

Chronological Summary of Significant Posts in

<https://www.diyaudio.com/community/threads/towards-a-wideband-non-switching-auto-bias-power-amp.375141/post-6735925>

Started 29 July 2021 by Ian Hegglun. Summary posted as a PDF due to text limit in Post 1.

Post 1 29 Jul 21 Updated 09 Feb 24	<p>Syn08 (Ovidiu) said this about implementing an Auto Bias loop here [https://www.diyaudio.com/forums/solid-state/374367-power-amp-output-stage-measurements-shootout-post6735627.html]:</p> <p>Quote: " I haven't see a solid non switching full solution for the entire audio band, but only partial improvements over the standard solution of an acceleration cap (100nF, in your case), which is not a solution for non switching, but only a band-aid to limit the effect of the crossover mess.</p> <p>Part of this lack of solutions is of course keeping the complexity within reasonable limits; Edmond's solution mentioned above, in despite of it's stability issues, is already a rather complex circuit, and I don't think anything simpler could be designed and successfully implemented."</p> <p>Well, there's the challenge. A wideband non switching Auto Bias amplifier circuit that works, doesn't oscillate and blow up, and is not too complex.</p> <p>To start this thread I'll post some of my findings from simulations of the LT1166 Auto Bias IC, as well as Class-i and Edmond's AutoBias2.</p> <p>Feel free to post any of your ideas and simulations.</p> <p>And if anyone has built a successful amplifier using an auto bias circuit then we'd love to hear how you did it, etc.</p> <p>Cheers, Ian.</p> <p>-----</p> <p>Edit: Post summary:</p> <p>Post 303 Shows 3D views of a PCB for Post 302 circuit (now called Topology 4).</p> <p>Post 302 The LT1223 again but now driving MOSFETs to demonstrate the autobias loop allows plug-in interchange of BJT's and MOSFETs. Interestingly, the MOSFET's achieve similar high BW with less drive current so 2 pair instead of 5 pair TO-92's can be used.</p> <p>Post 301 The previous LT1223 CFB opamp with a CFP autobias loop is OK for 16MHz(tbc) without the CFP output stage, instead the discrete HV booster is paralleled for 50mA drive to the power transistors with a $\pm 9V$ auxiliary supply.</p> <p>Post 300 The previous CFP BJT autobias loop is OK for 4MHz(tbc) with a LV LT1223 100MHz CFA with a discrete voltage booster giving low distortion.</p> <p>Post 295 Bridge <u>and current drive</u> is easy with a HV opamp, where one load terminal is tied to input common (grounded bridge) with a floating PS.</p> <p>Post 291 Current drive with a HV opamp is very easy using a resistor in series with the loads cold-side for feedback to the opamps inverting input node.</p>
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[Post 287](#) CFP BJT autobias loop is OK for 100kHz with a 33 Ohm base pull-up to 9V. Allows a low input current (1mA) drive using a HV opamp (OPA455) with a split rail standard power supply.

[Post 282](#) Only THT with current drive for 4 ohms suggested by Pawel.

[Post 281](#) Current drive version for 200W into 4 ohm, Rout 500 ohms and 0.02% at 1W. Uses 2x OPA1656 LV 100mA opamp drivers.

[Post 277](#) Class-G bridge 800W 4R using 4 slices per side for 20A peaks. Idle dissipation is reduced using Class-G plus McPherson's dissipation diverter.

[Post 274](#) Bridge version for 400W 8R is DC input and DC output. Uses capacitance multiplier with McPherson's dissipation diverter.

[Post 271](#) Mark Johnson query: What if the output capacitor divider caps are not exactly the same? Answer: the voltages equalise quickly due to the amps low output resistance.

[Post 269](#) Power supply circuit to check startup with no dc blocking capacitor. Simulation shows no startup or shutdown transient to the loudspeaker.

[Post 267](#) Input stage level shift with no dc blocking input capacitor. Uses an opamp with a -5V rail and a mirror input stage level shifter with no signal.

[Post 266](#) simulation using ZXT757 and ZXT857 300V complimentary pair for input stage level shift. Bias trimming calculation for output centring.

