



Bel Canto C5i

INTEGRATED DAC/AMPLIFIER

Let's be clear. Bel Canto calls the C5i an 'Integrated DAC/Amplifier' which is why I've labelled it as such in the heading to this review, but I am not sure I agree with Bel Canto that this is the correct term to describe it. The problem is that there's no existing single word in the audio lexicon that would suit. It's a new type of component, and I think it requires the invention of a new word to do it justice. My choice would be 'Amplidac'. Has a ring to it, don't you think... Bel Canto C5i Amplidac? I guess the reason Bel Canto doesn't use it is that it would be too 'different', but for mine, the C5i is different, so it's as good a reason as any!

THE EQUIPMENT

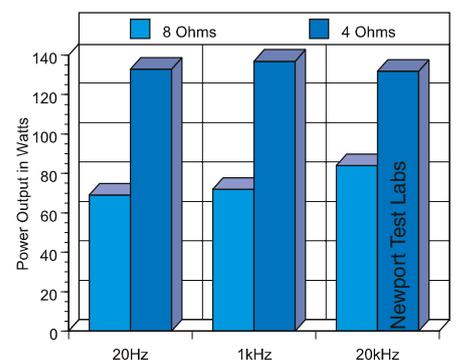
The new C5i (it replaces the S300iU) combines the functions of a DAC, a pre-amplifier and a power amplifier in one of Bel Canto's familiar (tiny) chassis. The DAC section has five digital inputs, including high-res USB (24-bit/96kHz) and two analogue inputs: a standard line-level input and rather strangely (but very welcome) a phono (MM) stage. There's even a headphone output (a full-sized 6.5mm socket on the front panel) that Bel Canto claims will drive 'the lowest imped-

ance headphones'. The other digital inputs are all capable of up to 24-bit/192kHz operation. Two are optical (Toslink with spring-flap dust-protectors) and two coaxial (RCA). As you may have already guessed from the word-lengths and bit-rates I've listed, Bel Canto is not using the Burr Brown chipsets it has used on previous components. It has instead switched to the opposition, Wolfson Micro, for the DACs it uses inside the C5i.

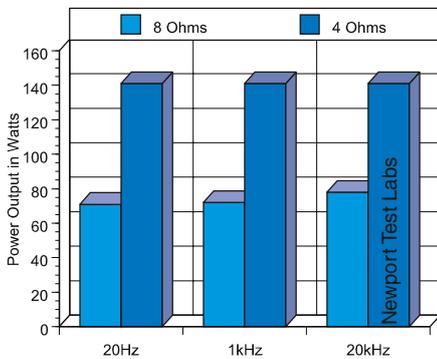
The power output stage, on the other hand, is from the same supplier Bel Canto has used for some time: Bang and Olufsen. Or, more specifically, the subsidiary company B&O set up to market its unique, patented ICE-Power modules, which is known as 'Bang & Olufsen ICEpower.' This subsidiary company was founded by Karsten Nielsen, whose PhD dissertation 'Audio Power Amplifiers Techniques Based on Efficient Power Conversion' was partially funded by B&O. In it, Nielsen described a Class-D (a so-called 'digital' amplifier, but actually a 'switching' amplifier) circuit that offered performance at the same or a higher level than existing conventional linear (Class-A/B) amplifiers. His original ICEpower modules have been significantly improved over the 12 years since the company was first established and ICEpower

is now shipping 3rd generation modules. However, despite the many improvements, Bel Canto says that it does not use standard ICEpower modules. According to John Stronzer of Bel Canto, the Class-D modules it purchases from B&O are 'heavily modified'.

The sole control on the front panel is a rotary control that operates as both a function selector and a volume control. In its volume control mode, you'll find it's more than just an ordinary volume control: It's a fully digital control, operating at 24-bit resolution.



