
DESIGN NOTES PART I

Thank you for your interest in the Zen TORII MK V

It is assumed that readers of this paper are familiar with the MK4 and have read the MK4 owner's manual. If you have a MK5 owner's manual then this paper is simply to document the differences between the two revision of our Zen TORII amplifier.

Changes

There are several changes between the MK4 and MK5. In fact the differences are greater than any at any previous time. Starting with the MK2, each revision was more of a refinement than a change. By that I mean that the circuit remained fundamentally the same in all prior revisions. The focus in the past was on improvements to the internal layout, noise floor, and tweaks to the sound quality of an already great sounding amp. Well, you can only improve the sound quality of a great sounding amp so many times. The MK4 was as good as it could get and pushed the sonics of the TORII to a place that many will enjoy for years to come.

Motivation behind the changes

It should be understood right from the start that Decware does not change things for the sake of marketing. There is always a less devious reason behind the improvements. In the case of the MK5 the improvements were motivated by a number of things.

Linearity

The first was linearity into problematic speaker loads. The very thing that makes the TORII sound so good can be problematic with about 5% of the speakers that have been paired with it over these many years, resulting in a tendency to have boomy bass.

This trait has always been easily overcome with room treatments, tube rolling or different speakers not to mention the many adjustments on the amp itself. A more linear amp into these problematic speakers would not need the adjustments on the MK4.

Since the MK2 these adjustments allow you to dial in the treble and make small adjustments to the tightness of the bass. While everyone loves these adjustments, they come at a price. The treble adjust no matter how slight robs that last 5% of the transparency. The bass tightness controls also suffer the same side-effect. One of the big things that motivated the MK4 revision was re-constructive feedback that helped to offset these side effects and give the amp better presence.

So, you can see that if there were a way to eliminate this personality trait of the TORII without straying too far from it's original design, it would be a win-win situation as long as the sound was as good or better.

Linearity cont.

To improve the amps ability to drive problematic speakers without changing it's fundamental design, the output stage was left untouched. Even though changing it with either an ultra linear transformer or negative feedback or both would have easily solved this, those options bring their own form of baggage and change the TORII into something else. The TORII is our most popular and best selling amplifier and well loved so we certainly don't want to start over!

The changes we made came from re-designing the input stage and phase inverter from scratch. Instead of using a direct-coupled cathodyne splitter I changed to a far better balanced long-tail pair type splitter driving a 6sn7 for additional gain which directly drives the output tubes.

After many many many trials I was able to get something simply wonderful to come out of the amp... rock tight bass on our test bed of problematic speakers combined with a far better presence. No feedback of any kind, no adjustments of any kind. The amp has never sounded this good.

Triode / Pentode

Since Pentodes are so much more efficient than Triodes, it only takes about 10 volts in a TORII to drive the output tubes, whereas the same output tubes wired as triodes requires over twice that voltage swing. Since the new driver stage can deliver about 28 volts, there is more than enough gain to drive a triode wired pentode. This switch is not designed to be operated while the amplifier is on.

Who wouldn't want to hear a Zen Torii in Triode mode? We installed a switch on each side of the amplifier to go between triode and pentode modes because we now can. The result is no different than having two completely different amplifiers.

Keeping the default KT66 output tube the same as the MK4, we found that Triode mode on a pair of 4 ohm Magnepans absolutely destroyed the sound of the amp in Pentode mode. And in Triode the speakers coupled better on the 8 ohm tap whereas in pentode mode the speakers coupled better on the 4 ohm tap.

On our more efficient crossover-less speakers, the result was much closer. Both sounded very good. However, change tubes to the new Tungsol 6L6G and Pentode mode sounded twice as good as triode mode, so much so, that on some speakers this tube would render the triode switch useless.

The point of all this is to make you understand that the speaker impedance switch on the TORII MK5 will be different depending on what tube is used, and which mode the amp is in, Triode or Pentode mode.

