

2019, Chapter 17

Full Heresy Mode

Most people like the well-trodden path, leading clearly towards a goal. Most take comfort in the simplicity of the broad and implacable interstate, clearly illuminated, inevitable as life.

Following a track is easy.

And when you find a direction towards success, then continuing on down the road sometimes leads to more success.

But it's also important to know when to jump the tracks. To reject the accepted wisdom—or even your own internal truths. Sometimes success means you need to question your own dogma...and be willing to change.

Sometimes you need to commit *heresy*.

People know we've been good at poking the sacred cows of audio. *But how good are we at skewering our own?*

Our Dogma

People who know us also know that we have our own internal direction, our own consistent track. To oversimplify, we prefer True Multibit on the digital side and discrete designs on the analog side:

- Mike has said that delta-sigma has its place, but that it's not very interesting, because almost anyone can design a competent delta-sigma DAC.
- I've said that I don't like to use op-amps rather than discrete design. Also, like Mike, I consider op-amps to be fairly boring; it takes more engineering skill for discrete.

Now, both of us have broken our own rules; Mike delivered the Modi 3, which is our best DAC by the measurement standards of the APx555 analyzer, and I've done Fulla 2 and 3 and Hel, which use op-amp output stages to good effect.

Aside: sorry, guys, let's step back and define a couple of things:

1. **Discrete design:** using individual transistors, resistors, capacitors (and probably diodes, inductors, etc) to create a gain stage.
 - a. This gain stage could be designed to drive speakers, headphones, or simply to provide voltage gain in a preamp.
 - b. It could be balanced or single-ended, voltage-feedback or current-feedback or no-overall-feedback.
 - c. The stage must be compensated for its purpose, which requires knowledge of the stage's characteristics, as well as control theory.
 - d. It usually has dozens to hundreds of individual parts.
 - e. Discrete design is a dying art. Someone recently called me "the youngest discrete analog designer." This is very sad, as I am not young. Please prove me wrong.
 - f. Examples: Most Class AB speaker amplifiers are still discrete, because high voltages are something most op-amps don't do well, plus (to be blunt) speaker amp designers can be a crotchety, stubborn bunch.
2. **Op-amp design:** using op-amps (ideal-ish amplifier building blocks in integrated circuits), either singly or in multiple stages, to create a gain stage.
 - a. This gain stage can be designed for voltage gain or to drive headphones; it would take many op-amps to run speakers. Of course this has been done. And for the completists, yes, I know, there are complete speaker "chip amps" out there (BIIIG chips!), but let's keep this more on the op-amp side.
 - b. Op-amps can be balanced or single-ended, voltage feedback or current feedback. However, as far as I know, there are no balanced current-feedback op-amps, nor are there any op-amps designed for no overall feedback (though you can run multiple stages with local feedback.)
 - c. Op-amps usually need some attention paid to compensation, but are generally easier than discrete, and have suggestions provided by the manufacturer.
 - d. Op-amp stages may have only a handful of parts, like the CMoy headphone amp, or can be more complex, including multiple stages and feedback or error correction (feedforward) loops. Typically they are simpler than discrete stages, at least in terms of parts count.
 - e. Op-amp designs are getting better and better. You can get some truly insane performance from op-amps these days, especially in terms of measured performance. There are also op-amps specifically designed for audio.

- f. Examples: pretty much every product that doesn't crow about "discrete" in some way uses op-amps.

But...to use an op-amp based stage when we have the budget and capability to go fully discrete...that's crazy talk!

Or at least that's what I've always believed.

Heretical Thoughts

"So, wait a sec," someone says. "You're going through all this angst because you prefer to use individual transistors and resistors and crap, rather than op-amps? Who cares!"

Well, wars have been fought over interpretations of religious texts. And flame wars have been fought over everything from operating systems to car engines to different ways of making coffee.

***Aside:** Sometimes I think our "functional comparison filter" is fundamentally broken. Most of this stuff really doesn't matter. If aliens came down to study us, I think they would probably summarize us as, "Promising bipedal species, but high danger of extinction due to broken pattern recognition leading to unnecessary conflict. Also, they eat anything. And we mean ANYTHING. Visit at your own risk."*

But yeah, I get it. Arguing over discrete vs op-amp seems like crazy talk.

Annnndddd...really, that's the whole gist of this: what's better these days, discrete or op-amp based design?