Power Output: Both channels driven into 8-ohm and 4-ohm non-inductive loads at 20Hz, 1kHz and 20kHz. [Bel Canto C5i]



Power Output: Single channel driven into 8-ohm and 2-ohm non-inductive loads at 20Hz, 1kHz and 20kHz [Bel Canto C5i]

This is not only a superior method of controlling volume *per se*, it also allows Bel Canto to pull a neat trick, whereby rotating the knob to the left will always reduce volume very quickly, whereas when you try to increase volume (by turning to the right), this will take place fairly rapidly up to a displayed level of 65.0, then more slowly up to 100. This 'multi-speed' system allows very precise—yet entirely safe—control over volume. The rotational action of the control is exceptionally smooth (no click-stops!) but it's sunk so deep into the fascia, and so close to the edge of the cut-out, that I found I could not really grip it very well. Bel Canto realised this, so it's moulded a fingertip-sized 'dent' in the control's surface that allows you to spin the entire control with just a single finger.

Switch the C5i on and the first thing it displays is its software revision: r1.00 the case of my sample. After this, the volume is automatically set to '50', the 'SP1' input is selected (or the last-used input) and 'Soft Mute' is activated. SP1 is short for SPDIF1, which is in turn short for Sony Philips Digital InterFace 1. This was a bit convoluted for me.

What's wrong with displaying the inputs as DI1, DI2, DI3, DI4, USB, AUX, and PHO? (Or maybe that's just me...)

You select the input you want using the same front panel rotary control you use to control volume. To turn it from a volume control into an input selector, you just press it inwards once. This toggles it into the input selection mode and when you do this, the selected input is displayed for about five seconds. While it's being displayed, if you rotate the knob it will scroll through the inputs in the order shown in the previous paragraph. (Warning: If you wait any longer than five seconds, it'll revert to being a plain

Bel Canto is now not using the Burr Brown chipsets it used on previous components, but Wolfsen Micro instead...

ol' volume control and so if you want it to be anything different, you'll have to start all over again!) You don't have to worry about adjusting volume before switching inputs: volume level is automatically reduced when you use the selector, then returned to its original level when you have finished. Very neat! The control knob rotation is also continuous, so there's no to-and-froing if you want to switch, for example, from PHO to DI1. I was a little worried that Bel Canto specifically warns that you should press the control only at its exact centre. This would seem to indicate to me that if you press anywhere else, you'll eventually affect the proper operation of the control in some way.

BEL CANTO C5i
Integrated DAC/Amplifier

Brand: Bel Canto
Model: C5i
Category: Amplidac
RRP: \$1,995
Warranty: Two Years
Distributor: Wicked Digital Pty Ltd
Address: Suite 118, 40 Yeo Street Neutral Bay, NSW 2089
 ☎ **1300 652 802**
 ✉ **info@wickeddigital.com.au**
 🌐 **www.wickeddigital.com.au**

