Dolby E Demystified

An Insider's Guide

DOLBY®

Presented by

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What is Dolby E?

Dolby E is an audio encoding technology created by the Dolby company. Dolby E enables broadcasting and postproduction facilities to carry up to eight channels of sound over their existing stereo (two-channel) infrastructures. Unlike consumer level codecs, Dolby E can be decoded and re-encoded many times within a broadcast chain without any discernible loss in quality.

Where is Dolby E used?

Dolby E can be used anywhere in the broadcast chain prior to the point where the audio will be delivered to consumers. Dolby E is never delivered to end users, but is instead decoded back to baseband, and then encoded into the required consumer format, such as Dolby Digital.

Why is Dolby E used?

Dolby E technology allows broadcasters to fit up to 8 audio channels into the space of a single PCM stereo pair. Thus when they need to add surround sound, or multiple languages, these can be carried within the existing infrastructure,making for a cost effective upgrade.

Dolby E uses a frame based structure for the audio data. This provides frame-accurate audio to ensure effortless switching, editing, encoding, and decoding.

Metadata is inserted along with the Dolby E data, and can be carried through to the Dolby Digital that is sent to the end user. The metadata controls aspects of how the audio is reproduced giving a better sonic experience for the customer.

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What you need to know to successfully use Dolby E

Dolby E is a high quality and flexible audio encoding solution, but a number of factors need to be understood and correctly controlled.

A Dolby E encoded stream can contain between four and eight tracks of audio. A range of channel groupings are supported, including stereo + stereo, or four mono tracks for four tracks of audio, and 5.1 and stereo, or four separate stereos, for eight tracks of audio.

Dolby E can be encoded as 16 bit or 20 bit words. When 16 bit encoding is chosen it is only possible to encode four or six tracks of audio. 20 bit word length is needed if you wish to encode the maximum of eight tracks of audio.

This has an impact on the file type that will be used to contain the Dolby E encoded data. File types such as MXF or MOV usually have audio tracks for 16 bit words or for 24 bit words. It is not possible to include Dolby E encoded audio with a 20 bit word length into files that are created for 16 bit audio, and files with 24 bit word length would be needed to carry Dolby E audio encoded as 20 bits. Note however that conversely, 16 bit Dolby E can be placed inside media files containing 24 bit audio with no limitation.

Dolby E and AC3

Dolby E streams contain AC3 metadata. This must be configured during encoding, as this metadata is automatically transferred to Dolby Digital, if that is being used to deliver to the end user. The purpose of AC3 metadata is to help control the end users hardware to give the best possible sound, and consistency across different programs and medias. For example, the AC3 metadata allows the users hardware to correctly play the audio whether the hardware contains just a single speaker, such as an old fashioned television, or has stereo speakers, or has a full 5.1 surround capability, and the audio will be processed appropriately to take account of the hardware configuration.

Dialnorm metadata must always be correctly set in the Dolby E stream. This is to allow the end user hardware to automatically adjust the playback volume level to give consistent loudness with different programs and media.

Get error-free cut-style editing and video switching

Dolby E streams contain timecode. This is not usually required for the end user but may be necessary at different stages of the overall Production workflow.

As Dolby E encoded audio uses a frame-based structure, the frame rate of the audio must match the video when both are wrapped into a single file. The position of the frames of audio and frames of video within the file must be corrected aligned for playback. Dolby specify a "guard band", which is a small null band around the 'top' of the audio within the frame. This allows error-free cut-style editing and video switching. However note that if the guard band at the top of the frame is increased too much, then the Dolby E data for the frame will not fit into the available space within the frame and would continue into the start of the next frame. This would cause an error in subsequent decode or playout applications.

The measurement of where the guard band ends and the Dolby E data starts is often called the line position. This relates to a specific video line to which the start of the Dolby E data is aligned. Dolby provide a table on the recommended alignment position for every different video format.

Using hardware to encode or decode Dolby E always takes one frame to complete, so if the audio is processed in real time, it will lag the video by one frame after processing (assuming correct synchronisation prior to processing). Some hardware compensates for this delay by buffering the video to match, but if this is not done, later correction will be required.

How can eNGINE help?

eNGINE contains four functions specifically for Dolby E processing

- Dolby E encode, including AC3 metadata and dialnorm
- Dolby E decode to baseband
- Guardband measurement and correction including frame advance/retard
- XML report on all AC3 metadata

Additionally eNGINE can correctly handle Dolby E data within other functions, such as when track mapping, or when ensuring Loudness compliance.

