The Hifisonix kx-Amplifier

A Low Distortion, Wide Bandwidth 25 Watt Class A, 50W class AB CFA Amplifier

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www.hifisonix.com

Double sided, silk screened PCB's for this project are available from Jim's Audio on eBay.

WARNING

This project is intended for experienced DIY constructors.

This project involves wiring up mains voltages.

Do NOT attempt this project unless you are completely aware of the dangers of mains voltages and fully understand mains voltage wiring practises and conventions.

A wiring mistake can be lethal. Do not take any risks.

Seek professional advice if you are not sure.

Always adhere strictly to the electrical regulations of your country.

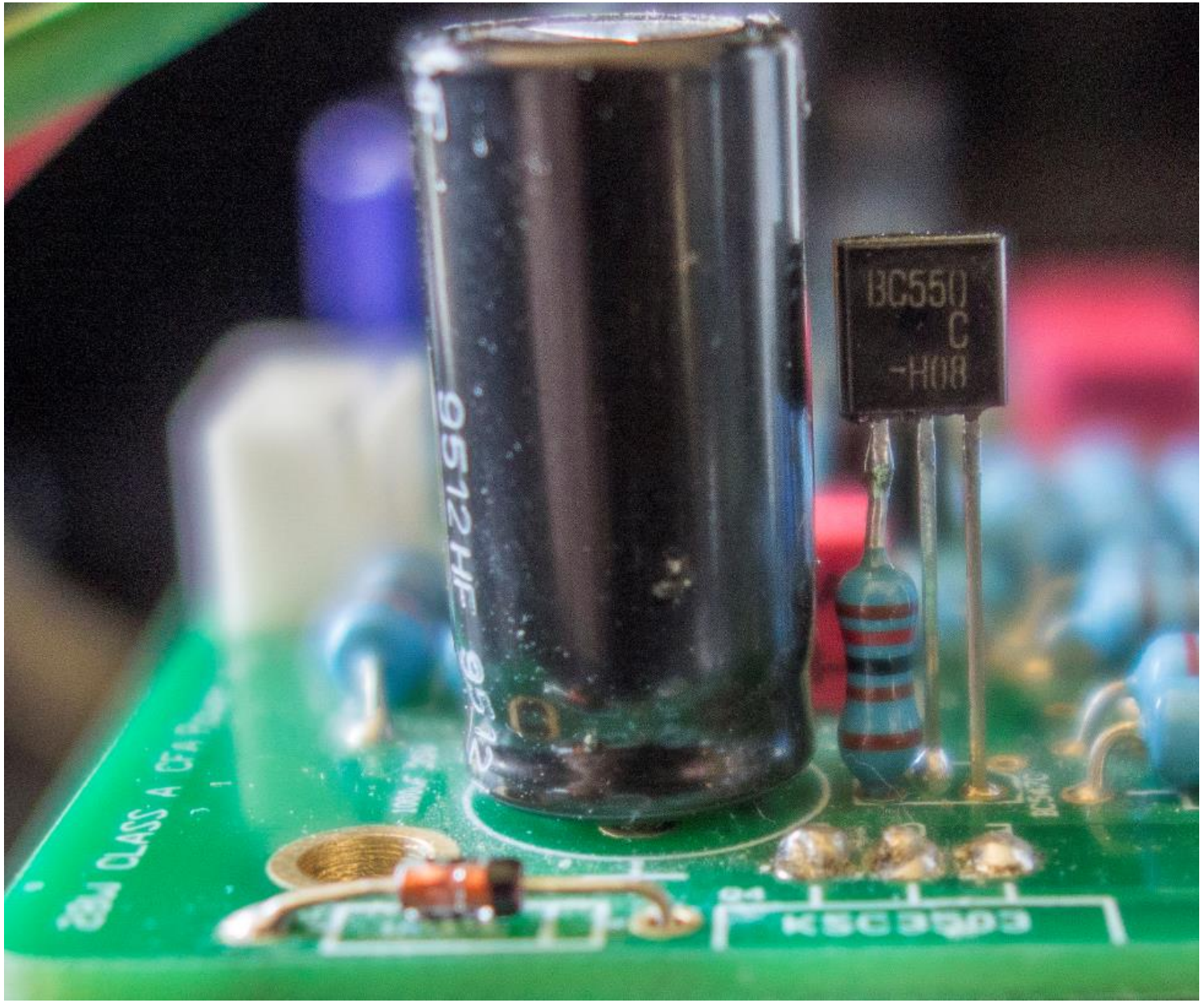

hifisonix

Update December 2020

- As of December 2020, 107 kx-Amplifier PCB sets have been sold by Jim's Audio. 6 builders have reported 15-20 MHz oscillation at between ~1.5mV and 80 mV at the output. Since the oscillation is at very high frequency, it is not loop related, but more likely parasitic oscillation (loop related problems are usually <5 MHz, and normally below 2 MHz even in a CFA amp like this).
- Builders reported that whilst monitoring the output, touching Q3 or Q4 collector or placing a scope probe on the collectors of Q3 or Q4 stopped the oscillation
- The probable cause of this issue appears to be parasitic oscillation in Q1 and/or Q2. These are emitter followers (called 'beta helpers' when used in an amplifier in this way) and have a tendency to oscillate at HF due to the formation of Colpitts oscillator structures arising from the parasitic L and C components around the devices. Modelling showed it was easy to get oscillation in the 30-40 MHz range with the probable parasitic L and C on the PCB – not as low as that reported, but a sure indication that there was potential for problems.
- If you can see this oscillation with a scope, or you can hear a clearly discernible hiss ('Shhh') from your amp with the inputs unplugged then do the following:- (note: a well-built kx-Amp must be absolutely silent on 90 dB sensitivity speaker with the inputs unplugged on both hum and hiss)

