dolby technologies, Singapore viewers will receive the best entertainment experience possible in future DVB-T2 broadcasts.

- Dolby Laboratories is a global leader in broadcast audio technology and has participated in many successful digital television rollouts in Asia, Europe and the Americas.
- Dolby believes that inclusion of advanced multichannel audio decoding is an essential requirement for HDTV platforms. Dolby therefore welcomes the inclusion of E-AC3 technology in the Second Generation Technical Specification. Dolby also notes the inclusion of HE-AAC audio technology.
- Dolby looks forward to continuing and developing our support for the Singapore broadcast industry to enable Singapore program makers, broadcasters, retailers and consumers all to benefit from the enhanced experience and consistency that E-AC3 technology provides.
- Dolby also proposes additional requirements to ensure loudness consistency across all audio formats and all receiver outputs.

## 2. Statement of Interest

Dolby Laboratories is the global leader in technologies that are essential elements in the best entertainment experiences. Founded in 1965 and best known for high-quality audio and surround sound

Dolby Singapore Pte Ltd. is a wholly-owned subsidiary of Dolby Laboratories, managing the Dolby sales, marketing, and technical support functions for the South East Asia region.

- Dolby Laboratories is a global leader in broadcast audio technology. Dolby creates technology, tools and services that enable superb broadcast audio to be created, distributed, transmitted and enjoyed in the home.

- Dolby AC-3 audio technology, known in the market as Dolby Digital, has been on-air in Singapore since 2007 for first generation HD terrestrial services. Dolby has provided training and assistance to Mediacorp and other parties to enable production and transmission of exciting surround sound programming. AC-3 technology is also used by Starhub and Singtel for their HDTV services.
- Dolby created E-AC3 audio technology as a solution for delivering audio for next generation broadcast and electronic media applications. This technology has been openly standardised by international broadcast organisations including DVB, ETSI and ATSC for digital broadcast applications. Decoding of this technology is included in the Second Generation Technical Specification.
- Dolby also contributed to the HE AAC audio technology and, through our subsidiary Via Licensing, operates the licensing scheme on behalf of the patent pool. Decoding of this technology is included in the Second Generation Technical Specification.
- Dolby has a regional hub office in Singapore which is a base for our support, sales and marketing efforts within the media technology industry in South East Asia. This team includes broadcast systems specialists who can support broadcasters with practical expertise in broadcast systems designs and operations. This team will relocate to Mediapolis in 2013 as part of expansion to support the digital terrestrial transition.

### **3. Comments on the Second Generation Technical Specification**

#### **Audio Decoding**

- Dolby welcomes the inclusion of E-AC3 audio decoding in the Technical Specification as a mandatory requirement in **Section 4.3.4**. This is in-line with other next generation DVB terrestrial platforms, including UK, France, Spain, Italy, Sweden, Finland, Serbia, Poland and South Africa. This requirement will enable broadcasters to put great quality surround, stereo and mono audio on-air and will enable consistent receiver behaviour for consumers. It will also enable efficient usage of spectrum due to the proven capability to broadcast to all listeners (surround, stereo, mono) with a single audio stream.
- Furthermore Dolby notes that, in other markets where E-AC3 has been mandated, receivers are available with the technology at a broad range of price points including very low cost set-top boxes. Dolby has made commitments to DVB and ETSI to license E-AC3 technology on a Fair Reasonable and Non-Discriminatory basis. E-AC3 technology is widely available and is already incorporated into DVB-T2 televisions and set-top boxes from large and small manufacturers.
- Dolby also notes the inclusion of HE AAC Level 4 decoding as a mandatory requirement in **Section 4.3.4**. Dolby welcomes the inclusion of the audio transcoding feature described in **4.3.4.4** and **4.3.4.5** which will ensure better consistency for viewers with home cinema systems.