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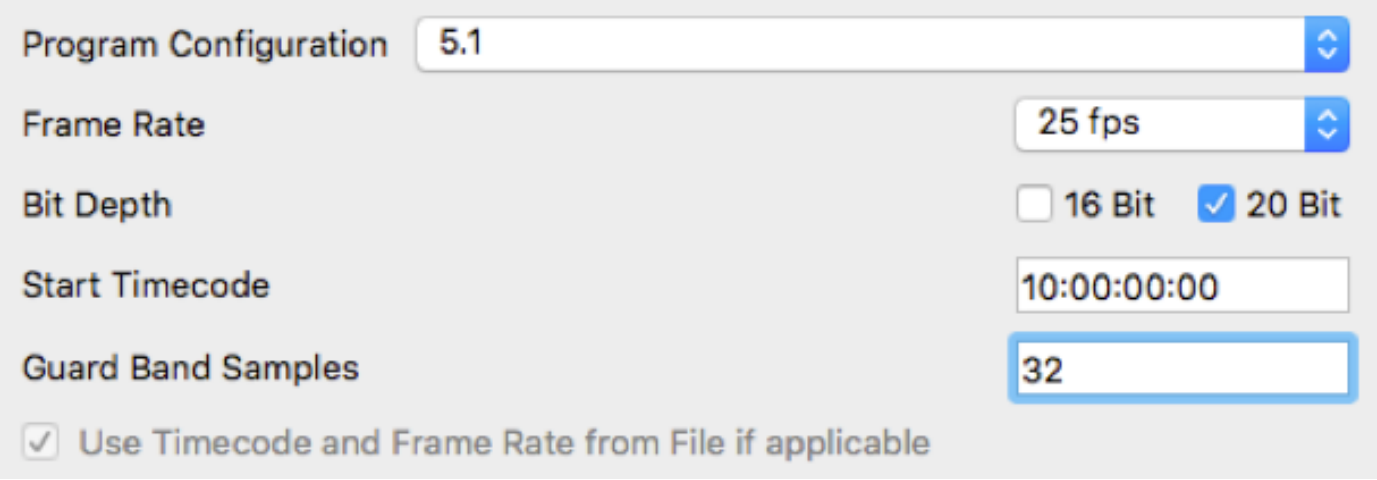
Dolby E Encode

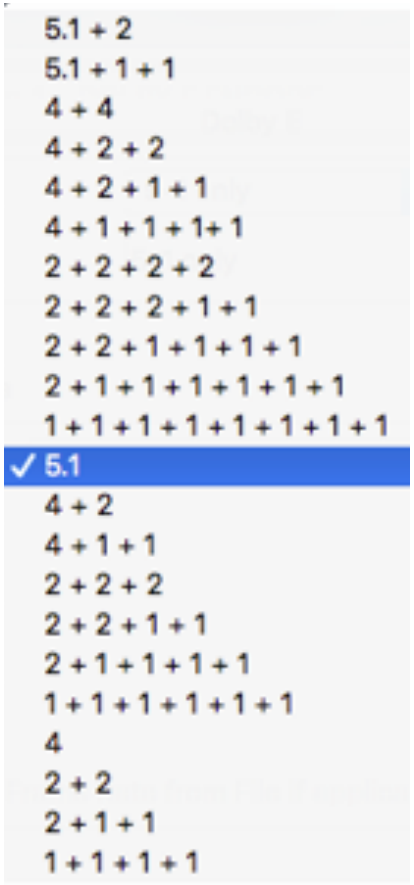
eNGINE can encode Dolby E data in either 16 or 20 bit format, and at any selected framerate. A preconfigured timecode can be set, or for instances where the source PCM material already contains timecode, this can be detected and inserted into the Dolby data. If the source material also includes video data, then the framerate for the audio can be automatically configured to match. The Program name within the Dolby metadata can be set based upon a pre-configured text string, or using the source filename, or by selectively taking parts of the source filename interspersed with specific characters if required.



eNGINE Encodes any configuration & any framerate

Any Program Configuration supported by Dolby is available, covering the range from two stereos or four monos, up to four stereos or stereo and 5.1 or eight monos.

The Loudness module within eNGINE permits the measurement of Loudness to any of the worldwide standards. The measured value is automatically inserted into the Dialnorm metadata value on encoding.