In the past, there'd be no question: we'd just do discrete, even down to levels most manufacturers would think ridiculous. Magni 1, at \$99, was discrete. Magni 2 and Uber were discrete. Magni 3 went to a new current-feedback gain stage, but it was still discrete. And still \$99.

But times change.

And so when I went to design Hel, I had a choice: I could do a Magni 3-style discrete stage, or I could go op-amp. We had the budget for either one. The Magni 3-style stage would be pretty big, though, and it would need a DC servo, and there were some new op-amps from TI that were looking pretty good, and we'd had good results with the Fulla 2 and 3 with op-amps...

...so I squinched up my face and did an op-amp stage for Hel.

And you know what? It sounded quite good.

"Gonna do a Magni 4 like this?" Tyler asked, when he heard the Hel.

"Switching supply and op-amps?" I asked. "Are you kidding?"

Tyler shrugged. "All I know is Hel sounds great, bro."

Aside: the "bro" thing is just Tyler's way of poking fun at another of our employees, a friend that he recommended we hire. Tyler actually has a Masters degree in philosophy. I think he's the most edumacated person at Schiit beyond Ivana, with her math Ph.D.

"Yeah, but why would you go op-amp when you can do discrete?" I asked.

Tyler shook his head. "That's engineering talk, not my thing."

His words hit home, because I was in the middle of deciding what to do with the next Magni. I knew it wouldn't be a Magni 4 (because it had the same functionality as Magni 3), but I always thought it would be an improvement on the current discrete Magni. I mean, Continuity was out, because Asgard 3 ran plenty warm with Continuity, so Magni with Continuity would be a nuclear reactor, but I knew I could add a driver stage, which would dramatically improve Magni 3's performance into low impedance loads (at least on an analyzer), but it might make it sound too cold and analytical unless the compensation was changed, because the loop gain would be different, and if we did some filtering, we could suppress some of the 60Hz fundamental (inaudible, but measurements are important).

But if we went op-amp...

My mind spun. If we went op-amp, we wouldn't have to worry about filtering. We wouldn't have to worry about drivers. We wouldn't have to worry about anything, because any decent engineer with the right op-amps could deliver insane measurements with little effort.

Aside: *yes, you read that right: discrete design is much, much more challenging than op-amp based design. That doesn't mean you can't get stellar results from either, but the fact remains: you want to do something that's easy, foolproof, and measures good: op-amp.*

"Ah, I broke the Jason," Tyler said, seeing the expression on my face.

"Just thinking about options," I told him.

"You're gonna try to prove me wrong, aren't you?"

"Maybe," I said.

Tyler laughed. "Definitely."

But yeah, he was right. How could a simple op-amp stage be better than a good discrete design? That was nuts. That was offensive.

That was heresy.

And so, after I spent literally a couple of hours laying out a larger version of the Hel stage on a blank Magni board, I put this on the top silkscreen:

Magni Heretical Edition

Because, you know, there was no way it could be better than the crazy Magni 3+ I had planned.

Right?

Right?

The Showdown

The thing is, to have a proper showdown I'd need to have a Magni 3+.

And that, my friends, was a lot more work. Like I said, I knew how to improve Magni 3. It needed a driver stage and some power supply filtering. And, at the same time, it would be smart to include the new matched dual BJTs that we were beginning to use in Nexus™ topology amplifiers—it would reduce the number of packages, and improve performance due to better matching.

***Aside:** another challenge of discrete design is that the individual transistors vary much more than, say, and op-amp (though those vary as well). The design either has to be insensitive to variation (most of what we do) or everything has to be matched (Nexus™).*

But even by going to the matched devices, I was left with a very complicated amp. Magni 3+, with the addition of a driver stage, had morphed into a tiny Vidar—literally. No kidding, the topology is that close.

We even had to add a Vbe multiplier to get control of bias (better than the previous diode bias)...just like Vidar.

As a result, Magni 3+ had to move to a 4-layer board, while Magni 3 had been 2 layers. Magni Heresy had no problem running at 2 layers. More layers equals more money, more parts equals more money. Magni Heresy uses more expensive parts, so it's kinda a wash, but the fact remains: Magni 3+ is a more complex amp.

It got worse. Early protos of Magni 3+ were unstable. I had to change the compensation to make it work with the driver stage.

