Halcro
dm38
POWER AMPLIFIER

John Atkinson

DESCRIPTION Solid-state stereo power amplifier with balanced (XLR) and single-ended voltage-mode and current-mode (RCA) inputs, and power-factor–corrected, switch-mode power supply. Rated output power: >180W into 8 ohms (22.6dBW), >350W into 4 ohms (22.4dBW). THD: <–110dB (<3000 parts per billion) up to 20kHz (100kHz measurement bandwidth) at full power, 350W into 4 ohms; THD at 1kHz <–130dB (300 parts per billion). IMD: <–110dB each intermodulation product resulting from a combined 19kHz+20kHz signal, each at 100W into ohms, equivalent to 350W peak power into 4 ohms. Noise: 5nV/root-Hz, voltage-mode inputs; 6pA/root-Hz, current-mode input. Slew rate: 100V/µs. Input impedance: 10k ohms, unbalanced voltage mode; 20k ohms, balanced voltage mode; 60 ohms, unbalanced current mode. Voltage gain: 30V/V (29.5dB), voltage mode; 5V/mA, current mode. Frequency response: not specified.
DIMENSIONS 31" (790mm) H by 16" (400mm) W by 16" (400mm) D. Weight: 120 lbs (55kg). Shipping weight: 187 lbs (85kg).
SERIAL NUMBER OF UNIT REVIEWED 110015.
PRICE $18,790. Approximate number of dealers: 18.
MANUFACTURER Halcro, 118 Hayward Avenue, Torrensville, South Australia 5031. Fax: (61) 8-8238-0852. US distributor: On A Higher Note, LLC, 26081 Via Estelita, San Juan Capistrano, CA 92675. Tel: (949) 488-3004. Fax: (949) 488-3284. Web: www.halcro.com.

One of the highlights of recent Consumer Electronics and Home Entertainment shows has been the demonstrations of sound quality put on by Australian amplifier manufacturer Halcro with Wilson Audio loudspeakers. At my first exposure to one of these demos—described in my April 2002 "As We See It"—enormous dynamic range was coupled with a grain-free presentation and almost holographic stereo imaging to produce a breathtaking sweep of sound. Paul Bolin reviewed Halcro's dm58 monoblock in October 2002, and that amplifier was subsequently voted this magazine's "Amplification Component of 2002" by our reviewers.

The dm58 is physically large; when I tried the review samples out in my system prior to measuring them, they dominated my room. So when Halcro's affable US distributor, Philip O'Hanlon, asked me if I would be interested in reviewing the company's first two-channel design, the $18,790 dm38, I didn't need much persuading.

Two channels, not one

The dm38 is basically the circuit of the dm58 monoblock, duplicated for stereo but with reduced output power because the same heatsink area now has to be shared by two channels instead of being dedicated to one. The aluminum chassis has an attractive brushed-silver finish, and keeps the same H-shape of the '58. The uprights, sitting on wooden plinths, contain the output circuitry and heatsinks; the lower of the two crossbars is the power-factor–corrected switch-mode power supply, the upper the input circuitry and the I/O connectors.

With two channels to handle, as well as balanced and unbalanced inputs, the latter offering both voltage-mode and current-mode operation, the rear panel of the upper module is crowded. But there is still room to connect fairly heavy-duty cables, and the output binding posts are usefully insulated with rubber shrouds.

AC power is supplied via an IEC connector on the base of the lower module, where the main power switch resides. The amplifier is switched in and out of standby with a button on the underside of the upper module.

Vanishingly low distortion

When Halcro burst onto the US high-end scene in 2001, they made much of their amplifiers' astonishingly low levels of distortion, and of the fact that the excellent linearity had been achieved without the compromises introduced by traditional circuits that use excessive amounts of negative feedback, such as the shifting of energy from the relatively benign low-order harmonics to the much more objectionable (because they are not musically consonant) high-order harmonics. Such amplifiers would have low distortion only as long as you weren't using them to amplify a signal! And there would be other problems, such as slew-rate limiting and marginal stability.

