

'Highway 86 build report'

Author : Mark Lavelle

Date : Thu, Jun 24th, 2004 @ 01:17

Annotated schematic:

<http://www.harmonicappliances.com/highway86-5/highway-86-a1.pdf>

Observations, in no particular order:

- Biased a little on the cool side (one ECL86 idling at 5.35W the other at 6.24W), the output is about 6 clean Watts (both volume controls at 10 o'clock), up to 18 really dirty Watts (both maxed).

- It's pretty darn bright, but not quite to the point of being ice-picky. This is one of the few amps I have that sounds **really** good through my 2x8" closed-back cab (built using the speakers from a couple of Electar Tube 10s). Previously I've only liked the 2x8 for very low wattage bass playing and seriously distorted stuff. FWIW, it also sounds really good through my 2x12 open back cab (Celestion Vintage 30 + G12H30), but it's better not to have it pointed straight at you...

- The Treble pot works (nyah-nyah!), but the "knee" seems to be at a lower frequency (more high-mid) than most stacks. Turning it down compensates very well for the overall brightness (if you want to), while turning it up gives you an interesting distortion/emphasis in the high mids no matter what level the volume is at. The Bass pot feels pretty normal.

- Adding the MV was definitely worthwhile! It lets you keep the volume reasonable (i.e., practice level) while still getting the PI overdrive. It seems to help in maximizing the clean volume, too, when you set it and the regular volume control right.

- I must be learning something about layout, because this baby is all point-to-point (with a few term strips) and dead quiet! In the same room with my PC on, I can't hear it **at all** with both volume & MV all the way up (until I plug in a guitar/antenna!).

- I knew the PT was heftier than necessary for the job, but I really expected the loaded B+ to be lower than 393V! The way I read the data sheets I don't think I'm actually **killing** the ECL86s -- and I **do** like the way it sounds now -- but I'm wondering if I should drop the B+ some more with a bigger R3.

- It responds a little better to my 2xP90 "Less Paul" than my Barden-ized Tele. Although the neck p'up on the Tele is certainly pleasing, the bridge p'up is a bit much for my taste. The Less Paul's P90s growl nicely when the guitar volumes are maxed, and clean up nicely when I back off.

- Question: are the DC voltages I'm seeing in front of the PI normal (see annotated schematic)? I don't assume there's anything wrong with them, but I've never looked at them before and they **seem** high...

Pictures of the guts (and scope traces) will have to wait until after the weekend - my

wife has the the digital camera on a trip.

Gotta play some more now... ;-)

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'Highway 86 build report'

Author : Matt H

Date : Thu, Jun 24th, 2004 @ 05:50

the first thing that jumps out at me is the plate voltage on the input pentode (compared to what i remember the Rt66 or DC30 having, granted those were with ef86's)

first option is to increase the dropping resistor between node B and C... though i think you might want to play with the biasing of the tube... maybe go a bit warmer... could be a fun experiment.

i'm glad it sounds good. :) I look forward to some of those amazing clips you're known for.

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'Highway 86 build report'

Author : Mark Lavelle

Date : Thu, Jun 24th, 2004 @ 12:14

On 06/24/2004 @ 05:50, Matt H wrote :

:the first thing that jumps out at me is the plate voltage on the input pentode (compared to what i remember the Rt66 or DC30 having, granted those were with ef86's)

--

The 6AU6 is rated about 10% higher for plate voltage, which is about how much higher my voltage is, so I'm not worried about that. I may experiment with the screen voltage a bit, as I don't have a good feel for what that'll do.

: ... though i think you might want to play with the biasing of the tube... maybe go a bit warmer... could be a fun experiment.

--

Are you thinking a smaller Rk, or something else?

: i'm glad it sounds good. :) I look forward to some of those amazing clips you're known for.

--

Me too! I don't know about "amazing" clips, though. I'll take credit for pretty good recording quality, but I've *gotta* find someone who can actually play guitar...

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'Highway 86 build report'

Author : JamesH

Date : Thu, Jun 24th, 2004 @ 12:50

<http://www.tubecad.com/january2000/page4.html>

This is a really neat idea, and seing as how your experimenting... I want to try this someday when I start playing around w/ my EF86's.

BTW I think it was Mark Hamstra that pointed me to this originally.