- Dolby notes that similar requirements for E-AC3 and HE AAC decoding and output transcoding exist in many other DVB terrestrial specifications, including EBU Tech3333, the UK D-Book, NorDig, and the Italy D-Book. Combined audio decoder implementations are widely available integrated into TV/set-top box chips to make it easier for manufacturers to meet these requirements. As a result, Dolby observes wide availability of this combined audio decoder feature set in DVB televisions and set top boxes including low cost DVB-T2 HD set top box models retailing to consumers at GBP£39 or less (including VAT).

#### **Loudness Matching**

- Dolby notes that, in our discussions with the Singapore broadcast industry, there appears to be strong interest in ensuring consistent loudness behaviour in receivers, regardless of the audio format or output used.
- Dolby welcomes the mandatory inclusion of E-AC3, HE AAC and MPEG1LayerII decoding in the Second Generation Technical Specification, as this provides the opportunity to mandate specific requirements to enable consistent loudness behaviour across all formats and all outputs.
- Dolby notes the inclusion of requirement **4.3.7**, requiring loudness alignment between audio formats. However, due to the flexibility and differences in the ways that E-AC3, HE AAC, and MPEG1LayerII audio can be configured, Dolby recommends that further language be added to clarify loudness matching requirements and ensure consistent and predictable implementation across all receivers.
- E-AC3 and HE AAC technology include the capability to set a target output level. For good consistency compared with MPEG1LayerII legacy services, Dolby recommends that a target output level is specified for the E-AC3 and HE AAC audio decoders that is equal to the typical loudness level of legacy MPEG1LayerII broadcast services. For DVB terrestrial platforms, this typically falls in the range -18 to -24 LKFS. Dolby notes that the EBU has recently recommended -23 LKFS as the target loudness for broadcast services, and that this target level is now included in many regional specifications as the target output level for E-AC3 and HE AAC decoding.
- Dolby also notes that the typical output level required for multichannel coded audio outputs is -31LKFS. To ensure level matching when coded audio output mode is enabled, any decoded stereo PCM audio presented on the digital output should also be normalised to -31LKFS.
- Dolby therefore recommends that **section 4.3.7** be supplemented as follows:

#### Loudness Matching

The IRD-T2 shall apply format dependent attenuation to decoded stereo PCM audio, in order to achieve loudness alignment between different input formats. The target output level for decoded E-AC3 and HE AAC audio at the stereo output is -23LKFS. Where the digital output connector is enabled for multichannel coded audio,

the target output level for coded multichannel and decoded stereo audio is -31LKFS.

#### **4. Conclusion**

- Dolby welcomes the mandatory requirement for E-AC3 audio decoding in the Second Generation Technical Specification for Singapore. This will enable broadcasters to put great sounding HD services on the air in full surround sound, whilst ensuring efficient use of spectrum. For the Singapore consumer, it will enable a great and consistent audio experience, whether they listen in surround, stereo or mono.
- Dolby also notes the inclusion of HE AAC audio decoding. Dolby observes that mandatory inclusion of E-AC3 and HE AAC decoding is required by many other regional specifications, and that both decoders are present in even very low cost set-top boxes.
- Dolby notes the interest in the Singapore broadcast industry in ensuring consistent loudness behaviour in broadcast receivers, and recommends minor additions to the specification language to make requirements more explicit.
- Dolby continues to invest in Singapore as a hub for collaboration with the broadcast and wider media industry in South East Asia. Dolby believes that audio plays a key role in establishing successful HD platforms, and is committed to supporting the development of production and broadcast systems expertise in the local industry to ensure that this is the case in Singapore.

Dolby Laboratories Singapore is grateful for the opportunity to comment in the Industry Dialogue. We stand by to support the roll-out of immersive, entertaining, and compelling DVB-T2 services for all Singaporeans.