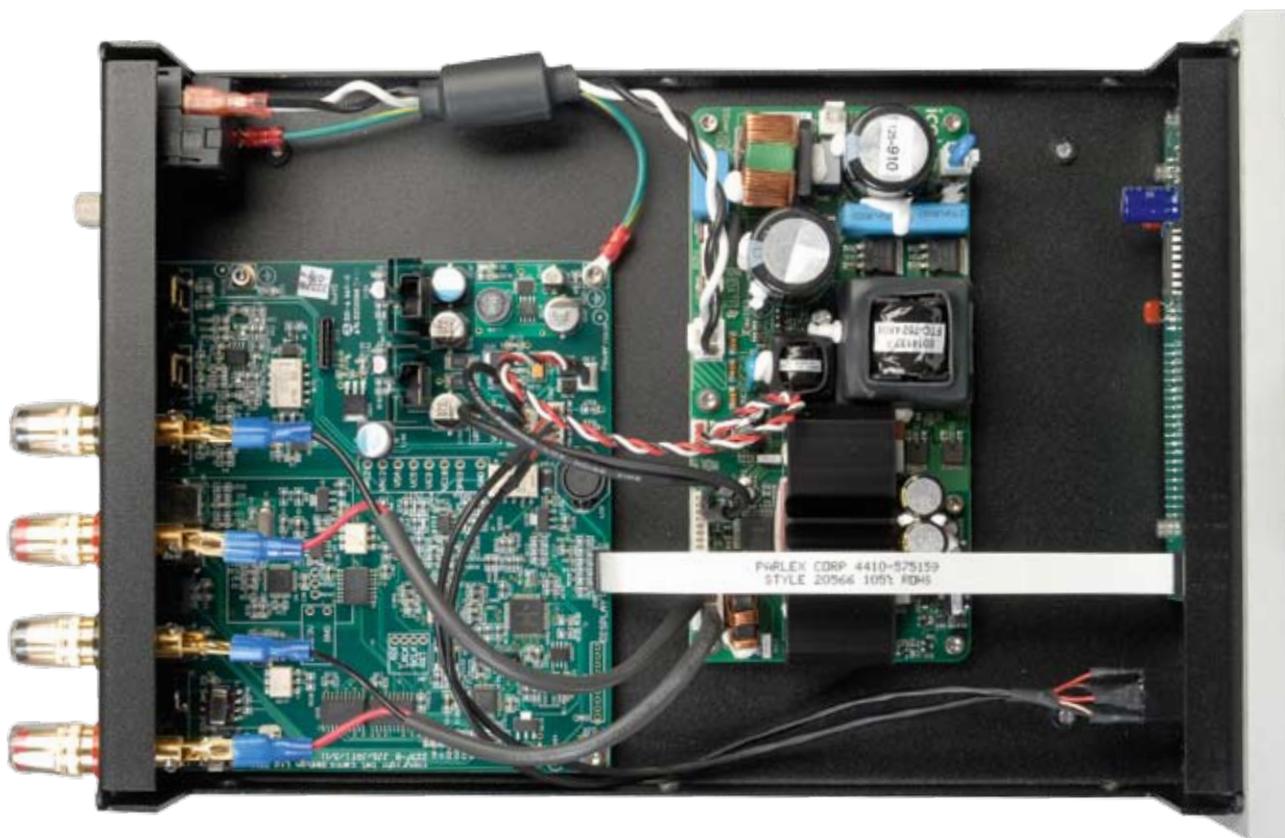
- Small form factor
- Excellent DAC
- Superb build quality
- Too few analogue inputs
- Display naming

LAB REPORT

Readers interested in a full technical appraisal of the performance of the Bel Canto C5i Integrated Amplifier should continue on and read the LABORATORY REPORT published on page 38. Readers should note that the results mentioned in the report, tabulated in performance charts and/or displayed using graphs and/or photographs should be construed as applying only to the specific sample tested.



Lab Report on page 38



However, if pressing it in the centre is essential for the control's continuing longevity, well... I can't see that that's such a big ask...

Just because the front panel is almost bare does not mean that the C5i's larder is bare: all the really tricky stuff is done using the supplied infra-red remote control. This neat little plastic remote allows you to control all the front-panel functions, but also lets you toggle through several different front-panel display modes, including a 'Display Off'

■ In Australia, I reckon 100 hours would just about suffice for this, but if you live in Reykjavik, watch out!

option. You can also switch between the two different MUTE modes Bel Canto has on offer: 'soft' and 'hard'. In addition to allowing you to 'cycle' through inputs, the remote also has numeric buttons that allow you to select input directly. The numbers 1-7 correspond directly with the inputs mentioned previously, in that order.

Because of the extremely low power consumption of the ICEpower modules, the Bel Canto C5i can stay switched on all the time,

so the mains power switch has been located in a rather 'out-of-the-way' location on the rear panel. The rear panel also houses all the inputs, plus a two-channel line output (post-volume control) that can be used to drive a powered subwoofer, and a ground post for a turntable. There's also an infrared input, so you can hide the C5i away somewhere yet still be able to control it with the remote. The speaker terminals are multi-way insulated posts. I was pleased to see that Bel Canto has a large warning that the 'negative' posts are NOT at ground potential. Further warnings about what you can and can't connect to the speaker posts are in the Owners' Manual, along with a further warning that you should not use speakers whose impedance dips below 3 ohms.

