AUDIO LOUDNESS EQUIVALENCE
CHANGES WITH REFSW 15.2

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Revision History

Revision	Date	Change Description
1.0	04/10/2015	Initial release

Table of Contents

List of Figures

Introduction

As part of the Dolby certification there are tests to ensure that the audio output level is the same between codecs. This ensures an equal listening level between programs or channels provided that the broadcaster is transmitting at the correct levels.

15.2 REFSW release includes changes to simplify the configuration of the loudness equivalence settings so that the application is no longer required to be as hands on with setting output levels.

This document will cover an overview of the expected input and outputs levels for loudness equivalence, changes that were made with the 15.2 release and how to test loudness equivalence with USR 15.2 and newer releases.

Loudness Equivalence Expectations

The expected input and output levels of outputs depend on the input content, Loudness Equivalence setting and the output type.

ATSC Specification

Input Expectations

- For Dolby AC3 and AC3 Plus codecs the input level is expected to be -31dB.
- For MPEG and AAC the expected input level is -24dB.

Output Expectations

- For Active Outputs such as the DAC or I2S Stereo Output the target output level is supposed to be -24dB, according to the CALM Act and ATSC A/85.
- For Passive Outputs such as S/PDIF the target output level is supposed to be -31dB, according to the CALM Act and ATSC A/85.
- If the downstream HDMI device supports AC3 compressed audio it should be treated as a passive output.
- If the downstream HDMI device does not support AC3 compressed audio it should be treated as an active output.
- If HDMI is configured for PCM multichannel it should be treated as a passive output and will be configured with line level on that path.

EBU Specification

Input Expectations

- For Dolby AC3 and AC3 Plus codecs the input level is expected to be -31dB.
- For MPEG and AAC the expected input level is -23dB.

Output Expectations

- For Active Outputs such as the DAC or I2S Stereo Output the target output level is supposed to be -23dB.
- For Passive Outputs such as S/PDIF the target output level is -31dB.
- If the downstream HDMI device supports AC3 compressed audio it should be treated as a passive output.

- If the downstream HDMI device does not support AC3 compressed audio it should be treated as an active output.
- If HDMI is configured for PCM multichannel it should be treated as a passive output and will be configured with line level on that path.

Figure 1: ATSC Active and Passive Output Levels

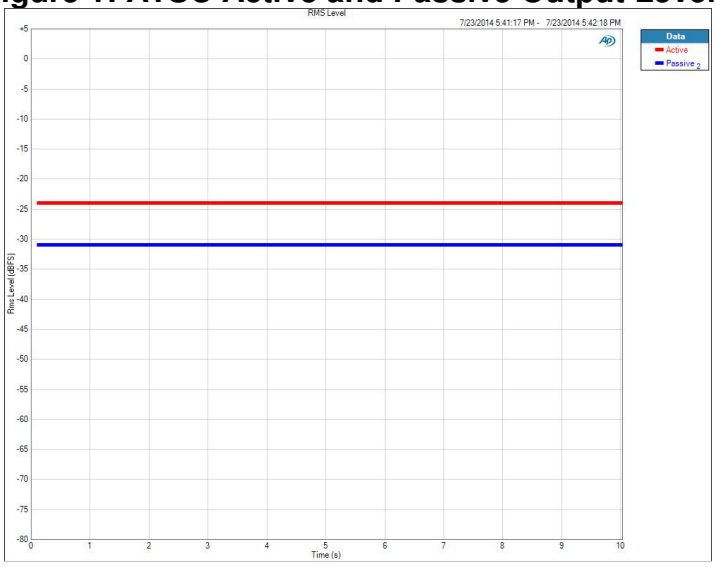
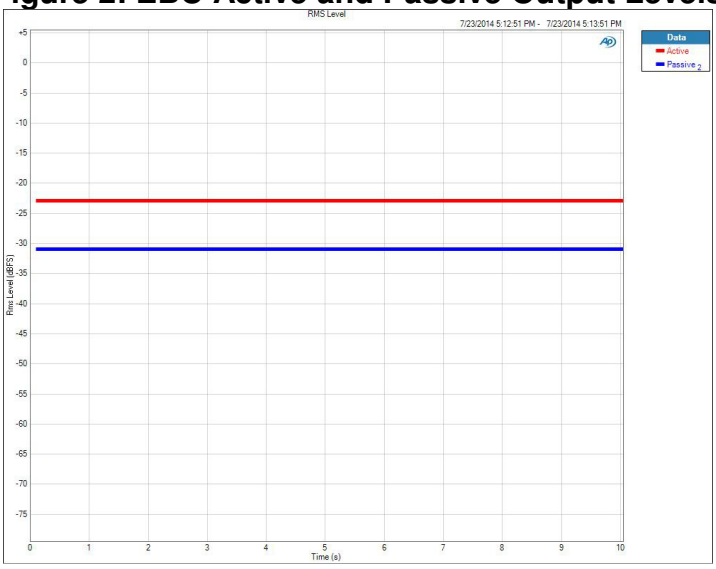