1. Change R4 and R5 from 10k to 1k (this will BTW improve the square wave response as well)*
2. Raise Q1 and Q2 up off the board and insert a 1k resistor in series with the collector - see next slide on how to do this)
3. Across each of the 1000uF capacitors under the board, solder an SMD 1206 1uF 50V X7R decoupling capacitor (example part from Mouser 187-CL31B105KBHNFNE)
4. As a general improvement with signal sources with 50 Ohm impedance (most CD players and modern preamps), replace R31 with a 1.8k resistor. This reduces the slight overshoot which is quite normal for a TPC compensated amplifier (See Cordell 'Designing Power Amplifiers' 1st Edition pages 177-180)

*if you leave the R4 and R5 10k resistors in situ, you must instead place a 68 Ohm in series with 330pF capacitor network across R4 and across R5. This has the same effect as the 1k resistor in that it dramatically lowers the impedance at the emitter of Q1 and Q2 at HF, suppressing the oscillation.



How to insert the 1k resistors in the collectors of Q1 and Q2

(thanks to builder Polsol from Cape Town, South Africa, for the technique)

The Original Hifisonix sx-Amplifier From July 2012 . . .

- Up to the end of 2016, about 100 sx-Amplifier modules had been built = ~50 complete amplifiers
- Original Design Objective: Very simple, very fast class A CFA
- Traded distortion performance for speed and low loop gain with wide bandwidth i.e. 'classic CFA'
  - 140 V/us slew rate
  - - 3dB bandwidth of 1.5MHz with front end filter disabled; 540 kHz with front end filter in-situ
  - Low loop gain: ~34 dB
  - Very wide loop gain bandwidth of 60 kHz
- DC coupled
- Distortion: typically <0.1% at 10W output, rising to 0.6% at 20 W peak class A (see comparison to JLH 10W and Hiraga amplifiers later in this document)
- Offset adjustment into lo-Z inverting feedback summing junction = high offset current required
- Closed loop gain of 14.3x (23 dB)

Areas for improvement

- Distortion performance due to load dependency of OPS - **Done**
- Improve/simplify the offset adjustment method - **Done**
- AC couple the input - **Done**
- Feedback from some builders that gain was too low – **Done** – raised to ~17.3 and can be optionally increased to 21x)
- Improve transistor selection - **Done**

Don't change/minimize change on

- Slew rate performance – **OK – no change**
- Loop gain bandwidth – **Reduced from 60kHz to ~12 KHz**
- Retain form factor and simple PSU requirement - **OK**

The result is the new Hifisonix

kx-Amplifier

kx-Amplifier – Quick Overview

- Uses *same PCB mounting footprint holes* as sx-Amplifier and nx-Amplifier, but PCB is slightly longer (3 cm) and wider (2 cm); additional two holes required to secure the driver transistors (easy to mod existing heatsink though)
- 'Souped-up' sx-Amplifier
  - EF2 output stage
  - Enhanced beta TIS stage
  - TPC compensation and higher feedback (>60 dB) across the audio band (sx-Amp was ~34dB DC to 60 kHz)
- Uses same PSU as original sx-Amplifier
  - Increasing supply rails to +-26-28 V DC will offset the slightly higher output voltage swing losses due to the EF2 OPS and is highly recommended.
  - However, original +-22~23 V DC supply will still work satisfactorily albeit with *less maximum power*
- AC coupled input with -3 dB LF corner frequency <2Hz
- Improved offset adjustment - done on hi-Z non-inverting input.
- Direct regulation of class A OPS standing current with smooth transition to class AB as demanded by load impedance – same as sx-Amp
- The kx-Amplifier can be switched between class A and class AAB mode – details later in this document.
- Transistor selection relaxed (types and gain ranges) to mitigate sourcing problems experienced on sx and nx-amplifiers due to device discontinuation by suppliers – e.g. BC547/557, KSA1381/KSC3503

kx-Amplifier Specifications (+- 26V Rails)

General Description: A low distortion, wide bandwidth class A amplifier specifically designed for driving high efficiency horn speakers, or high performance speakers in small listening spaces. At rated output power (25W peak class A into 8 Ωs) all distortion products are below -90dB and predominantly low order 2nds and 3rds. All specifications below are with +-26V (loaded) supply rails. There is no output quiescent current adjustment on the kx-Amp – just a feature to switch between class A and class AAB

Output power: >28 W peak class A into 8 Ωs = 15 W RMS class A into 8 Ωs class A; 50 W RMS into 4 Ωs class AB; 95W RMS class AB into 2 Ωs;

Standing current Class A mode: 1.2 amps (600 mA per output pair); standing current class AAB mode: 600 mA (300 mA per pair) +-20%

Distortion (measured): typically 0.006% at 15W into 8 Ωs; 0.015% at 50 W class AB into 4 Ωs; <0.1% at 90W into 2 Ωs

Large Signal Rise Time: 140 V/us (10%~90%, symmetrical)*

Closed Loop Bandwidth: 2 Hz to 300kHz (-3dB)