IN USE AND PERFORMANCE

I was a bit surprised to see in the User's Manual Bel Canto's opinion that: 'The sonic performance of the C5i will *begin* (my italics) to stabilise after 100 hours of continuous power up.' *Begin* to stabilise after 100 hours? This seems like an extraordinarily long time, and it's still only a beginning! I suppose the problem for Bel Canto is that because the Class-D output stage produces hardly any heat at all, you have to rely on all the small-signal internal components to bring the entire device up to the correct operating temperature. In Australia, I reckon 100 hours

would just about suffice for this, but if you live in Reykjavik, watch out!

It's a bit of a revelation when you realise that all you need to turn the Bel Canto C5i into a complete hi-fi system is a netbook and a pair of speakers. It's a revelation because if you use small bookshelf speakers, it means you can fit an entire high-fidelity stereo system into a small overnight bag. (Actually, it'll still fit in an overnight bag if you use a full-size laptop computer.)

It's even more of a revelation when you fire up this system with music, because the sound quality is simply amazing, particularly if you have hi-res files stored on your computer's hard drive. It's almost worth taking such a system in a small bag when you go over to a friend's place for dinner, so when they ask if you'd like a little music playing while you're eating, you can say: 'It's OK, I brought my own.' The saddest thing about this scenario is that in an overwhelming number of homes in Australia, your Bel Canto 'suitcase' system will sound far, far better than the stereo system or multi-channel AV system in that home!

Although I tried the C5i with tiny bookshelf speakers so I could satisfy myself as to the veracity of what I wrote in the preceding paragraph, I mostly used much larger, more efficient loudspeakers with the C5i in order to make the most of its lowish output power—though I appreciate it will work best

with low-impedance loudspeakers, due to its ability to operate more efficiently into such loads, and it will also work better with high-efficiency loudspeakers, no matter what their nominal impedance. However, even when driving 8Ω speakers, I found the sound quality to be truly excellent, with impressive dynamics, a smooth, controlled midrange and more-than-satisfactory power levels—with plenty of power in reserve—available for most applications. There is, perhaps, not an enormous amount of control over the bass cones in loudspeaker systems that have very large bass drivers (300mm), which mean the lowest-frequencies were not as taut as they could be, but the sound was still very musical, and there was certainly no lack of deep bass, and so few speakers these days have such large drivers that it's not really an issue. What I thought was particularly impressive was the lack of 'fuzziness' at low frequencies, by which I mean that the very low frequencies (below 60Hz) were particularly clean, which allowed a great deal more clarity to the lowest notes issuing from electric bass and double bass than I often hear, even from far higher-priced 'audiophile' amplifiers. True, there aren't a lot of notes played in most popular musical styles that are below 60Hz, but it's nice to know the C5i can come to the party when required. The immediacy of the sound from the C5i means the sound is truly 'fresh' even when you're listening to old favourites, which for me could mean anything at all written by Bach (though I'm not overly keen on the Cantatas) through Paul Simon in any of his guises as a performer (and is not his latest, 'So Beautiful or So What', simply one of the best he's ever done?), right up to Vampire Weekend (but not forgetting Superchunk's wonderful 'Majesty Shredding', not least for the cover!). I played all through the C5i and was impressed by all, but the C5i is so good, so articulate, that none of

this presented the amplifier with sufficient challenges. For that, I had to turn to works that exploited the full sweep of a modern symphonic orchestra: works by Beethoven, Mahler, Holst, Stravinsky... It really doesn't matter who you listen to, just pick your favourite, or the work with which you're most familiar, and listen to the way the C5i 'strips away' the Clingfilm from the recording process to reveal the music lying underneath.

■ Listen to the way the C5i strips away the Clingfilm from the recording process to reveal the music lying underneath

Again, I have to return to my earlier comment about the 'lack of fuzziness'... the C5i has a truly transparent quality to its sound.

