Product Review

DacT CT 100 RIAA Preamp

Reviewed by Charles Hansen and John and Sandra Schubel

Danish Audio ConnecT, Danish Audio ConnecT A/S, Skannerupvej 14, DK-6980 Tim, Denmark, Fax (+1) 248 282 0645, www.dact.com, dimensions: 10cm W × 9cm D × 4cm H.

The CT 100 is a dual-mono RIAA phono preamplifier circuit board, with both balanced and unbalanced line output capabilities. Each of the independent preamp sections has its own 3-pin power-supply connector (*Photo 1*). The board is 105mm × 63mm. An integral metal RF shield underneath the PC board increases the preamp length to 125mm and provides three mounting holes. The complete assembly is 35mm high at the tallest components.

The 8-page manual I received with the CT 100 is labeled "NLE 17 RIAA Amplifier," but the diagram of the circuit card is that of the CT 100. The manual is detailed and thorough. The finished board has no chassis, and requires a separate power supply or batteries. I used the DacT CT 102 power-supply board, which I reviewed in Oct '03 *aX* as part of a low-noise power-supply test. A "connector plate" fitted with two 3-pin XLR connectors is available for installing the CT 100 into a turntable, and detailed directions for such an installation are provided in the manual.

I mounted both PC boards in an aluminum project box (*Photo 2*), with gold unbalanced phono jacks and a chassis ground terminal to accommodate the turntable ground wire. I used shielded input and output connections of the shortest possible length to minimize noise.

Parts quality on the multi-layer PC board is first-rate, with polypropylene caps, surface-mount metal film resistors, and gold-plated PC board tracks. There are gold-plated male fast-on terminal blades for the input-output connections. As with the CT 102, there are a number of 8-pin DIP ICs whose identities have been hidden by white, red, or green paint. In the event of problems, you would need to send the CT 100 back to DacT for service.

The CT 100 can use supply voltages from ±9 to ±35V DC, with an absolute maximum of ±50V without damage. The maximum input voltage is ±1V. The input load and gain can be customized by use of four DIP switches (two per channel). The input resistance has 21 steps: 10, 15, 18, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100, 150, 180, 200, 400, 600Ω, 1k, and 47k.

Given the wide range of low resistances available, you would expect to use the CT 100 with either moving coil or moving magnet cartridges, and this is indeed the case. You can select gains from 40dB to 80dB at 1kHz in 34 steps. If need be, you can make channel balance adjustments as well. The input capacitance is also switch selectable for 100, 200, 300, or 400pF.

The CT 100 is designed with a transistor-buffered low line-level output impedance that also allows you to drive many high-quality headphones. Finally, you can activate the RIAA 7950µS (20Hz) and/or 3.18µS (50kHz) rolloff time constants by means of two of the gain DIP switches[1]. Two input bias current trimpots are set at the factory and their adjustments are sealed.

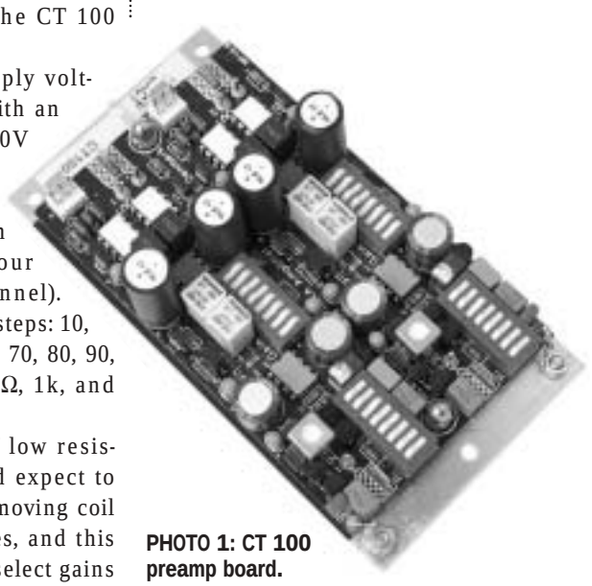

PHOTO 1: CT 100 preamp board.

