



# **Europa-family Audio Encoding Capabilities**

**Application Note for Harmonic DiviCom® Ion and  
Electra™ Encoders**

**Ver. 1.0**

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## 1.0 Audio Encoding technology overview

Audio, until recently, has taken second place to video in compression systems. As video bitrates have dropped, customers are beginning to pay more attention to the audio aspect of their systems. Some customers have the flexibility to move to the new more efficient codecs, while others are constrained by external factors (often regulations) to continue to rely on the older codecs. At the same time, multi-channel audio delivery has become increasingly important.

Harmonic announced a new family of encoders several years ago with the introduction of the Ion. This has been followed over time by various Electra-family members. These have a common chassis which is notably different from the older MV-family, featuring the ability to host more than one channel of compression in a single rack unit high chassis. This new chassis hosts not only the video/audio encoders but the latest multiplexer/stream processing family as well, the ProStream™.

It is very important to understand that Harmonic *must* remain neutral regarding the user's choice of audio codec. This is a similar situation to our support of various video codecs (we officially support 3, although only 2 are available as products). So we must not be perceived in the marketplace to “cheerlead” for any one codec over the others.

### 1.1 Audio Codecs

In contrast to the video encoding portion of an MPEG encoder, the audio encoder is usually purchased intact from one of several potential vendors of this technology.

Dolby<sup>1</sup> Digital (AC-3), Dolby Digital Plus, and Dolby E are, of course, sole sourced from Dolby Laboratories.

MPEG-1 Layer II, MPEG-2 AAC, HE AAC, and MPEG-4 AAC/HE AAC are available from several different vendors. Harmonic has purchased these from three different vendors, one of which is no longer in business. Our current vendors are Coding Technologies (AIC) and Fraunhofer IIS (AHC).

As a result of the change from Coding Technologies to Fraunhofer, Harmonic wishes to deprecate the use of the term “aacPlus™”, as this is a trademark of Coding Technologies<sup>2</sup>. The preferred use is of the term “HE AAC” which is not trademarked.

### 1.2 DSP Technology for Audio Codecs

Harmonic's original audio DSP designs used Motorola (now Freescale Semiconductor). These have not kept pace with the current DSP capabilities required for multi-channel encoding, so the newer designs rely on Texas Instruments (TI) DSPs.

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<sup>1</sup> Dolby, Dolby Digital, Dolby Digital Plus, Dolby E, and AC-3 are all trademarks of Dolby Laboratories.

<sup>2</sup> aacPlus is a trademark of Coding Technologies GmbH.

While the details of the underlying DSP should not be of concern to our staff outside of Engineering, it does determine encoder capabilities and is a driver for the number of audio options offered.