James

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'Highway 86 build report'

Author : Matt H

Date : Thu, Jun 24th, 2004 @ 15:23

I don't think the 10% higher rating of the 6au6 really "justifies" the higher voltages on there... not to say that those voltages are necessarily bad...

anyway- yes, thinking smaller cathode resistor. however, another way to control plate current is by varying the screen voltage... maybe try using a 1M linear pot wired as a variable resistor in series with the 1M pot that's on the screen... it would effectively give you a variable gain control.

for experimenting, if you could use a (trim?) pot on the cathode as well, that'd probably be ideal.

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'Highway 86 build report'

Author : A Colman

Date : Thu, Jun 24th, 2004 @ 08:05

Nice report MARk.Lot's to learn from reading that one.

I'm sure you'll tweak it to perfection.

Aharon

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'Highway 86 build report'

Author : Mark Lavelle

Date : Thu, Jun 24th, 2004 @ 14:27

On 06/24/2004 @ 08:05, A Colman wrote :

: I'm sure you'll tweak it to perfection.

--

Like I said to Phil, I'm gonna live with it for a while before I tweak (if I do, that is!). I believe you need to 'explore' an amp before messing with it or you could miss out on some of its strengths. They all have sweet spots, IME...

You deserve a ton of credit for inspiring me to build it. I was really overdue for a new build, and your schematic falling in my lap was just the kick in the pants I needed. Thanks!

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'Highway 86 build report'

Author : A Colman

Date : Thu, Jun 24th, 2004 @ 17:56

Wow,I'm glad I could be of a little service after all that I've taken from all of you,and let me tell you that I have been looking at your amps site quite a lot too,that's where the infatuation with the 6Au6 came from.You are right,if we teaked every amp to sound the same we would be in lame city.It's like having many girlfriends,each personality fills a void.....8^)

I'm still hunting n' gathering for mine.Just a few more parts.
Aharon

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'Highway 86 build report'

Author : Phil Rowley

Date : Thu, Jun 24th, 2004 @ 09:22

Hey, that's terrific!

To take some of the brightness off how about using higher value grid block resistors on the power tubes - maybe 8.2k (like the Marshall 18W, if MattH will excuse me :o) or 10k, like some of the WEM amps. The Marshall 1930 Popular, which also uses ECL86s, has a 47pF cap wired between the PI anodes.

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'Highway 86 build report'

Author : Mark Lavelle

Date : Thu, Jun 24th, 2004 @ 12:22

On 06/24/2004 @ 09:22, Phil Rowley wrote :

: To take some of the brightness off how about using higher value grid block resistors on the power tubes - maybe 8.2k (like the Marshall 18W, if MattH will excuse me :o) or 10k, like some of the WEM amps. The Marshall 1930 Popular, which also uses ECL86s, has a 47pF cap wired between the PI anodes.

--

I think I'll play it for a few days and see if I get used to it, first (the whole idea is to have a new and *different* amp, after all!), but I'm intrigued by the cap across the PI technique. Can you explain the theory behind that? Also, does it really go across the plates, and not the MV? If they're different, why? And what would a cap across the MV do?

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'Highway 86 build report'

Author : Phil Rowley

Date : Thu, Jun 24th, 2004 @ 12:30

It's very simple. The two anodes are out of phase and the small cap value causes higher frequencies to cancel out between the two. Yes, a small cap across your MV would do pretty much the same thing in this case...

On 06/24/2004 @ 12:22, Mark Lavelle wrote :

... but I'm intrigued by the cap across the PI technique. Can you explain the theory behind that?

Also, does it really go across the plates, and not the MV? If they're different, why? And what would a cap across the MV do?

--

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'Highway 86 build report'

Author : Matt H

Date : Thu, Jun 24th, 2004 @ 15:06

the cap across the PI-

it's not just a marshall thing, fender did it too... we had a discussion a while back...

it seems, in terms of fenders (dean owens was the one that pointed this out), the cap was found on amps with a 12ax7 LTPI, but not the 12at7's of the blackface/silverface eras... intersting?

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'Highway 86 build report'

Author : Phil Rowley

Date : Fri, Jun 25th, 2004 @ 13:54

Yes, that's very interesting. I was aware of it not being a Marshall thing - and heck all their early stuff was pretty much ripped off of Fender and Watkins. My reference in this case was actually related to a particular Marshall amp (the "10W"), that also used ECL86s, like this Highway 86....