Closed loop bandwidth without front end filter: 2Hz to 1MHz (-3dB) 2.8V pk~pk into 8 Ωs

Large Signal Rise Time: 750ns

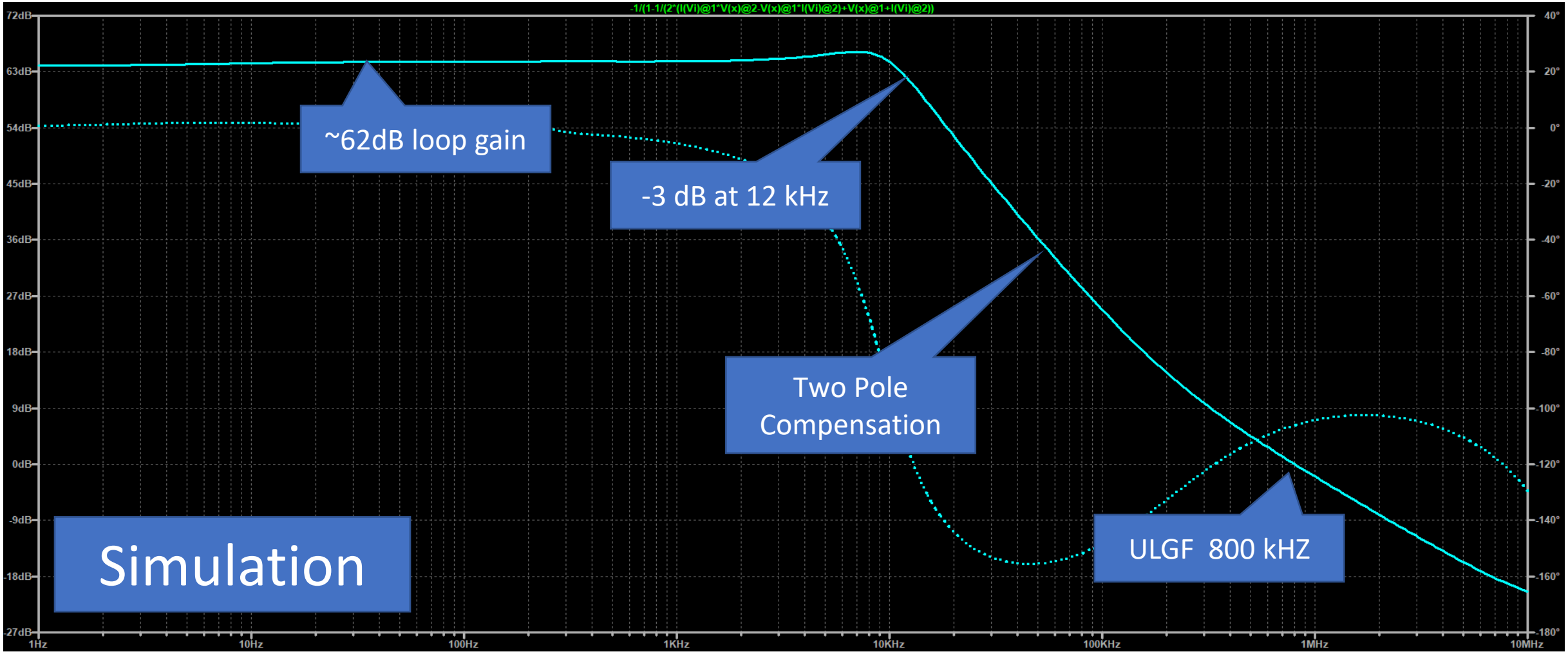
Loop Gain: 60 dB at 1 kHz

Loop Bandwidth: 2 Hz to 12 kHz -3 dB; Loop gain at 30 kHz is 45 dB and at 100 kHz ~23 dB

Unconditionally stable with any combination from 2 Ω to ∞Ω in parallel with 0 uF to 2 uF capacitance

