How to set the RMS Limiter on SigmaStudio 3.3 for DigiMod and D-Cell504

1. Preliminary Considerations

1.1. Help and support for SigmaStudio®

Along with this documentation, a number of other resources can be used to learn more about SigmaStudio, get more details about algorithms and techniques, optimize your design or just ask for support and troubleshooting.

- SigmaStudio 3.3 user guide released by Powersoft, available for download at:

http://www.powersoft-audio.com/en/products/software/dsp-programming-software.html (download section)

- SigmaStudio Help file: SigmaStudio has an extensive help file included with the installation explaining all of the software's features, signal processing blocks and possible operations. You can access the help file in the Help menu (shortcut F1), or by opening the file located in the help folder inside your SigmaStudio installation folder

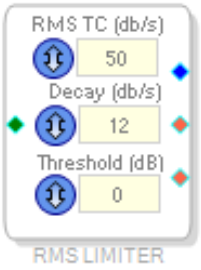
- All help and support requests regarding the use of SigmaStudio with Powersoft products can be addressed to:

support@powersoft.it

- http://www.analog.com/en/technical-documentation/frequently-and-rarely-asked-questions/resources/embedded-processing-dsp/sigmadsp/listing.html

- Further SigmaDSP® or SigmaStudio support inquiries can be directed to the EngineerZone forum (http://ez.analog.com/community/dsp/sigmadsp)

1.2. Where to find the RMS Limiter function in SigmaStudio



In order to use the RMS (Root Mean Square) Limiter, first create a schematic area and then locate the Peak Limiter feature in the ToolBox tree. This can be found under ADAU1702 objects in the folder RMS Dynamics Processor, by following this route:

ADAU1702 / Dynamics Processor / RMS / Limiter

Drag this object in a schematic area to use it.

1.3. General description

The Sigma Studio Limiter is an extreme compressor, completely preventing signals from surpassing the threshold. Whenever the level signal stators to go above it, the limiter immediately stops it and keeps it at threshold.

As you can see, the values SigmaStudio's Peak Limiter uses are not musical values. User settable parameters are:

- RMS TC: this is the RMS time constant value. It corresponds to the attack time. The unit of measurement is not in millisecond but it is expressed in dB/second.

- Threshold: this indicates the output level value above which the effect of the peak limiter begins. Output voltage values below this threshold value are untouched by the limiter's action. The threshold value is measured in dBs with respect to a specific module model-based reference value.

- Decay: this is the rate at which the limiter's effect wanes off. It is measured in dB/second. It is strictly related to the limiter's release time, which measures the duration of the limiter's effect after the output voltage has dropped below the threshold value.

To make sure you are using the limiters in Powersoft devices correctly, first calculate specific key parameters of your acoustic system that will be needed to determine the optimal parameter values to apply to the RMS Limiter by following the procedure illustrated in the next chapter.

2. Procedure

2.1. Preliminary

In the following section you will find the description of the steps needed to calculate the correct values with which to set the Peak Limiter for a single channel. In the Reference Files folder you will find a Microsoft Excel® file that automatically executes the following steps.

2.2. Find the speaker's RMS voltage (V_{RMS}) value

- Start from obtaining the declared long term AES or RMS power rating of your loudspeaker and the nominal impedance of each loudspeaker.
  - If 2 speakers are connected in series, the total power rating "P_AES" is twice that of the single speaker. The same goes for the total nominal impedance "Znom" which is twice that of the single speaker.
- If 2 speakers are connected in parallel, the total power rating "P_AES" is still twice that of the single speaker, but the total impedance "Znom" is half that of the single speaker. Now, to find a value threshold, calculate the VRMS(speaker).

The single speaker's RMS voltage level starting from the musical power and nominal impedance is:

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VRMS(speaker) = √(0.4*P_AES*Znom)[1]

2.3. Find the amplifier's output RMS voltage (V_{RMS}) value

- If your system is single ended the amplifier's output peak voltage is equal to the speaker's peak voltage:

$$V_{RMS(amplifier)} = V_{RMS(speaker)}$$

- If your system is in bridge mode, the amplifier's output peak voltage is half a single speaker's peak voltage

$$V_{RMS(amplifier)} = V_{RMS(speaker)} / 2$$

2.4. Calculate the Threshold value

To calculate the limiter's threshold value, use one of the following formulas according to the type of module you have.