To find out more about the Halcro amplifiers, I met with their designer, Bruce Candy, in London last November. ("Halcro," a Scandinavian name of Orkney Islands origin, is Bruce's middle name.) He was passing through en route from Helsinki and Australia, and I had just finished the sessions for Antony Michaelson's Mozart Clarinet Concerto project (see "Letters" in this issue). The most important part of the design is the output stage, Dr. Candy told me. He uses complementary vertical FETs, of a type normally used for switching, because they can turn on and

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off fast enough to eliminate crossover distortion. (Candy *hates* crossover distortion.) But the problem with these so-called switching FETs, he explained, is that it is "hard to make them stable with temperature so that all the devices draw the same current"—which is perhaps one reason they are not in widespread use in audio circuits.

Candy was reluctant to go into detail about how his patented Halcro output stage works, but he did tell me that the key to the design is that the distortion-canceling circuitry "float" up and down with the output stage. So even though the output-stage voltage rails are conventionally high, this important circuitry "sees" only a small voltage, of around 10V. This allows him to use very wide-bandwidth small-signal devices in the error-canceling circuitry. "This is all classical microwave stuff," Candy explained, which left me none the wiser, other than to assume that circuits that handle microwave frequencies must, by definition, be *fast*.

Continuing our discussion, we touched on: why tube circuits tend to sound good; protection circuitry (Candy is for it, when it is done right); how hard it is to design a switching-mode power supply that won't overheat while operating at high speed with high efficiency; the optimal loading for Shure moving-magnet cartridges, which he feels still sound great on classical orchestral music (though he admires how a moving-coil design will reproduce opera); why the ubiquitous use of simulation programs such as Spice is not necessarily a good thing for electronics engineers; and even jet engines—"you must think of it in terms of gain and gas flow, the relative impedances," Candy elaborated, "if you want to understand how the engine works." The conversation veered back to audio in the shape of class-D or switching amplifiers—Halcro plans to

MEASUREMENTS

Not having any convenient current-source test gear, I assessed the Halcro dm38's measured performance only via its conventional balanced and unbalanced voltage-mode inputs. I ran it for an hour at 60Wpc into 8 ohms before performing any measurements. The pillars in the centers of the aluminum side moldings were just too hot to touch, implying a temperature around 65°C, while the central boxes were cooler, at an estimated 50°C.

The voltage gain into 8 ohms was to specification at 29.5dB via the unbalanced input, but 6dB lower via the balanced input, which is unusual. Both inputs preserved absolute polarity, the XLR jack being wired with pin 2 hot. The input impedance, assessed at 1kHz, was just above twice the specified value, at 21.6k ohms unbalanced, 44.5k ohms balanced. This increase will make the amplifier compatible with a wider range of preamplifiers, however.

The output impedance was very low, at below 0.1 ohm in the bass and midrange, increasing slightly to 0.1 ohm at 20kHz. As a result, the modification of the dm38's response by the usual Ohm's Law interaction between the amp's source impedance and the manner in which the speaker's impedance changes with frequency will be minimal. With our simulated speaker load, the response variation was around ±0.1dB across the audioband. This can be seen in fig.1, which also shows the dm38's response into resistive loads of 8, 4, and 2 ohms, driven from its balanced input. Although a very small degree of infrasonic rolloff is revealed by fig.1, the Halcro amp otherwise has a wide bandwidth, with a high-frequency –3dB point at 122kHz. Driven by the unbalanced jack, the bandwidth was even greater, at –3dB at 172kHz (not shown), resulting in a nicely square 10kHz squarewave response (fig.2).

Channel separation via both inputs was superb, at 110dB or better at 1kHz. Although the crosstalk increased to –90dB at the band extremes, this is still excellent performance. The measured background noise (with the input shorted) was also superbly low, at –107.5dBA ref. 1W into 8 ohms. The unweighted audioband S/N ratio was only slightly worse, at 105dB, though extending the measurement bandwidth to 10Hz–500kHz degraded the measured figure to 86.5dB.