[Post 257](#) simulation using a level shift input stage rather than a transformer allowing a standard non-floating power supply.

[Post 256](#) [mr_jj](#) pointed out that Kenpeter back in 2010 had placed a resistor across the sensing diodes between the emitters of the power transistors to make it non-switching Class-AB! My hat is off to Kenpeter. I mention my independent finding in [Post 202](#). The Dadson's circuit found in [Post 44](#) from his AES Oct 1980 article shows the same autobias sensing diode topology using a Rush spreader arrangement but with Darlington power transistors, but no resistor across the sensing diodes.

[Post 254](#) Bench test using the OPA1656 100mA opamp to drive power transistors with autobias without discrete driver transistors.

[Post 244](#) Bench tests of a single channel amplifier shows -60dB THD using MUR1615 diodes and biased at 250mA. F-3dB is slightly over 100kHz.

[Post 243](#) Shinichi Kamijo "simple TL bias" circuit is similar topology to my autobias but with a follower output stage and a non-floating power supply.

[Post 235](#) Bridge version bench test. Two floating power supply amps on one supply, where one amp uses a small transformer to isolate the input signal.

[Post 222](#) Tutorial on the floating power supply transconductance autobias output stage. More in [Post 245](#) and [Post 251](#).

[Post 220](#) Using MUR1615 TO-220 power diodes instead of Schottky diodes **gives excellent linearity**. Bias can be trimmed by two resistors to

9V rail instead of two CCS's (simpler and less error prone).

[Post 215](#) Using MJE3055 TO-220 as diodes instead of Schottky diodes.

[Post 210](#) thru [Post 214](#), [Post 217-219](#). Option of using many (8-10) 1A silicon diodes in parallel per side instead of Schottky diodes so no need for a bias trim pot.

[Post 205](#) FDC6321 CMOS stage allows high current drive without a CFP output stage.

[Post 203](#) A prototype PCB allows stacking of up to slices (3 pair of output transistors).

[Post 202](#) Using a HCU04 CMOS input stage with a CFP output transistors so only 1mA is needed to drive the autobias transistors. The CMOS input stage provides some gain and soft clipping and the option of thermal-SOA protection by dynamically limiting the clip level (more in [Post 204](#)). Introduced R13 across the power diodes to provides the keep-on current of 18mA in Q1 and Q2 – even when clipping. Eureka!!

[Post 160](#) For those who want a non-floating standard power supply. LT6090-5 high voltage opamp – but it's not a fast opamp – sorry. BTW the floating supply versions above are not slew rate limited, only BW limited, so is the best option IMHO. Just parallel slices with higher voltage rails to get more power.

[Post 158](#) Similar to [Post 157](#) but with a diamond driver allowing higher input resistance of 10k but now requires compensation for stability (for when the input is open circuit). More voltage feedback gives lower output resistance. A zero feedback topology with very little local feedback – that's very rare.

[Post 157](#) **2 channel listening test** with only 6dB voltage feedback, single 43V floating supply, sounds great and doesn't blow up. It works!

[Post 156](#) Bipolar power transistors without Darlington drivers as per E Van Drecht autobias [patent](#) and floating voltage offset for bias as [peufeu Post 393](#).

[Post 150](#) bench test with MJL3281/1302 instead of MOSFET's. Good performance. Lower optimum bias with BJT's in place of MOSFET's.

[Post 141](#) Re design aims: minimalism and no source resistors. Ultra low THD is not necessary with no source resistors due to mainly low order harmonics up to 1W or so (thanks to the higher bias current for minimum distortion).

[Post 138](#) best thermal compensation so far with one of the autobias spreader transistors on one Schottky diode, the other spreader transistor at ambient to halve the temp.co (now just right). Slice paralleling best as per LT1166 application note.

[Post 137](#) bench tests with parallel IRF540N and two 10A Schottky diodes (instead of MOS-diodes). Current sharing resistors required. Good linearity with 400mA bias. Over-compensation required thicker thermal washers for the Schottky diodes.

[Post 135](#) bench tests with parallel IRF540N and MOS-diodes using the same. Good current sharing. Good linearity with 400mA bias. Over-compensation required thicker thermal washers for the MOS-diodes.

