JBL PROFESSIONAL

DSi 2.0 SERIES

DEDICATED AMPLIFICATION FOR JBL CINEMA SOLUTIONS

LEVELMAX™ LIMITER SUITE

REFERENCE GUIDE

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JBL's DSi 2.0 family of dedicated cinema amplifiers integrates DSP from Crown's CDi DriveCore series to deliver potent amplification for JBL's entire range of cinema loudspeakers. The DSi 2.0 series' built-in 32-bit/96kHz floating-point processing includes FIR filtering, LevelMAX limiting, 8-channel parametric EQ, delay settings and more.

This document provides deeper knowledge on the operation of the DSi LevelMAX Limiter Suite, giving you tools to become well-versed in its features and applying the right processes to both protect your loudspeakers and maximize system output.

Understanding Limiters

Limiters protect loudspeakers from damage in two common scenarios:

> **1. Mechanical Failure:** This occurs when a loudspeaker diaphragm travels beyond its safe excursion limit, displacing the voice coil out of its magnetic gap and deforming or damaging the diaphragm. Mechanical failure can occur when excessive peak voltage is delivered to the loudspeaker driver; this voltage is typically limited using a **peak limiter.**
>
> **2. Thermal Damage:** When a loudspeaker coil receives continuous high power, the voice coil and magnetic gap heat up, which can damage the coil. Heat also increases power compression, which will lead to less-efficient operation and ultimately, lower acoustic output. This phenomenon, typically noticeable in low-frequency drivers, happens when excessive RMS voltage is delivered to the loudspeaker driver; the signal can typically be managed using **RMS limiters.**

Most line-level devices in the audio chain before the amplifier allow for limiters to be set. This approach is not intuitive, as the user needs to calculate limiters based on the gain of the amplifiers driving the loudspeakers. It is very important to apply both a peak limiter and RMS limiter to protect the loudspeaker, for a couple of reasons:

It's not advisable to use peak limiters alone to protect loudspeakers against damage, as this process can actually increase the potential for thermal damage: Peak limiters reduce the dynamic range of the signal, thereby reducing the signal's crest factor (ratio between peak and RMS level). If the input signal is overdriven through the peak limiters, the signal's RMS level could increase beyond safe limits, thereby causing thermal damage to the driver.

LevelMAX has been designed to limit incoming signal to specified voltage thresholds. The addition of a thermal limiter allows thresholds for the faster-acting RMS and peak limiters to be set higher, providing higher output to loudspeakers and maintaining dynamic range before the onset of limiting while protecting the long-term integrity of the transducers.

JBL Cinema Speaker factory tunings make optimum use of the LimiterMax Limiter Suite, with access to expanded features including sidechain filters to optimize loudspeaker performance. Users do not have to set parameters when using these presets.

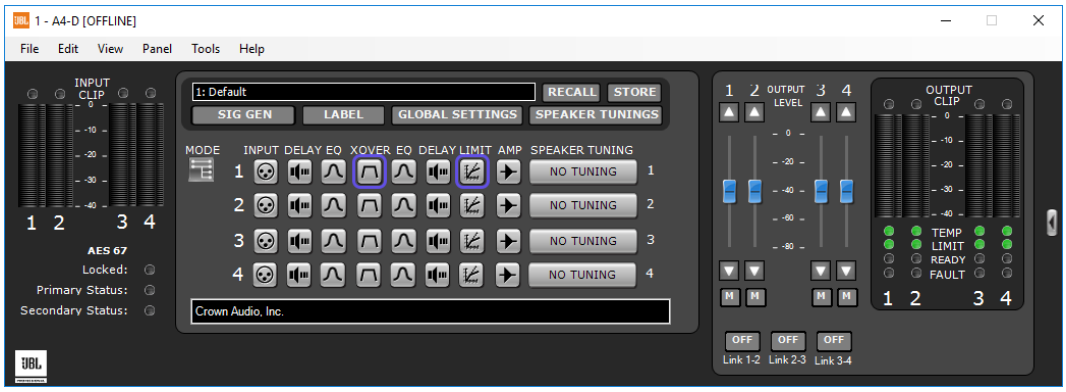


Figure 1: DSi2 Device panel showing Processing Objects. The XOVER and LIMIT PO's are highlighted.