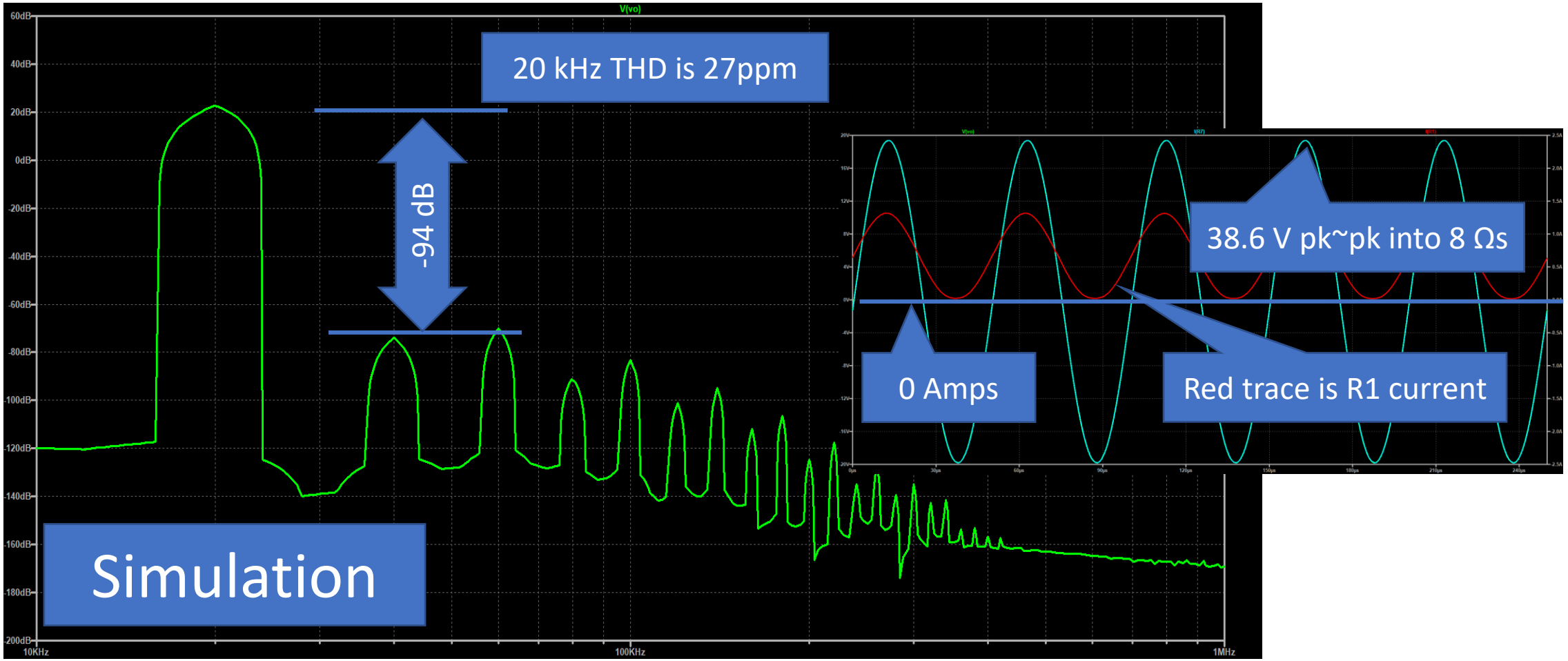
Note: CFA amplifiers do not slew rate limit, so large signal rise time is quoted instead.

