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Certain new digital products have become "must-haves" for the modern digital studio. A good candidate for this list is the L2 Ultramaximizer, a digital look-ahead peak limiter with Waves' proprietary IDR™ wordlength reduction system.

Designed to be the last process in the mixing chain or in the mastering studio, the L2 is a stand-alone, 48-bit/96kHz two-rackspace hardware unit, based on Waves'

second-generation technology from its L1 Ultramaximizer mastering software plug-in. Like the L1 process, the L2 increases the average audio level and maintains absolute maximum peak levels without clip and without adverse side effects. Its IDR (Increased Digital Resolution) function is a requantization process that increases the perceived digital resolution by as much as three bits or 18 dB.



WHAT'S INSIDE

Analog audio enters and leaves the unit as either balanced signals via the XLR connectors or as unbalanced through 1/4-inch jacks. Digital I/O includes both AES/EBU XLRs and S/PDIF RCA jacks. The L2 outputs audio as simultaneous analog and digital signals, making it ideal for mixing to both analog master tape recorders and digital media at the same time.

The A/D converters are AKM AK5393 chips with two Burr-Brown INA103 chips per channel for balanced input and output amplifiers. The rest of the analog "front end" was co-designed by Hutch of Manley Labs and Evgeny Klukin at Waves. Separate left/right +/-10dB input level trim controls let users tweak analog input operating levels, and six 16-segment LED meters display input level, output level and attenuation (gain reduction) for the left and right channels. These range from 0 to -96 dB and have an automatic peak hold function that's resettable from the front panel.

D/A conversion is handled by an AKM AK4324 chip, and the unit can operate at 88.2 and 96kHz double sample rate modes. Sync selections include internal (via a low-jitter clock),

digital--which strips sync from S/PDIF or AES/EBU data streams--or slaving to an external word clock. A rear panel RS-422 port could be used for future software/firmware updates or for recalling stored front panel settings from a computer database.

L2 AS LIMITER

After the inputs (analog or digital) are set, there are three main controls to adjust: Threshold, Output Ceiling and Release. The values of these continuous rotary controller knobs are displayed on six bright LED alphanumeric displays that are visible across any control room. When two channels are linked for stereo, the top knobs slave the lower knobs. When unlinked, the bottom knobs return to their previous values. I found this feature handy when using the unit as two separate mono limiters: It saved the lower channel's setting, which I used on a bass synth.

The L2 At A Glance	
Limiter Features	
<ul style="list-style-type: none"> ● Adjustable threshold (0 to -30 dBFS) ● Output ceiling (0 to -30 dBFS) ● Selectable auto/manual release time 	
IDR Features	
<ul style="list-style-type: none"> ● 2 master dither choices ● 3 noise-shaping curves ● Requantizer output: 24, 20, 18 and 16 bits 	
I/O	
<ul style="list-style-type: none"> ● Balanced and unbalanced analog ● S/PDIF (RCA) ● AES/EBU (XLR) digital 	

Setting the Threshold control is different from an analog limiter. If the Threshold is set to 0 dB, the output exactly reflects the input (within 0.1 dB), but as you lower the threshold value, the output level actually goes up. The first time I used the L2, I was conservative, but I soon discovered I could use large values such as -12 dB and push the output level up 12 dB. It follows exactly that when you adjust the threshold 10 dB below the highest input level reading, you see about 10 dB of gain reduction indicated on the Attenuation meter. The above-threshold signals are limited, while all below-threshold signals undergo a constant gain change that is controlled by the difference between the Threshold and Out Ceiling settings.

The Out Ceiling level can be considered the absolute maximum level coming out of the unit, no matter what happens on the input of the L2. This sort of confidence means that when mixing, you can be sure that no

digital clips will occur on your digital master. In practice, I set the Out Ceiling to 0.1 dB, or 1/10dB below maximum, as some CD plants might construe a certain number of successive samples at full digital level as "overs" and reject my master. If you are mixing to analog master tape, there is no way to adjust the final output level (makeup gain); it would have to be done at the input of the recorder. The unit is calibrated to output a +4dBu level when the meters read -20dBFS digital level, and it is capable of a maximum output level of +24 dBm.