Configuring the DSi 2.0 LevelMAX Limiter Suite

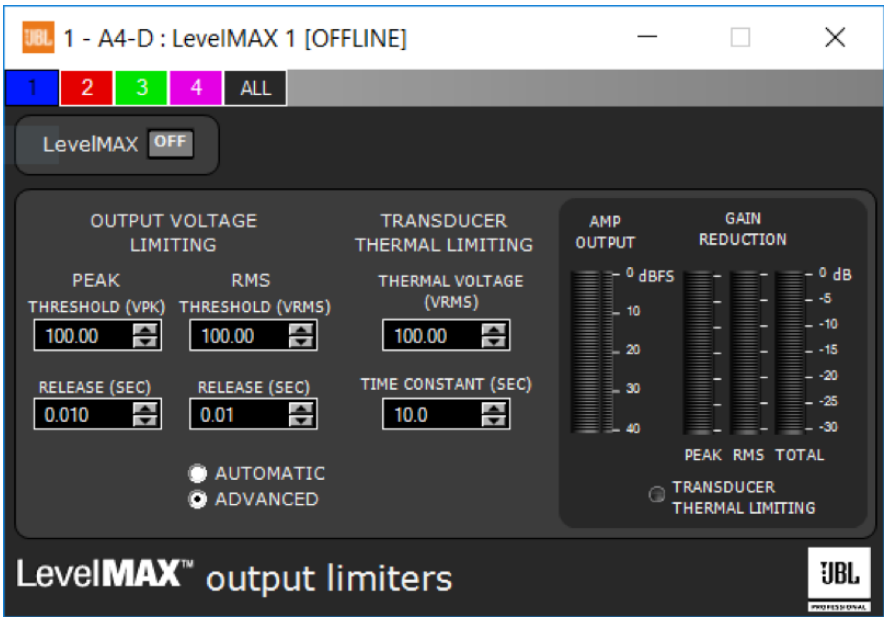
The LevelMAX Limiter Suite features three types of limiting:

- Peak, RMS, and Transducer Thermal

And two modes of operation:

- Auto and Advanced

The standard DSi 2.0 LevelMAX limiter panel (Advanced mode) is shown below:



In both Auto and Advanced modes, turning on the LevelMAX Limiter Suite will enable all three limiters: Peak, RMS and Thermal. We'll expand on LevelMAX's limiter types and operating modes below.

1.0 LevelMAX Peak Limiter

LevelMAX Peak limiting instantaneously limits the output voltage so it will not exceed the defined peak threshold voltage.

1.1 Peak Limiter Threshold

User-Defined Setting

In Auto mode, the peak limiter threshold value is automatically determined from the defined RMS threshold and the lowpass frequency. These values are set in the XOVER module, accessed by double-clicking the XOVER button on the main control panel. When a lowpass frequency is below 100 Hz, the RMS-to-peak threshold ratio is 6 dB. When the lowpass frequency is between 100 Hz to 400 Hz, the RMS-to-peak ratio increases from 6 dB to 9 dB. Above 400 Hz, the ratio remains at 9 dB.

1.2 Peak Limiter Attack

Factory Preset Only

The peak limiter attack time is instantaneous and cannot be modified. The output voltage is limited to the value defined by the peak limiter threshold (see 1.1).

1.3 Peak Limiter Release

User-Defined Setting

In Auto mode, peak limiter release time is determined by the highpass frequency defined in the XOVER module. In Advanced mode, peak limiter release time can be set by the user.

1.4 Peak Limiter Look-Ahead

Factory Preset Only

Peak limiter look-ahead inserts a delay into the peak limiter signal path in order to "look" at the input signal and anticipate when that signal will exceed peak threshold. If the look-ahead detects that the threshold will be exceeded, it reduces the signal gradually as it approaches the threshold, while maintaining the correct peak voltage. This approach eliminates the potential for a sharp signal discontinuity, which can create audible distortion.