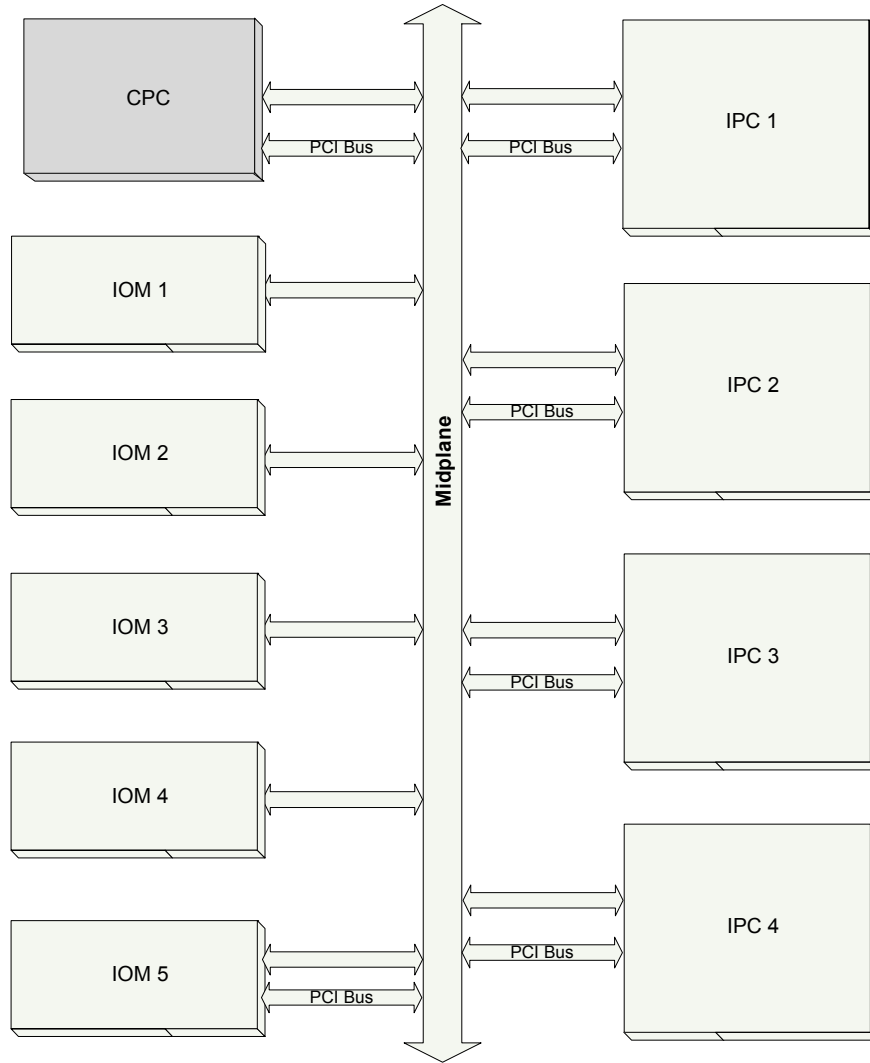
The key point to understand is that there are two different audio card families available on the Europa encoders, and that their capabilities are different and will always be different. This has led to confusion amongst Harmonic staff and is a major motivation in the writing of this Application Note.

## **2.0 Europa-family Architecture**

The Europa chassis design is 1 RU high (1.75 inches), 19 inches wide, and 22 inches deep (excluding cable connectors). The chassis can be configured as a 1, 2, 3 or 4-channel encoder.

The basic Europa chassis has one (1) Central Processing Card (CPC) connected to a midplane with up to four (4) optional Internal Processing Cards (IPC) and five (5) optional Input Output Modules (IOM). The IOMs have external connector access through back panels and can be replaced without opening the chassis. The IPCs do not have any direct external connector access and must have the lid removed to access these cards.

See the Block Diagram on the next page:



Europa Encoder Basic Block Diagram

The same chassis is used for both encoders and multiplexer/stream processing products. This Application Note will not discuss the multiplexer/stream processing products further.

The IPC cards are typically dedicated to video encoding, although more recent cards have both video and audio encoding capabilities.

## 2.1 Encoder IPC Cards Available

These account for the different encoder models within the Electra family as well as the Ion. At the time of this writing there are Ion, Electra 1000, Electra 5000, Electra 5400, and Electra 7000 encoders available. Each of these has a different IPC card which provides either MPEG-2 video compression or MPEG-4 Part 10 (“AVC”) compression (or both). The Electra 5400 and Electra 7000 cards are also capable of doing audio compression on the card as well, which is referred to as “Onboard Audio.”

### 2.1.1 Onboard Audio

The Electra 5400 and Electra 7000 compression boards each have a DSP mounted for audio compression. The audio is expected to normally be embedded in the video, but for non-embedded system architectures, the AHC-Base card will be available.

## 2.2 Encoder IOM Audio Cards Available

As noted earlier, these are based on either Freescale DSPs or TI DSPs, and as a result have very different capabilities.

### 2.2.1 AIC

The AIC card can compress two stereo pairs of audio, delivered to it as either analog (balanced) or AES3 or S/PDIF digital. AES3 digital may also be embedded in digital video.

### 2.2.2 AHC

The AHC card is a digital input only card capable of handling up to 4 stereo pairs, depending upon the associated daughter card mounted. There are 3 variants of AHC card:

- AHC-561
- AHC-RAC
- AHC-Base

The AHC also can accept either AES3 or S/PDIF digital. AES3 digital may also be embedded in digital video.