It is in the area of distortion, of course, that Halcro's reputation of being a maker of extremely linear amplifiers was made. When I measured the dm58 monoblock (see www.stereophile.com/amplificationreviews/683/index6.html), its performance was at the limits of my test equipment, so I approached the task of measuring the dm38's distortion with some trepidation. Fig.3 shows how the percentage of distortion and noise in the amplifier's output varies with power and load impedance. The downward slope below 10W of the three traces indicates that the measured percentage is actually dominated by noise. (As the output power drops, the identical level of background noise increases as a percentage of that output power.)

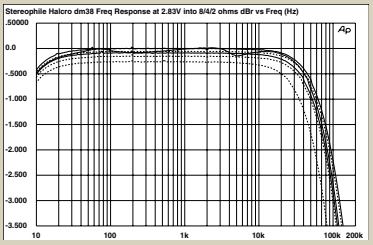

Fig.1 Halcro dm38, frequency response at 2.83V into (from top to bottom at 2kHz): simulated loudspeaker load, 8 ohms, 4 ohms, 2 ohms (0.5dB/vertical div., right channel dashed).

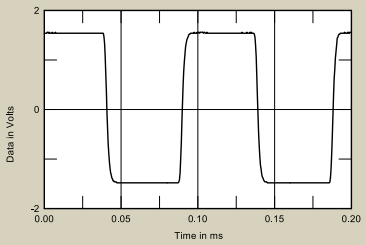

Fig.2 Halcro dm38, small-signal 10kHz squarewave into 8 ohms.

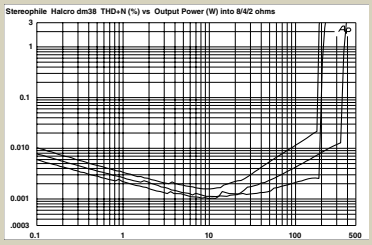

Fig.3 Halcro dm38, distortion (%) *vs* 1kHz continuous output power into (from bottom to top at 100W): 8 ohms, 4 ohms, 2 ohms.

introduce multichannel amplifiers for home-theater systems that use some innovative thinking on Dr. Candy's part.

But eventually we returned to the subject of Halcro's amplifiers and how hard it was for me to comprehend how an amplifier with as little distortion as one of Candy's designs could sound so radically different from a conventional amplifier when the distortion artifacts of the latter are already well below the threshold of human hearing. "That's a good question!" he laughed, venturing no answer.

When I got back to New York, I did some Web work and uncovered Bruce Candy's patents on the Halcro amplifier designs.[1] Rather than use conventional negative feedback to *reduce* the level of errors, he uses a complex, active error-correction circuit. Correction of errors in amplifier design goes back, in my memory, to Quad's "current-dumping," feed-forward design of the mid-1970s. As Dr. Candy points out in his patents, Malcolm Omar Hawksford, Masayuki Iwamatsu, and Robert Cordell all published papers or patents on this subject in the 1980s, and I believe Nelson Pass also attempted something along these lines with the "Stasis" circuitry used in 1980s Threshold designs.

The circuit diagrams in the patents are way beyond my ability to grasp. In Candy's words when I spoke with him, "It definitely would take the average amplifier designer quite some time to recognise the circuit as that of an amplifier if presented with no direct clue as to its purpose"—and I am not an amplifier designer at all, average or otherwise! However, it appears that the essential innovation of the Halcro amplifier is indeed the use of a floating

1 Two key patents are US 5,892,398, "Amplifier Having Ultra-Low Distortion," April 6, 1999; and patent application US 2003/0058044 A1, dated March 27, 2003.