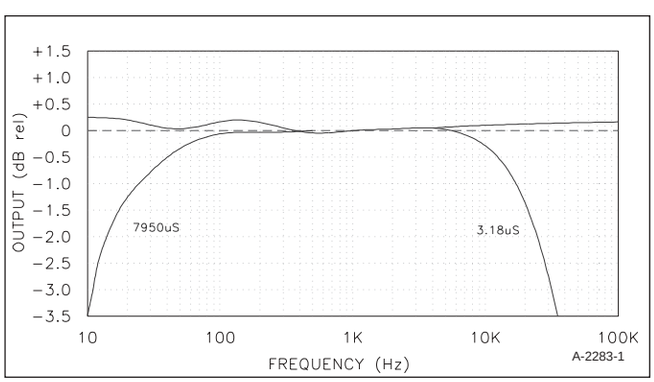

FIGURE 1: RIAA equalization error.

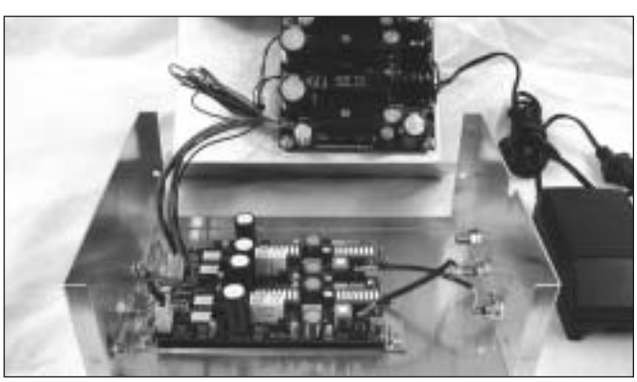

PHOTO 2: CT 100 preamp and CT 102 power supply in test chassis.

MEASUREMENTS

I set the CT 100 DIP switches as follows: 47k Rin, 100pF Cin, 40dB (MM) gain, and flattest response. I preconditioned the CT 100 at 2V RMS output, 1kHz for one hour. The line-level output load for all tests was 10k0. The left channel distortion measured 0.034% and the right channel was a bit higher at 0.038%. I subsequently used the right channel for the remaining measurements. A comparison of the DacT specifications (which are much more extensive than those listed here) and my measurements are shown in *Table 1*.

I used an inverse RIAA network (MM levels) for frequency response and the low-level distortion measurements. I measured the response and distortion vs. frequency with a test signal level into the inverse RIAA network that produces 10mV at 1kHz at the preamp input jack. This is equivalent to a cartridge with an output of 10mV at 5cm/s recording velocity (2mV/cm/s sensitivity). Typical vinyl records are recorded at 5cm/s maximum, while the RIAA specification allows a maximum recording velocity of 25cm/s (50mV at 1kHz for my testing). The RIAA specification requires that phono preamp THD+N remains below 1% with an input of 50mV at 1kHz.

The CT 100 maintains normal output polarity. The input impedance was 47k5. The output impedance was a low 31Ω at 20Hz and 1kHz, and 27Ω at 20kHz.

For S/N and DC offset measurements, I terminated the preamplifier input jacks with a "cartridge" load consisting of a 1k33 metal film resistor mounted in a shielded phono plug. The wideband output noise was 0.19mV left and right (–80dB). The initial DC offset voltage of –5mV settled to a wavering ±0.3mV.

The phono circuitry uses a DC servo to minimize the output offset, but whatever offset remains can be amplified by a DC-coupled power amplifier to values large enough to activate the speaker protection circuit. Crosstalk at 10kHz was a low –85dB. The A-weighted S/N ratio was –95dB relative to 2V RMS.

Figure 1 shows the relative RIAA equalization error (solid line), where 1kHz is the 0dB point. Gain at 1kHz, 10mV MM input, was exactly 40dB. Setting the DIP switches at the highest (MC) setting produced 80dB gain. The RIAA accuracy was within +0.2/–0.04dB from 10Hz to 20kHz. The two channels varied from each other by a maximum of 0.11dB at 125Hz, and less than 0.04dB over the rest of the curve.

I also plotted the response with the optional 7950µS and 3.18µS time constants engaged. The 7950µS high-pass filter also removes the slight hunting of the DC servo circuit, so it probably uses a series capacitor.

Figure 2 shows THD+N vs. frequency at a reference input level of 2mV/cm/s. I used the distortion test set 80kHz low-pass filter to limit out-of-band noise during the distortion tests. There is a dip in the THD curve at 60Hz, indicating the presence of some 60Hz hum pickup in my test setup. (The CT 102 does not bring 60Hz on board.)