When it came to substituting the C5i into my system, the phono input for my turntable was very much appreciated, but having two different dedicated tuners (an AM-only and an FM-only) with analogue-only outputs made me realise that the fact that the C5i has only one line-level analogue input might be a limitation for some. Audiophiles who use turntables, for example, will often use their own phono preamplifier, and will therefore not need a phono input for their vinyl-spinner, but a line level input. This means they then use up one of the available line inputs and would then not be able to connect an FM (or DAB+) tuner, for example. Luckily, there is always the option of using an external switching device, but perhaps Bel Canto could think of making a bypass for the phono stage input, so it could be switched

between 'phono' and 'aux?' Two line inputs would likely be sufficient for most set-ups these days.

The DAC in the C5i is impressively good. If you have any CD player that's more than a few years old, you will be able to improve its sound quality immediately by using the CD player's digital output and connecting to one of the C5i's digital inputs, effectively lifting its performance to a level that would approximate that of CD players in the stores today that have swing tags in the order of \$2,000... and more. Any concerns I harboured about DAC circuitry being in such proximity to a Class-D amplifier's output stage—and also a switch-mode power supply—were laid to rest from the first few moments of listening.

As a final afterthought, if you do decide to use small bookshelf speakers with the C5i, it's worth remembering that you can use the Bel Canto's analogue outputs to drive a powered subwoofer, so you can get even more (and potentially deeper) bass without impacting on the fact that the components in your system will take up so little room that you'll be able to make them virtually 'disappear' in even the smallest room.

CONCLUSION

Bel Canto's wonderful little C5i is going to find a very welcome home in a great number of applications. Choose your speakers carefully, and it's an excellent choice for a two-channel audiophile home system... particularly if you don't require ear-shattering volume levels. But, given its small size, low cost, and its extraordinary operational flexibility, I think it's going to be insanely popular with audiophiles who want state-of-the-art sound when they're sitting in front of their computer, no matter whether they're working, gaming, socially networking or watching movies.  **greg borrowman**

LAB REPORT ON PAGE 38



CONTINUED FROM PAGE 34

The power output of the C5i shows that Bel Canto, in partnership with B&O, is squeezing more than the usual amount of power from the ICEPower module, with the C5i easily 'beating' the claimed specification at all test frequencies and into both test loads. (*Newport Test Labs* didn't test into 2Ω loads, as it usually does, because of Bel Canto's published warning that loads under 3Ω should not be connected.) As you can see from the bar graphs, and from the tabulated results, the Bel Canto C5i was tested as delivering 72-watts per channel, both channels driven, into

8Ω (at 1kHz), and 137-watts per channel, both channels driven, into 4Ω (again at 1kHz). And, whereas many Class-D circuits cannot produce their 'rated' power at low frequencies, the C5i does: indeed it essentially delivers the same power at 20Hz as it does at 1kHz, the differences in the measured figures being so small they fall within the realms of measurement error and/or sample-to-sample differences. This is a significant achievement. The asterisks alongside the 20kHz power output figures indicate that these results are not the usual 'continuous' figures, because if the C5i is called on to deliver these power levels at such a high frequency, the amplifier's internal protection circuit decides that something must be amiss and cuts in after a few seconds to protect the amplifier. The protection circuitry is self-resetting, so it was only necessary to reduce the volume level, after which the amplifier would reset itself automatically and continue operating normally. I should note that when playing any 'normal' program material (music, movies, whatever...) you will never, ever,

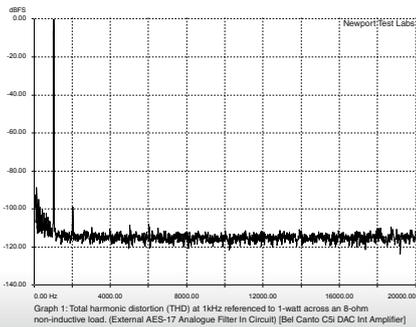
get a 20kHz signal reproduced anywhere near full power, so the protection circuit will never trigger in this fashion in normal day-to-day use: it'll only trigger if there really is a fault somewhere else in your system (or with the C5i itself). Overall, it's nice to know the protection circuitry works. (Interestingly, the circuit did not trigger when driving 4Ω loads, so I wondered whether the protection gets less sensitive with decreasing load impedance, and that this is the reason Bel Canto specifies that loads below 3Ω should not be used, but this is mere speculation on my part. I'll look into it for you...)