kx-Amplifier Loop Gain

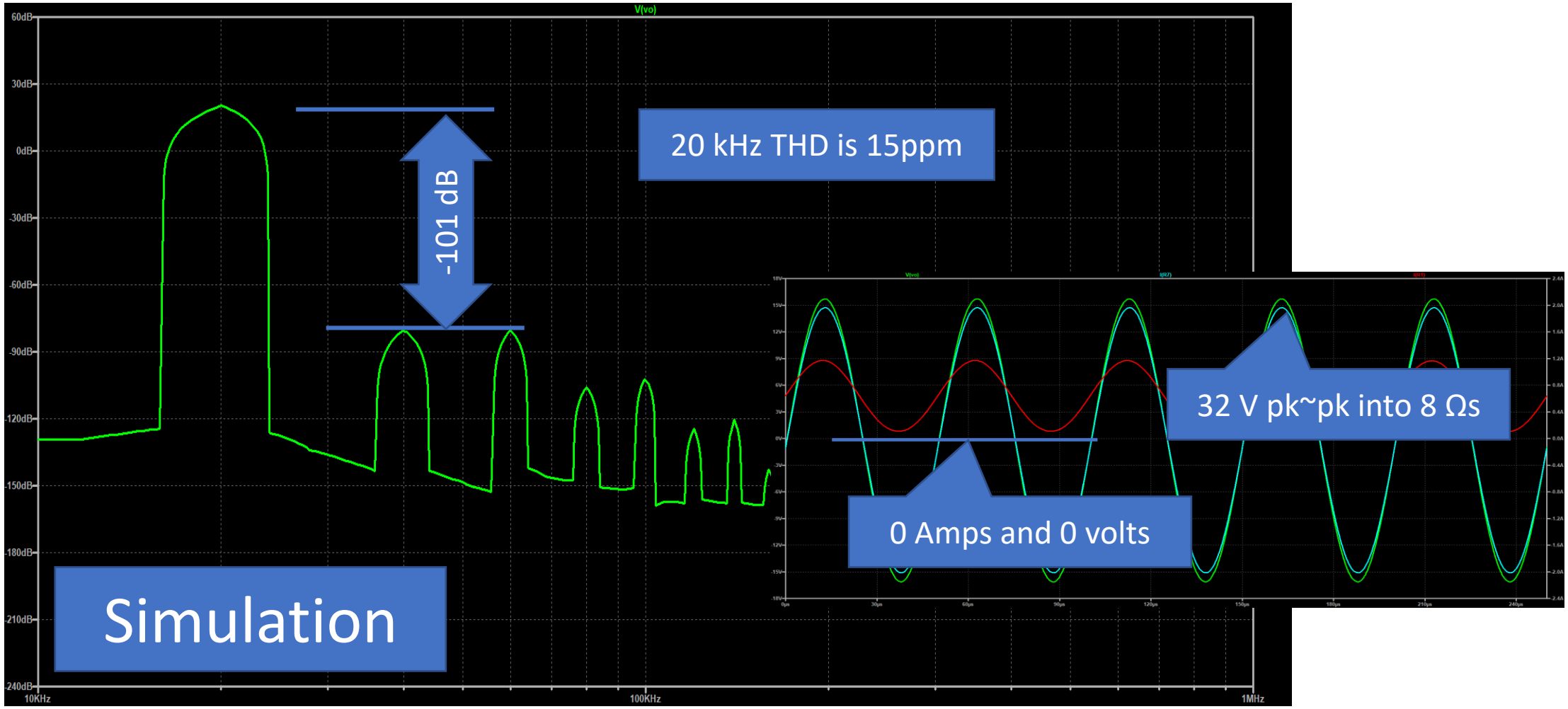


The kx-Amplifier features a wide 12 kHz loop gain bandwidth. In the original sx-Amplifier, the high loop bandwidth arose out of the low overall loop gain (32 dB) which kept the OPS pole frequency higher than the ULGF. This therefore only required 'light' MIC/'Alexander' compensation to ensure stability and >60 degree phase margin. In the kx-Amplifier, the loop gain is much higher at 62 dB and the wide loop bandwidth is achieved through the application of Two Pole Compensation (TPC). The OPS pole in the kx amplifier lies *above* 0 dB and before the unity gain frequency – much like the vast majority of amplifiers – so in this regard it could be considered more conventional than the sx-Amplifier. Both designs exhibit high slew rates of 140 V/us and very fast small signal rise/fall times.

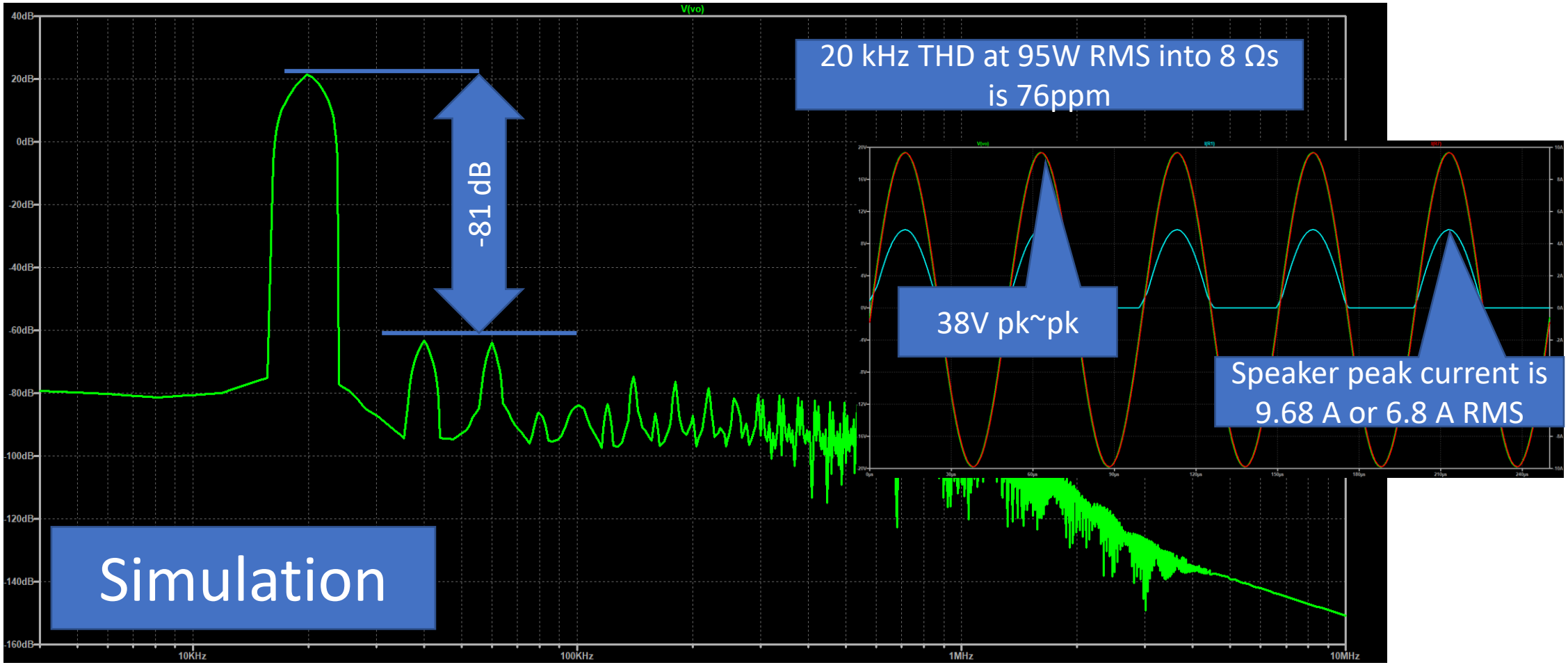
kx-Amplifier 20k THD at 23W RMS Output into 8 Ωs – output transitioning into class AB