The peak limiter look-ahead value is 0.5 ms, a value subjectively determined to be acceptable for most frequency ranges without adversely compromising overall latency. Overall latency remains constant whether the LevelMAX Limiter Suite is enabled (ON) or bypassed (OFF).

2.0 LevelMAX RMS Limiter

LevelMAX RMS limiting accurately limits the output signal to the specified RMS threshold voltage.

2.1 RMS Threshold

User-Defined Setting

The RMS Threshold should be set by the user to correspond to the transducer or system's short-term (2-hour) power-handling rating. Refer to the appropriate JBL specification sheet, technical manual or product manual for 2-hour power ratings. To calculate the RMS threshold in $V_{RMS,}$ use the equation:

RMS threshold (V_{RMS}) = √ AES power (W_{RMS}, 2-hour) * minimum impedance (ohms)
Where AES power (W_{RMS}, 2-hour) is the free-air component power rating

If minimum impedance data is unavailable, use nominal impedance. If 2-hour AES power ratings are unavailable, use 2-hour IEC power ratings. For most applications, we recommend operating LevelMAX limiters in Auto mode so that peak thresholds are automatically calculated based on the RMS threshold and selected lowpass frequency (see 1.1).

2.2 RMS Attack Time

Factory Preset Only

The RMS attack time is set automatically in Auto or Advanced modes and is based on the peak-limiter release time. The RMS attack time has been designed to smoothly transition from peak to RMS limiting while minimizing audible limiter artifiacts.

2.3 RMS Release Time

User-Defined Setting

In Auto mode, the RMS release time is determined based on the highpass frequency that is defined in the XOVER block. In Advanced mode, the RMS release time can be set by the user.

2.4 RMS Detector Time

Factory Preset Only

The RMS detector time is based on the high- and lowpass frequencies defined in the XOVER block and is not user-adjustable.

3.0 LevelMAX Transducer Thermal Limiter

LevelMAX transducer thermal limiting is designed to protect transducers from long-term thermal damage by gradually adjusting the RMS threshold until the target long term thermal threshold voltage has been reached. The thermal limiter functions only when the RMS limiter is enabled and when the thermal voltage threshold is lower than the RMS threshold. On the main limiter panel, the thermal protection LED turns on once the thermal limiter is 0.75 dB into limit.

3.1. Thermal Voltage

User-Defined Setting

The thermal voltage threshold should be set to correspond to the transducer or system's long-term (100-hour) power-handling rating. Refer to the appropriate JBL specification sheet, technical manual or product manual for 100-hour power ratings. To calculate the thermal voltage threshold in V_{RMS} use the equation:

Thermal threshold (V_{RMS}) = √ power (W_{RMS}, 100-hour) * (nominal impedance)
Where power (W_{RMS}, 100-hour) is the 100-hour power rating.

If 100-hour power-handling data is unavailable, set the 100-hour power rating to approximately 0.8 x 2-hour power rating.

3.2 Time Constant

User-Defined Setting

The thermal-response time (time constant) is the length of time the average RMS signal falls above the thermal threshold voltage before limiting begins. When the threshold is exceeded for the defined thermal-response time, the RMS threshold is lowered until the target thermal voltage has been reached.

Note: The thermal response time is not the time it takes to reach the target voltage, although the longer the thermal-response time, the longer it takes to reach the target voltage. Thermal-response time is also dependent on the amount of gain reduction and the ratio between RMS and thermal thresholds. Thermal response time is transducer-dependent and should be based on the initial temperature rise of the transducer voice coil to protect it from thermal overload. If detailed transducer data is unavailable, the thermal response time should be left at its default value of 10 seconds.

By managing your signal with the DSi LevelMAX Limiter Suite, you'll maximize the efficiency of your cinema sound system while protecting your investment. For more information about operating JBL DSi 2.0 amplifiers, please consult our manual and quick-start guide.