#### 2.2.2.1 AHC-561

The AHC-561 boasts a Dolby Cat. 561 daughter card which gives it the capability to do Dolby Digital or Dolby Digital Plus native multichannel encoding (5.1 channels) plus a stereo encode simultaneously. It can also do Dolby E to Dolby Digital or Dolby Digital Plus “transcoding.”

It has 4 BNC connectors to deliver the 3 pairs for the 5.1 encode and the 1 pair for the stereo encode. It also has a RJ45 connector (with a Harmonic supplied adapter) for Dolby metadata input. Note that Dolby metadata is a serial stream, not an Ethernet stream.

The Cat. 561 card does not perform AAC or HE AAC compression. System architectures requiring Dolby E to AAC or HE AAC “transcoding” will utilize the onboard DSP to perform the AAC or HE AAC compression, and thus be available only if either the 5400 or 7000 video card is present.

#### 2.2.2.2 AHC-RAC

The AHC-RAC carries its own DSP capable of one multi-channel encode or 3 pairs of stereo encode. It has 4 BNC connectors which can deliver the 3 pairs for the 5.1 encode and 1 pair for the stereo encode to an onboard encode (only if either the 5400 or 7000 video card is present). It also has a RJ45 connector (with a Harmonic supplied adapter)

for Dolby metadata input. Note that Dolby metadata is a serial stream, not an Ethernet stream.

The AHC-RAC card is capable of performing Dolby Digital, MPEG AAC or HE AAC, and MPEG-1 Layer II compression. It is expected to support MPEG Surround by sometime in 2008. Dolby Digital Plus compression may be added later.

### **2.2.2.3 AHC-Base**

The AHC-Base provides 4 BNC connectors (one is not used) permitting the onboard audio DSP to be fed 3 stereo pairs (6 channels) of non-embedded AES3 audio. It will not be an available option until late 2007.

### **2.2.3 ASI Card**

For the record, there is an ASI output card available, which is another IOM card. In the future there may be other IOM cards (such as an MPEG decoder card) offered.

## **3.0 Understanding Baseband Audio**

Baseband audio exists either as analog or digital waveforms. Analog is, of course, the most basic and the native form of audio (it is created by microphones and consumed by your ears). Analog audio may be carried by balanced or unbalanced lines (balanced is used in professional applications). The AIC card's analog input, while nominally balanced, can handle unbalanced inputs as well.

Analog signals are generally considered to include the frequency range of (roughly) 20 Hz to 20 kHz. They range in level from microvolts (the typical output of a microphone) to many volts (speaker levels for a large professional application). As a result, their levels are typically expressed in "dB" (abbreviation for decibel). A dB is a ratio between values, and can be measured either as a power ratio or a voltage ratio.

Professional audio systems measure level typically in terms of dBu, which is a voltage ratio based on 0.775 volts. The historical background is out of scope of this document (readers who wish to learn more may consult Digital Television Fundamentals by Robin and Poulin, 2nd Edition (ISBN 0-07-135581-2) or Audio Engineer's Reference Book by Talbot-Smith (ISBN 0-240-51528-5)).

It should be noted that older (tube-era) systems measured level in terms of dBm, which is the equivalent voltage level to dBu but requires 600 ohm terminations on all circuits.

### **3.1 Audio Reference Levels**

Professional analog audio systems are designed to operate with all signals normalized around a standard operating point referred to as the facility reference level. This is (for modern facilities) typically +4 dBu, but older facilities in the US may operate at +8 dBu. Many European facilities use 0 dBu as their reference level.

The operating level assures proper signal interchange and protects the signals' "headroom" (or ability to fluctuate without distortion). The concept of headroom becomes critical with the move to digital audio.

Digital audio levels are measured in relationship to what is termed "full scale," which is the point where all the bits are ones. There is no more signal level possible in this situation, and if an audio signal impacts full scale it becomes highly distorted.

