

White Paper

Dolby E Processing Working with Dolby E in a Broadcast Environment

November 2011

What is Dolby E

Dolby E is an audio compression format that allows broadcasters to distribute surround and multi-channel audio throughout their facilities prior to transmission. As a professional audio coding system, it enables broadcasters to carry up to eight channels of audio using only a single AES/EBU pair. In addition to carrying multi-channel audio, Dolby E carries metadata, which makes it a compelling solution for carrying 5.1 surround soundtracks prior to transmission as Dolby Digital, or Dolby Digital Plus. Dolby E can be used within the broadcast infrastructure to carry multi-lingual, or other multiple-version programming using existing equipment. Due to its association with HDTV, Dolby E processing has become widely adopted and a standard requirement in most broadcast infrastructure products.

Features of Dolby E

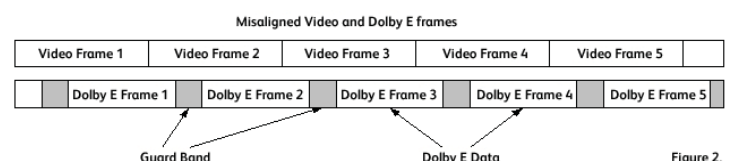
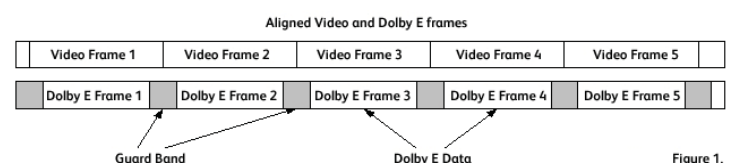
- A key feature of Dolby E is that its audio frames are synchronous and aligned with the corresponding video frames, so that programs can be switched and edited without having to decode the audio before any manipulation can take place.
- Dolby E is exceptionally high quality so it can be repeatedly encoded and decoded as required throughout the broadcast chain without any discernable loss of audio quality.
- Dolby Digital metadata is conveniently transported within the Dolby E audio stream (frames). This ensures that the intended user listening experience is maintained right from the initial encoded process. Metadata covers an extensive range of audio parameters and plays an important part in the decode process.
- Integration is simple, since Dolby E offers an easily quantifiable and manageable latency of exactly one video frame per encode, or decode cycle. This makes it easy to keep audio and video synchronous (maintains lip-sync), regardless of a broadcast system's complexity.

Dolby E System Awareness

A basic requirement of Dolby E is that Dolby E frames can be encoded and transported synchronously with video frames. Figure 1 illustrates correct synchronization between Dolby E frames and video frames. Conversely, Figure 2 shows unsynchronized Dolby E frames where the audio frames are misaligned relative to video frames. Unsynchronized Dolby E frames may result in audible glitches in decoders and lip-sync errors. In addition, the ability to perform seamless editing and switching can be seriously impacted. Dolby E relies on the correct alignment which is also paramount for the system to work correctly with Dolby E data.

Phase synchronization is a key requirement, as it maintains the seamless switching and editing property of Dolby E. Dolby E encoders will produce Dolby E frames with a specific alignment of phase relative to the video stream and Dolby E decoders will accept a certain tolerance of phase alignment. Therefore broadcast infrastructure products and systems are expected to maintain phase alignment to within a certain tolerance. The principal of phase synchronization is to keep each Dolby E frame as closely aligned to a video timing reference as possible. The ideal is to align each Dolby E frame to the exact video frame with which it is associated.

A term that is used in the context of phase synchronization is Guard Band (see Figure 1). The guard band refers to a number of audio sample locations that do not contain Dolby E data. The guard band is intended to be aligned with the editing and switching areas so that edits and switches will not corrupt Dolby E data. Equipment in a broadcast chain is expected to maintain the alignment with minimal impact on the position of the guard band, i.e. within a specific delay tolerance. Therefore, when the video is switched, or edited, there is no loss of Dolby E data. If the guard band has been delayed in time so that Dolby E data is now present at the switching and editing point, Dolby E data will be lost and audio corruption will occur.



