HiFi-M8 Design Criteria

How we Design Things

There are many customers under the sun and not all products are designed for the same customer. They say "different strokes for different folks." There has been talk online about the CEntrance HiFi-M8. It's different and people are wondering why. Here we list our design criteria for the product to inform the community about our design choices.

As Engineers, we are used to the idea of "design to spec". With each product, we optimize the design for a particular set of criteria, a certain type of use, and a certain type of customer. As a consulting firm for over 100 audio companies, we've designed guitar amps and pedals, mixing consoles and audio processors, amps and DACs, and many other pieces of audio gear. With each product, the engineer works with a set of optimization criteria because it's not possible to have everything at once. So good engineering is about meeting the needs of a particular customer, in each particular case.

Desktop vs. Portable Audio

Race Cars and School Buses are designed to do different things. One is designed for speed, the other for capacity. They cannot be compared to each other, because they are in different categories. Similarly, Desktop and Portable Audio products should not be put in the same category and should not be measured the same way. They are quite different in their ability to deliver clean power to the headphones and flexibility while on the move.

For example, a desktop DAC will fail when used to watch a movie on an airplane, but a portable DAC will be great for this use. And if that portable DAC has several headphone outputs, you can enjoy the movie together with a friend. So Desktops and Portable DACs should be in separate categories, because they are optimized for different type of use.

At CEntrance, we know desktop DAC design. Several years back, the CEntrance DACmini made it to the cover of Stereophile Magazine. That desktop DAC/Amp offered amazing performance for its price and is still in use today.

With the HiFi-M8 we went in a portable direction, because a lot of our customers today find themselves on the move.

HiFi-M8 Design Parameters

HiFi-M8 V2 was crowd-sourced and is the result of hundreds of conversations with real customers. On request of the community, it was optimized for the following parameters:

1) Battery operation, Portability, Robust chassis design, and Reduced risk of bumping the controls while in transit.

2) Output flexibility and Output power, Pitch-black Noise floor, and Perfect channel tracking for BA IEM use.

3) Overall flexibility as a "Swiss Army Knife" for the Hi-Fi enthusiast on the move.

In short, HiFi-M8 is a portable DAC/Amp, designed for mobile audiophiles, who change headphones often, their collections spanning from Balanced Armatures to Overheads.

Optimization Process

HiFi-M8 was optimized for portable use and lowest noise. This came at the expense of the slightly elevated THD (0.004%). Here is the why:

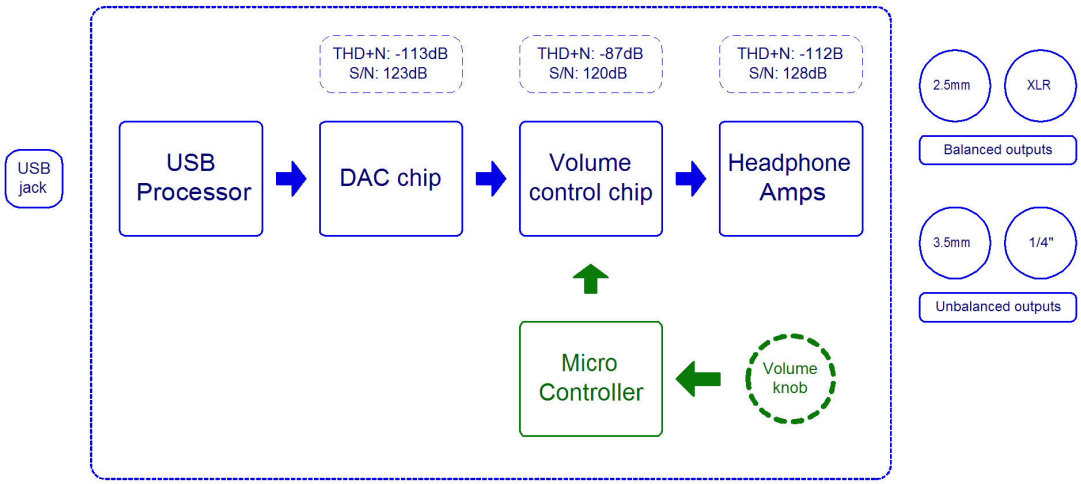
Balanced Armature IEMs are very sensitive. Nobody wants an annoying volume surge when a control is accidentally bumped on a moving train.