[Post 116](#) Pass F4 variant: Class-A balanced bridge, autobias transconductance amplifier with gain, soft-clip, 100W 8R, 0.001% 1W.

[Post 115](#) Pass F4 variant: Class-A with autobias as a transconductance amplifier with gain, soft-clip, 200W 4R, 0.001% 1W.

[Post 111](#) Pass F4 variant: Class-A buffer with autobias, 200W 4 ohms. Needs high level drive (40Vpk) preamp.

[Post 105](#) All the autobias versions thus far are in one attached file including the latest versions of the electrothermal subcircuits. A tutorial for using these electrothermal 'widgets' with demo jigs is at [my website](#).

[Post 99](#) using **IGBT's** with autobias MOS-diodes. Changing to IGBT's gives about the same idle current without changing the bias settings -- thanks to the Autobias feedback loop. Sim'd THD doesn't change much no matter what power devices are used.

[Post 93](#) Replace Schottky diodes with **MOS-diodes**. No Vbe multiplier feedback resistor used. No need to thermally couple the spreader to the power transistors. Autobias MOS-diodes keep the idle/crossover current much more stable than Schottky's.

[Post 90](#) Similar to Post 65 Vbe multiplier coupled to Schottky diodes in the MOSFET sources, **but now Autobias** by adding two current sources to add some DC voltage to the Schottky diodes allowing the trimpot to be eliminated. Once the current sources are carefully set you can change the power MOSFET's to BJT's and the idle current is almost the same – thanks to the Autobias feedback loop. QED.

[Post 78](#) Comparison of a 4mR RDSon MOS-diode with a 10A Schottky diode show similar volt drop at 10A but temperature coefficient is negative for Schottky (results in thermal runaway in an autobias loop) and MOS-diode has a positive temp-co. (thermally safe in an autobias loop).

[Post 65](#) CFA diamond splitter, output stage with voltage gain, Non-switching Rush Vbe multiplier coupled to Schottky diodes in the MOSFET sources (See Post 45).

[Post 53](#) Syn08 Simpler non-switching MOSFET, $\pm 15V$ LME49710, No bias loop, CFP keep-on current, CFP with voltage gain uses current mirrors.

[Post 52](#) Syn08 Non-switching MOSFET 500W/4ohm, THD 0.0005%. No bias loop, CFP keep-on current, CFP uses current mirrors.

[Post 45](#) Peufeu auto bias and non-switching basic circuit using Schottky diodes in place of source resistors as [peufeu's thread here](#) like the E Van Drecht patent. See Post 65.

[Post 37](#) The LTspice library LT1166 model.

[Post 20](#) Type B: HV opamp LT6090 Vin pin driven, $\pm 50V$ 100W, SR 17V/us due to opamp OK to 50kHz. THD 0.0001% 100W and 0.000015% 1W.

[Post 14](#) Edmond Stuart's AutoBias2 circuit.

[Post 11](#) Marcel van de Gevel links to his published and successful auto bias amplifier EW+WW Feb 1996. BW 140KHz, THD 0.006%. Has a cross-conduction crowbar (Q19,Q20) to trigger speaker relay. Ingenious non-complement design with a CA3046 array

[Post 6](#) Voltage Gain Topology, LV opamp Top/Bottom pin driven, gain 20dB, ss-BW 3MHz. THD 0.002%. Post 27 shows slew limiting, OK up to 300kHz.

[Post 5](#) Type A: LT1166 Top/Bottom pin driven open loop voltage gain is 47dB, BW 15kHz. (Post 2 UGB version 8kHz BW with current source

