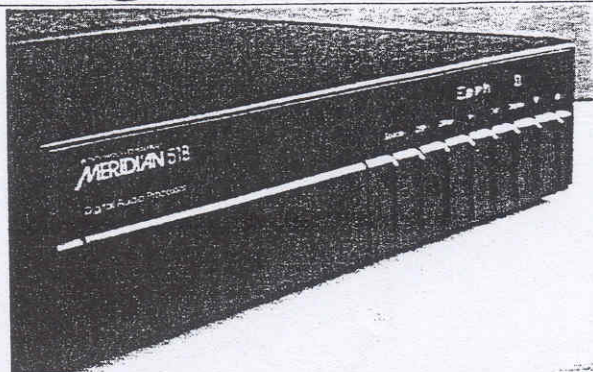


Digital Audio

Meridian 518 Digital Audio Processor
Sugg. Retail: \$2500
Distributor: Canorus Inc.
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Trying to describe a component like the *Meridian 518* is a little difficult, because it doesn't play CDs, doesn't convert from digital to analog (nor vice versa), and its processing, ephemeral as it is, cuts to the chase of the state of the art in digital processing. But what does it do? For \$2500 you really should know this.

Well, let's start with jitter, described in the novel-like manual (written by *Meridian* resident genius Bob Stuart) thusly: "...where the data is passed from process to process, the exact timing of the samples may become disturbed so that the samples arrive occasionally slightly early or late. Inaccuracy in the timing of the incoming stream is called 'jitter'...When a jittered digital stream is fed to a DAC, the sound is degraded - typically a listener will describe it as 'harsh', 'glassy', or 'bright' or lacking in 'spaciousness'."

"The de-jittering element is of great importance to some players, and of enormous significance to any Laserdisc player as they tend to have relatively high jitter output."

The *518* employs a double phase-locked loop to restore proper timing to the data stream, but this is only the beginning, the first of half-a-dozen techniques provided in this processor. The overall goal is to push the standard of reproduction, as expressed in bits (that is, dynamic range and, hence, low-level resolution) from the 16-bit CD standard to as close to 20 bits as possible. Though this is hard to quantify exactly in dB (though quite precise estimates are offered by *Meridian*, as noted below), we are talking about an effective pushing down of the noise floor to close to -120 dB over much of the audible frequency range.

And this is all done within the CD's 16-bit standard. How? Well, it's achieved through a number of techniques that have been employed elsewhere, but never combined so artfully in a single digital processor (except in the *518*'s professional progenitor, the *618*). This combination of techniques requires quite a lot of computing power, and is done in 72-bit architecture, more than twice the horsepower of the *Audio Alchemy DTI Pro32* (see following review).

As noted, this process starts with removal of jitter and data stream re-clocking. After de-jittering, the *518* allows use of a precision Gain control to optimize dynamic range without data loss, offers several modes of Dither combined with Noise-Shaping to respectively, bridge the gap between low-level samples to complete their data, and then move noise out of the

audible region to frequencies above hearing range. The five noise-shaping curves have been designed to put the small amount of remaining noise in regions where the ear is least sensitive. One of the first noise-shaping techniques (and now one of the cruder ones, as the diagram next page shows) was Sony's Super Bitmapping.

The *Meridian* shapes shown are the C and D ones, the former recommended for classical recording (in mastering use) or classical recordings (for home playback of CDs).

Yet another option is the use of the now-seldom-employed Emphasis circuit embedded in the CD standard. Pre-emphasis/de-emphasis is a simple encode/decode cycle in which high frequencies are boosted in mastering and symmetrically attenuated in playback, the (usually and preferably analog-domain) de-emphasis circuit triggered by a flag in the digital data.

Since most record companies over the years have concluded that the CD was quiet enough without the use of emphasis, it has been seldom seen in commercial releases, with one exception. For many years *Denon*, one of the world's pioneers in digital recording, and one of the larger Japanese record companies, used emphasis on all their releases, but about two years ago quietly ceased this practice. Very few DACs or CD players have an Emphasis indicator, though all *Meridian* models always have had such an LED. The word *Emph* is illuminated on the *518*'s front panel when passing an emphasized signal.