When processing video streams containing Dolby E, care needs to be taken otherwise many issues can arise. Some examples are below:-

- 1. Delay issues:** Products that process the video stream but don't delay the audio stream to match the video processing delay will result in a misaligned video to Dolby E framing relationship. Therefore, the video frames will no longer be synchronously aligned to the Dolby E frames. Thus further processing actions could cause the corruption of Dolby E frames and consequently create artifacts such as audio pops and clicks, once decoded.
- 2. Dolby E frame alignment issues:** Switching between video streams that have aligned video and Dolby E framing, i.e. using video routers, can still cause the Dolby E frames to become misaligned due to the audio data sample distribution. Further processing could then cause corrupted Dolby E frames to be produced and again create artifacts such as audio pops and clicks, once decoded.
- 3. Switching issues:** Switching between misaligned audio streams (AES or Embedded audio) containing Dolby E content can result in corrupted Dolby E frames that when decoded will produce artifacts such as audio pops and clicks.
- 4. Data processing issues:** Dolby E is designed to pass through existing audio equipment. However, care must be taken as Dolby E can no longer be classed as purely audio due to its compressed nature. This means equipment has to be Dolby E aware so as not to apply the same audio functions that are familiar with normal audio, e.g. gain, phase inversion, audio sample rate conversion, mixing, etc. These functions if applied to Dolby E data will result in corrupted and/or unrecoverable Dolby E data with no ability to decode the Dolby E stream downstream.

Note:

Dolby E has been developed to a maximum frame rate of 30Hz. Video standards with a higher frame rate e.g. 50Hz, 59.94Hz will require greater system design care as Dolby E alignment will occur every 2 video frames. It should be noted that when a frame synchronizer drops or repeats video frames (greater than 30Hz) this will drop or repeat only half a Dolby E frame which will cause corruption of the Dolby E structure.

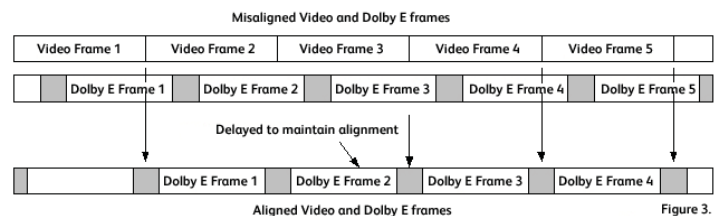
Dolby E Friendly Products

When handling Dolby E data, products need to be aware and have the ability to avoid the issues described earlier. For this reason, Snell has developed Dolby E friendly products that give the user the confidence Dolby E data is being handled with care and that system integrity is being maintained at all times. The following toolsets described below are necessary to resolving today's Dolby E issues. These tools significantly reduce system complexities and simplify Dolby E system integration as a whole. Snell products mostly utilize the quick alignment method of toolset 1 although some of our most advanced Dolby E alignment products provide both toolset 1 and 2. The smooth synchronization method is a Snell algorithm

which has been approved by Dolby. It should be noted that Dolby's recommendation is to have a minimum implementation of toolset 1.

1. Manual and automatic delay compensation

(Toolset 1): Snell Products have the ability to delay the Dolby E data by the amount of video processing delay being applied to maintain the correct alignment. Compensating for processing delays of equipment upstream i.e. streams with already misaligned video and Dolby E framing, can also be applied manually, or automatically and in fine or large step increments. Additional delay can be applied to the audio and video in steps of video frames. This is to pre, or post compensate for any Dolby E decoder, or encoder latency found up or down stream in the system. This is essential to correct for potential lip-sync issues.



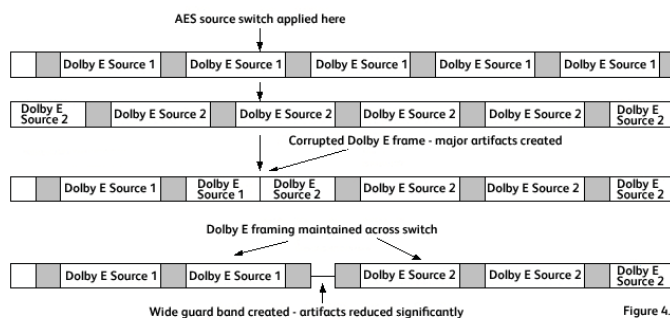
2. Auto Dolby E alignment tracking with smooth synchronization (Toolset 2):

Snell's unique Dolby E auto alignment feature has the ability to compensate for all misalignment eventualities, automatically. It constantly reads the position of the incoming guard band and not only initially corrects for any video and Dolby E framing errors but also maintains alignment through constant tracking and smooth synchronization. This is a unique Dolby E processing feature. Also, the user can custom specify a Dolby E framing point (video frame line number), or use broadcast system defaults providing total system flexibility. This flexibility enables, for example, post framing compensation for further processing delays that will be applied in the system downstream.

Previous product solutions in the market only had a quick one jump correction feature and did not constantly track and correct any subsequent drift of alignment. The main reason for constant tracking and smooth synchronization of the guard band and frame alignment is due to repeated upstream switching. This in turn causes a variable drift of the Dolby E frame alignment in respect to the video framing. This issue alone is a very common problem within systems carrying Dolby E.

Previous products also applied framing correction without the consideration of how Dolby E decoders will behave while the alignment is being applied. This is not the case with Snell Dolby E friendly products. All these issues are simply taken care of and thus provide a complete and seamless Dolby E correction system.