Tube matching

Since the TORII MK2 there has always been a single ganged volume (gain) control on the amplifier. This combined with the original direct coupled phase inverter made for a slightly tweaky amp when it comes to channel balance. Channel balance required not only a matched quad of output tubes, but a matched pair of input tubes. Easy for us, not always so easy for the customer.

Tube matching cont.

As a nice side effect of the new input/phase inverter design, combined with the addition of dual volume controls, is that the input tubes no longer need to be matched and the output tubes may be two independently matched pairs instead of a matched quad. This will make tube replacement twice as easy, and probably cost you less money.

Tri Volume Setup

The MK5 features dual volume controls which give the amplifier the ability to be adjusted independently for each channel. Prior to this there was no way to adjust the channel balance.

In addition to the dual volume controls, there is a third Master Volume control that adjusts both channels simultaneously. The advantage of this is that once you have the left and right controls adjusted the way you want them, you can use the Master Volume to turn the amp up and down without losing your setting.

Another advantage this offers is the ability to adjust your input levels. For example, with a 2 volt source you're likely to adjust the left and right controls nearly all the way up. However, on a high output source that is greater than 2 volts you can adjust the controls down a bit, leaving a nice full usable range on the Master Volume.

Besides being able to use the left and right volume controls as input level controls and a means to adjust channel balance, you will find a certain degree of magic in "playing the taper" of the left and right controls against the taper of the Master Volume Control. This can be a subtle but powerful way to manipulate the sound and brightness of your amp.

Tube Changes

Tube locations on the MK5 are different than they were on the MK4. There have also been changes in some of the tube types.

The 5u4 rectifiers have been moved to the locations previously occupied by the OA3 tubes. The OA3 tubes have been deleted. In the locations previously occupied by the rectifiers are a new tube for the TORII called 6SN7. This is a popular dual triode with a well respected reputation many feel rise above the 6922/6DJ8/7DJ8 family of tubes used in the TORII. In a MK5 you now have two input tubes that control the voicing (or signature) of the amplifier. The 6922 like all previous models and a delicious sounding 6SN7.

Output tubes

The MK5 is still primarily voiced around the KT66 output tubes. The most common alternate tubes are the 6L6G and the EL34. We like Tungsol for all three types for current production tubes. Of course there is a plentiful supply of New Old Stock in all of these as well.

The Hazen Grid Mod was deleted from the MK5 to maintain consistent performance between the different tube types in Triode Mode since all of the tube now share the same direct connection between the suppressor grid and cathode.

Gain

Unlike previous versions of the TORII where the input sensitivity was 2 volts, the MK5 is far higher. Even in triode mode there is more gain than the amplifier can use, so it is impossible to have both the left and right volume controls and the Master volume all the way up at the same time. In Pentode mode there is over 6dB more gain than in triode mode. This means you'll have the volume controls adjusted considerably lower in Pentode mode than you will when in Triode mode. This is one of the reasons why you should not switch between the two modes when the amplifier is on.

This added gain also changes the dynamic between TORII and external preamps. With the MK4 a good preamp could add a sense of power and dynamics to the sound vs. running the amp direct from a 2 volt source. Now, you have the same ability built right into the MK5.

So, in summary, the TORII MKV is like having two completely different sounding amplifiers and getting a free preamp. Not to mention a more speaker friendly amplifier. And even though it has no adjustments for bass and treble character like before, the sound can be sculpted at least 4 times more via three main things; output tube, speaker impedance switch and pentode triode switch. So in the Zen tradition, the amplifier offers far more by becoming actually simpler... you gotta love that.

—Steve Deckert / Decware High Fidelity Engineering Co.

DESIGN NOTES PART II

Thank you for your interest in the Zen TORII MK V

After spending several more weeks, building two more prototypes, and spending 19,000 dollars on the R&D (Money that could have been well spent fixing my yard after having to replace the entire septic system this winter) the TORII MK V has been canceled until further notice, probably forever. The design notes below will explain what lead to this decision and why the decision was made, but in short after extensive evaluation and despite it's wonderful sound, the MK V did not beat the MK IV.