Distortion of the output stage was very low, as you can see for yourself in Graphs 1 through 4. (Note that in all cases, except

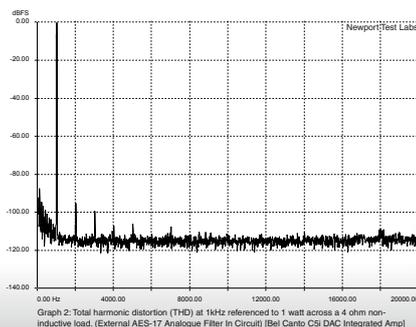
Bel Canto, in partnership with B&O, is squeezing more than the usual amount of power from the ICEPower module, with the C5i easily 'beating' its output specification

frequency response, because of the Class-D output, it was necessary to connect an external low-pass filter between the output of the C5i and the test equipment, to filter out all frequencies above 20kHz. This filter, built to AES-17 standard, is necessary when testing any amplifier with a Class-D amplifier, because the ultra-sonic noise generated by the circuit interferes with the performance of the test instruments.) Graph 1 shows that at an output of 1-watt (8Ω) there's only a single obvious harmonic distortion component (at -100dB or 0.001%THD) though third, fourth, fifth and sixth harmonic components are just visible in the noise floor only because you know where to look. Essentially, all are around 118dB down (0.0001%). Maintaining the same power output, but halving the load impedance sees the second harmonic increase to -95dB (0.0017%) and the third harmonic component become obvious at -100dB (0.001%). Third, fourth and sixth harmonic distortion components are visible, but all are 110dB down (0.0003%).

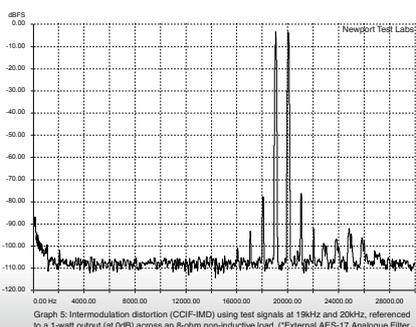
Distortion at maximum output was high, so *Newport Test Labs* tested it at the power outputs for which the C5i is actually rated: 60-watts (8Ω) and 120-watts



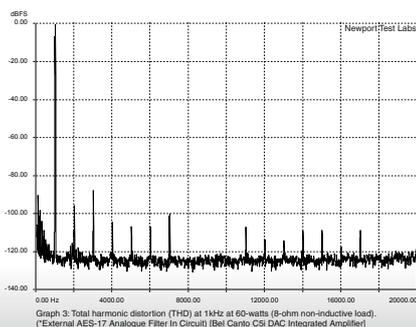
Graph 1: Total harmonic distortion (THD) at 1kHz referenced to 1-watt across an 8-ohm non-inductive load. (External AES-17 Analogue Filter In Circuit) [Bel Canto C5i DAC Int Amplifier]



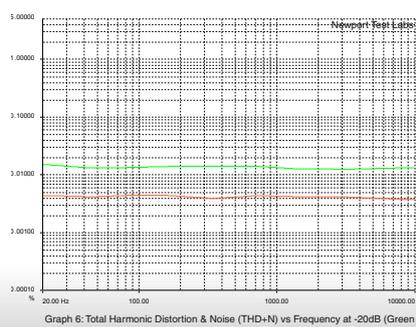
Graph 2: Total harmonic distortion (THD) at 1kHz referenced to 1-watt across a 4-ohm non-inductive load. (External AES-17 Analogue Filter In Circuit) [Bel Canto C5i DAC Integrated Amp]



