Weiss POW-R Review

"AUDIO MEDIA" October 1999

A consortium of manufacturers has received a very positive response to their introduction of a new dithering process. GLENN MEADOWS describes the POW-r process and reviews POW-r equipped hardware from Weiss Engineering.

Word length reduction -- now there's a topic that can fill a whole magazine. As we move further into the arena of 24-bit recording, the real need to deal with WLR on a regular basis is becoming even more important. Just what is word length reduction, and why is it such an important topic?

Dithering About

Originally, commercial digital audio was designed to be 16 bits in resolution, and, for the consumer, at a 44.1kHz rate. We were told that this was all we'd ever need. When the early CDs came out, it quickly became evident that things were not quite right, especially at the low levels of the recordings. Even at the higher signal levels, there was this nagging 'edge' to the music. As it turns out, there were more things that needed to be done to the signal as part of conversion and storage. Proper dithering soon became a major concern. Some people dithered with DC, some with white noise -- anything to keep the bottom two bits of the converters active and randomly toggling. Dither was the solution, but the problem was not quite solved.

Careful listeners realized that white or pink noise, or the commonly used DC offset, just wasn't the whole answer. Various digital designers started manipulating the white noise into other noise spectrums -- taking the 'little bit of noise' that they were adding, and massaging its frequency content to make it less audible. This subjectively made the recordings sound better, but in quiet passages you could still hear the annoying artifacts or noise. In the early' 90s, Apogee developed and released their UV-22 process, which was probably one of the first truly commercial 'dither' successes. Their method puts a clump of noise right outside the audible band, just prior to the Nyquist frequency, moving the power curve typically beyond audibility. The energy level used by UV-22 to keep the converters from gating is similar to that used by other dithering techniques, yet adds only a minimal amount of noise in the audible range. Apogee's very successful product is widely used, both in their own products, as well as under license to other manufacturers.

Other dithering schemes, from different manufacturers, have their own adherents. If you aren't using some form of dither in your DSP processing in your DAW, you need to be aware that you are probably doing pretty nasty things to the music you are working on.

Enter POW-r

Now in 1999, we have a new entrant into the 'dither' race. A recently formed consortium of high-end audio and digital designers got together and analyzed all the available styles and forms of dither. They realized that it might be time for another entrant into the field, and chose the 'please mother, I'd rather do it myself' approach. These four designers are John La Grou, from Millennia Media; Daniel Weiss, from Weiss Engineering; Dr. Glenn Zelniker, from Z-Systems and David McGrath, from Lake DSP. The product they have developed is called POW-r. POW-r (Psychoacoustically Optimized Wordlength Reduction) is a unique algorithm that reduces longer word lengths (20, 24, even up to 32 bits) to shorter word lengths, including the CD-standard 16-bit format. The process is the closest thing to perfection that I have heard to date.

Nyquist band dither (NBD -- not really noise shaping), has been around in theory since Shannon. One aspect of the POW-r algorithm generates a type of NBD pattern using an innovative real-time DSP-based technique to generate the dither pattern, fully decorrelating signal from NBD generation, thus avoiding low-level correlated noise, LF motorboating and other effects that some associate with NBD techniques. The algorithm is patent-applied-for and provides what the POW-r consortium believes to be a previously unavailable level of sonic realism in word length reduction.

POW-r is a scalable algorithm, meaning it is dynamically optimized for all sample rates from 32kHz to 200kHz, and beyond. POW-r retains much of the apparent dynamic resolution and clarity of high-bit sources in a 16-bit word. Three settings allow selection of POW-r algorithms to be fine-tuned for highly dynamic sources (orchestral), less dynamic sources (rock/pop) or less complex sources (spoken voice). POW-r Type 1 is a type of 'near-Nyquist' second-order curve, which most resembles a well-known WLR process in its shape. POW-r Type 2 is a variety of fifth-order

curve, and POW-r Type 3 is a variety of ninth-order curve.

POW-r is designed for portability and will operate flawlessly in DSP, logic and native software DAW applications. It includes user-adjustable parameters for fine-tuning bit reduction for different audio sources.

In Use

I've used the processor on several projects and I have to admit, this is one of those items that really grow on you. On initial listening, you have to do a double take to see if the box is actually in the line and engaged. My Apogee AD-8000 D/A section displays the actual length of the word being decoded, and thus verifies that the data is going from 24 bits down to 16 bits. Monitoring was done with my Prism DA-2 converters.

I ran a large selection of 24-bit projects through the POW-r box, and compared the results to those I could get with several other WLR schemes. The difference was initially subtle, but the more I listened and compared, the more I realized that what I was hearing out of the POW-r processor was as close to the 24-bit source material as I had ever heard. On several recordings I was unable to reliably detect which was the 24-bit, and which was the 16-bit POW-r version. Normally, I can easily hear such differences in my mastering room. With most dithering systems, there is a telltale loss of image width. Some dither schemes add an edgy sound to the high end. With others, there is a muffling of the mid-range detail. Many times the dithered 16-bit version of the 24-bit master is something of a disappointment. POW-r changes all of that.