I tried various ground connections between the distortion test set, the inverse RIAA network housing, and the preamp chassis, and the one that met with the least hum is shown in the figure. When I engaged the distortion test set 400Hz HP filter, the THD+N dropped to 0.016% above 2kHz.

For distortion vs. output voltage at 1kHz and 20kHz, I fed the sine-wave generator directly into the phono preamp without the interposing inverse RIAA network. The THD+N vs. line output level at 1kHz is shown in *Fig. 3*. The input overload at 1% THD clipping for a

TABLE 1:
SPECIFICATIONS AND MEASUREMENTS, DACT CT 100

PARAMETER	SPECIFICATION	MEASUREMENT
MM Input Sensitivity, 1kHz	10mVin, 1Vout (40dB)	10mVin, 997mVout
Input Overload,		
20Hz		10.4mVrms
1kHz	100mVrms	95mVrms
20kHz		825mVrms
Gain, 1kHz, MM	40dB	40dB
MC	80dB	80dB
Input R,C	10Ω-47k0, 100-400pF	See text
RIAA Accuracy	±0.05dB	+0.2/–0.04dB
Output (unbalanced, 10k load)	±14.2V	13.8Vp-p (9.77Vrms)
Output Resistance	0.1Ω (Vo=1V)	31Ω (27Ω 20kHz)
Distortion, 1kHz 2Vrms	0.0003%	0.038% (see text)
Power Supply Rejection	120dB (Av=40dB)	
S/N, A-Wtd, Ref 5mVin	98dB	95dB
Crosstalk, 10kHz (Av=40dB)	–120dB (dual supply)	–85dB

10mV MM cartridge was quite generous: 10.4mV at 20Hz, 95mV at 1kHz, and 825mV at 20kHz. The ±15V DC supply rails provided by the CT 102 power-supply board limit the output voltage swing to 9.77V RMS. Again, the low-level THD+N noise was dominated by the unavoidable 60Hz hum component of my test setup.

The distortion waveform for 2V RMS into 10k at 1kHz is shown in *Fig. 4*. The upper waveform is the amplifier output signal, and the lower waveform is the monitor output (after the THD test set notch filter), not to scale. This distortion residual signal shows mainly the second harmonic, with some high-frequency noise.

The spectrum of a 50Hz sine wave at 2V RMS into 10k is shown in *Fig. 5*, from 0 to 1.3kHz. The THD+N measured 0.029%, and the few harmonics present are all below –95dB. The calculated THD based on the first five 50Hz harmonics is 0.0022%. The higher level spikes are all odd harmonics of the 60Hz power line frequency. The highest is 60Hz at –68dB, with the 180Hz harmonic at –79dB.

Expanding the spectrum analyzer horizontal scale to 40kHz (*Fig. 6*) shows the presence of the CT 102 power-supply switching frequency at –50dB at about 38kHz. While the gain of the RIAA preamp falls off at high frequency, the power-supply rejection ratio also decreases at –6dB per octave.

The 1kHz square wave with the flattest RIAA response setting (*Fig. 7*) is just about perfect, as are the 40Hz and 10kHz square waves (not shown).

REFERENCE

1. The fourth RIAA time constant of 7950µS is defined in IEC Publication #98, Amendment 4, dated September 1976. The fifth 3.18µS time constant is based on the Neumann cutting lathe amplifier manual; see "On Reference RIAA Networks," Jim Hagerman, *Audio Electronics* 2/99, pp. 10-13.

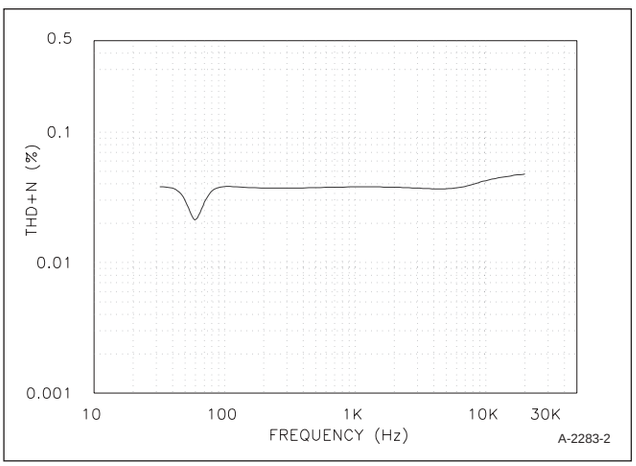

FIGURE 2: THD+N vs. frequency.