Between 10W and 30W into 8 ohms—the lowest trace—the distortion starts to rise out of the noise floor, at around 0.001% (–100dB), but the sawtooth shape of the trace indicates that this is at the limit of my Audio Precision System One's resolving power. From 30W into 8 ohms to the "knee" in the trace at 190W, the slight rise in the THD+N percentage is due to an increasing level of distortion harmonics. This is different from the dm58, where there was no rise below the knee (see fig.8 in my October 2002 measurements). However, even at 190W into 8 ohms, the actual THD figure is still very low, at 0.025% (–91dB).

There is a more clearly marked rise in the measured distortion percentage above 10W into 4 ohms, and even more so into 2 ohms. But note that the Halcro comfortably exceeds its specified output power both into 8 ohms—205W (23.1dBW) was available at 1% THD—and into 4 ohms, where it gave out 370W (22.7dBW) at the same THD figure. It stumbled slightly into 2 ohms, giving out 182W (16.6dBW), which implies significantly lower voltage delivery. This was not unexpected; Halcro's Bruce Candy has made no secret of his opinion that speakers with impedances below 4 ohms are unnecessarily demanding on amplifiers.

Fig.4 shows how the measured THD+noise percentage changes with frequency into 8, 4, and 2 ohms. (The output level chosen for this graph was 10V, which is where the amplifier's distortion starts to become distinguishable from the background noise.) The measured figure into 8 and 4 ohms hovers around 0.001% over the entire audioband, though a very slight rise is apparent above 20kHz—the dm58's performance was very similar in this respect—and the right channel was slightly less linear than the left. But into 2 ohms, there is both a fourfold increase in THD and a rise toward the top of the audioband.

Figs.5, 6, and 7 show the dm38's linearity in a different manner. The bottom trace in fig.5 shows the waveform of the amplifier's output when the 1kHz driving signal has been removed with a sharp notch filter. The level was 1W into 8 ohms. A small degree of second-harmonic distortion can be seen, overlaid by noise. In fact, as implied by fig.3, the actual noise at this power level was much higher in level than the residual distortion—I averaged 32 'scope readings to drop the relative level of the random noise compared with that of the repetitive

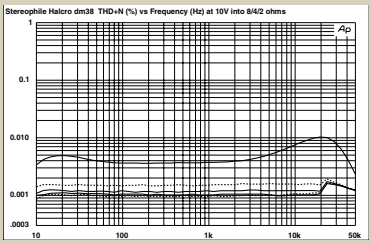

Fig.4 Halcro dm38, THD+N (%) *vs* frequency at 10V into (from bottom to top): 8 ohms, 4 ohms, 2 ohms (right channel dashed).

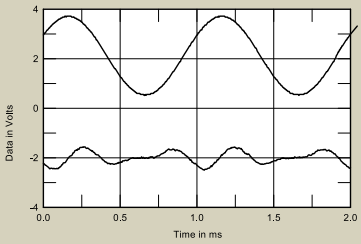

Fig.6 Halcro dm38, 1kHz waveform at 61W into 8 ohms (top), 0.0015% THD+N; distortion and noise waveform with fundamental notched out (bottom, not to scale).

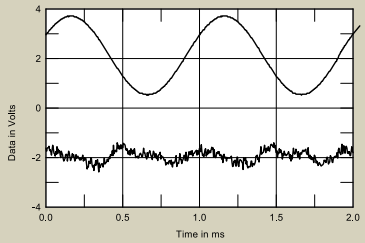

Fig.5 Halcro dm38, 1kHz waveform at 1W into 8 ohms (top), 0.002% THD+N; distortion and noise waveform with fundamental notched out (bottom, not to scale).