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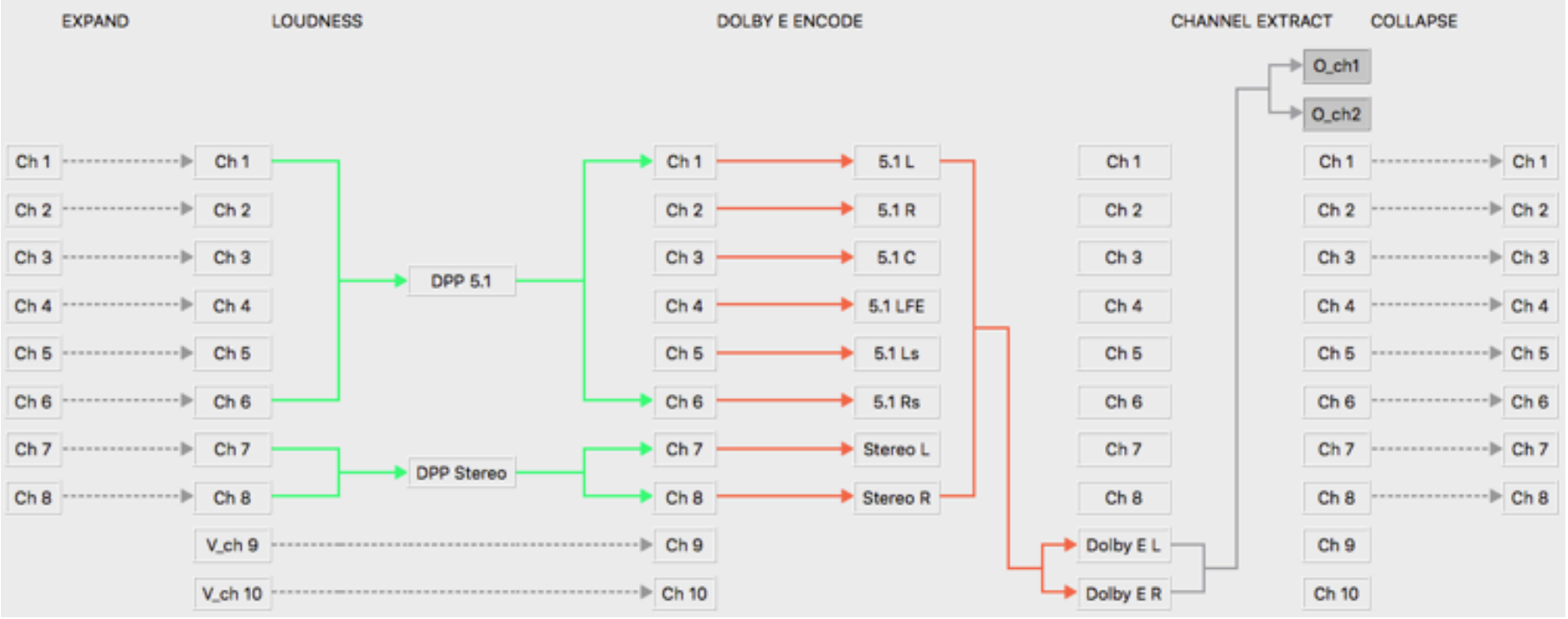
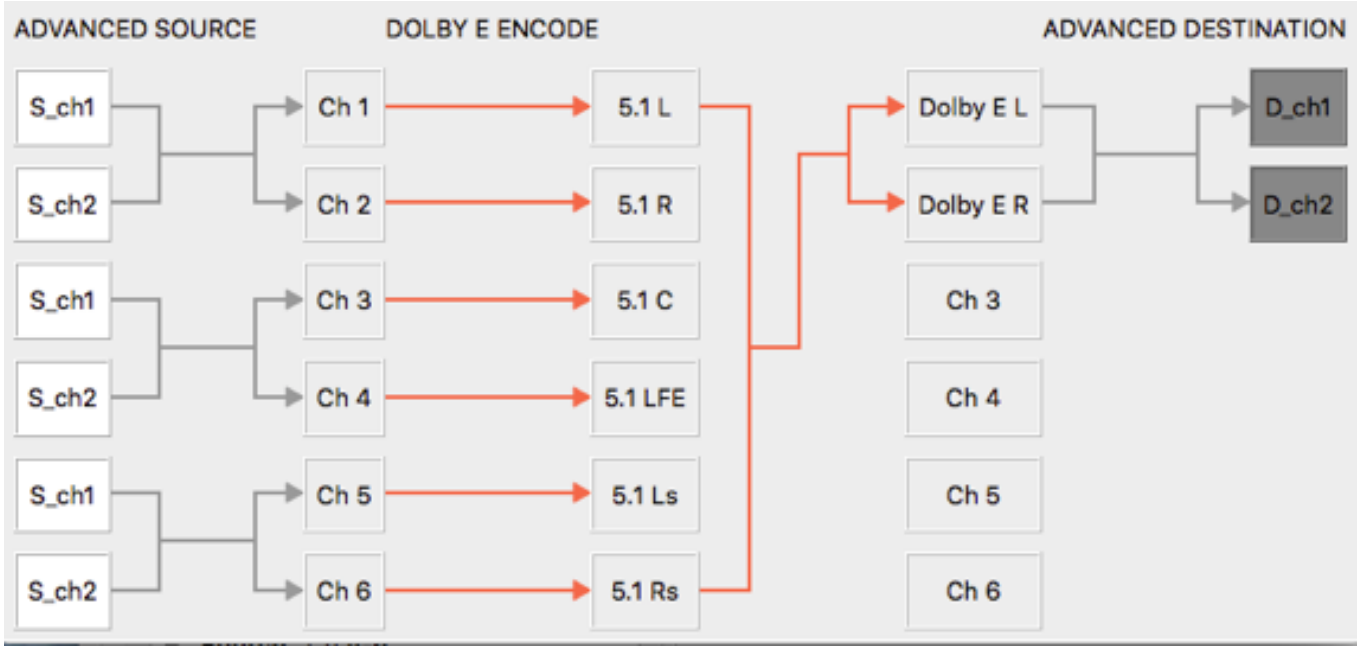
eNGINE can encode as a stand-alone operation, or it can be part of a workflow. The following example shows a 5.1 and stereo in an 8 channel file being Loudness corrected prior to Dolby E encoding. In this example, the Dolby E data is created in a new, two channel WAV file.



Encode from multiple source files

eNGINE can also encode from multiple source files, such as if the 5.1 is contained in six mono WAV files, or in three stereo WAV files, as shown below.