- Threshold dB = -9 + $20\log_{10}(V_{RMS(amplifier)}/92.0)$ for DigiMod 2000HV/2000HV IS/3000PFC - DigiMod 2004PFC2/3004PFC4 @ 38 dB gain.
- Threshold dB = -9 + $20\log_{10}(V_{RMS(amplifier)}/46.0)$ for DigiMod 1000/1500/1000 IS/1500 IS - DigiMod 2004PFC2/3004PFC4 @ 32 dB gain.
- Threshold dB = -9 + $20\log_{10}(V_{RMS(amplifier)}/25.4)$ for D-Cell504

2.5. RMS Time constant /Attack time Conversion table

Use the following conversion table to set the RMS Time constant (in dB/s) starting from the attack time (in ms).

- High power woofer with ≥ 4" inch voice coil
  - 5dB/s = 1000ms
- High power woofer with 3" to 4" inch voice coil
  - 10dB/s = 500ms
- Woofer/midrange with 2" to 3" voice coil
  - 25dB/s = 200ms
- Small midrange with about 2" voice coil or big HF driver (3"-4" VC)
  - 50dB/s = 100ms
- Regular HF driver about 2" voice coil
  - 100dB/s = 50ms
- Small low power HF driver about 1" voice coil
  - 250dB/s = 20ms
- Small tweeter ≤ 1" voice coil
  - 500dB/s = 10ms

Now, set the value that you prefer in the RMS TC setting at the top of the object window.

[1]*The 0.4 correction factor is due to the fact that speaker manufacturers declare higher continuous power ratings than the "real" thermal power handled by the voice coil. An empirical safety factor between 2 and 3 has been obtained after burning-out several voice coils!. So, take AES rating and divide by 2.5 (or multiply by 0.4 which is equivalent).*

2.6. Decay/Release time conversion table

Use the following conversion table to set the Decay like Release time.

- 8000 ms => 17dB/s
- 4000 ms => 16dB/s
- 2000 ms => 15dB/s
- 1000 ms => 14dB/s
- 500 ms => 13dB/s
- 250 ms => 12dB/s
- 120 ms => 11dB/s
- 60 ms => 10dB/s
- 30 ms => 9dB/s

Now, set the value that you prefer in the decay setting at the center of the object window.

3. Example

Set the RMS limiter parameters for an EighteenSound 18LW1400 woofer to be used on a bridged DGM1500IS Powersoft amplifier module (use the Microsoft Excel® file in the Reference File folder).

- Declared AES Power = 1000 W
- Nominal Impedance = 8 Ohm

In the Microsoft Excel file,:

- Enter 1000 under the cell P_AES
- Enter 8 under the cell Znom
- Press Enter.

The pertaining threshold value (-6 dB) will be found in the "TH in Bridge Mode" cell corresponding to the DigiMod 1500IS cell. Enter this value in the threshold setting in the object window in SigmaStudio.

- Attack time = 1000ms => 5 dB/s. Therefore, enter 5 dB/s in the RMS TC box at the top of the object window.
- Release time = 4000ms => 16 dB/s. Enter 16 dB/s as release time in Decay setting box at the center of the object window.

4. Note

This setup should guarantee a safe setting for the RMS limiter, so as to avoid speaker failure with any input musical program. BUT BEFORE SELLING YOUR PRODUCT please make stress tests to evaluate speaker performance. Eventually, if speakers remain cooler than expected, the threshold setting can be moved up 1 dB or (take care!) 2 dB. Should speakers give off a "burnt" smell, the threshold must be moved down 1 dB or 2 dB. IT WILL BE ALWAYS A COMPROMISE BETWEEN SAFEST OPERATION AND LOUDEST PERFORMANCE.