The first Mk V prototype

Anticipating a certain number of MK IV owners would insist on upgrading their amps to a MK V, it was decided to start with a MK IV and rebuilt that. This of course means that the labor to build this perfectly new MK IV amp was largely lost since most of the amp had to be disassembled and redesigned. I felt it was the right approach despite the fact that it would have cost a fraction as much to start from scratch. But if you're going to offer an upgrade path, you have to know exactly what it's going to involve and the costs.

After writing part 1 of these design notes I think it's pretty obvious to the readers that I believed I was done and the results were a huge success. All the gain in the world, wonderful manipulation, and pentode OR triode mode... what's not to love?

To make sure this was the case, further evaluations were done with all the popular tube compliments that would inevitably be used in this amp... the same ones used in the MK IV and possibly more.

Some interesting things were learned. One of my favorite tubes in pentode mode was the new Tungsol 6L6G as it was silky, juicy, textured and forgiving. Sadly it became the worse sounding tube in triode mode with all speakers tried.

The high gain input stage is what made triode mode possible in the first place, as it takes 26 volts with a B+ of 285V to drive the tubes. In contrast the exact same tubes require only 8 volts to drive when in pentode mode under these same conditions.

Nevertheless, my top concern was pentode and when the input stage was designed and voiced it was done so with the sole goal of making the existing pentode output stage of the TORII sound even better.

The input stage as mentioned in Part 1, was a long tail splitter driving a 6SN7 which in turn drove the output stage. What wasn't mentioned was the fact that to get the linearity and sound I was after, the 6SN7 was biased into hard class. Some would say very hard class A as it drew 17mils. The gain of this combination is a whopping 40 dB. That's well over twice what I need to drive the output stage, but that's what it took to make the project sound better than a MK IV. Many mark IV owner's have found a similar result by adding our CSP3 preamp.

The first Mk V prototype cont.

Of course it's very easy to lower the gain using the same circuit by shunting more voltage to ground after each stage. In fact, this works quite well, but it robs some of the incredible air and detail TORII's are known for. This sets the stage for what will become the ultimate reason to abandon the design.

Since there is about twice the gain that the output stage can use, using all of it, ie, turning the pre-volume controls and the master volume control all the way up means hard clipping the amplifier. While not ideal, my customers can hear so the frequency at which this would happen would be low and the problem could be overlooked if not for one nasty little problem...

Once the hard clipping begins, the tubes will begin to draw grid current which is a no-no in amplifier design due to the simple fact that it will short live the tubes. Here is the real problem with that - As the volume is turned up to the point where the amp reaches it full power (25 watts) it doesn't take a lot past that point for grid current to develop which starts dropping the power of the amplifier. This means that as you continue to turn the volume up, the power after peaking at 25 watts begins to drop until you reach a finality of 12 watts.

I can see a scenario where the amp is paired with power hungry speakers, like say Harbeths as an example, and a customer needs the full 25 watts to drive them. How many times will he or she turn the volume up beyond that and start going through output tubes in months instead of years?

Someone here suggested putting a light on the amp to warn when grid current was starting and my thoughts were "yea, that's just what we need... a warning light to remind customers that they're doing something wrong..." I have a better idea... how about an amplifier where the customer can't do anything wrong, like every Decware amplifier ever built!

So, this is the reason, despite the incredible sound, I had to pull the plug on the project, and I have to admit it was like cutting off a finger.

The second Mk V prototype

It should be noted, that before I realized the first attempt drew grid current I was happy as could be with it and wrote Part 1 of this paper.

I did what I always do when designing amplifiers: Build one as good as you possibly can until you're 100% happy with it and ready to offer it to the public. Then before you do, build a second one that tries to beat the first. The second one can use anything you can come up with to try to beat the first. It's amp wars, and let the best man win.