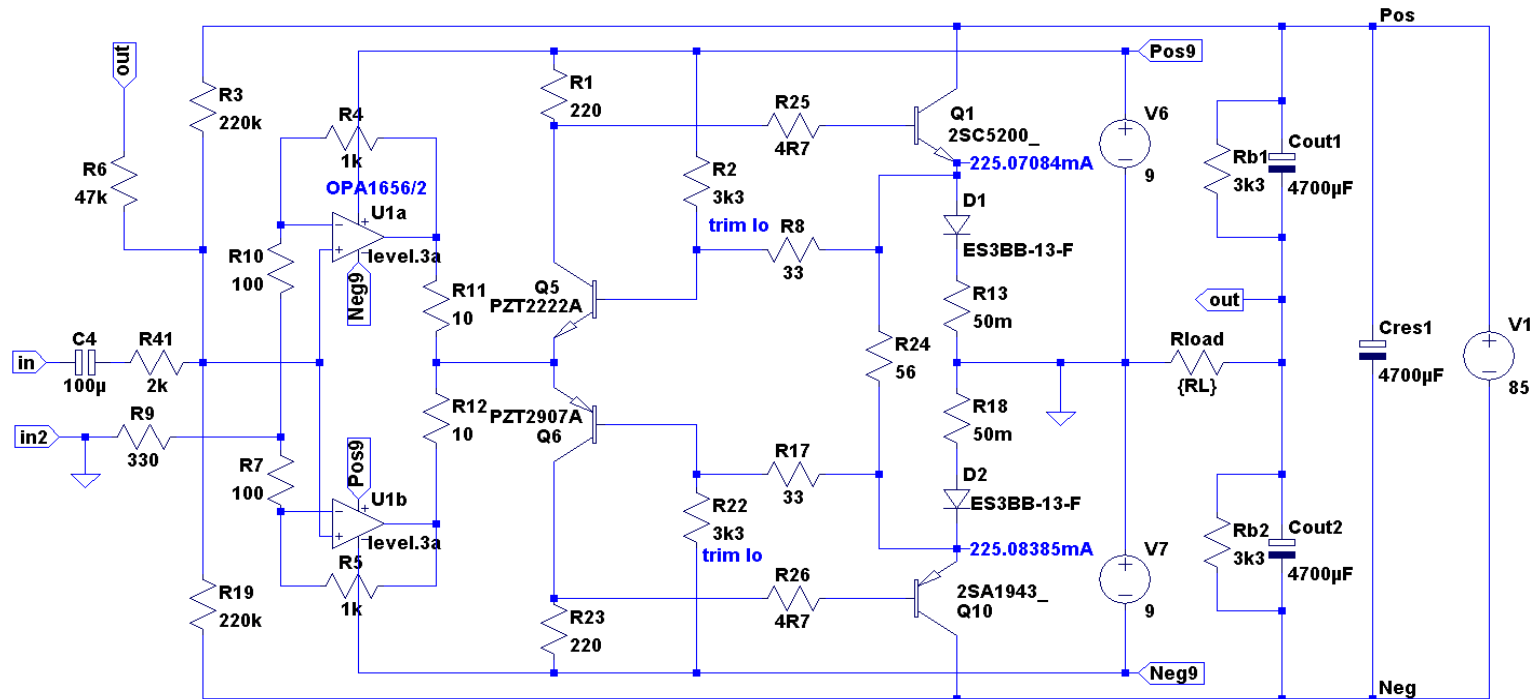
drive to Top/Bottom pins.)

[Post 3](#) Syn08 LT1166 + HV opamp [LM4702](#), LM4702 app Top/Bottom drive with Darlington's. Breadboarded 28KHz BW. Not datasheet version. Like Post 20.

Edit Feb 2025. Overview of development: Toward a Wideband Non-Switching Auto Bias amplifier