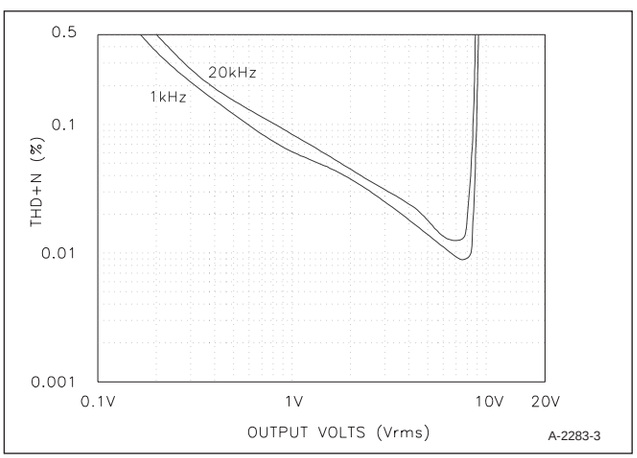

FIGURE 3: THD+N vs. line output voltage.

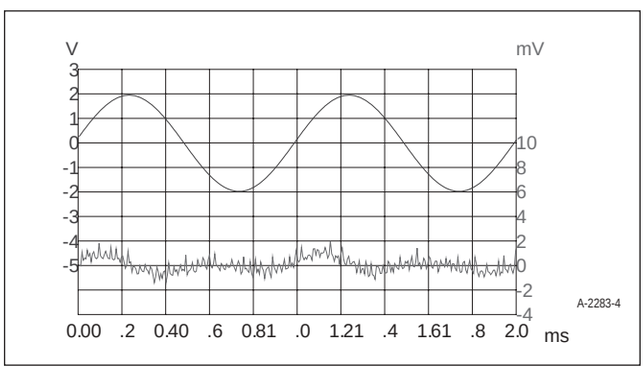

FIGURE 4: 1kHz residual distortion.

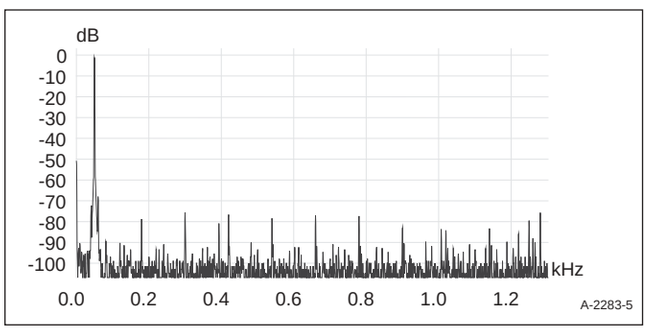

FIGURE 5: Spectrum of 50Hz sine wave.

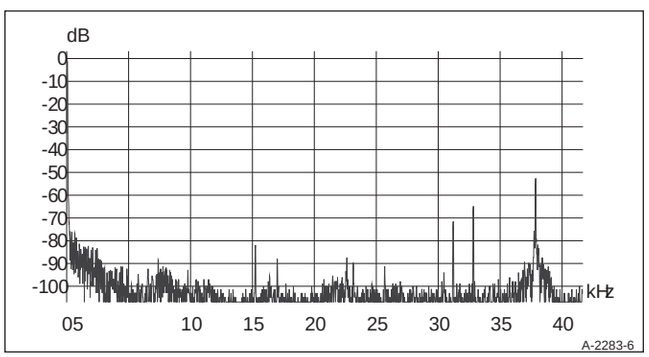

FIGURE 6: Spectrum of 50Hz sine wave, expanded scale.