3. Dolby E aware switching: When switching between misaligned audio streams containing Dolby E content, a corrupted Dolby E frame results that, when decoded, will produce artifacts such as audio pops and clicks. To minimize this problem, Snell products take into account the Dolby E framing of the sources and only switch between sources in their respective guard bands.



A Dolby E aware switch generates a resultant Dolby E stream that produces significantly less artifacts to the decoded audio than a non-aware switch due to the guard band being preserved.

4. Data processing issues: Due to Dolby E being of a compressed audio nature, care must be taken to not apply regular audio functions that we so typically find in system architecture today. Functions like audio gain, phase inversion, audio sample rate conversion and audio mixing etc., when applied to Dolby E data will result in corrupted and/or unrecoverable Dolby E data with no ability to decode the Dolby E stream in future. Therefore, Snell Dolby E data aware products do not apply these familiar audio functions when working in a Dolby E environment.

Why buy Snell Dolby E friendly products?

The previously described undesirable system scenarios are caused by common working methodologies of today. Implementing Dolby E systems is demanding and fraught with potential for problems. Using Snell's unique Dolby E tools and safeguards makes system integration much easier and results in an altogether more dependable system, less likely to throw up spurious Dolby E errors, or even failures.

Dolby E required toolset

- Unique automatic Dolby E alignment with constant smooth synchronization
- Automatic Delay compensation
- Dolby E aware switching
- Dolby E data aware

Where to find Snell Dolby E friendly products?

Product availability

Alchemist Ph.C-HD Dolby E Authoring option
(Dolby E authoring, transcoding and decoding within motion compensated video standards (frame rate) conversion processing)

Mach HD V4 Dolby E transcoding option
(Dolby E transcoding and decoding within motion compensated video standards (frame rate) conversion processing)

IQDBD00/01**-2A
SD/HD Dolby D/E Processor, Decoder and Remultiplexer with advanced Dolby E handling

IQDBE00/01**-2A
SD/HD Dolby E Processor, Encoder and Remultiplexer with advanced Dolby E handling

IQDBE02/03**-2A
SD/HD Dolby D Processor, Encoder and Remultiplexer with advanced Dolby E handling

IQSYN3047-1A3
SD/HD/3G Frame Synchronizer with Embedded Audio Processing

IQSYN3147-1A3
Dual SD/HD/3G Frame Synchronizer with Embedded Audio Processing

IQOSY30**-1A3
SD/HD/3G Frame Synchronizer with Fiber Interfacing

IQSYN3354-2A3
SD/HD/3G Frame Synchronizer with Advanced Audio Processing

IQMUX3352-2A3
SD/HD/3G Multiplexer and Frame Synchronizer with AES/EBU and Analog Audio Inputs

IQDMX3352-2A3
SD/HD/3G Demultiplexer and Frame Synchronizer with AES/EBU and Analog Audio Outputs

IQUPC0054-2A3
SD/HD/3G Up Converter with Synchronizer

IQUCC0054-2A3
SD/HD/3G Up and Cross Converter with Synchronizer

IQUDC1054-2A3
SD/HD/3G Up, Down and Cross Converter with Synchronizer

IQDNC0054-2A3
SD/HD/3G Down Converter with Synchronizer

IQDNC0153-2A3
SD/HD/3G Downconverter with Analog Monitoring Outputs



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- IQDCC0054-2A3**
SD/HD/3G Down and Cross Converter with Synchronizer

 - IQUDC1153-2A3**
SD/HD/3G Up, Down and Cross Converter with Synchronizer and Analog Interfacing

 - IQUPC0153-2A3**
SD/HD/3G Up Converter with Synchronizer and Analog Interfacing

 - IQUAV1055-3A3**
SD/HD/3G Up, Down and Cross Converter with Audio Processing

 - IQSYN2126-1A**
SD/HD Frame Synchronizer with embedded audio processing

 - IQSYN2127-2A**
SD/HD Frame Synchronizer with embedded audio processing

 - IQMUX4626-1A**
SD/HD 10 Channel Audio Remultiplexer with advanced Dolby E handling

 - IQMUX4729-2A**
SD/HD 16 Channel Audio Remultiplexer with advanced Dolby E handling

 - IQMUX4831-1A**
SD/HD 10 Channel Audio Remultiplexer with advanced Dolby E handling (Balanced Audio I/O)

 - IQMUX4931-1A**
SD/HD 16 Channel Audio Remultiplexer with advanced Dolby E handling (Balanced Audio I/O)

Snell Ltd are a recognized Dolby E compliant equipment manufacturer and member of the “Dolby E partner program”.