Digital levels are thus expressed as "dBFS" or dB *below* Full Scale, always a negative number. Digital reference levels are either -20 dBFS (in accordance to SMPTE RP155) or -18 dBFS (in accordance to EBU Recommendation R68).

### **3.2 AES Digital Audio**

Digital audio was standardized by the AES and the EBU simultaneously, which is why many people refer to it as 'AES/EBU' digital audio. The EBU, however, is not actively maintaining the standard, so the actual normative document is AES3-2003 as of this writing. It defines a serial data stream which can transport digital samples of 16, 20, or 24-bit depths and at a variety of sampling frequencies. At 48 kHz, the bit rate will be 3.072 MHz. Most video systems work with 20-bit samples. CD resolution is 16-bits. The greater the number of bits the lower the signal-to-noise ratio. For 16-bits it is 94 dB, for 20-bits 118 dB, and for 24-bits 142 dB. Given that most audio is transmitted to be listened to in a home, 118 dB seems more than enough, and thus the use of 24-bit audio is limited (typically to the studio).

There is a consumer variant of the AES3 standard called S/PDIF and Harmonic's audio cards will accept that signal as well as AES3.

AES3 signals can be carried via either twisted pair or coax cables. The electrical characteristics are different (impedance and voltage levels) between these. Many audio facilities use twisted pair, but most video oriented facilities use coax. Adapters to convert between the two are widely available and reasonably cheap.

### **3.3 Embedded Digital Audio**

The SMPTE standards provide the method of formatting up to 8 stereo pairs (16 audio channels) in the ancillary data space of either an SD or an HD serial digital video signal. Embedding audio within the video signal offers advantages over traditional methods of building separate audio and video systems, particularly in broadcast facilities. Utilizing embedded audio offers a number of attractive benefits: simplified system design, reduced cable, distribution amplifier ("DA"), and routing switcher requirements, all of which lead to cost savings.

Harmonic only supports embedded digital audio that is synchronous to the carrying video. Only the 48 kHz sampling rate is fully supported in all products.

### 3.4 Multi-channel Digital Audio

With multi-channel “surround” mixing consoles the mapping of channels to audio pairs became vitally important. SMPTE has standardized it (SMPTE 320M “Method A”) and Harmonic will support this channel assignment mapping. It is:

Pair 1: L/R; Pair 2: C/LFE<sup>3</sup>; Pair 3: LS/RS

If a customer requires a different channel mapping, they will need to purchase outboard digital audio manipulation equipment to bring the audio into the right mapping.

### 4.0 Audio Compression Specifics

The MPEG Committee has always had an Audio Working Group. They have produced (in turn) MPEG-1 Audio, MPEG-2 Audio, MPEG-2 Advanced Audio (“AAC”), and more recently MPEG-4 Audio. Dolby has played a key role in the development of all of the MPEG audio codecs (and gets a sizeable proportion of the royalties!). This is not widely understood by the industry.

#### 4.1 MPEG Layer II Compression

The original MPEG-2 Audio Standard (ISO/IEC 13818-3-1993) specified a “BC” or “Backwards Compatible” (with MPEG-1 Layers I and II) coding mechanism. It permitted compatible methods to carry additional channels of “surround sound” information while permitting those listeners with simple stereo receivers to hear just the stereo portion of the signal. It did not offer any bitrate reductions, as that was not a goal.

It also provided a “NBC” for “Not Backwards Compatible” Layer, Layer III (which was not used by the broadcast industry widely, but was adopted by the computer industry as “MP3”).

#### 4.2 Dolby Digital and Dolby Digital Plus Compression

Dolby® Digital technology (also known as AC-3) is an efficient perceptual coder used throughout the world to deliver high-quality digital audio to consumers via DVD-Video discs, terrestrial and cable digital television systems, and direct broadcast satellite transmissions. Because of its widespread usage, there is an ever-increasing need for program content and transmissions with audio encoded with the Dolby Digital algorithm.