On 06/24/2004 @ 15:06, Matt H wrote :

:the cap across the PI-

:

: it's not just a marshall thing, fender did it too... we had a discussion a while back...

:

: it seems, in terms of fenders (dean owens was the one that pointed this out), the cap was found on amps with a 12ax7 LTPI, but not the 12at7's of the blackface/silverface

eras... intersting?

--

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'Highway 86 build report'

Author : A Colman

Date : Fri, Jun 25th, 2004 @ 15:53

Yeah,the 1930 10W tremolo,I was looking at the schem today.....
Aharon

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'Highway 86 build report'

Author : Phil Rowley

Date : Fri, Jun 25th, 2004 @ 15:57

One wierd thing in that design is the way the volume and tone controls are at the input to the amp before the first preamp tube. So you would get a lot of interaction between the guitar and amp controls. However, if you slightly change it to the Watkins Westminster preamp, which is very similar to the Watkins Dominator and Marshall 18W's trem channel, then you won't get that problem. The Watkins/WEM amps are in the "bargain Bin" section on Schematic Heaven...

On 06/25/2004 @ 15:53, A Colman wrote :
:Yeah,the 1930 10W tremolo,I was looking at the schem today.....
: Aharon
--

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'Highway 86 build report'

Author : Balijukka

Date : Fri, Jun 25th, 2004 @ 03:11

Hi Mark
Congratulations again for outstanding work.
Finally found a break to study your project.
Some answers and more questions.

- Nyah is a descendant in Balinese, doubling the word makes it a plural. So it's Kids in american. :-)

- IMHO that high mid emphasis happens because when turning treble up, the 10n "bass cap" cut-of frequency shifts higher and at the same time the bass volume rises.
So it feels like high mid boost. Ingenious and brilliant, whoever (Dr.Z?) designed it.

- I think Matt is on the right track about the biasing v4.
Strange situation, plate current is only 0.9mA and screen current 0.32mA, almost same. Yes it's very cold. The high (far away from limits still) plate voltage will drop with more current.
The screen voltage is very low, so it runs cold, and with smaller amplification.
This might be the reason for the brightness. I'll mail you the transfer curve.
Almost the same situation as was with the Verberator triode. might even get similar cutting.
Voltage divider pot at the screen is a good idea.

- The cap between plates. I'd found out that a cap there actually kind of brightens the sound.
By killing the really high frequencies, it sort of frees the tubes capacity for the slightly lower frequencies.
And most of all takes the harshness away from overdriven PI, and lets you drive the power tubes.

- Also a cap in series with(or 2, both sides of) a 5-10W resistor (8-12k) across the OT primary is a nice way to smoothen the sound if the harshness comes from power tubes.
It also can even up the OT freq response.

- PI grid idle DC voltages should be same as the tail junction 81.7V. Where does the current leak?? Heaters??

- You still get bias DC in your MV pot. Gonna scratch.

- Please check what happens to the sound when you turn MV really low.
That's when the load for the PI gets so low it might f.. up the PI.

- Use tiger palm for sore fingertips. :-)

Jukka

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'Highway 86 build report'

Author : Mark Lavelle

Date : Fri, Jun 25th, 2004 @ 13:32

Hoo boy! A lotta stuff to respond to here...

On 06/25/2004 @ 03:11, Balijukka wrote :
: - I think Matt is on the right track about the biasing v4. Strange situation, plate current is only 0.9mA and screen current 0.32mA, almost same. Yes it's very cold. The high (far away from limits still) plate voltage will drop with more current. The screen voltage is very low, so it runs cold, and with smaller amplification. This might be the reason for the brightness. I'll mail you the transfer curve. Almost the same situation as was with the Verberator triode. might even get similar cutting. Voltage divider pot at the screen is a good idea.

--

Got the email - thanks! I've decided to spend a lot more time on tweaking that 6AU6, since it *is* obvious (now that we've all done the math) that I'm not exactly operating it normally...

: - The cap between plates. I'd found out that a cap there actually kind of brightens the sound. By killing the really high frequencies, it sort of frees the tubes capacity for the slightly lower frequencies. And most of all takes the harshness away from overdriven PI, and lets you drive the power tubes.