Ratio for this peak limiter is infinite, and attack time is based on the look-ahead feature. Call it processing time or latency, there is a delay between the input and output of the L2. It is 64 samples at 44/48 kHz, or 1.5 ms, in which time the processor sees the peaks coming and scales them so that they are not clipped but "made shorter." This delay isn't critical when using the L2 for processing either live or recorded music. The delay would only matter if L2 processed signals were mixed with other phase-related signals.

Release time is variable from 0.01 to 1,000 ms as indicated on the LED display. Waves suggests using the ARC (Automatic Release Control) at all times, even for light limiting. ARC recalculates and updates the release time with every sample to deliver the fastest possible release time that will yield the lowest distortion. The exact method is a company secret and is based on the psychoacoustic and biomechanical response characteristics of the ear as it relates to peak and average levels. This method was first used in the Waves Renaissance Compressor Plug-in.

I experimented with a couple of sequenced drum machine parts that were periodic (a repeating loop) and found I could manually adjust the release time with precision. I used ARC for program mix processing, but I still opted for manual release time when I limited a Roland 808 bass drum sound that had a very long decay time. The only other time to use manual is when you intentionally want to create release-time pumping effects. To use the L2 as a stand-alone A/D converter, set the Threshold and Out Ceiling controls to 0 dB, making the limiter "bit-transparent" (i.e., out of the circuit).

IDR, DITHER AND NOISE SHAPING

IDR relies on the L2's internal 48-bit resolution to represent and process the audio signal, even if the input signal is 16-bit. This new, ultraprecise digital signal is then requantized to your desired, selected, final bit depth, be it 16-, 18-, 20-, 22- or 24-bit. Simple truncation of the 48-bit internal signal would result in rounding errors of the digital word and would produce distortion of low-level signals--a loss of resolution of low-level information such as reverb tails, ambience and directional cues that our ears require to reconstruct a mental image of a soundstage. Requantizing by truncation is improved by adding a precisely controlled amount of noise called Dither to the signal. This can convert low-level, nonlinear distortion (noise) caused by the truncation of the 48-bit word into analoglike steady hiss. Since an increased noise floor is not desired, the noise is shaped to fit in the part of the audio spectrum least noticeable to the human ear. The IDR method would capture as much as 27 bits of perceived resolution even when outputting a 24-bit signal and as much as 28 bits when at 88.2 or 96 kHz (four bits better when at double sample rates). This technology is based on mathematical work and research done by company consultant, the late Michael Gerzon.

There are three Dither modes selectable on the L2. No Dither or Off is the same as the Bypass button when you want to just clone a copy but at a different bit depth, say, 24-bit down to 16. Type 1 Dither adds a 5dB increase of broadband noise to eliminate all low-level distortion and signal-dependent modulation artifacts. Type 1 is the choice for high-quality mastering applications. Type 2 is a narrow-band dither that is 5 dB quieter than Type 1, but with some low-level distortion. It's a trade-off between adding less noise and keeping a little of the distortion.

Noise-Shaping options on the L2 are Off, M or Moderate, N or Normal, and U or Ultra. With Noise Shaping off, there is equal distortion, or noise, at all frequencies. The Moderate option reduces perceived hiss by 6 dB, while Normal reduces by 12 dB and is best for the creation of production masters. Ultra will reduce noise by as much as 18 dB, but the caveat is that no further digital processing or editing should happen to this signal because of the additional

high-frequency energy used.

AND THE REST

Waves has included a very good manual with the L2, because a lot of the concepts and operations are new and, if incorrectly used, can yield irreversibly poor results (such is the case with all powerful digital processors). Single-page "quick-start" instructions walk the user through the proper setup and operation. The unit is extremely easy to use--with no LCD screens or submenus to navigate--and once set up properly, operation is basically a one-knob adjustment and all front-panel settings are stored in nonvolatile memory for your next session.

The L2 Ultramaximizer makes a superb final processor for all digital audio recordings. Selling for \$2,395, the unit is a worthwhile investment for any studio seeking to maximize both digital level and resolution while eliminating any danger of clip. Waves, 306 W. Depot Ave., Suite 100, Knoxville, TN 37917; 865/689-5395; fax 865/688-4260; Visit: www.waves.com.

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