The HiFi-M8 volume knob is a thumb-wheel for reduced risk of bumping while in transit. Anything that sticks out would be easy to move. A thumb-wheel that is almost flush with the chassis back panel is hard to accidentally bump (same with EQ and gain switches) so that's what we chose.

Block Diagram

As you see in the block diagram below, the volume knob controls a digital potentiometer, which is used to achieve perfect channel tracking across the adjustment range. This is important for Balanced Armature use. With those sensitive headphones, many customers end up listening at minimum volume levels, where normal analog pots start showing serious channel tracking errors. This meant we needed a "digital pot."

HiFi-M8 V2 simplified block diagram, USB Input



Making a Choice

Here is where we had to make a design choice. The best digital potentiometers out there have very low THD but consume so much power that using them in a battery-powered device is impractical. The battery would drain too fast and the user experience would suffer. So we had to select a part that offered the best design compromise between battery life and audio quality. Yes, you can do almost anything when you design a wall-powered product, where the energy supply is unlimited. Not so lucky with a portable. This is why battery-powered DACs are complex optimization projects. If the battery is too large, it will become too heavy and take too long to charge. If it's too small, it'll drain too fast, so size has to be chosen just right.

We ended up choosing a digital pot that offered the best compromise between power consumption and audio quality. As you can see from the numbers in the block diagram above, the volume control chip is in fact the “bottle neck” for THD, bringing it down to 0.004%. The rest of the circuitry's contribution to THD is negligible. If we were to “short out” this volume control chip, THD would be closer to 0.0001%, gaining us one decimal point (but losing the perfectly tracking thumbwheel volume knob).

What you get in return is portability and output flexibility. If you prefer pitch-black noise floor, then HiFi-M8 will deliver quite well. If you like to fall asleep listening to music, you know that residual hiss in the headphones is so annoying that it makes it difficult to fall asleep. So we worked really hard to make the noise floor inaudible in practice, even with the most sensitive headphones. THD doesn't prevent you from falling asleep, but audible hiss certainly does.

HiFi-M8 really shines in its ability to drive a variety of headphones, from the very sensitive Balanced Armature IEMs, to the hard-to-drive overheads (we all know the usual suspects.)

How important is 0.004% THD on a moving train? Knowing that most headphones' distortion is orders of magnitude higher, we believe it's a fair practical spec. Ultimately, the customer will decide, considering all other product features, such as output power, balanced jacks, Bluetooth input, cool LED meters, portability, flexibility, etc. Our research has shown that it was totally rational to make this decision for this product.

In summary, HiFi-M8 V2 does not try to be what it's not. It's NOT your lowest-THD Desktop DAC. Many of those already exist. Instead, it's a capable, portable workhorse, a "Swiss Army knife" solution for the audiophile on the move. If you are that person, you are most welcome to check it out. As you can probably tell by now, we love our customers and spend a lot of time making sure they are happy.

Incidentally, this is a case when a single SINAD measurement, which combines THD and Noise in one figure, is misleading. Noise performance in HiFi-M8 is actually quite stellar, which you cannot see from SINAD. We saw how this caused some confusion online.

A Personal Note

I learned sound engineering from the amazingly talented Malcolm Chisholm in Chicago. His recording of Chuck Berry's "Johnny B. Goode" was included on a golden disc sent to space with the Voyager mission, as part of the "Best of Earth" package. Malcolm used to say: "No matter how many #1 albums you have, someone out there will hate your work."

We humbly respect that someone and invite you to remember what brings us joy – it's the user experience and the music itself, so let's not forget to enjoy it!

Michael Goodman
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CEntrance