This is quoted from Dolby’s Professional Encoder Licensee information and provides a good summary of their technology. AC-3 is the compression standard chosen by the ATSC and is also recognized by the DVB. It has a number of unique features which were designed to ensure high listener satisfaction. These include elaborate metadata which assists the decoder in adjusting listening volume, downmixing from multi-channel to stereo, and other features. Dolby’s website ([www.dolby.com](http://www.dolby.com)) has a

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<sup>3</sup> LFE = Low Frequency Effects (the “.1” in 5.1)

great deal of technical background material available to read (click on “For Professionals”).

Dolby Digital Plus adds a number of new tools to the Dolby Digital algorithms to permit operation at lower bitrates. Dolby spent considerable time making sure that the audio quality was not going to be negatively impacted by these changes and has not been as aggressive in their claims as some MPEG audio proponents have been.

### **4.3 MPEG AAC and HE AAC Compression**

Sadly, there is much confusion surrounding AAC. One reason for the confusion is that AAC is documented in two quasi-parallel documents, one from the MPEG-2 Audio Working Group, known as ISO/IEC 13818-7, and the other from the MPEG-4 Audio Working Group, known as ISO/IEC 14496-3.

The MPEG-2 Audio Working Group produced the original AAC Standard in 1997. For a variety of reasons, this was not widely adopted. Meanwhile, the MPEG-4 Video Working Group, which focused on high coding efficiency for computer generated objects (and paid little attention to live video coding) had expanded to also focus on audio coding at much lower bitrates.

They realized that the MPEG-2 AAC techniques could be extended (including artificially generated sources) in a manner which was compatible with the original AAC decoders. The MPEG-4 Audio Working Group produced ISO/IEC 14496-3 in 2000, with a 2nd Edition completed in December of 2001. One notable change made by the MPEG-4 document is to completely redefine the original “profiles” defined in MPEG-2 AAC.

The result of this is needless user confusion. The MPEG-4 Group felt that they wanted to make many tools for generating artificial sounds (useful in computer games) available for certain other applications. As a result, they broke the tools from the MPEG-2 AAC “Main Profile” into separately specifiable tools. In a similar manner, they removed the “Low Complexity” profile in favor of an “LC” tool, which is a part of the MPEG-4 Main Profile.

Both MPEG Audio Working Groups cooperated on the development of a new tool called “Bandwidth Extension,” also known as “SBR” (an acronym for “Spectral Band Replication”), these additions were added in 2003 as Amendment 1 to ISO/IEC 14496-3-2001. A companion revision of the MPEG-2 AAC Standard was produced in 2003 and Amendment 1 which added SBR was adopted in 2004. The resultant coding is referred to as “HE AAC” (HE is an abbreviation for “High Efficiency”).

Harmonic’s implementation of AAC is a LC implementation, which in plain English means it excludes the set of tools intended for artificial sound generation as well as several others. Harmonic’s implementation of HE AAC adds the SBR tools to the LC tools (termed “SBR+LC” by some). It is noteworthy that LC also helps keep STB

processor and memory requirements realistic. The HE AAC tools require much more decoder power than simple LC.

There are a great many tools available in MPEG-4 AAC. Some of them, in time, may be added to “mainstream” broadcast usage. Most of them will not. The guidance of the DVB is especially valuable here. The current version of ETSI TS 101 154 includes the “latest, greatest” MPEG audio innovations. Harmonic’s choices have been guided by the DVB and we have been (and remain) an active participant in the revision of TS 101 154.

### **4.3.1 AAC Transport Encapsulations**

Coded audio does little good unless it can be delivered to the listener. While this may seem obvious, this aspect of coding systems is frequently ignored by the compression specialists until they are done with the base codec standard. Thus transport is frequently an after-thought. In the case of the original MPEG-2 AAC Standard, it was not. The Standard defined two transport encapsulations, one called ADIF for “Audio Data Interchange Format,” the other called ADTS for “Audio Data Transport Stream.” The names are quite descriptive of the intended usage.

As described in ISO/IEC 14496-3-2001 the transport for AAC/HE AAC audio is provided by two tools, known as LATM and LOAS. LATM is an acronym for “Low Overhead Audio Transport Multiplex.” LOAS is an acronym for “Low Overhead Audio Stream,” and furnishes an outer wrapper for LATM’s inner wrapper of the raw audio ES syntax. Their relationship is never really defined in unambiguous terms within 14496-3-2001, leading to a good deal of confusion.