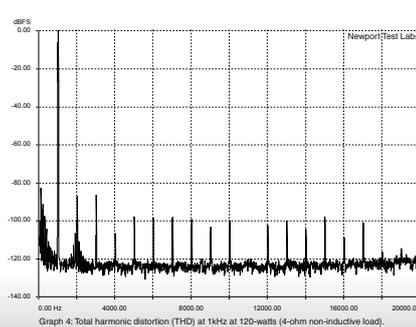
Graph 5: Intermodulation distortion (CCIF-IMD) using test signals at 19kHz and 20kHz, referenced to a 1-watt output (at 0dB) across an 8-ohm non-inductive load. (External AES-17 Analogue Filter In Circuit) [Bel Canto C5i DAC Integrated Amplifier]



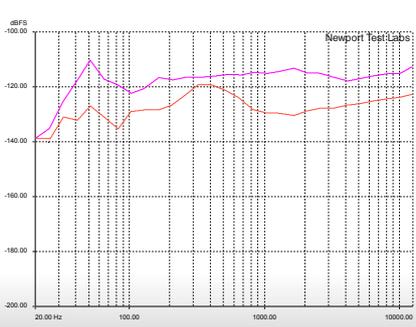
Graph 3: Total harmonic distortion (THD) at 1kHz at 60-watts (8-ohm non-inductive load). (External AES-17 Analogue Filter In Circuit) [Bel Canto C5i DAC Integrated Amplifier]



Graph 6: Total Harmonic Distortion & Noise (THD+N) vs Frequency at -20dB (Green Trace) and -1dB (Red Trace). Digital input. 24-bit/48kHz. [Bel Canto C5i]



Graph 4: Total harmonic distortion (THD) at 1kHz at 120-watts (4-ohm non-inductive load). (External AES-17 Analogue Filter In Circuit.) [Bel Canto C5i DAC Integrated Amplifier]



Graph 8: Idle Channel Noise Spectrum. Digital input. 24-bit/48kHz. [Bel Canto]

(4Ω). As you can see, at 60-watts, although there's a spray of harmonically-related distortion components, all except the second and third harmonics are more than 100dB down, so none contributes more than 0.001% to the overall THD figures. The second is at -97dB (0.00014%) and the third is at -89dB (0.0035%) and so are totally insignificant and would be completely inaudible. (Even if you could hear them, you'd hear them as 'pleasant-sounding' since these 'distortions' are, musically-speaking, the octave and the fifth above, which sound pleasing to the ear.) Distortion increases when load impedance is halved (increasing power output to 120-watts), but essentially, all the components are around 100dB down or more, except for the second and third harmonics, both of which are at this time almost equal in level, at around -87dB (0.0044%). The comments I made previously about audibility once more apply. The overall THD+N figures are tabulated in the result chart, and come in at 0.012% and 0.007% respectively.

Note the noise floors on Graphs 3 and 4: you can see that noise across most of the audio band is more than 120dB down. There is, however, some low-frequency noise visible (at the extreme left of the graphs) and it's this that no doubt affected the overall 'wideband' signal-to-noise ratios, which came in at 86dB (A-weighted) referenced to 1-watt and 96dB (A-weighted) referenced to rated output. Considering the circuitry inside the C5i, I thought these were truly excellent results.

Frequency response was recorded manually to avoid the use of an external filter, which would have affected the high-frequency results, and the Bel Canto proved to have a response that extended from 15Hz to 42kHz -1dB, and from 8Hz to 76kHz -3dB. There were minor variations in linearity depending on load impedance, but these were much less than with early ICEpower modules, so a lot of work has obviously been extended improving the module's load tolerance. Tested into a simulated loudspeaker load that has an impedance/capacitance profile similar to that you'd experience with a typical two-way bookshelf speaker, the frequency response of the Bel Canto C5i was very close to its response when driving a completely non-inductive 8Ω test resistor, which is very clearly a superior result.