--

Interesting idea. It had occurred to me to add that cap with a front panel switch, for a choice of flavors.

: - PI grid idle DC voltages should be same as the tail junction 81.7V. Where does the current leak?? Heaters??

--

Why shouldn't there be a voltage drop across the 1M resistors?

: - You still get bias DC in your MV pot. Gonna scratch.

--

Is there a tonally neutral fix? very small caps on either end of the pot, maybe?

: - Please check what happens to the sound when you turn MV really low. That's when the load for the PI gets so low it might f.. up the PI.

--

Bingo! The MV does malfunction at the very low end. I'm thinking that adding a 10K in series might avoid that...

: - Use tiger palm for sore fingertips. :-)

--

I'll look around for it!

FYI, I've decided to lower the B+ everywhere with a bigger resistor at R3 before attacking these other issues. The amp is more than loud enough, and with ECL86s not being produced any more I don't think I should be going out of my way to stress them. 6AU6s, OTOH, are cheap & plentiful...

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'Highway 86 build report'

Author : Phil Rowley

Date : Fri, Jun 25th, 2004 @ 14:14

On 06/25/2004 @ 13:32, Mark Lavelle wrote :

:

: - You still get bias DC in your MV pot. Gonna scratch.

: --

: Is there a tonally neutral fix? very small caps on either end of the pot, maybe?

:

The standard fix here is a DC blocking cap in the signal path, both before and after the MV.

: Bingo! The MV does malfunction at the very low end. I'm thinking that adding a 10K in series might avoid that...

:

Fascinating! I never thought of that before, but it kind of makes sense...

: : - Use tiger palm for sore fingertips. :-)

: --

: I'll look around for it!

Surely, that was meant to be Tiger Balm...? Good stuff, but don't let it get into your eyes, whatever you do, or even on your...<censored>... :o)

: FYI, I've decided to lower the B+ everywhere with a bigger resistor at R3 before attacking these other issues. The amp is more than loud enough, and with ECL86s not being produced any more I don't think I should be going out of my way to stress them. 6AU6s, OTOH, are cheap & plentiful...

:

Yes, 390V is pretty high for ECL86s, and especially their screens. If you can get the screen voltage below 300V, they'll feel much happier. Maybe start by making R9 something like 2k and/or place some zeners in series. Then reduce R7 and R8 to 100 ohm each.

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'Highway 86 build report'

Author : Balijukka

Date : Fri, Jun 25th, 2004 @ 22:05

Hi Mark

- "not operating normally" - most of the times it's the key to the great tone.

-The have a voltage drop across the 1M there must be a current going through it. I just can't see where that current goes. Maybe I'm just dumb.

- the 10k sounds good, nobody ever anyway turns the master to zero.

Waiting for the pictures

Jukka

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'Highway 86 build report'

Author : Mark Lavelle

Date : Fri, Jun 25th, 2004 @ 23:21

On 06/25/2004 @ 22:05, Balijukka wrote :

: - "not operating normally" - most of the times it's the key to the great tone.

--

Touche! And you're the one who noticed my unorthodox CF in the Verberator, too! That's why I tend to think of myself as knowing just enough about electronics to be dangerous...

: -The have a voltage drop across the 1M there must be a current going through it. I just can't see where that current goes. Maybe I'm just dumb.

--

The Root 666 scheme is marked up with pretty similar voltages there, but I don't know anywhere near enough about how it works to have an intellegent opinion as to why.

: Waiting for the pictures

--

I'm waiting for my wife to get back home(tomorrow eve, actually) -- and not just for the camera, either!

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'Highway 86 build report'

Author : Stephen Keller

Date : Fri, Jun 25th, 2004 @ 15:28

On 06/24/2004 @ 01:17, Mark Lavelle wrote :

: - The Treble pot works (nyah-nyah!), but the "knee" seems to be at a lower frequency (more high-mid) than most stacks. Turning it down compensates very well for the overall brightness (if you want to), while turning it up gives you an interesting distortion/emphasis in the high mids no matter what level the volume is at. The Bass pot feels pretty normal.

--

I'm glad it worked, but I'm still puzzled how it works. I guess I'll have to study that schematic some more. Thanks for the build report.

Stph

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