#### **4.3.1.1 MPEG-2 AAC and HE AAC**

As noted above, the MPEG-2 AAC and HE AAC bitstreams are encapsulated as ADTS and carried in the MPEG-2 Transport Stream.

#### **4.3.1.2 MPEG-4 AAC and HE AAC**

As noted above, the MPEG-4 AAC and HE AAC bitstreams are encapsulated as LATM/LOAS and carried in the MPEG-2 Transport Stream.

## **4.4 Coding Modes and Channel Notation**

MPEG audio offers “stereo”, “joint stereo”, “mono”, and “dual mono” coding modes. Dolby Digital uses very different terminology and a single coding mode.

Dolby’s own documentation uses “n/m” where ‘n’ are the number of “front” channels and ‘m’ the number of rear channels. So stereo is expressed as 2/0 while surround 3/2 (the deficiency of this is that the LFE channel is not expressed).

The industry tends to use notation of “x.y” where ‘x’ are the number of full range channels and ‘y’ the number of limited range (LFE) channels. So we typically say 2.0 for stereo, 5.1 for surround with LFE, etc.

#### 4.4.1 SPPC

The encoders support a Separate PID Per Channel feature (SPPC) for MPEG-1 Layer II audio compression only. SPPC allows for two audio circuits per audio adapter port, effectively doubling the audio capacity of the encoder for mono (2 ports = 4 mono audio circuits). An appropriately optioned encoder can encode a maximum of 20 mono channels.

SPPC is supported by both AIC and AHC-RAC cards.

#### 4.5 Bitrates and Sampling Frequencies

Audio bitrate values were originally standardized by the DVB in TS 101 154 and have become accepted widely since. A similar list is given in ATSC A/52 for Dolby AC-3. Most other standards do not provide bitrate lists. Harmonic has chosen to keep these operating points for all of its supported codecs.

For MPEG-1 Layer II, these are 32, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320, 384 kbps. Typical operating points are 256 kbps for stereo.

For AC-3 these are 56, 64, 80, 96, 112, 128, 160, 192, 224, 256, 320, 384, 448, 512, and 640 kbps. Note that ATSC A/53 constrains AC-3 maximum bitrate to 448 kbps or lower. Typical operating points are 192 kbps for stereo, 384 kbps for 5.1.

For AAC these are 64, 96, 112, 128, 182, 192, 224, 256, 320, and 384 kbps. For HE AAC these are 32, 48, 56, 64, 96, 112, and 128 kbps. The SBR tool is automatically disengaged if the user selects a bitrate over 128 kbps. Typical AAC operating points are 112 kbps for stereo, 224 kbps for 5.1. Typical HE AAC operating points are 64 kbps for stereo, 128 kbps for 5.1.

Customers should be encouraged to choose their operating points for any audio codec based on listening tests with real program material. Some codecs handle different types of content better than others and several operating points may be desirable.

Sampling frequencies are constrained by the DVB to 32 kHz, 44.1 kHz, and 48 kHz. The ATSC only permits the use of 48 kHz. Most professional audio uses 48 kHz sampling.



## 5.0 Supported Encoder Configurations

### 5.1 AIC and Onboard

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio features with AIC					
Embedded audio	2 pairs per AIC, from any group (1-4)	2 pairs per AIC, from any group (1-4)	2 pairs per AIC, from any group (1-4)	2 pairs per AIC, from any group (1-4)	2 pairs per AIC, from any group (1-4)
External audio (AES or analog)	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC
MPEG-1 Layer II encoding (basic)	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC
AC-3 2.0 Encoding (basic)	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC
AC-3 pass-thru (basic)	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC
AAC/HE AAC 2.0 (license)	Not planned	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC	2 pairs per AIC
SPPC (MPEG-1 Layer II only) (basic)	4 channels per AIC	4 channels per AIC	4 channels per AIC	4 channels per AIC	4 channels per AIC