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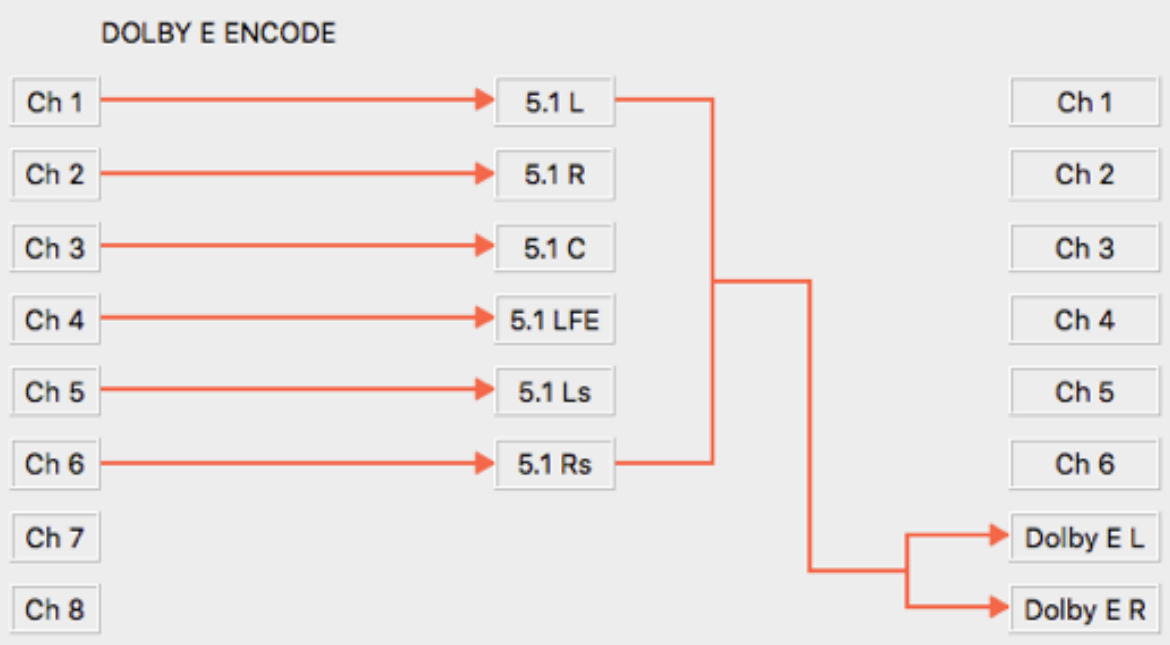
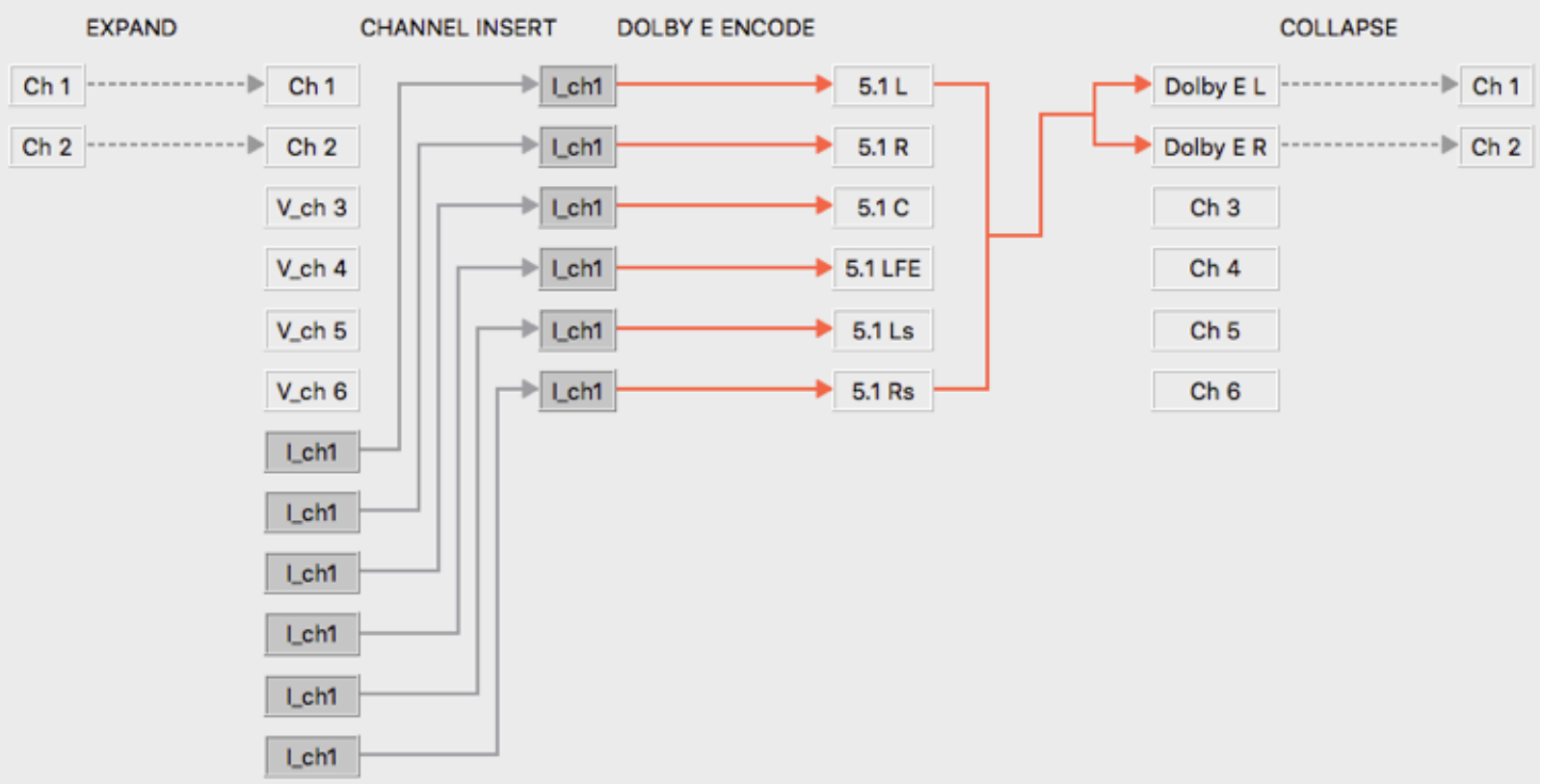
Alternatively, the encoded Dolby could be placed back in to the original source file, as in the following example.