Why didn't I realize it drew grid current you ask? Because I would never turn an amp up to the point of obvious distortion and then continue to turn it up. Most of you probably wouldn't either, but when you manufacture an amplifier with a lifetime warranty and a have a valuable reputation to protect, you just don't accept compromise of any kind.... and I know from years as a commercial maintenance engineer that despite how stupid it might seem for a human to operate something so improperly, it WILL happen.

Once I realized that the first prototype just wasn't going to be acceptable, I made my goal to build a second one that did not have the issue, and maintained the good sound of the first. Since modifying the input stages in any way ruins the magic sound, the only other alternative was to raise the voltage of the output stage high enough so that the tubes could not be driven into grid current.

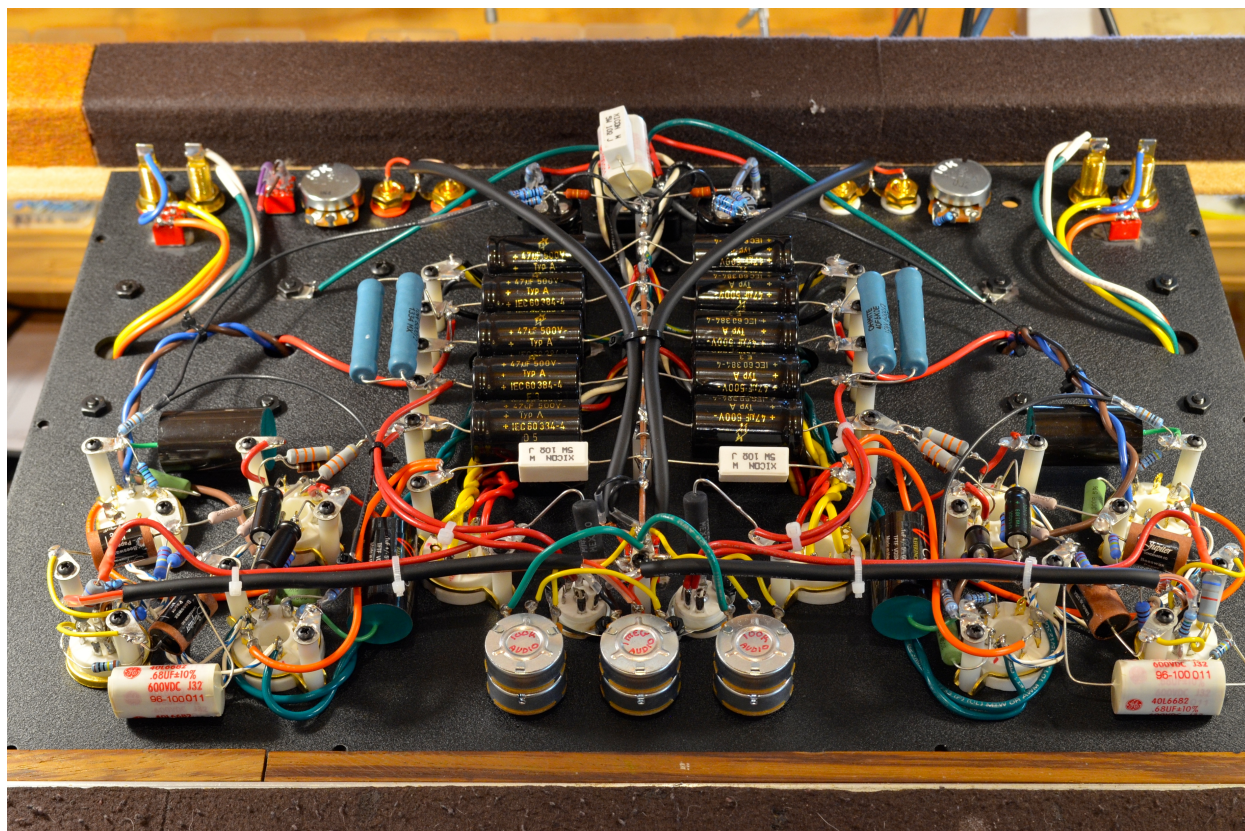
To accomplish this, new power transformers would have to be made that gave me another 150 volts. They were. Prototype two was under way. Upon completion, as anticipated, the amp had more power. You would think this would be a good thing, but in a straight pentode amplifier with no feedback, it is a recipe for hardness in the sound combined with occasional "gotcha's" in the treble.