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio features with Onboard audio				when available	when available
Embedded audio	Not applicable	Not applicable	Not applicable	3 pairs max, must be from same group (1-4) Q3/Q4 2007	3 pairs max, must be from same group (1-4) Q3/Q4 2007
External audio (only input is from AHC, AIC is not planned to be supported)				3 pairs max Q3/Q4 2007	3 pairs max Q3/Q4 2007
MPEG-1 Layer II encoding (basic)	Not applicable	Not applicable	Not applicable	3 pairs max, Q3/Q4 2007	3 pairs max, Q3/Q4 2007
AC-3 2.0 Encoding (basic)	Not applicable	Not applicable	Not applicable	3 pairs max, Q3/Q4 2007	3 pairs max, Q3/Q4 2007
AC-3 pass-thru (basic)	Not applicable	Not applicable	Not applicable	2 pairs max, Q3/Q4 2007	3 pairs max, Q3/Q4 2007
AAC/HE AAC 2.0 (license)	Not applicable	Not applicable	Not applicable	3 pairs max, Q3/Q4 2007	3 pairs max, Q3/Q4 2007
SPPC (MPEG-1 Layer II only) (basic)	Not applicable	Not applicable	Not applicable	6 max, Q3/Q4 2007	6 max, Q3/Q4 2007
AAC/HE AAC 5.1 (license)	Not applicable	Not applicable	Not applicable	1 max, Q3/Q4 2007	1 max, Q3/Q4 2007
AC-3 5.1 Native encoding (license)	Not applicable	Not applicable	Not applicable	1 max, Q3/Q4 2007	1 max, Q3/Q4 2007
Note:				all pairs must use same compression standard	all pairs must use same compression standard

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio combinations with AIC assume no ASI board mounted					
Chassis with 1 video card	Up to 5 AIC cards => 10 pairs total	Up to 5 AIC cards => 10 pairs total	Up to 5 AIC cards => 10 pairs total	Up to 5 AIC cards => 10 pairs total	Up to 5 AIC cards => 10 pairs total
Chassis with 2 video cards	Either 1 AIC per each video card Either 2 AIC per each video card No other combination allowed	Either 1 AIC per each video card Either 2 AIC per each video card No other combination allowed	Either 1 AIC per each video card Either 2 AIC per each video card No other combination allowed	Either 1 AIC per each video card Either 2 AIC per each video card No other combination allowed	Either 1 AIC per each video card Either 2 AIC per each video card No other combination allowed
Chassis with 3 video cards	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed
Chassis with 4 video cards	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed	Only 1 AIC per each video card No other combination allowed
usable for Low resolution Service	Not applicable	Not applicable	yes, any	yes, any	yes, any

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio combinations with Onboard audio				when available	when available
Chassis with 1 video card	Not applicable	Not applicable	Not applicable	up to 3 pairs per each video card all pairs must use same compression standard	up to 3 pairs per each video card all pairs must use same compression standard
Chassis with 2 video card	Not applicable	Not applicable	Not applicable	up to 3 pairs per each video card all pairs must use same compression standard	up to 3 pairs per each video card all pairs must use same compression standard
Chassis with 3 video card	Not applicable	Not applicable	Not applicable	up to 3 pairs per each video card all pairs must use same compression standard	up to 3 pairs per each video card all pairs must use same compression standard
Chassis with 4 video card	Not applicable	Not applicable	Not applicable	up to 3 pairs per each video card all pairs must use same compression standard	up to 3 pairs per each video card all pairs must use same compression standard
usable for Low resolution Service	Not applicable	Not applicable	Not applicable	yes, any	yes, any

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio combinations with AIC + Onboard audio				when available	when available
Chassis with 1 video card (max 5 AIC)	Not applicable	Not applicable	Not applicable	up to 13 pairs or 10 pairs and 1 multichannel	up to 13 pairs or 10 pairs and 1 multichannel
Chassis with 2 video cards (either 1 or 2 AIC per each video card)	Not applicable	Not applicable	Not applicable	up to 7 pairs per video card or 4 pairs and 1 multichannel	up to 7 pairs per video card or 4 pairs and 1 multichannel
Chassis with 3 video cards (max 1 AIC per video card)	Not applicable	Not applicable	Not applicable	up to 5 pairs per video card or 2 pairs and 1 multichannel	up to 5 pairs per video card or 2 pairs and 1 multichannel
Chassis with 4 video cards (max 1 AIC per video card)	Not applicable	Not applicable	Not applicable	up to 5 pairs per video card or 2 pairs and 1 multichannel	up to 5 pairs per video card or 2 pairs and 1 multichannel