Encode from WAV files to existing MFX or MOV files

eNGINE can also encode from WAV files and merge this Dolby into an existing MXF or MOV file. In this next example, we take six mono WAV files, Dolby E encode them as a 5.1, and add this Dolby in to a stereo MXF.



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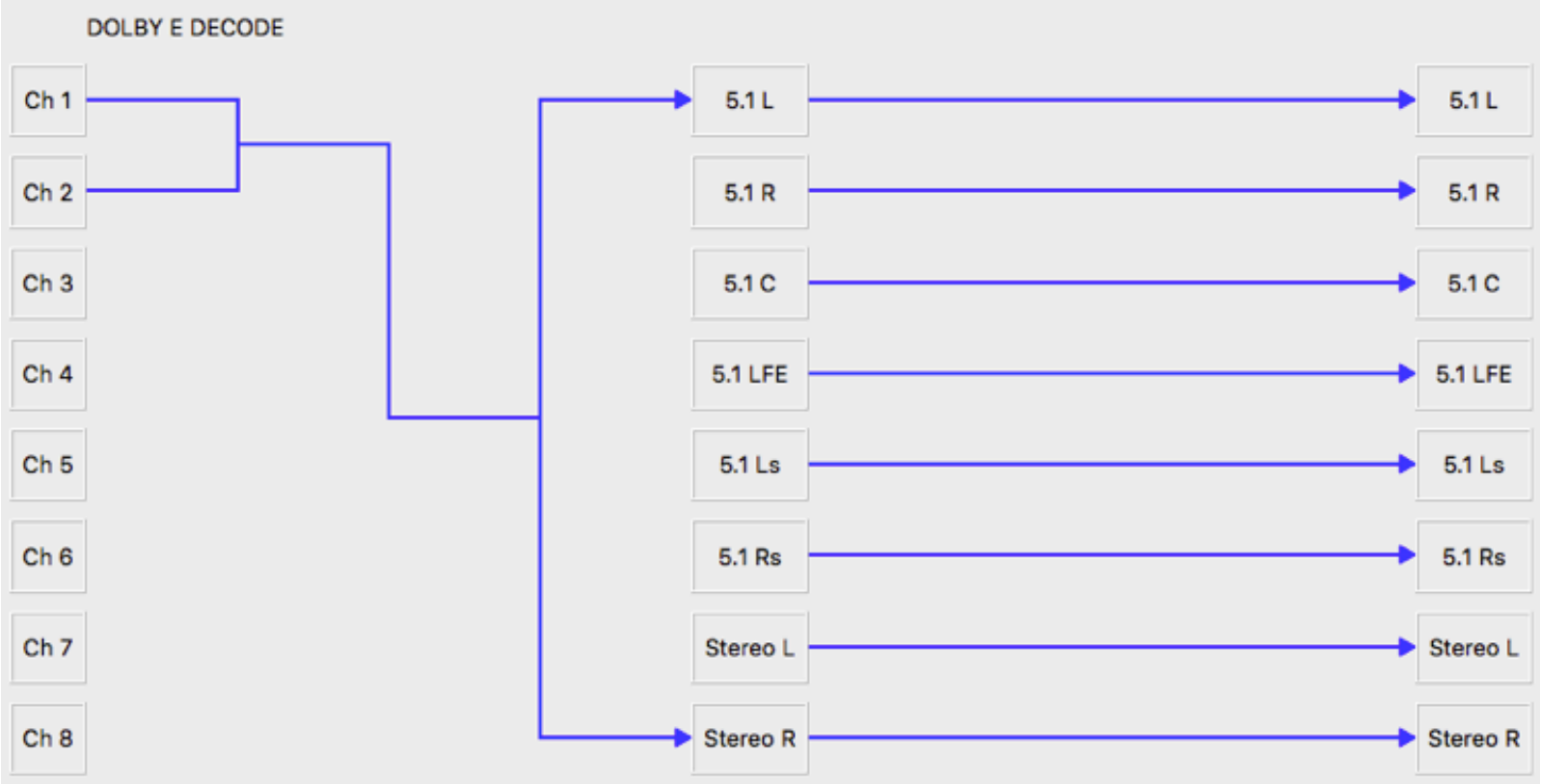
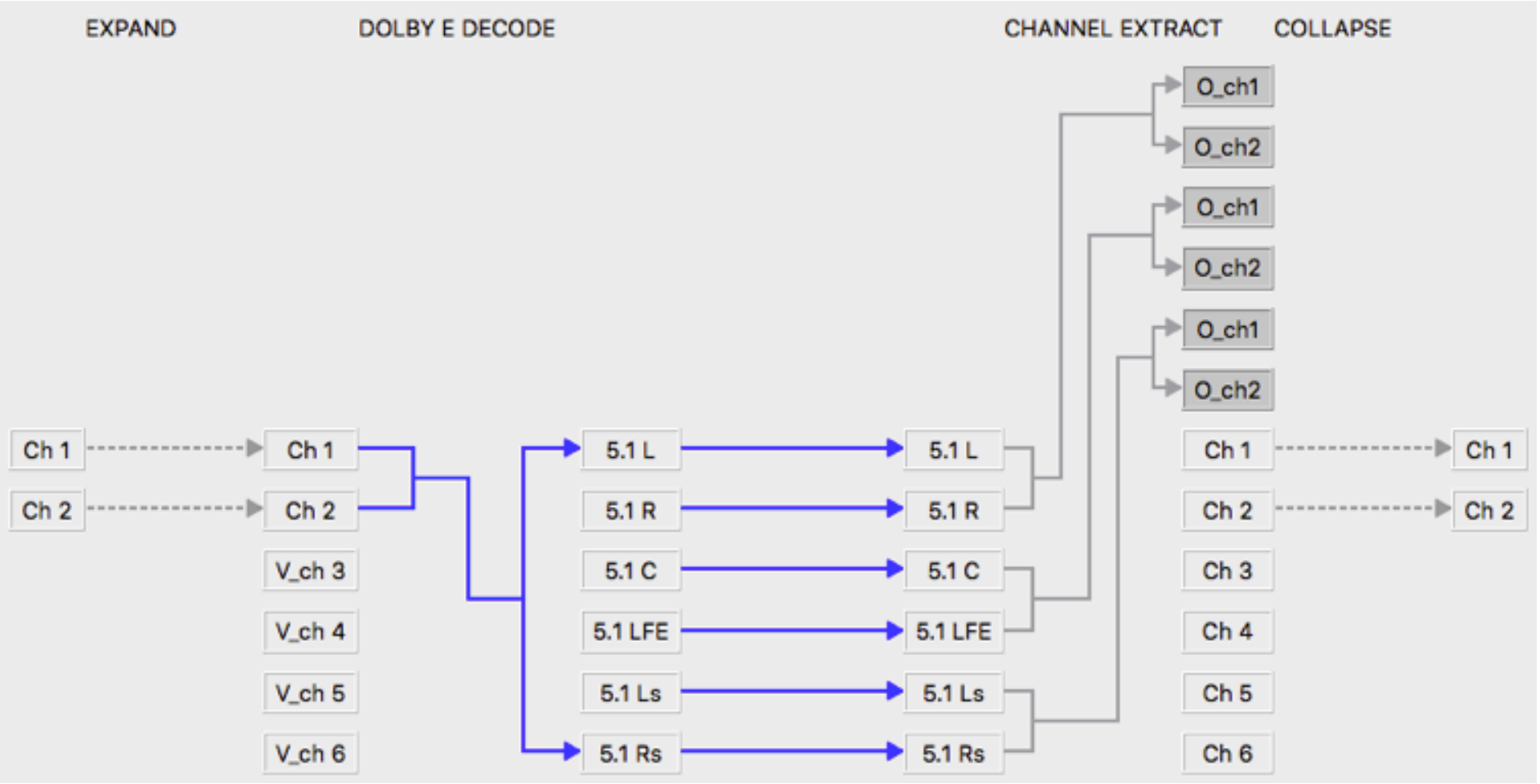
eNGINE Decodes all Dolby supported configurations