Figure 2: EBU Active and Passive Output Levels



Configuring Loudness Equivalence with REFSW 15.2

Starting with the 15.2 release, setting up loudness equivalence requires only applying settings at platform init time. NEXUS and APE will handle all attenuations and determine if the downstream HDMI device supports AC3.

Configuring Loudness Equivalence Mode

To enable loudness equivalence the loudness equivalence mode needs to be set as part of the NEXUS_PlatformSettings. The loudness equivalence mode should be set to NEXUS_AudioLoudnessEquivalenceMode_eAtscA85 for boxes adhering to the ATSC A/85 specification and NEXUS_AudioLoudnessEquivalenceMode_eEbuR128 for boxes adhering to the EBU R128 specification. The system default mode is NEXUS_AudioLoudnessEquivalenceMode_eNone so a specification needs to be configured if loudness equivalence is required.

```
{
     NEXUS_PlatformSettings platformSettings;

     NEXUS_Platform_GetDefaultSettings(&platformSettings);

     platformSettings.audioModuleSettings.loudnessMode =
NEXUS_AudioLoudnessEquivalenceMode_eAtscA85;

     /* or */

     platformSettings.audioModuleSettings.loudnessMode =
NEXUS_AudioLoudnessEquivalenceMode_eEbuR128;

     NEXUS_Platform_Init(&platformSettings);
}
```

Output Level Adjustments

With the 15.2 release the output level adjustments are now handled internally. The application is no longer required to set output volume levels. If an output volume level was changed we will internally apply an additional attenuation based on the expected behavior. IE if HDMI was set to -2dB and loudness mode ATSC was set and HDMI is passive then HDMI would be configured for -9dB of total attenuation.

Testing Loudness Equivalence

A new application was created for testing loudness equivalence called audio_loudness. The application is located under nexus/examples/audio. The application is pre-configured with loudness test files that were acquired from the MS-12 test kit. Similar files should be available from the MS-11 test kit.

Using audio_loudness

The new test application was created with few input parameters required. The possible input parameters are:

- -mpeg – This configures the application to test with the MPEG stream
- -ddp – This configures the application to test with the DDP stream
- -aac – This configures the application to test with the AAC stream
- -ddre – If testing with the MS11/MS12 license it will configure a DDRE in the chain
- -atsc – Configures the loudness equivalence mode to be ATSC standard
- -ebu – Configures the loudness equivalence mode to be EBU standard
- -multichannel – Will connect HDMI to the multichannel output of the decoder or DDRE if present
- -compressed – Will connect Spdif and HDMI to the compressed output of the DDRE if present

Content is expect to be located at “<bin_folder>/videos”.

Content file names from the MS12 test kit are:

- Loudness_-31dBFS_ddp_DVB_h264_29fps.trp
- Loudness_-31dBFS_heaac_DVB_h264_29fps.trp
- Default_Dialnorm_23dB_heaac_DVB_h264_29fps.trp
- Ref_Level_997Hz_23dB_DVB_h264_29fps.trp
- Ref_Level_997Hz_24dB_DVB_h264_29fps.trp

An example for testing DDP with a DDRE and the ATSC standard would be:

./nexus audio_loudness –ddp –ddre –atsc

Test	Expected Active Level ATSC	Expected Active Level EBU	Expected Passive	Actual Measured Active Level	Actual Measured Passive Level	Command Line ATSC	Command Line EBU
Legacy (Standalone):							
MPEG->Stereo	-24	-23	-31			./nexus audio_loudness -mpeg -atsc	./nexus audio_loudness -mpeg -ebu
AAC->Stereo	-24	-23	-31			./nexus audio_loudness -aac -atsc	./nexus audio_loudness -aac -ebu
AAC->Multichannel	-24	-23	-31			./nexus audio_loudness -aac -atsc -multichannel	./nexus audio_loudness -aac -ebu -multichannel
AC3->Stereo (Active)	-24	-23	-31			./nexus audio_loudness -ddp -atsc	./nexus audio_loudness -ddp-ebu
AC3->Multichannel	-24	-23	-31			./nexus audio_loudness -ddp -atsc -multichannel	./nexus audio_loudness -ddp -ebu -multichannel
MS11 Standalone							
MPEG->Stereo	-24	-23	-31			./nexus audio_loudness -mpeg -atsc	./nexus audio_loudness -mpeg -ebu
AAC->Stereo	-24	-23	-31			./nexus audio_loudness -aac -atsc	./nexus audio_loudness -aac -ebu
AAC->Multichannel	-24	-23	-31			./nexus audio_loudness -aac -atsc -multichannel	./nexus audio_loudness -aac -ebu -multichannel
AC3->Stereo	-24	-23	-31			./nexus audio_loudness -ddp -atsc	./nexus audio_loudness -ddp-ebu
AC3->Multichannel	-24	-23	-31			./nexus audio_loudness -ddp -atsc -multichannel	./nexus audio_loudness -ddp -ebu -multichannel
MS11 Full:							
MPEG->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -mpeg -atsc -ddre	./nexus audio_loudness -mpeg -ebu -ddre
MPEG->DDRE->Compressed	-24	-23	-31			./nexus audio_loudness -mpeg -atsc -ddre -compressed	./nexus audio_loudness -mpeg -ebu -ddre -compressed
AAC->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -aac -ddre -atsc	./nexus audio_loudness -aac -ddre -ebu
AAC->DDRE->Multichannel	-24	-23	-31			./nexus audio_loudness -aac -atsc -ddre -multichannel	./nexus audio_loudness -aac -ebu -ddre -multichannel
AAC->DDRE->Compressed	-24	-23	-31			./nexus audio_loudness -aac -atsc -ddre -compressed	./nexus audio_loudness -aac -ebu -ddre -compressed
AC3->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -ddp -ddre -atsc	./nexus audio_loudness -ddp -ddre -ebu
AC3->DDRE->Multichannel	-24	-23	-31			./nexus audio_loudness -ddp -atsc -ddre -multichannel	./nexus audio_loudness -ddp -ebu -ddre -multichannel
AC3->DDRE->Compressed	-24	-23	-31			./nexus audio_loudness -ddp -atsc -ddre -compressed	./nexus audio_loudness -ddp -ebu -ddre -compressed
MS12 Standalone:							
MPEG->Stereo	-24	-23	-31			./nexus audio_loudness -mpeg -atsc	./nexus audio_loudness -mpeg -ebu
AAC->Stereo	-24	-23	-31			./nexus audio_loudness -aac -atsc	./nexus audio_loudness -aac -ebu
AAC->Multichannel	-24	-23	-31			./nexus audio_loudness -aac -atsc -multichannel	./nexus audio_loudness -aac -ebu -multichannel
AC3->Stereo	-24	-23	-31			./nexus audio_loudness -ddp -atsc	./nexus audio_loudness -ddp-ebu
AC3->Multichannel	-24	-23	-31			./nexus audio_loudness -ddp -atsc -multichannel	./nexus audio_loudness -ddp -ebu -multichannel
MS12 Full:							
MPEG->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -mpeg -atsc -ddre	./nexus audio_loudness -mpeg -ebu -ddre
MPEG->DDRE->Compressed	n/a	-23	-31			./nexus audio_loudness -mpeg -atsc -ddre -compressed	./nexus audio_loudness -mpeg -ebu -ddre -compressed
AAC->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -aac -ddre -atsc	./nexus audio_loudness -aac -ddre -ebu
AAC->DDRE->Multichannel	-24	-23	-31			./nexus audio_loudness -aac -atsc -ddre -multichannel	./nexus audio_loudness -aac -ebu -ddre -multichannel
AAC->DDRE->Compressed	-24	-23	-31			./nexus audio_loudness -aac -atsc -ddre -compressed	./nexus audio_loudness -aac -ebu -ddre -compressed
AC3->DDRE->Stereo	-24	-23	-31			./nexus audio_loudness -ddp -ddre -atsc	./nexus audio_loudness -ddp -ddre -ebu
AC3->DDRE->Multichannel	-24	-23	-31			./nexus audio_loudness -ddp -atsc -ddre -multichannel	./nexus audio_loudness -ddp -ebu -ddre -multichannel
AC3->DDRE->Compressed	-24	-23	-31			./nexus audio_loudness -ddp -atsc -ddre -compressed	./nexus audio_loudness -ddp -ebu -ddre -compressed