## 5.2 AHC Combinations

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio features with AHC RAC	when available	when available	when available	when available	when available
Embedded audio	Roadmap	Roadmap	Roadmap	up to 4 pairs per AHC, from any group (1-4), Q4 2007	up to 4 pairs per AHC, from any group (1-4), Q4 2007
External audio inputs (digital only)	Roadmap	Roadmap	Roadmap	up to 4 pairs per AHC, Q4 2007	up to 4 pairs per AHC, Q4 2007
MPEG1 Layer II encoding (basic)	Roadmap	Roadmap	Roadmap	3 pairs max, Q4 2007	3 pairs max, Q4 2007
AC-3 2.0 Encoding (basic)	Roadmap	Roadmap	Roadmap	3 pairs max, Q4 2007	3 pairs max, Q4 2007
AC-3 5.1 pass-thru (basic)	Roadmap	Roadmap	Roadmap	2 pairs max, Q4 2007	2 pairs max, Q4 2007
AAC/HE AAC 2.0 (license)	Roadmap	Roadmap	Roadmap	3 pairs max, Q4 2007	3 pairs max, Q4 2007
SPPC (MPEG1 Layer II only) (basic)	Roadmap	Roadmap	Roadmap	6 max, Q4 2007	6 max, Q4 2007
AAC/HE AAC 5.1 (license)	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007
AC-3 5.1 Native encoding (license)	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007

Encoder:	ION	Electra 1000	Electra 5000	Electra 5400	Electra 7000
Audio features with AHC 561	when available	when available	when available	when available	when available
Embedded audio	Roadmap	Roadmap	Roadmap	up to 4 pairs per AHC, must be from same group (1-4), Q4 2007	up to 4 pairs per AHC, must be from same group (1-4), Q4 2007
External digital audio inputs	Roadmap	Roadmap	Roadmap	up to 4 pairs per AHC, Q4 2007	up to 4 pairs per AHC, Q4 2007
AC-3 2.0 Encoding (basic)	Roadmap	Roadmap	Roadmap	3 pairs max, Q4 2007	3 pairs max, Q4 2008
AC-3 5.1 pass-thru (basic)	Roadmap	Roadmap	Roadmap	3 pairs max, Q4 2007	3 pairs max, Q4 2008
AC-3 5.1 Native encoding (license)	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007
Dolby Digital Plus 5.1 Native encoding (license)	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007
Dolby Digital Plus 7.1 Native encoding (license)	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007
Dolby E transcoding to AC-3 2/0, 5/1, or 7/1	Roadmap	Roadmap	Roadmap	1 max, Q4 2007	1 max, Q4 2007



## 6.0 FAQ

Which operators will use MPEG-2 AAC/HE AAC and which will use MPEG-4?

Operators based in Japan are constrained by Government regulations to use MPEG-2 AAC/HE AAC (ADTS encapsulation). The DVB has specified LATM/LOAS encapsulation, so all DVB compliant systems will choose MPEG-4 AAC/HE AAC.

Which operators will use MPEG AAC/HE AAC and which will use Dolby Digital/Dolby Digital Plus?

The ATSC currently only permits the use of AC-3 (Dolby Digital). They have standardized Dolby Digital Plus, with its use constrained to “E-VSB” operations (non deployed as of this writing).

Many other operators use AC-3 due to the huge penetration of Dolby compliant home theatre systems, which do not necessarily handle MPEG-1 Layer II surround or AAC/HE AAC surround. This may change over time, but be aware of this factor influencing codec choice.

Please feel free to submit additional questions! We expect to revise this document over time to keep it current.