**Annex A: Technical Bulletin 11**

- *This document is marked as confidential.*



**Annex B: Audio Technologies for European Digital Terrestrial TV**

- *See attached document.*





**Annex C: Low Cost Receivers DVBT2 with E-AC3/Dolby Digital Plus (UK DVBT2 examples)**

## Sharp TU T2



Only £39 (S\$77)

Even budget DVB-T2 receivers include Dolby Digital Plus

All UK DVB-T2 Freeview HD receivers feature Dolby Digital Plus

**Public Web Links references to UK DVBT2 receivers:**

- [http://www.amazon.co.uk/s/ref=nb\\_sb\\_noss\\_1?url=search-alias%3Daps&field-keywords=freeview+hd+box](http://www.amazon.co.uk/s/ref=nb_sb_noss_1?url=search-alias%3Daps&field-keywords=freeview+hd+box)
- <http://www.freeview.co.uk/HD/Products>

## Audio Technologies for European Digital Terrestrial TV

*Information prepared for Singapore receiver specification – August 2012*

This information is presented under the following headings:

International codec standards, (as specified in the DVB reference document ETSI TS 101 154)

- Dolby Digital (AC-3 as described in ETSI TS 102 366)
- Dolby Digital Plus (EAC-3 as described in ETSI TS 102 366)
- Dolby Pulse (based on HEAAC as described in ISO/IEC 14496-3)
- HEAAC (as described in ISO/IEC 14496-3)

International Broadcast Standards

- DVB: The Digital Video Broadcasting specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream (ETSI TS 101154)
- DVB: The Digital Video Broadcasting Specification for Service Information (SI) in DVB systems (ETSI EN 300 468)

Local / Country Specific Broadcast Standards

- EBU: HDTV Receiver Requirements (EBU – TECH 3333)
- UK: The UK Digital TV Group. Digital Terrestrial Television: requirements for Interoperability (The D-Book; Issue 6.1)
- France: HD Forum. Functional and signal specifications for HD DTT (TNT) (Version 2.4.e)
- Italy: HD Forum Italia. Compatible High Definition receivers for the Italian market: baseline requirements. (HD Book Final 2.0)
- Poland: Requirements for the Polish Digital Terrestrial Television Receiver, Profiles 0,1 & 2
- Scandinavia and Ireland: NorDig Unified Requirements for Integrated Receiver Decoders for use in cable, satellite, terrestrial and IP-based networks (ver 2.2.1)
- Spain: Foro Técnico de la televisión digital. Especificación de receptores de televisión digital terrestre para recepción de alta definición. (Versión 1.0.2)

It will be seen that the DVB standard lists Enhanced AC-3 (Dolby Digital Plus) as one of several audio codecs that may be used with HD services. No one codec has any mandatory status over another.

It will also be seen that all the countries listed have specified Enhanced AC-3 (Dolby Digital Plus) audio in conjunction with HEAAC audio to be built into receivers as a mandatory requirement for HD services. In each case it is expected to be the choice of the terrestrial broadcasters as to which audio system they chose to transmit.

Of the HD Terrestrial TV services on air as of January 2012, Dolby Digital Plus is being transmitted in France, Poland and Spain for stereo and surround sound. German Terrestrial TV remains with Dolby Digital audio on a DVB T1 service Finland is currently using Dolby Digital for surround. The UK is still broadcasting AAC audio (not HEAAC). Norway and Denmark are broadcasting surround with HEAAC while Sweden is testing Dolby Digital Plus. Italy, Ireland, and Portugal are currently broadcasting in stereo only.

## **1) International codec standards**

### Dolby Digital (AC-3 as described in ETSI TS 102 366)

The audio used on DVD, US and DVB TV services with MPEG2 video. All decoders provide stereo decoding (including 5.1 down-mix) and a surround output.

### Dolby Digital Plus (E-AC-3 as described in ETSI TS 102 366)

The new generation of Dolby Digital; used on BluRay and TV services with H.264 video. All decoders provide stereo decoding (including 5.1 down-mix) and a surround output. A Dolby Digital Plus decoder includes Dolby Digital decoding and a Dolby Digital bit-stream output for compatibility with all home theatres systems; but the combination of Dolby Digital and Dolby Digital Plus decoding is available for the same royalty as Dolby Digital alone.