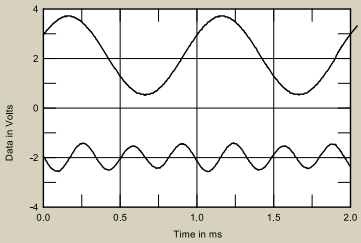

Fig.7 Halcro dm38, 1kHz waveform at 120W into 4 ohms (top), 0.0055% THD+N; distortion and noise waveform with fundamental notched out (bottom, not to scale).

power supply for the distortion-canceling circuitry, to allow the use of small-signal devices, including a differential-input op-amp with an extremely high (100MHz) gain-bandwidth product, coupled with multiple nested correction loops and enormous care taken with isolating the input circuitry from the magnetic coupling effects of the high-current output stage.

Candy stresses that there are significant differences between his circuit and earlier distortion-cancellation designs. Unusually, the Halcro amplifier doesn't appear to use the usual fully complementary topology, Candy's feeling is that the complete cancellation of even-order distortion this product produces works against his design goal of having less odd- than even-order distortion. He also explains that, wherever possible, the circuit is arranged to keep the voltage across and current through semiconductors under "very near constant conditions," to eliminate the variation of the devices' operating parameters with frequency, voltage, and current. (I conjectured 21 years ago, in the August 1983 issue of *Hi-Fi News*, that a possible reason amplifiers with class-A output stages sounded good was not so much the elimination of crossover distortion, but the fact that the output transistors were carrying a constant current and were therefore immune to having their temperature, hence gain, modulated by the music signal.[2])

Sound

"To this day, I have yet to hear any amplifier that equals the dm58's combination of complete neutrality, harmonic generosity, lightning reflexes, and a sense of boundless power that is difficult to describe," was how Paul Bolin summed up his experience with Halcro's dm58 monoblock. It also nicely describes my reaction to the dm58 when the review pair briefly spent some time in my listening room.

The dm38 didn't pale in comparison with my 18-month-old memories of the dm58s. "Awesome dynamics," I noted, after playing Prince's *Musicology* (CD, NPG 74645 84692 7) two times through after hearing Prince live at Madison Square Garden; "awesome!" This CD also demonstrated the Halcro's iron-fisted control of the bass, which made the Mark Levinson No.33H monoblocks' low frequencies sound rather fat and slow in comparison.

Perhaps more important, as well as excellent *macro*dynamics—the differences between loud and soft and how consistent the amplifier's presentation

2 My thanks to Dutch reader Hans Polak for sending me an informative analysis of this subject, and for drawing my attention to the writings of French engineer M. Perrot on this subject, which Perrot calls "Thermal Distortion" and claims is a reason tube amplifiers are preferred to solid-state. See http://peufeu.free.fr/audio/memory/memory-10-annoyance.html.

measurements, *continued*

signal.[1] Increasing the output power to 61W makes the distortion waveform more evident (fig.6), with some higher harmonic content starting to make an appearance. It is important to note, however, that the actual THD+N level was just 0.0015% (–96dB). Finally, fig.7 shows that halving the load to 4 ohms without altering the output level introduces a fairly pure-looking third harmonic. Again, it must be noted that the absolute level of this distortion is still very low: 0.0055%, or –85dB.

At lower frequencies and higher powers into both 8 ohms (fig.8) and 4 ohms (fig.9), the third harmonic remains predominant. (This behavior is higher than the residual harmonic distortion level in my Audio Precision signal generator, so is presumably real.) With the Halcro's switching power supply and what must be excellent internal grounding arrangements, there is not a trace of AC-related spuriae to be seen in these spectra.

Finally, fig.10 shows a spectrum of the dm38's output while it drove an equal mix of 19kHz and 20kHz tones into 4 ohms at a level a dB or so below visible waveform clipping on the oscilloscope screen. The source was 24-bit data decoded by a Benchmark DAC1, which produces a second-order difference component below –100dB with this signal (see fig.8, May 2004, p.119). The difference component in the Halcro's output lies at –94dB (0.002%), which, allowing for the Benchmark's contribution, means the dm38 is misbehaving very slightly on this test. *Very* slightly.[2]

Its measured behavior indicates that the dm38 is best not used with amplifiers that have impedances lower than 4 ohms. But even though its circuit is not quite as breathtakingly linear as that of the dm58 monoblock—assuming my dm38 sample was representative—it still offers superb measured performance in line with Halcro's reputation. *—John Atkinson*