That's because Bob Stuart believes in using emphasis, and for good reason. Looking at the diagram, we can see the

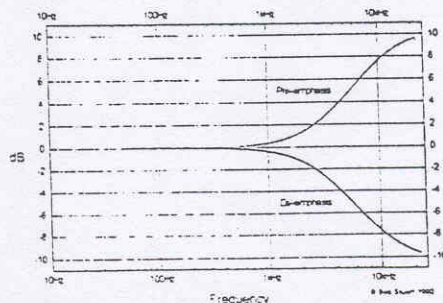
symmetrical boost and cut parameters, which reach 10 dB near 20 kHz, where noise will be highest and musical signal least. Like Dolby B, emphasis reduces noise by as much as 10 dB, but because the emphasis is applied in the digital domain, it has another very important virtue: as frequency increases and the music consists of largely harmonic energy, its level decreases and becomes closer to the noise floor, where sampling can be less than complete (the problem we are also addressing with dither); by boosting this a few dB in mastering (and the boost pretty closely tracks the frequency, ie; about 3 dB at 3 kHz, 8 dB at 8 kHz), the samples are moved away from the noise floor, and therefore their sampling is more complete, at a higher bit rate.

The result, confirmed by mastering engineer and colleague Clive Allen in his experience with the review *518* and our own *607* A/D converter used for *Audio Ideas* recordings (including our new *Ian Sadler* organ CD coming this fall), is greater detail captured and maintained on recordings mastered and edited with emphasis, even if they are not ultimately committed to CD with emphasis on.

According to Bob Stuart, the quantifiable result of using only emphasis through the whole chain is a "one-bit [increase in] noise reduction...a 2-bit increase in high-frequency resolution", and a "more than ten-fold (20 dB) reduction of converter noise." Regular readers may recall our reporting that some California recording studios a few years ago started using Dolby SR noise reduction with digital recorders to achieve a similar result. The idea was, if you have problems of resolution and noise down near the noise floor, then use a technique that keeps all audio well above it in the digital domain, restoring original dynamic range after the fact. These studio engineers knew it worked, but didn't quite understand why, perhaps. If they had, they might have realized that emphasis was already there as a neat tool to achieve exactly the same benefit.

I realize at this point that this review is turning into another feature on digital audio. I guess we can call it *Squeezing The Orange* this time, because what the *518* allows is something no other digital device in my experience does, including the *Audio Alchemy DTI Pro32*. It allows digital playback that approaches and perhaps occasionally surpasses the sweetness and naturalness of analog, and, more important to me, allows the making of truly superb recordings with 18-to-20-bit resolution within a 16-bit system, with no playback decoding (unlike HDCD) except emphasis, if employed. I guess we're finally past the *lemon* stage in digital audio.

But there is yet another resolution-enhancing feature in the *518*: Word-Length Matching at both input and output. Input matching is important only to professional users who are trying to, as Keith O. Johnson so palpably put it, "cram a bowling ball down a garden hose," (Wtr 93) that is,



convert a 20- (or even 24-) bit recording to 16 bits. But for those with DACs (or editing systems) that will pass 20 bits or more or of resolution, this word-length matching allows the audible benefits of dither and noise-shaping to be most fully realized.

I should summarize the processing operations here, before going on to discuss the audible consequences. The digital signal is first de-jittered, and then can be subjected to precise gain control (including smooth fades up and down), dither and noise-shaping combined in various ways to optimize dynamic range and resolution while reducing quantisation distortions, and pre-emphasis to bring subtle harmonic energy up in level away from the noise and quantization floor. The use of these in combination can result in gains in subjective dynamic range in excess of 20 dB. For example, using just High-Pass dither with no noise-shaping provides an increase of 3.5 dB, and adding emphasis doubles this to 7 dB. The five noise-shaping modes, A through D, are each progressively greater in their effect; therefore the higher the upper octave energy in a recording, the less powerful the noise-shaping that should be used. Shape A adds 6.4 dB of dynamic range, while Shape D provides 15.3 dB, an additional 3 dB achieved when emphasis is also employed.