Indeed this was the case, but the testing continued with lots of tube rolling, several tweaks, and subsequent evaluation. Also as anticipated, the higher voltage made Triode mode sounded wonderful with virtually all tubes. Simple solution, make the amp a Triode amp and walk away from pentode because at these higher voltages that is the sonically responsible thing to do.

The amp was done and passed all the tests with flying colors. No grid current no matter what tubes or what you did to it. Bulletproof. And the sound, was equally good to Prototype 1's pentode mode but even more linear.

On the following page is a picture of this masterpiece. Some of my best work with a nearly perfect point to point layout. Everything seemed to be coming together and I was not only sure the grid current issue was solved, but the amp had as much power in Triode as the previous Torii's had in pentode! Despite the grid current issue with Prototype 1, it remained in the listening room ready to go head to head with Prototype 2 in the sound quality contest. If Prototype 2 wasn't as good or better, it won't matter that the potential grid current issue was solved.

The second Mk V prototype cont.



Prototype 2

Once the treble controls that were installed on Prototype 1 as an option and no longer needed Pentode triode switches were removed (sill partially shown in the picture) the amplifier went into burn-in mode so I could do the evaluations.

After being on and playing for 4 hours I began to realize there was a new problem. Heat. While none of the parts shown inside the amp got more than 100 degrees (cool in the world of tube gear), the larger transformers and new location of the rectifier tubes created a scenario where infra-red heat from the rectifier tubes was absorbed into the power transformers making them run 30 degrees hotter than I was comfortable with. Torii MK IV transformers run at 117 degrees on average with a worse case scenario being 135 degrees. This Torii ran at 144 degrees on average and I don't know what a worse case scenario would increase it to because this is just too hot for comfort. Keep in mind that the current demands on the transformers were well below what the iron was rated for. And the heat as far as the transformer goes is a non-issue because it can operate at over 180 degrees F without deterioration or failure.

The second Mk V prototype cont.

That said, my take is this... if a customer can't put their hand on a transformer without pulling away because "it's hot", then it doesn't get built, despite the lack of reliability issues. And then there's the other problem... the infra red heat reflected back from the transformer washes over the black chassis and heats it.

The chassis reaches 125 degrees in spots. This in turn heats the three volume controls which are the only parts that actually touch the chassis directly. *(All other parts are floating in air or on a bed of silicon.)* This in turn makes the gold knobs reach the same temperature as the chassis and although it's not going to burn you or anything, it is a bit of a surprise to grab a volume control that is unusually hot. Solving the issue with wood knobs, or plastic is a bandaid approach at solving problems to it's not going to be considered. If a customer can't order gold knobs or touch the transformers for any length of time, the project is a failure.

I'm pretty certain this is the best sounding failure I've ever built. As you can image, the time and money put into this and two incredible sounding failures in a row raised my stress level to a point where I actually snapped on my wife for the very first time since I met her some twenty years ago.

So for now, **the obvious conclusion is that the TORII MKIV can not be beat.** Therefor we will continue to offer the MKIV with one revision - the amps will now be built with the three volume controls standard and that alone will improve the functionality and sound of the amp. As you might remember this makes it possible to achieve channel balance if needed without a preamp. It also creates a wonderful level of control as you play the audio taper of the input posts against the audio taper of the master volume.

—Steve Deckert / Decware High Fidelity Engineering Co.