1 Each doubling of the number of captures increases the uncorrelated noise level by 3dB but the correlated distortion by 6dB, thus dropping the noise contribution by 3dB. (I trigger the 'scope with the unfiltered waveform so that it starts its capture at exactly the same point for the averaging.) **–JA**

2 It is fair to note that the sample of the dm38 reviewed by Martin Colloms in the June 2004 issue of British magazine *Hi-Fi News* was significantly more linear than my sample. Of course, that sample was set for 240V operation, though that should not be a factor with an amplifier using a switch-mode power supply. **–JA**

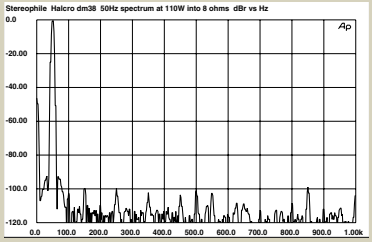

Fig.8 Halcro dm38, spectrum of 50Hz sinewave, DC–1kHz, at 110W into 8 ohms (linear frequency scale).

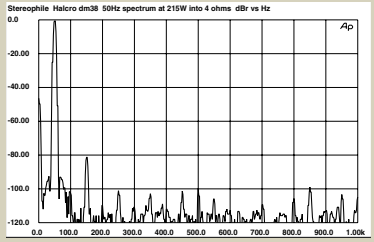

Fig.9 Halcro dm38, spectrum of 50Hz sinewave, DC–1kHz, at 215W into 4 ohms (linear frequency scale).

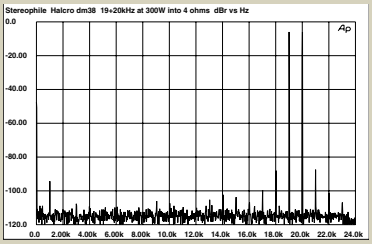

Fig.10 Halcro dm38, HF intermodulation spectrum, DC–24kHz, 19+20kHz at 300W peak into 4 ohms (linear frequency scale).

was at the dynamic extremes—the dm38 also excelled at reproducing *micro*dynamics. By this I mean how well it preserved the tonal and imaging differences among different sonic objects at different levels. A favorite test track for this aspect is the DVD-Audio version of bassist Ray Brown's *Soular Energy* (Hi-Rez Music HRM 2011). In the track "Mistreated but Undefeated Blues," the late Emily Remler's electric guitar and Red Holloway's tenor sax play exactly the same line in the verse at exactly the same pitch. The Halcro allowed me easily to identify how each instrument was contributing to the combined tone, regardless of the speakers I was using.

At the risk of venturing into the semantic void, it wasn't just that the dm38 reproduced the sounds of instruments or voices with superb fidelity; it also excelled at reproducing the *space* between those instruments. Remember that the stereo image is an illusion, its fragility due to the brain's having to put aside what the ears actually hear in favor of reconstructing a simulated space between and behind the speakers.

On *Contrasts and Parallels*, the fairly new M•A CD from the Hungarian Kálmán Oláh Trio (MO65A), the piano, bass, and drums play around with themes from grand master Johann Sebastian Bach. Todd Garfinkle used a single pair of mikes for this recording, but the problem with a purist setup such as this is that it can be hard to get a sufficiently similar blend of direct sound and reverberation for each instrument so that the ensemble blends properly. Track 5 features a drum solo, and yes, the drums sound more reverberant than the piano and bass—but as reproduced by the Halcros driving the Revel Ultima Studios, the kit was clearly and unambiguously set back behind the other instruments in the same acoustic.