eNGINE can decode Dolby E in all Dolby supported configurations and can decode audio within media files such as MXF and MOV, or can decode directly from WAV files

The workflow shown here is compatible with 8 channel MXF and MOV files, and places the decoded audio back into the original file.

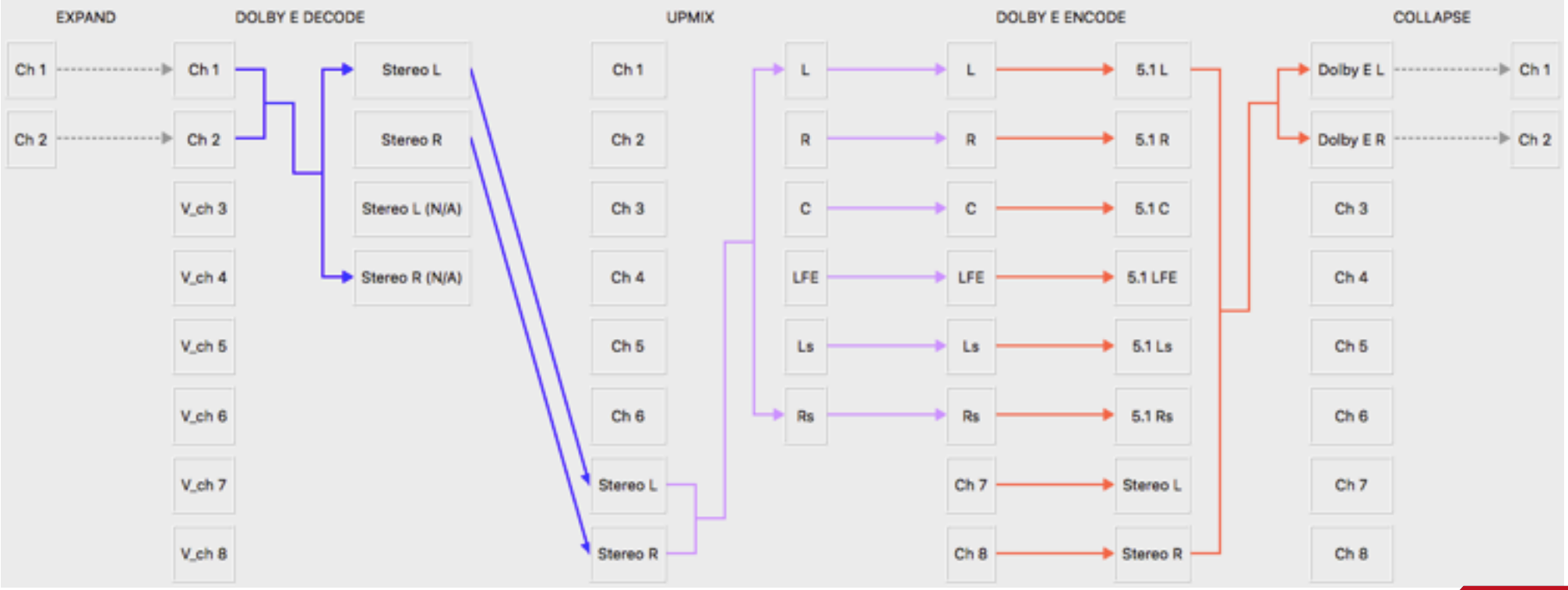


The next example decodes Dolby within a two channel file, such as a stereo MXF, and creates three stereo WAV files. The first contains the Left and Right channels. The next contains the Centre and LFE channels, whilst the third contains the Left Surround and the Right Surround. In this configuration, the original source file would remain unchanged.



Dolby Decode in your Workflow

Dolby decode can be incorporated into a workflow with additional processing steps. For example, the following workflow for two channel MXF/MOV files decodes an existing Dolby E stream containing two stereos, then upmixes to create a 5.1, then encodes the resultant 5.1 plus the original stereo back into the source file.



Dolby E Guard Band Measurement

Dolby E uses a frame structure for the audio, and the audio frames must line up with the video frames in order to ensure that frame accurate editing is possible, and for switchers to be able to change source in a real time environment, without glitches in the audio. The Guard Band is used to ensure the video and audio data alignment is acceptable.

The guard band correction module within eNGINE lets you measure the existing guard band, and if it is outside the minimum and maximum range that you specify, then the data is realigned to the point that you configure.

As Dolby E encoding or decoding usually makes the audio one (more) frame delayed with respect to the video, eNGINE also lets you advance or retard the audio in frame increments to correct for this when needed.

The measured guard band is displayed on the eNGINE UI if doing a manual test, or is included in the XML reports when using the automation interface.