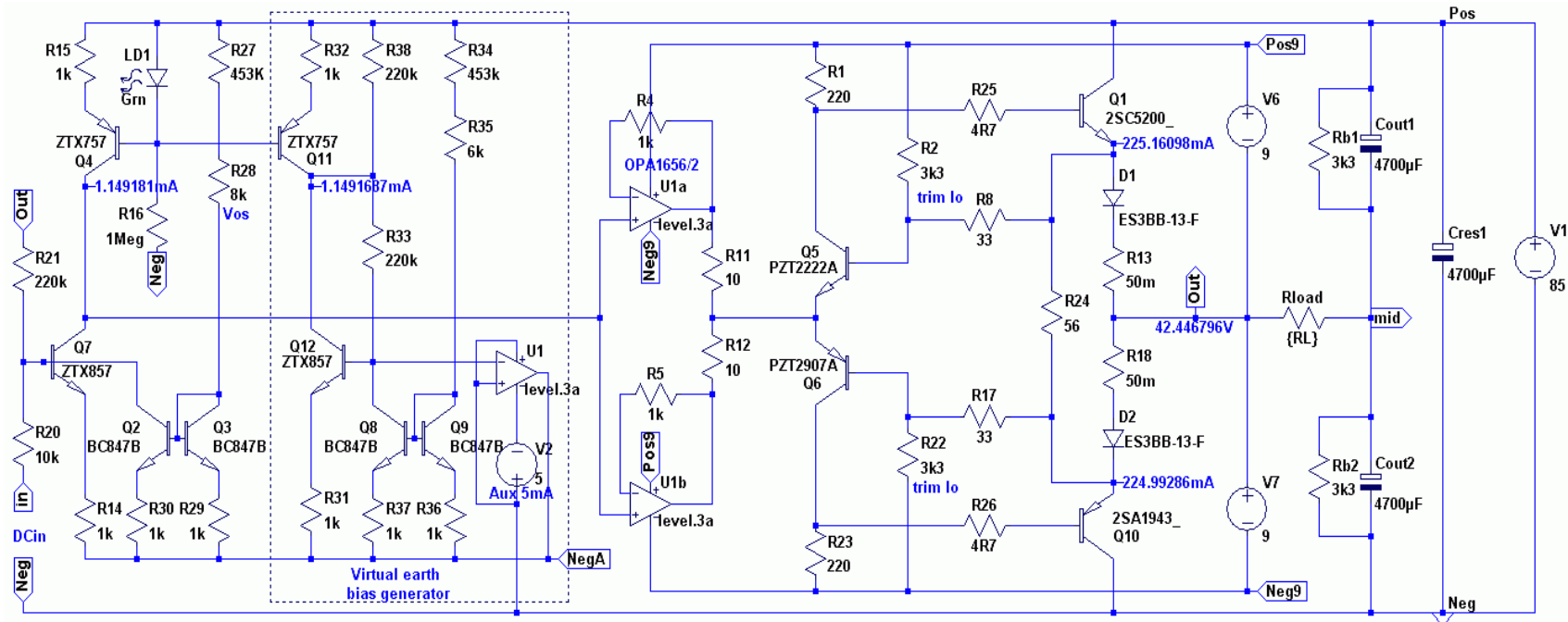
The challenge! “A wideband non switching auto bias amplifier circuit that works, doesn't oscillate and blow up, and is not too complex”.[Post1](#) aim 29 July 2021 by [IanHegglun](#).

- I have exceeded my expectations. A non-switching autobias topology – simple, stable, scaleable.
- Two related topologies: 1) The floating supply version, and 2) The non-floating supply version.
- Several diyAudio members have suggested that I provide a non-floating supply version.
- **Topology1.** The floating supply version is the simplest, eg, Fig.1 below, 100W into 8R, only 2 power transistors & 2 bias transistors, 2x3A diodes, a dual opamp, and a $\pm 9V$ 2W supply. Notice no Darlington driver transistors, instead two 100mA opamps operating in parallel. THD 0.1% 1W.