***Aside:** a question to the engineers out there—what does the driver stage do, and why does it change the loop gain characteristics of an amp? Bonus: why would you want a driver stage in a speaker amp, but maybe not in a headphone amp? Why might you go to Darlington drivers in a speaker amp?*

Luckily, I found a simpler compensation method (technically, Miller Inclusive Compensation) that was both simpler and more effective than Magni 3, so the parts count actually went down on the second prototype.

Eventually, I had both a Magni 3+ and Magni Heresy. I took them both home, together with a current Magni 3, to do some listening comparisons...

Listening Redacted!

Sorry, guys, I won't be giving detailed impressions of what I thought about all the amps.

"Why?" some will cry. "You're a terrible tease, Mr. Stoddard!"

Here's why: I'd like you to let me know what you think. And I don't want to color your impressions. More on how we'll get your impressions later.

Here's what I will say: If I thought either amp really sucked, we wouldn't have introduced them both. You would have ended up with one new Magni, rather than two.

From the first listening, we went on to more detailed measurements.

Magni 3+, for us, was a measurement monster. It posted up THD+N numbers that are 10-15dB better than Magni 3 when loaded at 32 ohms. We're talking THD+N of -105-106dB at 1V RMS into 32 ohms.

Aside: *also for the engineers, explain why that's to be expected when you add a driver stage?*

Magni Heresy still beat it handily. Magni Heresy, despite its super-straightforward topology (OPA1662 for gain, OPA1688 x 8 for output buffer, no overall loop feedback, but local feedforward—internal to the OPA1688 topology—in the output stage), is more like THD+N of 113-115dB at 1V RMS into 32 ohms. These are crazy good numbers.

Now, of course, there are two responses to this:

1. "Numbers don't matter! Tell me which one sounds good!"
2. "Numbers are everything! Why would you buy an inferior product?"

Here's the thing: both of these absolutes don't get into the nuances.

For the "numbers don't matter," guys, here's the thing: *they both sound good*. Both are amps I'm proud to sell. Both have strengths and weaknesses, though. So I can see some people preferring Magni 3+ and some other people preferring Magni Heresy. No harm, no foul.

For the "numbers are everything," guys, here's the other thing: *you're gonna be hard-pressed to find studies claiming that the human ear can perceive the difference between -106dB and -114dB*. So it really comes down to which one you like better. If it's Magni Heresy because of the numbers, again, no worries. If you hear a difference and prefer Magni 3+, also no worries.

Aside: *a rhetorical question for everyone: if op-amp based design is so much easier, and measures so much better, why would anyone pursue discrete design at all?*

Aside to the aside: *keep reading for our answer later.*

Welcome to Thunderdome 2

So here we are. We have, for your consideration, Magni 3+, a really great-measuring discrete mini speaker amp, and Magni Heresy, an even-better-measuring op-amp based design. We're not priming you with words about how we feel one or the other is better. Instead, we're waiting to hear what you think.

Based on the results, either one, or both, may win.

If you overwhelmingly go for Magni 3+, we make more of those.

If you overwhelmingly go for Magni Heresy, we make more of those.

If it's split, we make more of both.

And, to make it more interesting, we have an offer for you: If you're one of the first 250 people who buys both amplifiers, you can keep both for 30 days, and return one afterwards with no restocking fee.

Yes, you heard that right. Buy both, keep them till the end of December (or a bit afterwards, we're not buttheads), and return one without having to pay a restocking fee.

So, yeah. You decide: discrete or op-amp.

This is what we mean by challenging our own internal dogma. This is what we mean by going off the rails. This is what we mean by Heresy.

Trouble Deciding? A Voter's Guide

"Wait a sec!" you might be saying. "You're not giving me enough to go on! No listening impressions, no huge detail on either Magni, how am I supposed to decide?"

Okay, fair enough. Let's break this down:

Both amps are:

1. Affordable, high performance headphone amplifiers and preamps that offer best-in-class power with very high measured performance.
2. Priced at \$99.
3. Offer two gains, 1 and 5.5, for use with virtually any headphones.
4. Include preamp outputs, for use with speaker amps or powered monitors.
5. Have noise floors below audibility into IEMs.
6. Deliver tons of power for hard-to-drive planar or high-impedance headphones (both are rated at 2.4W RMS per channel into 32 ohms.)
7. Run by the same 24VA AC wall-wart, rectified internally to +/- 16V DC rails
8. Safe, with turn-on delay and instant shutoff

However, Magni 3+ is:

1. Congruent with Schiit's philosophy of doing discrete design whenever possible.
2. Offers an exotic current-feedback topology with low overall loop gain, high open-loop bandwidth, Miller-inclusive compensation, and super wide bandwidth.
3. Uses matched parts extensively.