This specification can be found at:

[http://www.etsi.org/deliver/etsi\\_ts/102300\\_102399/102366/01.02.01\\_60/ts\\_102366v010201p.pdf](http://www.etsi.org/deliver/etsi_ts/102300_102399/102366/01.02.01_60/ts_102366v010201p.pdf)

### Dolby Pulse (based on HEAAC as described in ISO/IEC 14496-3)

The bandwidth efficiencies of HEAAC (High Efficiency AAC) coupled with true Dolby metadata and a Dolby Digital surround bit-stream output for compatibility with home theatre systems. All decoders provide stereo decoding (including 5.1 down-mix) and a surround output..

*All the above technologies use true Dolby metadata to signal 5.1 audio to decoders, to control the stereo and mono down-mixes and to provide loudness control and dynamic range optimization.*

### HEAAC (as described in ISO/IEC 14496-3)

Surround sound capability is possible and requires a more complex decoder and additional technology to provide a digital output for home theatres, like that offered by Dolby Pulse.

## 2) International Broadcast Standards

The Digital Video Broadcasting (DVB) specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream - ETSI TS 101154

This specification can be found at:

[http://www.etsi.org/deliver/etsi\\_ts/101100\\_101199/101154/01.10.01\\_60/ts\\_101154v011001p.pdf](http://www.etsi.org/deliver/etsi_ts/101100_101199/101154/01.10.01_60/ts_101154v011001p.pdf)

The relevant portion for audio is Section 6.

### 6 Audio

This clause describes the guidelines for encoding MPEG-1 or MPEG-2 Layer II backward compatible audio, or AC-3 audio, or Enhanced AC-3 audio, or DTS audio, or MPEG-4 AAC audio, or MPEG-4 HE AAC audio, or MPEG-4 HE AAC v2 audio, or combinations of MPEG Surround audio with MPEG-1 Layer II, MPEG-4 AAC audio, or MPEG-4 HE AAC audio, or MPEG-4 HE AAC v2 audio in DVB broadcast bitstreams, and for decoding this bitstream in the IRD.

The following clauses do not imply that either MPEG-1 audio, or MPEG-2 Layer II backward compatible audio, or AC-3 audio, or Enhanced AC-3 audio, or DTS audio, or MPEG-4 AAC audio, or MPEG-4 HE AAC audio, or MPEG-4 HE AAC v2 audio, or combinations of MPEG Surround with MPEG-1 Layer II, MPEG-4 AAC audio, or MPEG-4 HE AAC audio, or MPEG-4 HE AAC v2 audio are mandatory. *The codecs that a given IRD supports will define which of the following clauses the IRD shall comply with.*

This states a list of “legal” audio codecs and is clear that none are mandatory, meaning any can be freely chosen. Enhanced AC-3 (Dolby Digital Plus) is included.

The Digital Video Broadcasting (DVB) Specification for Service Information (SI) in DVB systems - ETSI EN 300 468

This specification can be found at:

[http://www.etsi.org/deliver/etsi\\_en/300400\\_300499/300468/01.11.01\\_60/en\\_300468v011101p.pdf](http://www.etsi.org/deliver/etsi_en/300400_300499/300468/01.11.01_60/en_300468v011101p.pdf)

Carriage of Enhanced AC-3 (Dolby Digital Plus) is described in Annex D.

### Annex D (informative):

### Service information implementation of AC-3 and Enhanced AC-3 audio in DVB systems

This annex describes the implementation and implementation guidelines for DVB Service Information for conveying AC-3 and Enhanced AC-3 audio elementary streams within a DVB transport stream.