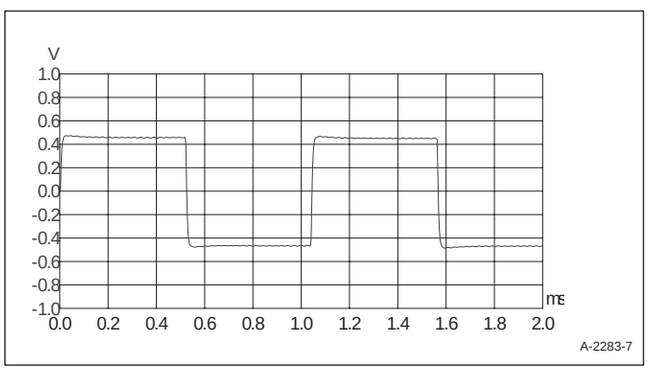

FIGURE 7: 1kHz square wave.

LISTENING CRITIQUE
DANISH AUDIO CONNECT DACT CT100 PHONO PREAMPLIFIER

By John and Sandra Schubel

We used Charles Hansen's listening room as the venue for the evaluation of the DacT CT100 Phono Preamplifier powered by a DacT CT102 power supply. The listening room is equipped with a Parasound HCA-1000A power amplifier driving NHT Super One speakers and a powered NHT SW2 subwoofer, and included two turntables: a Thorens TD 295 Mk III equipped with an Ortofon OMB 10 cartridge, and a Music Hall MMF-2 equipped with a Shure V15 type V cartridge. We used a passive preamplifier at the output of the CT100 to set listening levels, as well as the record selections previously used in the "Budget Phono Preamp Test" (*audioXpress*, April 2003, pp. 40–56).

We started out with the Moldau (Smetana), RCA Red Seal LSC-2471. The sound seemed distant and distorted. My [John's] first concern was that the record had experienced excess wear from the numerous playings required in the budget phono preamp review.

We tested this hypothesis by changing the CT100 for Charles Hansen's phono preamp (*Audio Electronics* 6/97, pp. 8–21), and again played the Moldau. The fuzziness was now gone. The culprit appeared to be the preamp, not the recording.

INSTRUMENTS

Next, we decided to use the Hagerman Bugle preamplifier that was the standout in the "Budget Phono Preamp Test" as a reference preamplifier for the evaluation of the CT100. I again used the Radio Shack sound pressure meter to assure consistency of levels. It quickly became apparent that the gain of the CT100 at 1kHz was very close to that of the Hagerman Bugle. We also noted that the CT100/CT102 combination background noise was as quiet as the Bugle with its two 9V batteries.

We again played the Moldau. The treble ranges sounded clear and crisp, particularly the triangles, but the bass was "blurry." I noted that the midrange had a distant, gritty sound. In general the sound was dry and distant.

When compared to the Hagerman Bugle, the instruments were not as well defined and the listener was placed further back from the sound stage. The placement of instruments across the sound stage was not as accurate. Interestingly, the CT100 handled crescendos better than the Hagerman.

We next turned our attention to "America" as recorded on "Lincoln Mayorga & Distinguished Colleagues Volume III, Sheffield Labs SL5/SL6." The CT100's sound on this cut is bright, but again the listener is distant from the sound stage. The bass on this cut was solid but gritty, and now the treble range, particularly the glockenspiel, sounded muddy. Similarly, the blocks and vibes sounded distant. The staging of the instruments was not all that clear, the instruments were not well defined, and the guitar, in particular, seemed lost in the soundstage.

We next listened to "That Certain Feeling," also on Sheffield Labs SL5/SL6. In comparison with the Hager-

man Bugle, there was a lack of "snap" to the chimes, although the sound was generally brighter. The saxophone was gritty, and the trumpets very bright. The sound of the kick drum was solid, but the sound of the congas lacked richness. Both Sandra and Charles agreed that there was a lack of clarity in both sound and in placement of the trombone and brass.

We next challenged the CT100 with "Scheherazade" (Rimsky-Korsakov) as recorded by Leopold Stokowski and the London Symphony Orchestra, London SPC 21005. The horn entrance at the beginning of the piece was unpleasantly bright, with a kazoo-like sound. The violins lacked warmth. The harp, however, sounded clear.

As the piece progressed, the violin solo was very clear. In other sections of the piece, however, the violins sounded strident, with too much emphasis over other instruments. As the violins modulated upward, they retained the same balance with respect to other instruments, but were just too loud. The bass was again solid but fuzzy. The sound of the cello was dry, possessing no richness of tone.