4. Is essentially a small speaker amp, right down to the driver stage and Vbe multiplier.

And Magni Heresy is:

1. Completely opposite of our historic design philosophy, but congruent with developments like Hel.
2. Offers a two-stage op-amp based topology with an OPA1662 used for voltage gain, and 8 OPA1688 amp stages configured as noninverting buffers, used for current gain, with no overall loop from output to input.
3. Uses audio-specified op-amps extensively.
4. Is a simple but effective topology that includes feedforward locally in the output stage.

Still confused? Well, if you've lived in California (I'm sorry), you probably have seen our various propositions on a state ballot. These propositions are always delivered with an "argument in favor" and a "rebuttal to the argument." So, we thought we'd have a little fun and deliver the arguments and rebuttals for Magni 3+ and Heresy in this format.

IMPORTANT: Again, we are HAVING FUN with this presentation. It is satire. It is sarcasm. Please point the inevitable links taken out of context at this disclaimer.

Argument in Favor of Magni 3+

Paid for by Schiit Fans Forever, an independent audio PAC

Are you kidding me? There's only one choice, discrete! How can you mouthbreathers be seriously considering a cretinoid design that uses op-amps? I had an op-amp equalizer back in 1983 and it hissed like a motherfucker! I mean, it was SSSSSSSSSSSSSSSSSSS all day long. And it sounded like butt, too. Choose the only real Schiit design, Magni 3+! It's a real speaker amp, they said! Or they said that it was like a speaker amp! Heck, it'll probably run speakers! I mean, Schiit designers are like amazing audio gods, so there you go! Choose Magni 3+ and unicorns and rainbows will descend from the sky and you'll be transported to audio bliss. There is no substitute for discrete!

Rebuttal to Argument

Paid for by MeasureMeants United, Inc.

Discrete? You mean discrete? What, did you not get past third grade or something? Or are you eight thousand years old? Because in case you haven't noticed, op-amps have made amazing strides in the past, er, decades, since you had any experience with them. Some inexpensive ones have input noise of 3.5nv/Hz or even less, which, to you Neanderthals, means they don't hiss. Discrete design is overrated, and the numbers tell all—and that is that Magni Heresy delivers better measurements. Why choose the inferior product? Choose Heresy, and break free of your past.

Argument in Favor of Magni Heresy

Paid for by We Luv Measurements, LLC.

Okay, we're going to keep this simple: why choose something with inferior performance for the same price? Yes, you can disassemble all you want, but it comes down to this: Magni Heresy performs better than Magni 3+, full stop. You can see it on Schiit's own measurements. In closer examination, you'll also see that Magni Heresy even puts out more power before clipping—besting the vaunted “discrete” design. There's no reason to choose less performance. Choose Magni Heresy, the clear winner.

Rebuttal to Argument

Paid for by the Old Engineers Discrete 4 Lyfe Brigade

Yes, op-amps can offer excellent steady-state measurements. We'll concede that. After all, any decent engineer can go to the TI site and create a great-measuring amp, using their op-amps. However, where's the art? What does it really sound like? Numbers may not tell the whole story. Also, is there any concern for the future of audio? Are we all supposed to sit back and wait for TI to dispense the Next Great Op-Amp from On High? Or, worse, all follow the Suggested Reference Design? Or even worse, the Patented Topology From the Tastemakers Du Jour? We suggest you look at what happened to the industry when Stereo Review held sway. Fight the New Interregnum, choose Magni 3+.

So there you go. Again, this is parody. We hope you had some fun!

So Why Discrete?

Sorry, guys, I said we'd expand on why we'd bother with discrete when it's so easy to get great results from op-amps, but, I really have to take my own preconceived notions into consideration. I mean, it's the definition of insanity to keep doing the same thing over and over and to expect a different result.

But it's a question worth asking again: why would we bother with discrete when op-amps are easy?

Some answers are practical:

1. Need to keep in practice for things like Vidar. No op-amps swing 100+ volts into 8 ohms.
2. It's a key differentiator. It's the only thing that allows us to do unique stuff like Continuity and Nexus.
3. It gives us more flexibility. You're not gonna turn an op-amp based design into a Raal-driving design without huge changes, whereas Jotunheim gave us a big leg up on Jotunheim R.