kx-Amplifier 20k THD at 16W RMS into 8 Ωs Output – class A

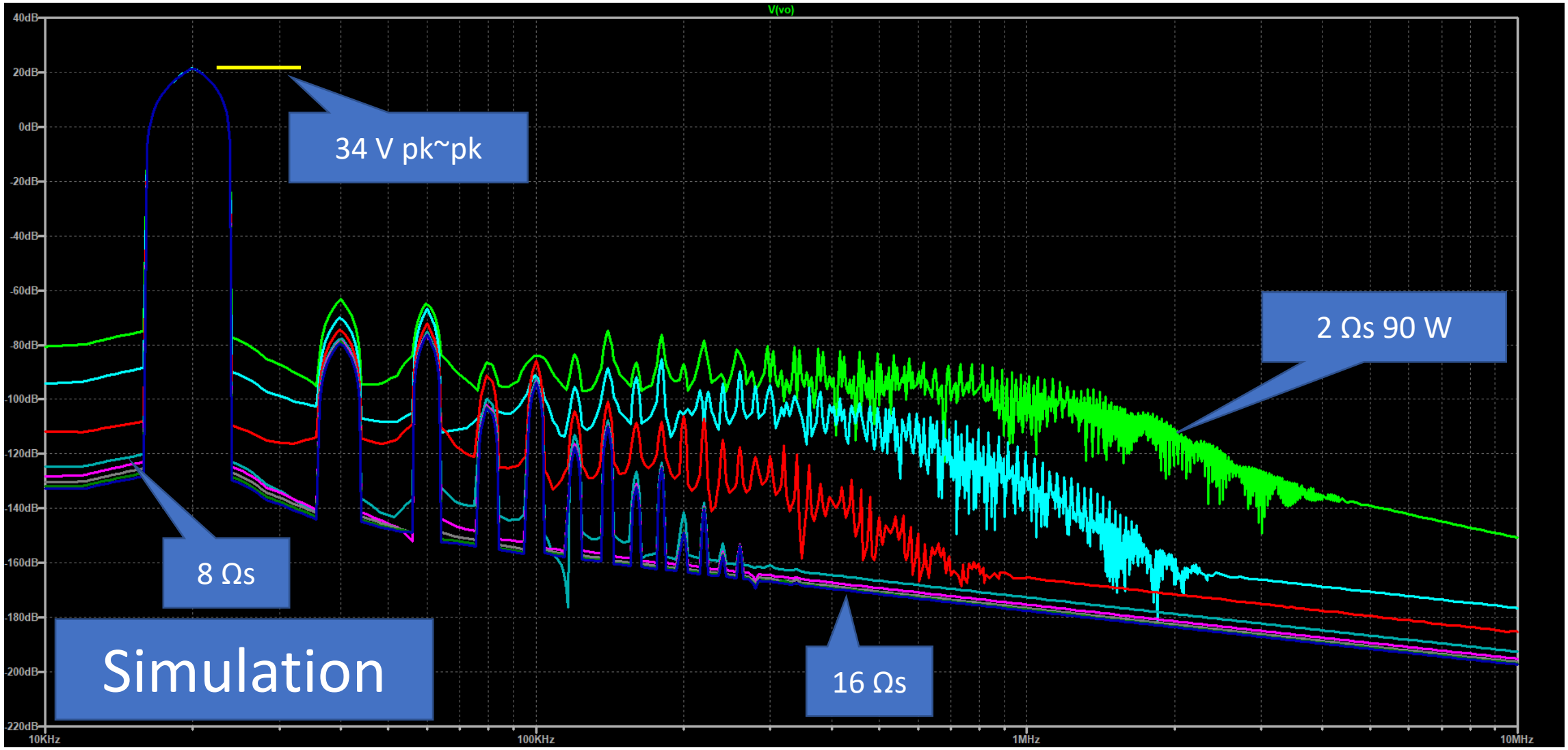


kx-Amplifier 20k THD at 95W RMS Output into 2 Ωs – class AB

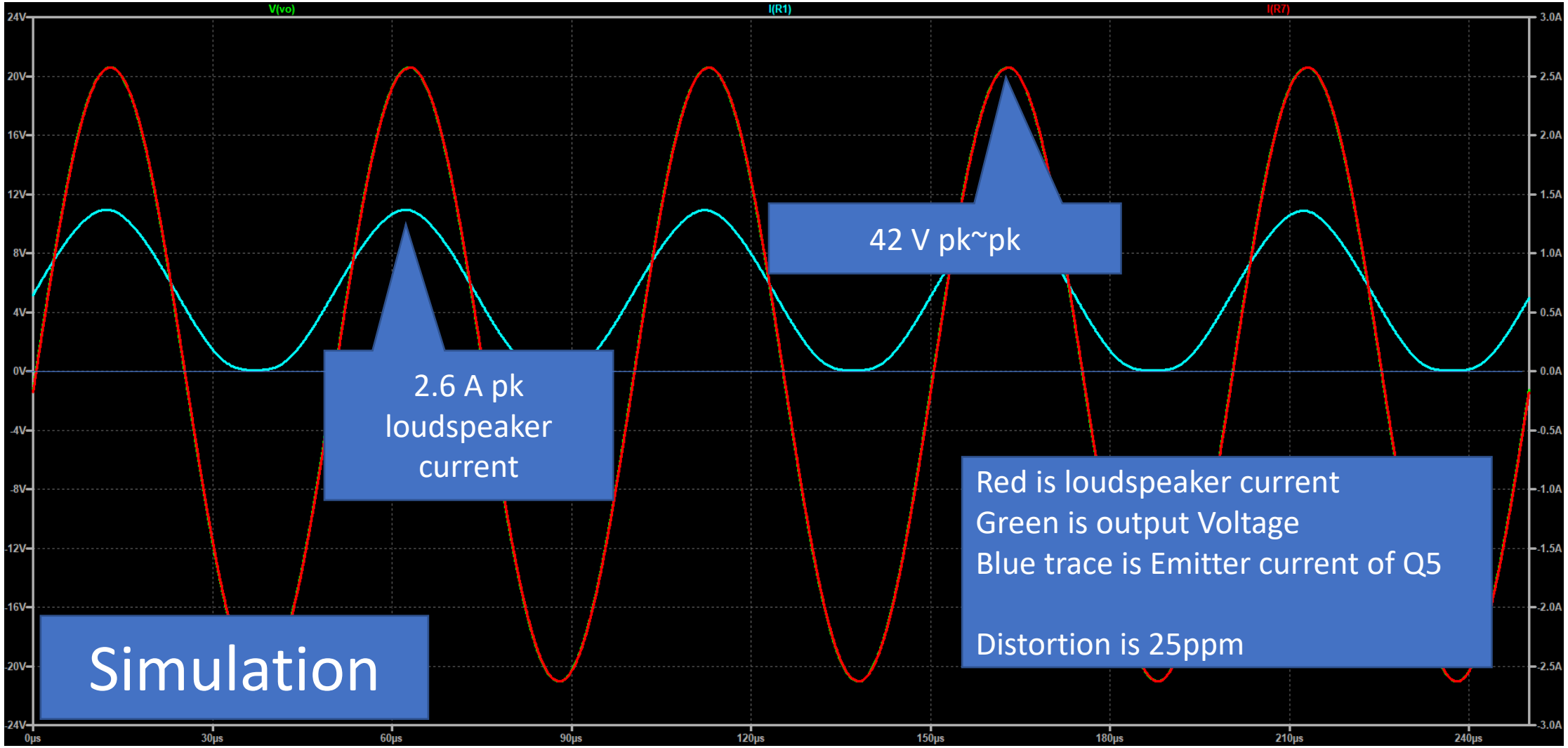


This plot demonstrates the load handling capability of the kx-Amplifier. The 20 kHz distortion at 90W RMS into 2 Ωs is still a respectable 0.0076% or about 15 times better than the JLH, Hiraga or sx-Amplifiers at their rated power into *8 Ωs*. This is a direct result of higher loop gains and TPC which provides and additional ~20 dB of feedback at HF compared to Miller compensation. The underlying open loop linearity of the kx-Amplifier is also very high, contributing to this performance.

kx-Amplifier 20k FFT 34 V pk~pk 2 Ωs to 16 Ωs



kx-Amplifier 20 kHz at the onset of class AB delivering 27 W into 8 Ω



About the kx-Amplifier ‘mode selection’ option and Heatsink requirements