British recording engineer Tony Faulkner has found Shape C (15.1 dB/17.9 w/emphasis) most appropriate to achieve the greatest improvement with the least likelihood of playback problems. *Problems*, you say? Yes, there is a downside to everything, I guess, and here it is all that noise shifted up around 20 kHz. Looking at the diagram that shows shapes C and D, it is obvious that a lot of quantization noise has been packed into that frequency region in D. This can tend to overload some less expensive 1-bit DACs and cause distortion, though whether this will exceed the inherent distortion elsewhere in a modest audio system is yet to be determined. As well, in editing noise-shaped and pre-emphasized material, error rates have to be minimized because there is less audible masking at high frequencies, and clicks may accompany error correction of dropouts. In fact, I have heard this effect on CDs with large errors; when interpolation is occurring, occasional burbles and clicks much like LP surface noise can be heard at low levels, but still distracting. The partial solution is to use either the Flat or Highpass dither without noise shaping to minimize their audibility, but this also causes a mild but audible

collapse of soundstage depth, as the low-level enhancement is reduced. After saying all this about these digital enhancement methods, I should point out again that the benefits can only be fully realized with 20-bit DAC performance and very good low-level linearity. Here's how Bob Stuart discusses it under the heading, *Requirements for D/A Conversion*: "Noise-shaping can be used to extend the audible dynamic range of a channel beyond that which would be expected for a normal digital channel of the same word-size. The essential principle by which this is achieved is representing numbers below the LSB as an average of successive bracketing numbers. For this system to work, the channel must exhibit differential linearity equal to the resolution required."

"We can illustrate this best by example. Let us assume that a signal has been encoded with 20-bit precision and that a shaper type D has been used to convey this signal onto a 16 bit CD channel. Measurement in the digital domain shows very clearly the success with which the subjective dynamic range is extended. Implicit in this theory is the fact that the digital channel has near-infinite differential linearity, ie, each bit has a magnitude precisely twice or half the magnitude of the next."

"When this signal is applied to a D/A converter some problems may arise. First, the D/A process may be associated with an oversampling digital filter. Commonly these parts take no precautions with regard to dither and introduce a quantisation noise floor themselves at the approximate level of the LSB in the filter, thereby obliterating low-level information in the signal. Secondly the D/A converter will not have perfect differential linearity - there is no longer any reason why successive bits will maintain a precise 2:1 ratio. The effect of this is also equivalent to quantisation at the linearity level of the converter."

"In summary, therefore, the wide subjective dynamic range inherent in the recording cannot be reproduced unless the replay D/A system has both a word-size (in terms of associated oversampling filters) and a differential linearity equivalent to the original material, which in this example was 20 bit. The result would be further improved by the correct use of dither and noise-shaping in the digital filter. That a subjective channel dynamic range of approaching 20 bit can be conveyed on a 16 bit channel is quite remarkable. On reflection, it should not be surprising that to realise this benefit, both the A/D and D/A sub-systems must have the required 20-bit precision."

I've quoted this at some length for more technically inclined readers, and to emphasize that buying a 518 to go with a DAC in which the resolution has been intentionally limited is largely a waste of the money spent. It must be used with a very good DAC, preferably one that will throughput 20-bit words.

In my system I started with the *Monarchy M-33*, which uses 20-bit double differential Burr-Brown PCM-63 K Series DAC chips, setting the input word length of the 518 to CD's 16 bits, and the output to 20-bit words. I then experimented with the various dither and noise-shaping options. I must confess it was very difficult to hear differences between the various dithers and shapes in quick comparisons, so I will leave detailed discussion of this for a future followup. Suffice it to say, as I did above, that the noise-shapes

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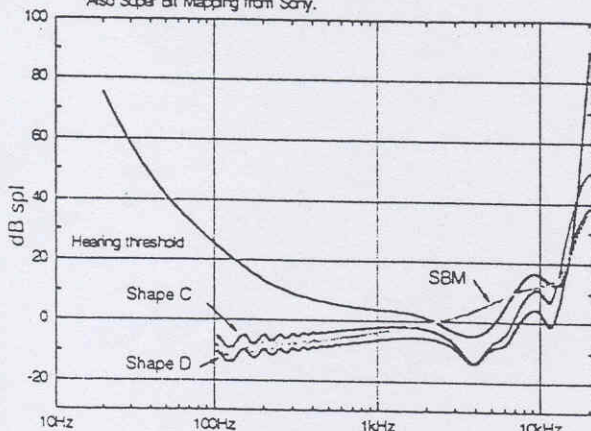
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have subtle effects on inner detail and soundstage resolution, with the ultimate effect that the recording sounds more realistic and resolved (that is, less digital) when any noise-shaping is employed.