But the rest are philosophical. It comes down to the why of what we do, rather than the what of what we do. We believe that there are advantages to discrete design. The same way we believe there are advantages to True Multibit. Same way we believe that everyone should go their own way, do their own thing, and not just copy the reference designs, so we have a vibrant and competitive marketplace of ideas. Same way we reject things like Atmos and MQA and THX as fundamentally anti-competitive, the one-way street to a stagnant monoculture.

But not everyone agrees with us. There are tons of companies out there with different philosophies, happily making a wide variety of interesting gear. The best companies out there all have good reasons for what they're making, and they aren't necessarily the same as our reasons.

Aaaaannndd...to us, that's the way it should be. Allowing a diverse, vibrant market to be eroded by blind adherence to One True Ideal—whether that's a reference design or a secret-sauce acronym topology promulgated (and licensed) as the Best There Is—is fundamentally sad.

It's instructive to look backwards, and see how marching in lockstep down a single path—any path—can be fundamentally destructive.

For people who came on the scene after the death of the audio print magazines, consider the example of Stereo Review.

Stereo Review was the largest magazine out there. It had over a million subscribers at its peak. A page of advertising cost over \$20,000. For one month. In 1990. So Stereo Review was the 800 lb gorilla of the audio world.

Now, the thing is, Stereo Review didn't believe that anything sounded different than anything else. Their reviews all read kinda like, "Of all the receivers we've tested, this is definitely one of them."

But they did present the numbers, and they obsessed over small differences in measurements (differences that, today, pretty much everything exceeds.) And due to this singular focus, and due to the market power of this huge magazine, manufacturers learned to do one thing: generate numbers.

The result?

Interesting topologies went by the wayside. The number of options shrank. And whole sectors of the industry—including pretty much the entirety of the US-made audio industry—were decimated as everything was reduced to a race to the lowest price for the best numbers.

Or, consider home theater. Home theater, when it appeared, was portrayed as the savior of audio. Many companies had lots of ideas about how to make it work best, with various multichannel schemes, and

the products rapidly evolved—usually with some kind of Dolby Pro-Logic, an analog multichannel scheme with steering (gain riding), but many times with other kinds of matrices.

Then came Dolby Digital, which was a much higher bar for manufacturers. Suddenly there were many fewer options, because far fewer companies could deliver a Dolby Digital decoder (especially when you factor in HDMI as well).

From then, the market has been largely determined by the releases of new tech from Dolby (and to a lesser extent, from DTS), and changes in the HDMI standard. Something new comes out—HD, Atmos, whatever—and everyone scrambles to deliver it. Can't be left behind! Can't sell the old gear if it doesn't do the latest things!

But each year the hurdles get higher and higher (last I checked, there were 1200+ test tracks for surround). And each year, the number of companies delivering the internal decoding engines, or have the tech chops to do their own, shrinks further. The home theater market has almost become a monoculture.

Here's the bottom line: We don't want to see monolithic control. We don't want to see everyone doing the same thing. We'd much rather everyone try their own unique approach.

So...we'll continue doing what we're doing (and testing our own dogmas), and we sincerely hope everyone else will continue to go their own ways as well (and test their own internal biases), because that's the only way we'll all get better.

Let's Come Together

So here we go. At the end of the chapter. We've challenged our own internal dogmas, and we've decided to, well, leave it to you.

But let's not fight about it. Come on, guys. This is audio. It should be fun. Whether you like Magni 3+ because it's all philosophically congruent and schiit, or you like Magni Heresy because it's such a radical departure—or if you still like (gasp) tubes in Vali 2, that's your choice.

The bottom line is: both Magni 3+ and Magni Heresy are great amps. Both have their strengths. Both deliver good (or great) measurements. Both are affordable and built right here in California.

So try one out...or both out...and see what you think. Meet with friends, get their opinions. It's perfectly OK to like one or the other or both or none, and it's perfectly fine to base your opinion on what you hear, or on the measurements, or simply how you feel.

SCHIIT HAPPENED: THE ONGOING STORY OF THE WORLD'S MOST IMPROBABLE START-UP

We sincerely hope you enjoy these new amps.

And, if you don't, we hope you find the perfect amp for your needs.