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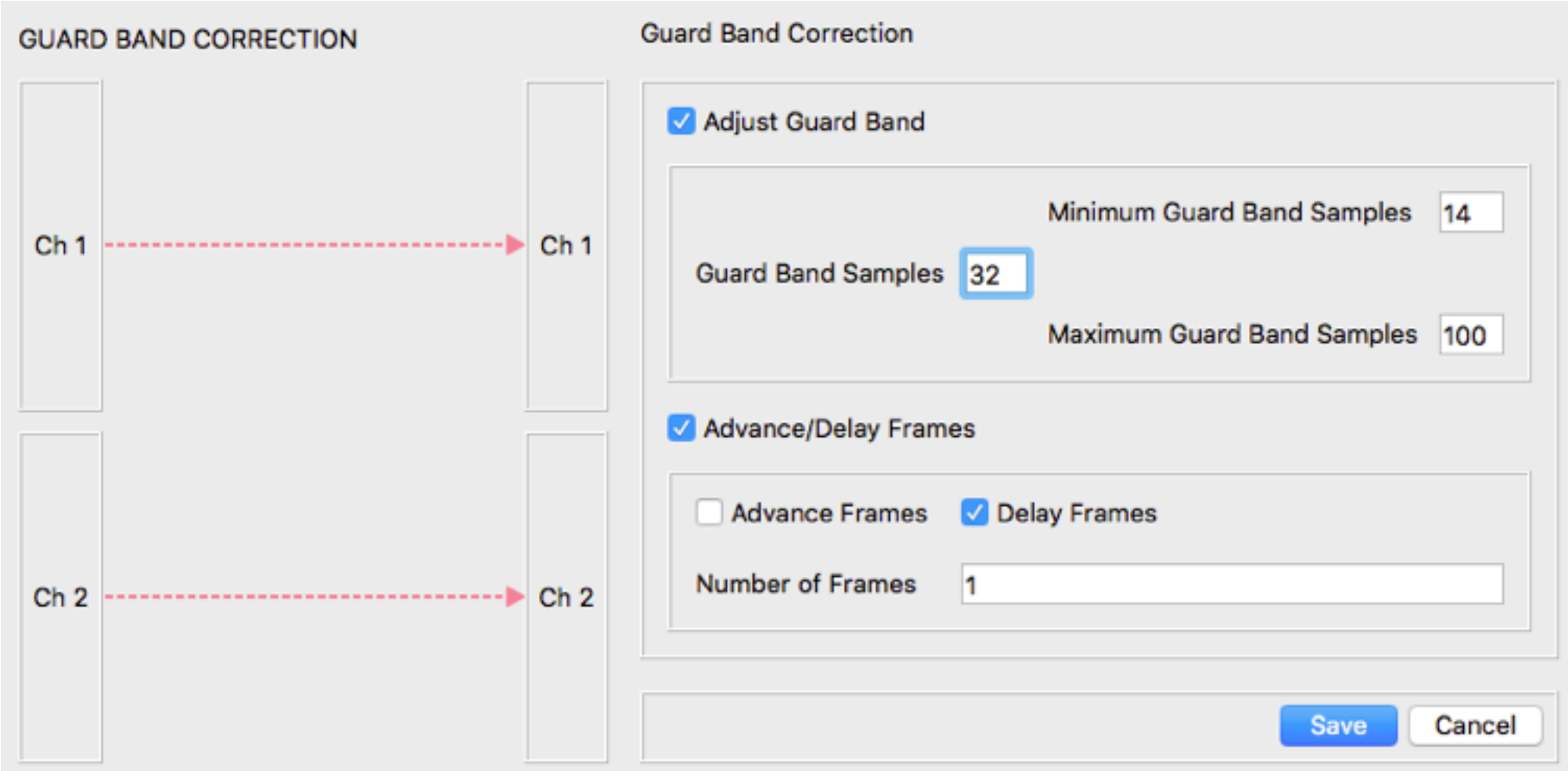
GUARD BAND CORRECTION
Ch 1
Ch 1
Ch 2
Ch 2
Guard Band Correction
Adjust Guard Band
Minimum Guard Band Samples
14
Guard Band Samples
32
Maximum Guard Band Samples
100
Advance/Delay Frames
Advance Frames
Delay Frames
Number of Frames
1
Save
Cancel

Dolby E XML Reporting and Correction

Once audio has been Dolby E encoded, it is not always clear whether the AC3 metadata has been correctly configured. The 'Examine' function within eNGINE lets you find out. It measures files containing Dolby E, and reports every item of AC3 metadata for all audio groups. The report is available in XML format for easy access within other automation tools.

```
<DolbyEInfo>
    <DolbyEStream>
        <DolbyELeftChannel>1</DolbyELeftChannel>
        <DolbyERightChannel>2</DolbyERightChannel>
        <DolbyEProgramConfiguration>5.1 + 2</DolbyEProgramConfiguration>
        <DolbyEFrameRate>25 fps</DolbyEFrameRate>
        <DolbyEBitDepth>20-bit</DolbyEBitDepth>
        <DolbyEGuardBandSamples>36</DolbyEGuardBandSamples>
        <DolbyEStartTimecode>N/A</DolbyEStartTimecode>
        <DolbyEFrameOffset>257</DolbyEFrameOffset>
        <DolbyEProgram>
            <DolbyEProgramNumber>0</DolbyEProgramNumber>
            <DolbyEProgramType>FivePointOne</DolbyEProgramType>
            <DolbyEProgramDescription>Prog 1</DolbyEProgramDescription>
            <DolbyEProgramAC3Metadata>
                <AC3_acmod>3/2</AC3_acmod>
                <AC3_adconvtyp>Standard</AC3_adconvtyp>
                <AC3_bsmod>Complete main</AC3_bsmod>
                <AC3_bwlpfon>Enabled</AC3_bwlpfon>
                <AC3_cmixlev>-3dB</AC3_cmixlev>
                <AC3_compr1>Film Standard</AC3_compr1>
```

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Sometimes the problem is more basic than this. We frequently hear from customers that they have files that are supposed to contain Dolby E, but their existing tools report that the file is PCM. This often happens as some products only look at the very start of the file to decide whether it contains Dolby E or PCM. eNGINE can scan many minutes into each file to correctly identify files that contain Dolby E.

The Examine function reports the delay from the start of the file until the Dolby E starts. In the example shown below, the first 256 frames of the file contain PCM audio, with the Dolby E only starting from frame 257. This means that the Dolby E data only starts 10 seconds in to the file.

```
<DolbyEGuardBandSamples>36</DolbyEGuardBandSamples>
<DolbyEStartTimecode>N/A</DolbyEStartTimecode>
<DolbyEFrameOffset>257</DolbyEFrameOffset>
<DolbyEProgram>
    <DolbyEProgramNumber>0</DolbyEProgramNumber>
```

Dialog Intelligence

Dolby have developed algorithms to detect dialog in sound tracks. This function is not used when Dolby E encoding or decoding. However it is required when carrying out loudness measurement and correction in certain loudness standards, such as ATSC A85. This function is optionally available within eNGINE's Loudness module.

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