I listened to material ranging from country music (including some of the Shania Twain masters), to a recent solo piano project and some traditional jazz. In my opinion, all three of the algorithms are better than anything else I've heard to date. To my ears, Type 2 was usually the most transparent of all of them. With Type 2, I was virtually unable to pick the 24-bit from the 16-bit. There were times that I preferred Type 1 or 3 because of what they contributed to the overall final product, but as far as audibility goes, Type 2 gets the nod.

Packaging, I/O And Control

The POW-r iteration that I've been testing is found in a box made by Daniel Weiss Engineering, and is a functional equivalent to the actual shipping product. The test unit was in a prototype case, but the electronics are identical to what you will get if/when you purchase one of the remarkable boxes. (Any idea if I like the process or not?)

The demo box had rear-mounted AES and SPDIF I/O, as well as SDIF II I/O on BNC and DB-9 connectors. Another DB-9 pin connector provides remote control access to the functions on the front panel. The sparse front panel contains a power switch, four input selector push buttons, a red LED to indicate an invalid input and three green LEDs to show the sample rate. There are five additional push buttons; one turns on the POW-r processing, the next three select the output word length, and the last turns on the 0 in 0 out function. This last function causes the output to go to digital black when the input is digital black. The release version hardware will vary somewhat from this description.

On the prototype box, to select between one of the three processing algorithms, you press and hold the 'Process ON' button. The unit cycles through the three options and changes the blink/steady state of the ON light. 'ON solid' corresponds to POW-r mode 1, 'ON blinking slow' to POW-r mode 2, 'ON blinking fast' to POW-r mode 3 and 'ON light off' to no processing.

A number of pro audio companies have entered into license or intent-to-license arrangements with the Consortium, including SADiE. Sonic Solutions has selected the POW-r group as their HDSP plug-in partner for high-definition word length reduction.

Interested readers might call one of the four companies involved with the POW-r consortium to check out what they are now offering. Each company has plans for products of their own. Daniel Weiss is selling the standalone processor reviewed here, and hopefully will be including POW-r in his other products. Z-Systems is already including POW-r in their z-q1 and z-q6 digital equalizers and their z-c11 digital dynamics processor. John La Grou and Millennia Media are planning to release microphone pre-amps with integral A/D converters that employ the POW-r algorithms.

Closing Remarks
I recently had the opportunity to talk with three other engineers who have worked with and heard the POW-r system. They provide our closing comments; two very positive, and one less enthusiastic.

From Digital Domain in Orlando, mastering engineer Bob Katz: "I really liked the low-key approach of the POW-r consortium. No sales talks, just 'would you like to check out this box?'. I said, 'sure', yawned, thinking, 'oh well, another dithering box'. No one told me that I was supposed to have a jaw-dropping experience, but there you go.

"I have little to add to Glenn's enthusiastic comments, except that I also give POW-r a rave, and that my favorite POW-r algorithm is Type 3, though I have a great deal of difficulty telling Type 2 from Type 3. Usually, I can easily hear the difference between fifth and ninth order curves with other dithering boxes, but POW-r is doing something mysteriously far beyond noise-shaping or near-Nyquist dither. I've just begun to learn to recognize the small artifacts of POW-r, and they are an order of magnitude smaller than anything else on the market. Shall we say 'inconsequential'? Never has 16-bit (reduced from 24-bit originals) sounded this good before!"

Paul Stubblebine, of Paul Stubblebine Mastering in San Francisco: "POW-r is not as close as I was hoping, compared to a 24-bit source. Comparing POW-R dithered recordings to HDCD dithered recordings, the HDCD dithered material is more to my liking. My listening impression under the different circumstances [variations of the HDCD dither] was pretty consistent: while the POW-r certainly isn't bad, the HDCD dithered material sounded better resolved, less congealed when things got complex, deeper and wider when the arrangement is sparse and spacious, more natural, inviting and engaging. Of course, the 24-bit sounded better yet."

Producer/engineer and Director of New Technology for Telarc International, Michael Bishop: "Over the years at Telarc, we've gone through the whole range of dithering schemes to keep PCM digital well-behaved -- everything from levels of DC to white noise and various noise-shaping curves. We had eventually come to employ the UV22 dither from the Apogee UV1000 unit as our standard means of getting from 20- and 24-bit PCM to the 16-bit PCM CD master.

"Our introduction to the POW-r word length reduction algorithm has changed all of that. POW-r is making it possible to have so much more of our 24-bit master represented on the 16-bit CD than we could do with other dithering or word length reduction algorithms. I have been able to have a signal level near -120dB from digital peak in 16-bit still be audible and not distorted. That great increase in depth better represents the width and depth of the 24-bit PCM master in its 16-bit CD form than the other means of dithering available, in my opinion. In fact, Telarc's project producers insist that POW-r word length reduction be used exclusively for mastering all of our PCM-source masters. Once one hears something this good, there's no going back!" *