J8 in the circuit is a 2 pin link that **when CLOSED** increases the standing current from ~300 mA per output pair to around 600 mA per pair . This allows the amplifier to be switched from class A to class AAB mode, retaining some of the characteristics of the class A sound but at much reduced power consumption.

Further, in the class AAB mode, you can run the kx-Amplifier at +-35V rails which will provide 50W RMS into 8 Ωs, and close to 100W into 4 Ωs. But do note, with the higher supply rails you will still need substantial heatsinks even in class AAB mode, where the standing dissipation will be around 50 Watts

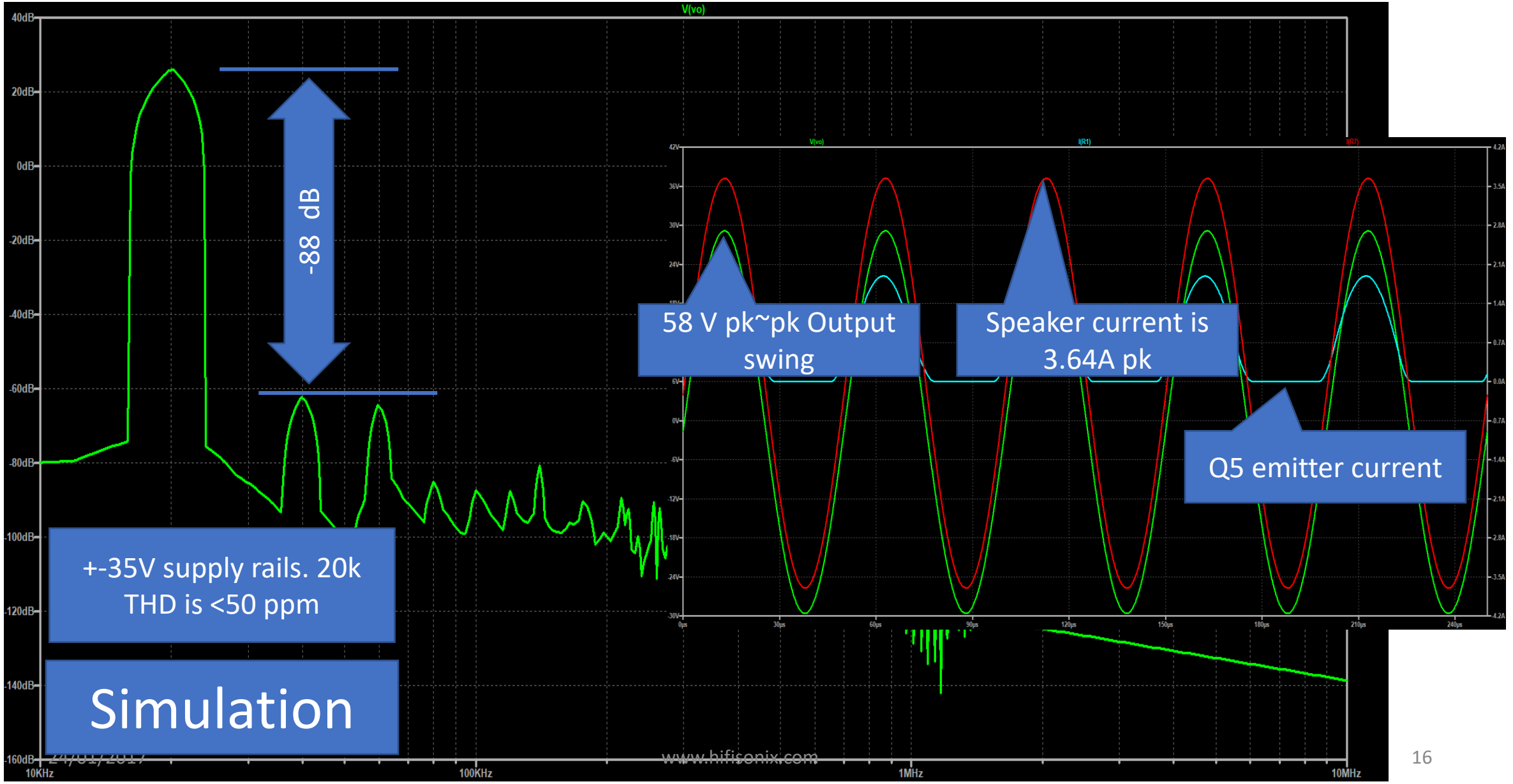
IMPORTANT: running the kx-Amplifier on +-35V rails in class A mode will result in a standing dissipation of 100 Watts per channel. You can therefore only run in class AAB mode on +-35V rails