I had a similar experience with the new Christmas album from Minnesotan choir Cantus, which I was editing and mixing using the Halcro amplifier. For the sessions at the recital hall attached to the Mennonite music school in Goshen, Indiana, I basically used the same three mike arrays I'd used for Cantus' *Deep River* CD in 2003: a central ORTF pair of DPA cardioids, a spaced pair of DPA 4006 omnis, and, farther back, a pair of high-voltage DPA 4003 omnis placed either side of a Jecklin disc. Okay, there *was* a

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The densely packed upper module carries the input circuitry and the I/O hardware.

major difference, in that I'd used the spherical acoustic equalizers on the 4003s, which boosts treble on-axis to give better channel separation at high frequencies. But as I was applying an inverse curve to this boost in the mix, I hadn't expected there to be a major difference in imaging specificity between the two projects. Yet listening to test mixes of the 2004 recording via Revel Studios driven by the dm38, the individual choristers could be heard to be more easily differentiated in space than they had been in the 2003 CD.

So, the dm38 combined great dynamics and great bass control with a superbly transparent view into the recorded soundstage. Its treble was free from grain and its midrange was as smooth as silk. However, I couldn't escape the feeling that the amplifier's tonal balance was on the lean, cool side. This was a constant, regardless of the speakers I used, and was exacerbated when I used the dm38 with Halcro's dm10 preamplifier (using balanced connections). My room is quite live in the treble, and the overall balance worked better with the Levinson No.380S preamplifier driving the dm38 or the dm10 driving the Levinson monoblocks.

Even so, the sniffing on Emmanuel Ax's lush-sounding recording of Brahms' *Handel Variations* (Sony Classical SK 48046) was a little more noticeable than I had expected from my auditioning of this 1992 CD on other amplifiers. Similarly, the occasional rattle, as Ray Brown lets the plucked strings of his double bass rebound against the fingerboard on *Soular Energy*, was presented slightly more forward in the soundstage than the image of his instrument.

Where the recording was already a little on the threadbare side—for example, on Daniel Barenboim's 1994 set of Beethoven's *Diabelli Variations* (CD, Erato D104960), which I was studying in order to prepare for a forthcoming recording project with pianist Robert Silverman—the thin-sounding piano actively annoyed me. But when the recording was itself neutrally balanced, such as Tony Faulkner's SACD of the Mozart Clarinet Concerto (*K622*, Musical Fidelity MFSACD017), the Halcro dm38 simply removed itself from the sonic equation in a most satisfying manner.

A clue to the overall quality of the Halcro was circumstantial without my actually being aware of it—except in hindsight, when I noticed the CD jewel boxes littering my listening-room floor at the end of one weekend.

I found myself digging deep into my collection to play recordings I hadn't played in years: old 'uns like Dished Up for Piano, Martin Jones playing Percy Grainger's piano music (CD, Nimbus NI5220); new 'uns like Tony Faulkner's recording of Elgar's Symphony 3 (CD, Naxos 8.554719). The chain of musical association triggered by M•A's Hungarian jazz trio CD led in turn to June 2004's "Recording of the Month," Bach's *The Well-Tempered Clavier, Book One* (CD, ECM New Series 1853/54), with Till Fellner, and then to András Schiff performing the *Goldberg Variations* (CD, ECM New Series 1825).

Such an open window on the music has always been a sign that something special is happening with a component. The Halcro dm38 is special.

Summing up

It may be expensive, but Halcro's dm38 effortlessly joins the ranks of top-rated power amplifiers, not only for its sound quality but also its measured performance (not a given; witness some recent reviews). As with its monoblock siblings, loudspeaker loads that dip significantly below 4 ohms are best avoided if the amplifier's dynamic range is not to be compromised. However, this will not have practical consequences in listening rooms of normal size.

Like the dm58 monoblock, the dm38 is balanced toward the cool side of the spectrum—though I am sure Bruce Candy will argue that the Halcro amplifiers are actually neutral compared with the competition—so it will work best with speakers and source components that don't themselves sound lean. But with optimal system matching, the Halcro's effortless dynamics and astonishingly clean presentation will satisfy the listener's soul.