The clarinets and flutes sounded natural on this recording. There was not as much definition between these instruments, however, as we would have liked. Placement of the instruments on the sound stage was again vague. Sandra noted that the piece was not interesting to listen to on this preamplifier.

VOICES

Our final listening selections were "Surely He has Borne our Griefs" and "All We Like Sheep Have Gone Astray" from Handel's "Messiah" recorded by Christopher Hogwood and the Academy of Ancient Music, and the Choir of Christ Church Cathedral, Oxford(L'oiseau-Lyre D189D3).

Our first observation was that the violins were again shrill, with much more presence and overtones than experienced with the more neutral-sounding Hagerman Bugle. In general the choir sounded brighter, with more emphasis on the treble voices. The bass voices were still there, but sounded less musical. When the choir sings forte, the sound becomes raspy.

In general the quality of the voices was less pleasing, perhaps due to the emphasis of higher frequency overtones. Sandra found the sound of the choir to be tiring. She thought that the breathing was softer, and that there was no boy-choir ringing sound. She found the sound of the choir to be generally less interesting.

We did not believe that we had good seats in the hall, although there was a general brightness to the sound. We could pick out the harpsichord more easily than with the Hagerman Bugle, although it was very quiet compared to the voices. The organ also seemed to stand out with more clarity.

By comparison, when we listened to this performance using the Hagerman Bugle, we sensed we were just three rows back. Using the CT100 cartridge loading DIP switches to remove all the capacitive loading (the Bugle has no loading capacitors at all) did not appreciatively alter the results.

The conclusion that we all reached was that this preamplifier produced a sound that lacked clarity, and seemed to be a bit excessive in the treble ranges. In general, the sound produced was tiring to listen to. Charles, in particular, was surprised by the sound of this preamp, as it produced excellent measurement numbers, with only +0.1dB response error at 10kHz. This listening experience reinforced to us the importance of auditioning audio equipment rather than just examining the numbers.

Manufacturer's response:

First we would like to thank audioXpress *for taking time to test our products and for allowing space in the magazine for the review and for our following comments.*

However, we do regret that audioXpress' *policies have made it impossible to enter into a dialogue regarding the results of the review. Not only are some of the measurements in the review so far from DACT's published specifications that we would have expected the reviewer to become suspicious something was wrong, and contacted us to discuss the situation. But also the listening tests show so severe problems that again, we would have expected to have been contacted and asked if something might be wrong. The listening impressions stated in the review are far from what you would expect from high quality audio highly acclaimed by other sources. We refer to the review section at www.DACT.com.*

After having read the review draft we did re-check the very same CT100/CT102 combination that was used for the review. Powered by the review of the CT102, we have performed various measurements on the CT100 review unit. We have again verified our own specifications: the unit meets the data that we publish under the measurement conditions given for practical use.

THE SOUND

It is said in the review that the listening test is a very important part of an evaluation of an audio product. We could not agree more. However, the sound character of CT100 that the review spells out is so far from everybody else's experiences that we can hardly believe it is the same product. This is not only supported by our own years of listening to CT100 but also by customer feedback and other reviews that CT100 has received.

Without having been given the opportunity to discuss with the reviewer, we are left with trying to guess what might have happened.

First of all, it appears that the input settings (gain, capacitance, and resistance) were set once and for all, and never tried reset to check if other settings obtained a better match for the specific cartridges. If the cartridge manufacturer's recommended settings were used, it might have been the right settings, although this is not always the case. If the settings were less well considered, certainly this could cause less than optimal sound reproduction.

More importantly however, we worry about the "passive preamplifier" that was used for the listening tests. DACT has a decade of experience in manufacturing high quality stepped attenuators and we know very well about the potential problems of passive preamps. At www.DACT.com we even publish an article about passive preamps.

The listening part of the review was carried out so the passive preamplifier was connected at the output of the CT100 phono stage for adjusting its volume. The review is not clear about whether the same passive preamplifier was used for the other phono stages used in the review for comparison. In any case, the review does not mention any details about this passive preamplifier: Based on the reported listening critique, we assume that the used passive preamplifier

comprised an ordinary carbon or conductive type potentiometer. We know that passive preamplifiers may cause similar sound characteristics as reported in the review—especially if the passive preamplifier is based on a poor quality volume control.