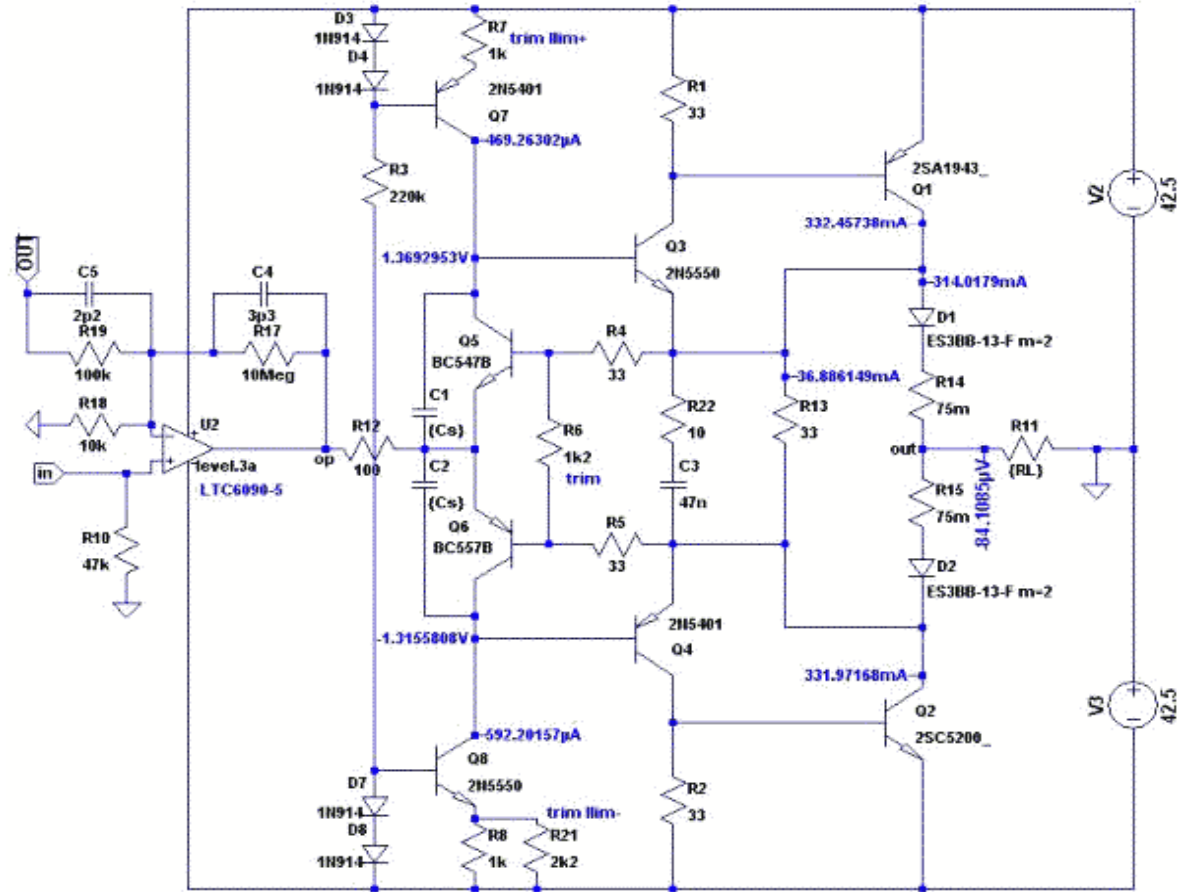
Topology 1: Completed Wideband Non-Switching Auto Bias amplifier with opamp driver.

- Can be paralleled eg [Post254](#) and bridged eg [Posts274](#) .
- Uses two output capacitors in series. They are forced to half the rail voltage by the feedback loop referenced to half the rail voltage by a voltage divider (R3,R19). They prevent DC damaging the loudspeaker. It's is simple, effective and reliable, with negligible effect on sound quality.
- **Topology2.** The non-floating supply version. It is a modified floating supply version with an addition input stage where the input is now referenced to the negative rail. The input stage lowers distortion to 0.02% at 1W and a low output resistance of 50 milli-Ohm.