But what was much less subtle was the instant improvement heard from the de-jittering and any of these resolution increasers with the output set to send a 20-bit data stream to the input of the M-33 via an AES/EBU cable. Listening to master DATs, including a recent Bell'Arte Singers performance of the *Monteverdi Vespers*, I could easily hear the increased resolution in depth of soundstage, audience noises, and other almost subliminal spatial cues. Things simply got drier without the 518 in the system.

Playing well-loved CDs, I also found that the best had much more information than I had previously thought. Little details in the mix of Jennifer Warnes' *The Hunter* (Attic ACD 1344), including the title tune and the collection of drums and percussion things on *Way Down Deep* became much more individually discernible. This was also true of a fantastic reissue from England, *Sandy* (Island Masters IMCD 132), Sandy Denny's superb 1972 second solo album. Here the guitars came right into the room, and the deep bass became even deeper and more focused (this was also the case on *The Hunter*). Voices gained an uncanny realism, losing that slightly hard and zippy quality previously characteristic of digital playback.

With classical CDs the soundstage opened up and individual instruments and lines were easier to distinguish, as were reverberation tails from surfaces in the recording venue. A good example (one of many) was Tony Faulkner's wonderful Teldec *Britten* recording of Andrew Davis and the BBC Symphony. The utterly immense soundstage on the *Young Person's Guide to the Orchestra* (a "Carnival of the Instruments", if you like) and *Variations on a Theme by Frank Bridge* was as deep and wide as I've heard from a recording in any medium, but this CD also exhibited some clicks and burbles in the *Four Sea Interludes' Fugue and Finale* and the *Passacaglia* from *Peter Grimes*; I looked at the disc and could find only one small scuff-scratch near the label that probably covered the 3 or 4-minute stretch of music in question. I guess I'll have to have a buff at it with a polishing compound some day soon. Removing the noise-shaping curves made this interruption less audible, but it also diminished the realism of the soundstage.

Since this is a 1990 recording (9031-7-126-2), it was probably made before Faulkner started using a 618 and *Meridian CD-R* recorder, but it does demonstrate his remarkable ability to capture an orchestra's complete sonority and the space in which it is created. I understand from the *CyberFi* interview that he is now using a new Sony optical hard disc recorder.

In addition to improvements in soundstaging, I heard greater definition and pitch specificity in the deep bass on familiar CDs through the 518. This made its bass a little less prominent than that of the *DTI Pro32*, but "tighter and more integrated", as my listening notes say. I also felt that the use of emphasis resulted in a bit more transparency, but this was, like the individual noise shapes' differences pretty hard to pin down in the short term.

Overall, the *Meridian* sound was "a little

more relaxed and comfortable", while that of the *Pro32* was more forward and propulsive. In switching between them, there almost seemed to be a timbral shift as the *Audio Alchemy* image leaped forward, though the greater and more enveloping ambient field of the 518 was as great a difference.

I guess it's clear where the nod goes in this instance. The *Meridian 518* digital processor allowed my M-33 (already a substantially superior DAC to the v3.0) to show a remarkable improvement in all the areas cited, so much so that I can't imagine listening to digital audio without it. I also see its utility in any production phase of our *Audio Ideas* recordings, from actual session use between the *Meridian 607* DAC and recorders, to use in redithering and enhancing the digital signal at every production stage, including editing and glass mastering. I'll follow up on that, too, as we explore the long-term uses of this product.

This must be the longest review ever written about a product that doesn't actually do anything but condition a digital signal. But in the case of the *Meridian 518*, that processing represents the difference between cardboard-cutout reproduction (like the people you see standing around IKEA stores, or the Sams smiling at you in Sam The Record Man stores) and lifelike recreation of a musical experience.