Channel separation was very good at low and midrange frequencies (89dB at 20Hz and 88dB at 1kHz) but diminished to 66dB at 20kHz. This latter figure is not as good as good linear amplifiers can manage, but still far better than you'll need for either channel separation or stereo imaging. Channel balance, on the other hand, was exceptionally good, with an error of only 0.003dB—close enough to perfect as makes no difference. I suspect this is the best figure I've ever seen

Bel Canto C5i Integrated Amplifier - Power Output

Channel	Load (Ω)	20Hz (watts)	20Hz (dBW)	1kHz (watts)	1kHz (dBW)	20kHz (watts)	20kHz (dBW)
1	8 Ω	71	18.5	72	18.6	78	18.9
2	8 Ω	69	18.4	72	18.6	84	19.2
1	4 Ω	141	21.5	141	21.5	141	21.5
2	4 Ω	133	21.2	137	21.4	132	21.2

Note: Figures in the dBW column represent output level in decibels referred to one watt output.

(Measured with External AES-17 Analogue Filter In Circuit). Serial Number of Test Unit: C5i-087

Bel Canto C5i Integrated Amplifier — Test Results

Test	Measured Result	Units/Comment
Frequency Response @ 1 watt o/p	15Hz – 42kHz	-1dB
Frequency Response @ 1 watt o/p	8Hz – 76kHz	-3dB
Channel Separation (dB)	89dB / 88dB / 66dB	(20Hz / 1kHz / 20kHz)
Channel Balance	0.003	dB @ 1kHz
Interchannel Phase	0.15 / 0.03 / 0.37	degrees (20Hz / 1kHz / 20kHz)
THD+N	.012% / 0.007%	@ 1-watt / @ rated output
Signal-to-Noise (unwghted/wghted)	80dB / 86dB	dB referred to 1-watt output
Signal-to-Noise (unwghted/wghted)	92dB / 96dB	dB referred to rated output
Input Sensitivity (CD Input)	930mV	(for rated output)
Power Consumption	N/A / 14.6	watts (Standby / On)
Power Consumption	15.7 / 72.3	watts at 1-watt / at rated output
Mains Voltage Variation during Test	241 – 255	Minimum – Maximum

Bel Canto C5i DAC/Amp (AES-17 Standard using 48kHz/24-Bit)

Digital Section	Result	Units/Comment
Out of Band Spurious Components	-113.507B	
Suppression of Imaging Components	-112.326dB	(Worst Case)
Level Dependent Logarithmic Gain	-3.905dB	
Intermodulation Distortion (1)	-80.168dB	18kHz/20kHz 1:1 Ratio
Intermodulation Distortion (2)	-59.094dB	41Hz/7993Hz 4:1 Ratio
Low Level Noise Modulation	3.1960dB	Worst Case
Idle Channel Noise	-113.141dB	CCIR-RMS weighting
Signal-to-Noise Ratio	-113.967dB	CCIR-RMS weighting
Power Line Products	-121.017dB	50Hz
Non-Linear Interchannel Crosstalk (a)	-80.333dB	3kHz (2nd-order ref 17kHz/20kHz)
Non-Linear Interchannel Crosstalk (b)	-120.027dB	6kHz (3rd-order ref 17kHz/20kHz)
Non-Linear Interchannel Crosstalk (c)	-116.828dB	10.040kHz (2nd re 40Hz/10kHz)
Non-Linear Interchannel Crosstalk (d)	-113.348dB	10.080kHz (3rd re 40Hz/10kHz)
Absolute Phase	Inverted	Normal/Inverted

from an integrated amplifier. Inter-channel phase was also excellent, with the 'worst-case' figure being a mere 0.37° error at 20kHz.

The muting circuit reduced output by exactly 20dB. Power consumption was not quite as low as I thought it might be, but it is still an inconsequential 15.7-watts when running at 1-watt, and increases to just 72.3-watts when the amplifier is operating continuously at maximum power (which would be never).

The performance of the Bel Canto C5i's DAC is tabulated in the accompanying table and in the graphs accompanying this review. Newport Test Labs used the AES-17 standard

again, which requires the use of 48kHz/24-bit test signals. Compared with the performance of standalone DACs, the DAC inside the C5i performs very well indeed, so little more needs to be said about this.

More importantly, as you can see for yourself, the measured performance of the C5i's DAC was in all ways technically superior to that of the C5i's amplifier sections, so it will be the performance of the amplifier section that is the limiting factor in the C5i's overall performance, not the performance of the DAC itself.  **Steve Holding**