### 3) Local / Country Specific Broadcast Standards

EBU: HDTV Receiver Requirements EBU – TECH 3333

Section 5: Audio

#### 5. Audio

HD IRD shall fulfil the minimum decoding requirements for standard definition (SD) according to ETSI TS 101 154. For audio, the HD receiver shall provide at least one stereo decoder MPEG-1 Level 2. The receiver should support audio bitrates of up to 192 kbit/s per single audio channel and up to 384 kbit/s for two-channel stereo. In the case of transmitted stereo, the HD receiver shall support linear PCM at the digital output interface. In the case of a transmitted 5.1 audio signal, the HD receiver shall provide a downmix of the multichannel audio signal. The HD receiver shall provide support for 5-channel plus LFE (Low Frequency Effects), i.e. 5.1-channel surround sound corresponding to the loudspeaker layout described in ITU-R BS.775. In the case of simulcast, i.e. transmitted stereo and 5.1 audio signal, the HD receiver shall provide the transmitted stereo at its analogue and digital stereo output interface.

In this document the following notation is used:

**System A:** Dolby Digital Plus or E-AC-3 (DD+) transcoded to Dolby Digital or AC-3 (DD)

**System B:** HE AAC transcoded to DD or DTS

The audio may be carried by **System A** and/or by **System B**, as determined for the relevant network.

Both **System A** and **System B** shall be supported for networks where there is no mandatory operator acceptance of IRDs.

Either **System A** or **System B** may be required for networks where an operator is in charge of specifying the functionality of the IRDs and ensuring that the minimum requirements are met.

There follows a detailed table of specific audio requirements in which Enhanced AC-3 is mandatory in all 5.1 and stereo operational modes in “System A”.

This specification can be found at <http://tech.ebu.ch/publications/pid/4624>

The UK Digital TV Group:  
Digital Terrestrial Television: requirements for Interoperability (The D-Book). Issue 6.1

Section 4: Audio System Characteristics

Encoding	<p>All audio components associated with SD MPEG2 television and MPEG1 Layer II radio services shall be encoded according to <a href="#">ISO/IEC 13818-3</a> constrained according to <a href="#">TS 101 154</a>.</p> <p>When the video component is not SD MPEG2, the audio component may be encoded using Dolby E-AC3 encoding according to <a href="#">TS 102 366</a> or MPEG-4 High Efficiency AAC according to <a href="#">ISO/IEC 14496-3</a> (up to HE-AAC Level 4 excluding the use of the Parametric Stereo tool), in either case constrained according to <a href="#">TS 101 154</a>.</p>
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Section 22.3 HD AVC DVB-T2 receiver

**22.3.1.1 Video and Audio Decoding**

All receivers shall include MPEG-4 AVC video ([ISO/IEC 14496-10](#)) decoding, as constrained by the ETSI [TS 101 154](#) Specification for the use of Video and Audio Coding in Broadcasting Applications based on the [MPEG-2](#) Transport Stream. As a minimum, the following resolutions shall be supported: 720x576, 544x576, 480x576, 352x288, 1920x1080, 1440x1080, 1280x1080 at interlaced 25 frames/s; 1280x720, 960x720 at progressive 50 frames/s; 1280x720, 960x720, 1920x1080, 1440x1080, 1280x1080 at progressive 25 frames/s.

All receivers shall include Dolby E-AC3 audio (ETSI [TS 102 366](#)) decoding and MPEG-4 HE-AAC ([ISO/IEC 14496-3](#)) decoding, as constrained by the ETSI [TS 101 154](#).

HD Forum (France): Functional and signal specifications for HD DTT (TNT) version 2.4.e

Section 2.2 in the summary:

## **2.2. Audio**

- For every HD channels, various audio streams will be broadcast (French Version, Original Version, and audio description). These audio streams may be very different: mono, stereo, multi-channel. Chapter 3 lists the combinations or codecs to be supported and the way receivers should use these streams. It is important to note that, for multichannel audio, support of both Dolby Digital+ and HE-AAC is requested, which means that the downmixing of these streams should be implemented for receivers that are not connected to Home Cinema equipments.
- The transcoding of a multichannel HE-AAC component to Dolby Digital or DTS is mandatory only from Dec. 31, 2009 on.

There follows a detailed table (Chapter 3) of specific audio requirements in which Enhanced AC-3 (here referred to as Dolby Digital +) is mandatory in all 5.1 and stereo operational modes.