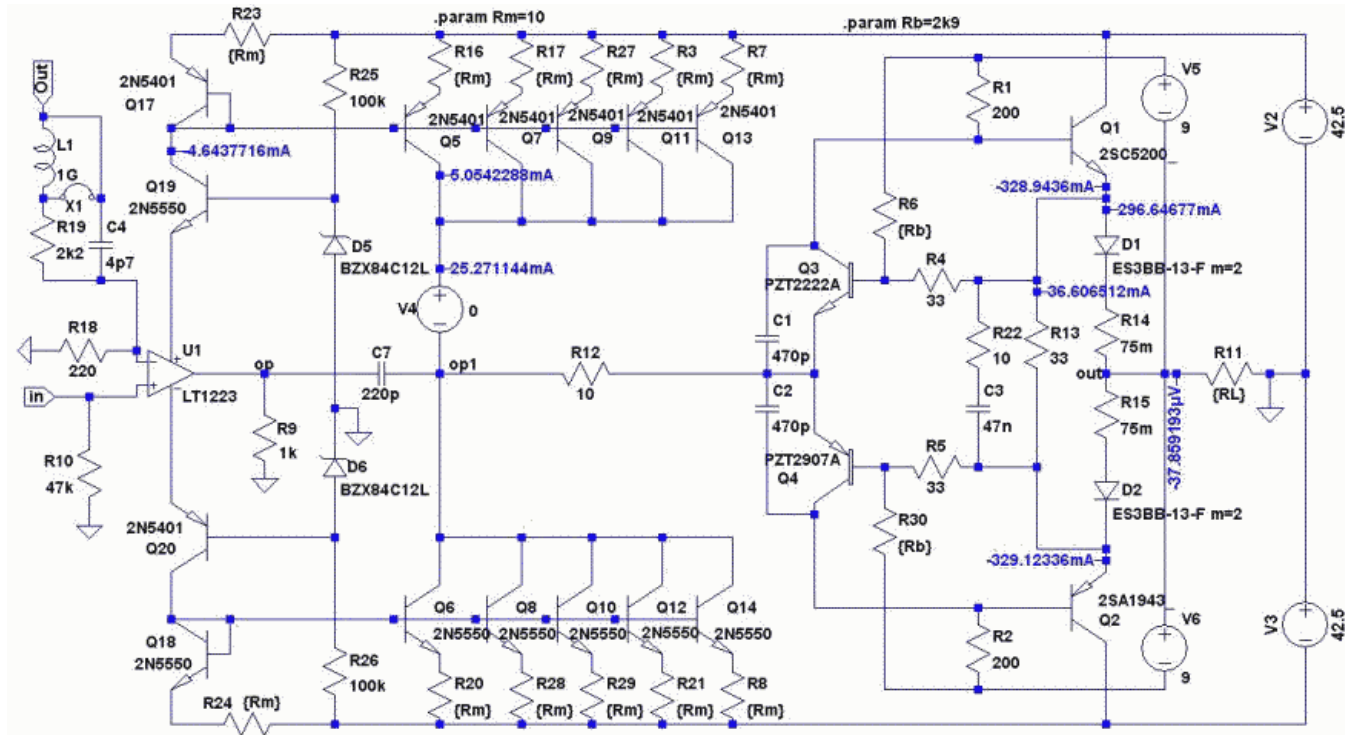


Topology 2: Wideband Non-Switching Auto Bias amplifier with DC input and non-floating Power Supply.

- An alternative bias circuit, see above Topology 2 dotted area, it eliminates the input capacitor which eliminates the long settling time at turn on.
- The alternative bias circuit avoids a 3rd input stage which avoids a 3rd pole which requires careful frequency compensation. Both Topology 1 and Topology 2 do not use frequency compensation!
- The loudspeaker is protected from DC damage by the two output capacitors in series.
- Topology 2 can be paralleled eg [Post257](#), and bridged eg [Posts274](#) and Class-G bridge [Post277](#).
- Topology 2 has been simulated and a PCB is underway for bench test and listening tests.
- Topology 1 has been bench tested eg [Post244](#) & [Post254](#) and a listening test [Post157](#). The Topology 1 PCB needs updating for an opamp.
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- **Topology 3.** See [Post287](#) and [Post291](#).
- CFP BJT autobias loop is OK for 100kHz with a 33 Ohm base pull-up to 9V. Allows a low input current(1mA) HV opamp (LT6090-5 or OPA455) to be used with a split rail standard power supply.



- Topology 3. Wideband Non-Switching Auto Bias amplifier with DC input and non-floating Power Supply and no auxiliary $\pm 9V$ supplies.
- Topology 4. See [Post301](#) and [Post302](#)
- Using a LV LT1223 CFB opamp with a CFP autobias loop is OK for 16MHz(tbc) without the CFP output stage. The opamps discrete HV booster is paralleled for 50mA drive to the power transistors. The trade off is the $\pm 9V$ auxiliary supply.



- Topology4. Wideband Non-Switching Auto Bias amplifier with DC input and non-floating Power Supply and no CFP power stage, instead the auxiliary $\pm 9V$ supply.