MEASUREMENTS

Inverse RIAA network

Measuring a high precision phono stage using an inverse RIAA network requires the utmost attention and care. It is very important to make sure that the measurements carried out on the output of the inverse network show the performance of the Device Under Test (in this case the CT100 phono stage) rather than the performance of the inverse network or a combination of both. We would have found it very useful had the review included information about the inverse RIAA network used for the measurements, especially its inverse RIAA correction accuracy.

Instead of using inverse RIAA networks, we suggest simply measuring the output voltage of the phono stage as a function of frequency, and compare to the theoretically correct RIAA curve. This is the way DACT measures the correction curve, and each CT100 we ship has been checked and found to be within ±0.05dB of the correct curve. We have re-checked the review unit and found it to be within the specified ±0.05dB.

Without having been able to discuss with the reviewer, our conclusion on the measured RIAA curve accuracy is that it probably shows more about the (in)accuracy of the inverse RIAA network used for the measurements than it does about the CT100 RIAA correction.

Output impedance

There is a very significant deviation between the output impedance measurements referred to in the review (30Ω) and the figure we measure (0.1Ω).

Again we are left guessing what causes the difference and we suspect that the review figure is a result of overloading the CT100 output. CT100 features output current limitation of 25mA for protection purposes. If the output impedance is measured at overload conditions (specified load for measurements is 1kΩ), so the output devices of CT100 entered into their current limitation region, the output impedance would increase dramatically. We believe this is the reason why the review states a wrong output impedance of 30Ω.

Distortion

On the review unit we have re-tested THD and found it to be in accordance with our published specifications below –110dB at 1kHz.

At 50Hz, 2nd harmonic is –110dB and 3rd is –104dB and we have measured THD to be –101dB at 50Hz.

The CT100 provides ultra-low distortion to secure state-of-the-art sonic performance. This is a challenge to even today's test equipment capabilities concerning signal purity and low noise. DACT recommends as a minimum, that the test signal THD is below –126dB and the test analyzer signal noise level to be below –130dB for reliable results. DACT distortion measurements are obtained with such test equipment at the facilities in Denmark. Distortion measurements of CT100 according to audioXpress *test, Fig. 5, are not possible since no harmonics below or slightly above the noise level of –100dB can be detected and evaluated.*

We cannot confirm that the review THD can be concluded from Fig. 5 and it appears that audioXpress *was unable to measure harmonics below approximately –100dB.*

OUR CONCLUSION

It appears that a number of issues have caused this review to turn out very differently from what it normally would.

We find several of the measurements performed under less realistic conditions resulting in deviating results. We have checked the CT100 review unit again after the review and have been able to verify our specifications. None of the measurement results from the review have made us doubt the correct CT100 specifications that we publish.

As for the listening results, we also must conclude that the review does not give a rightful picture of what our CT100 phono stage stands for.

I wish we had been able to have a constructive dialogue with audioXpress *at an earlier stage to straighten out the misunderstandings. We feel that this lengthy response to the review is required for the* audioXpress *readers to evaluate this example of differences in opinion concerning listening and measuring.*

Allan Isaksen, DACT

Charles Hansen responds:

In instances where the listening results seem to have a large disconnect from the measured data, as was the case with the CT100, I try to determine the reason. If I happen to have a schematic available, I attempt to find where in the audio circuitry the observed anomaly has occurred (see "Budget Phono Preamps," audioXpress *April 03, pg. 44 sidebar "Solving for Instability"). This was not possible with the CT100 since I did not have a service schematic and could not even do any intuitive troubleshooting because the identities of all the IC packages were hidden by various colors of paint.*

There was some speculation by Allan Isaksen of DacT about the health of the CT102 power supply provided for the review (see audioXpress *Oct. 03, pp. 60-61). I made sure that the DC rails from the CT102 into the CT100 phono preamp were at their specified voltages and noise levels prior to any listening audition or measurements. The CT100 current draw is nowhere near the current limit fold-back point I measured during the CT102 tests.*

As mentioned in the CT100 review, two different turntable/cartridge setups were available, as well as two other active phono preamps. We tried all the combinations of capacitor dip switch settings on the CT100 in an effort to improve the sound, to no avail. The only resistive loading available for MM cartridges was 47k (the next value being an inappropriately low 1k). I did not take note of where the dip switches were left when I shipped the two units back to DacT. ❖