HD Forum Italia (Italy): Compatible High Definition receivers for the Italian market: baseline requirements. HD Book Final 2.0

Section 6, basic requirements, subsection 6.1.1.1 Mandatory features.

A/V Decoding		
<p>Audio Decoder (SD and HD modes)</p>	<p>The following standards shall be supported:</p> <ul style="list-style-type: none"> <li>- MPEG-1 Audio Layer I &amp; II</li> <li>- HE-AACv1 up to level 2 for stereo and level 4 for multichannel (5.1)</li> <li>- AC-3 (aka Dolby Digital)</li> <li>- Enhanced AC-3 (aka Dolby Digital Plus) up to 5.1 channels</li> </ul> <p>Receivers are required to support audio description in the following formats as per [10]:</p> <ul style="list-style-type: none"> <li>- MPEG-1 L2 broadcaster mix</li> <li>- MPEG-1 L2 receiver mix</li> <li>- HE-AACv1 and Enhanced AC3 receiver mix</li> </ul> <p>Receivers may support other modes of audio description. Receiver may support "clean-audio" in broadcaster-mix format.</p>	<p>Ref.: [9] Full decoding of stereo transmissions is mandatory for any of the standards listed aside.</p> <p>PCM Stereo downmix of 5.1HE-AACv1, AC-3 or Enhanced AC-3 transmissions is mandatory. Presentation of the downmixed analog signal on SCART and RCA outputs (if present) is mandatory.</p> <p>Transcoding of 5:1 HE-AACv1 transmissions to AC-3 or DTS and of Enhanced AC-3 transmissions to 5:1 AC-3 signal is mandatory unless the receiver provides a minimum 5 channel audio reproduction system capable of driving at least 5 speakers. Presentation of the transcoded or native AC-3 signal on SPDIF output (if present) is mandatory.</p>

This specification is available via <http://www.hdforumitalia.org/>

WYMAGANIA NA ODBIORNIK DLA POLSKIEJ NAZIEMNEJ TELEWIZJI CYFROWEJ  
Profil 0, 1 i 2 (Poland)

Section 1, Scope.

## **1. ZAKRES DOKUMENTU**

W niniejszym dokumencie zebrano parametry i zestaw wymagań, których spełnienie jest niezbędne do poprawnego odbioru sygnałów dostarczanych drogą rozświeczną naziemną wykorzystujących system DVB-T i strumień transportowy MPEG-2 do przesyłania usług stosowanych w telewizji cyfrowej w Polsce. Jako podstawowe wymagania przyjęto parametry odbiornika naziemnej telewizji cyfrowej zdefiniowanego w ETSI TS 101 154 [14] jako „25 Hz H.264/AVC HDTV video, MPEG-2 Layer 2 and E-AC-3 audio, for a Baseline IRD able to decode up to 1920 x 1080 interlaced 25 Hz video pictures or 1280 x 720 progressive 50 Hz video pictures”. Wymagania dotyczą odbiornika cyfrowego z dekoderm (IRD) występującego jako urządzenie samodzielne (STB) oraz stanowiącego odpowiednią część zintegrowanego odbiornika TV (iDTV), zasilanych z sieci energetycznej prądu przemiennego. Odbiorniki zasilane bateryjnie lub przez interfejs komputera nie są objęte niniejszą specyfikacją.

English translation:

Requirements for the Polish Digital Terrestrial Television Receiver, Profiles 0, 1 and 2  
Profiles 0, 1 and 2

1, Scope

Present document define the technical and exploitation requirements whose fulfilment is indispensable to correct reception of signals delivered by means of the terrestrial broadcasting using the DVB-T system and MPEG-2 transport stream to deliver audio-visual content and another services. As essential requirements we adopted parameters of the digital television receiver defined in ETSI TS 101 154 [14] as „25 Hz H.264/AVC HDTV video, MPEG-2 Layer 2 and E-AC-3 audio, for a Baseline IRD able are decode up to 1920 x 1080 interlaced 25 Hz video pictures or 1280 x 720 progressive 50 Hz video pictures”.

The requirements refer to the integrated digital receiver with decoder (IRD) available as independent device (STB) or consisting a suitable part of the integrated TV-set (iDTV), both supplied from the power network of the alternating current. Receivers supplied from battery or through computer interface are not covered by this specification.

This specification can be found at: [cyfryzacja.gov.pl/files/documenty/SPECv061.pdf](http://cyfryzacja.gov.pl/files/documenty/SPECv061.pdf)

NorDig Unified Requirements for Integrated Receiver Decoders for use in cable, satellite, terrestrial and IP-based networks (ver 2.2.1)

The audio decoder is specified in section 6.

**6.2 Additional Audio Decoder requirements for M4 Level**

**6.2.1 General**

The NorDig IRD shall support reception of multi-channel (up to 5.1) audio, as specified below, in addition to the mandatory audio requirements for the M2 level. The IRD shall provide audio outputs for stereo/mono and should provide outputs for multi-channel audio. There may also be additional audio channels and audio components for additional languages and/or for impaired people; these channels/components shall be treated as specified below.

The multi-channel audio may be carried by “System A” and/or via “System B”, as determined for the relevant network; i.e. both “System A” and “System B” shall be supported for networks where there is no mandatory operator acceptance of IRDs, while either “System A” or “System B” may be required for networks where an operator is in charge of specifying the functionality of the IRDs and ensuring that the minimum requirements are met.

**6.2.2 Audio formats**

The NorDig IRDs shall (see section 6.2.1) support reception of System A and/or System B, in addition to the audio requirements for the M2 level.

- System A: E-AC3 [36] with ability to transcode to AC3 [36]
- System B: HE AAC [57] with ability to transcode to AC3 [36] or DTS [33].

The audio system(s) shall be implemented as specified in this chapter.

Note that M2 and M4 are profiles with I the spec. M2 Level includes SDTV based on MPEG 2 video compression and M4 Level includes HDTV and SDTV, based on MPEG 4 AVC video compression. The NorDig IRD is specified to include both the M2 and the M4 Levels; i.e. backward compatibility with existing SDTV transmissions will be provided by NorDig compliant IRDs.

This specification can be found at: <http://www.nordig.org/>

Section 4.3 Audio decoding

**4.3.1 Audio Formats**

The program audio elementary stream is distributed in mono, stereo or multi-channel (5.1). In presence of audio 5.1 elementary streams the receiver shall make the down-mix from 5.1 to stereo, if no 5.1 output is active.

All audio streams shall correspond to one of the following profiles:

- Mono or stereo, in MPEG 1 Layer II, according to:
  - Minimum bandwidth of 64Kbps and a maximum of 128Kbps in mono;
  - Minimum bandwidth of 128Kbps and a maximum of 256Kbps in stereo;
- Mono, Stereo or multichannel 5.1 using Dolby Digital AC-3 and E-AC3, according to Digital Audio Compression Standard TS 102 366.
  - Support for data rates from 64kbps to 640kbps for AC-3.
  - Support for data rates from 32kbps to 3024 for Enhanced AC-3.

**Note:** - All sample rates required to be supported are listed in TS 102 366;
- Mono, Stereo or multichannel in AAC-LC (ISO/IEC 13818-7), AAC-HE V1 (ISO/IEC 14496-3:2001) or AAC-HE V2 (ISO/IEC 14496-3:2005)
  - Minimum bandwidth of 16Kbps and maximum of 32Kbps in mono.
  - Minimum bandwidth of 32Kbps and maximum of 128Kbps in Stereo.
  - Minimum bandwidth of 128Kbps and maximum of 256Kbps in 5.1.

This specification can be found at:

[http://www.televisiondigital.es/Terrestre/ForoTecnico/receptor-tdt/Documents/ReceptoresTDT\\_alta.pdf](http://www.televisiondigital.es/Terrestre/ForoTecnico/receptor-tdt/Documents/ReceptoresTDT_alta.pdf)