DO NOT run the kx-Amplifier on +-35V rails in class A mode.

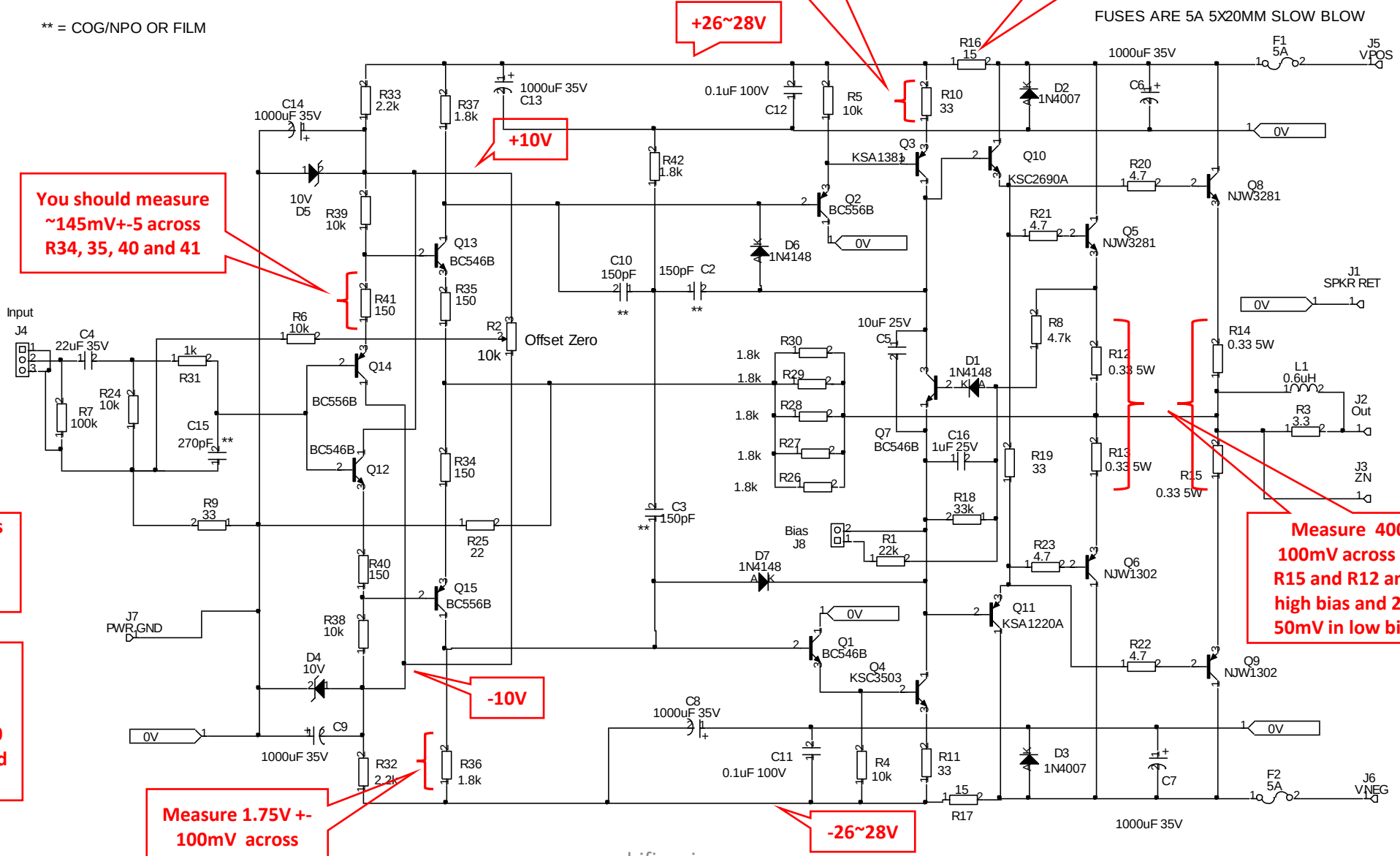
The kx-Amplifier requires a heatsink of at least 0.3˚C/Watt or lower per channel. Each channel heatsink will therefore weigh a minimum of 1.5 kG

So, either run on the +-22-26V and have the option to switch between the two modes, or leave J8 ***permanently OPEN*** and run the amplifier on +-35V rails in class AAB mode.

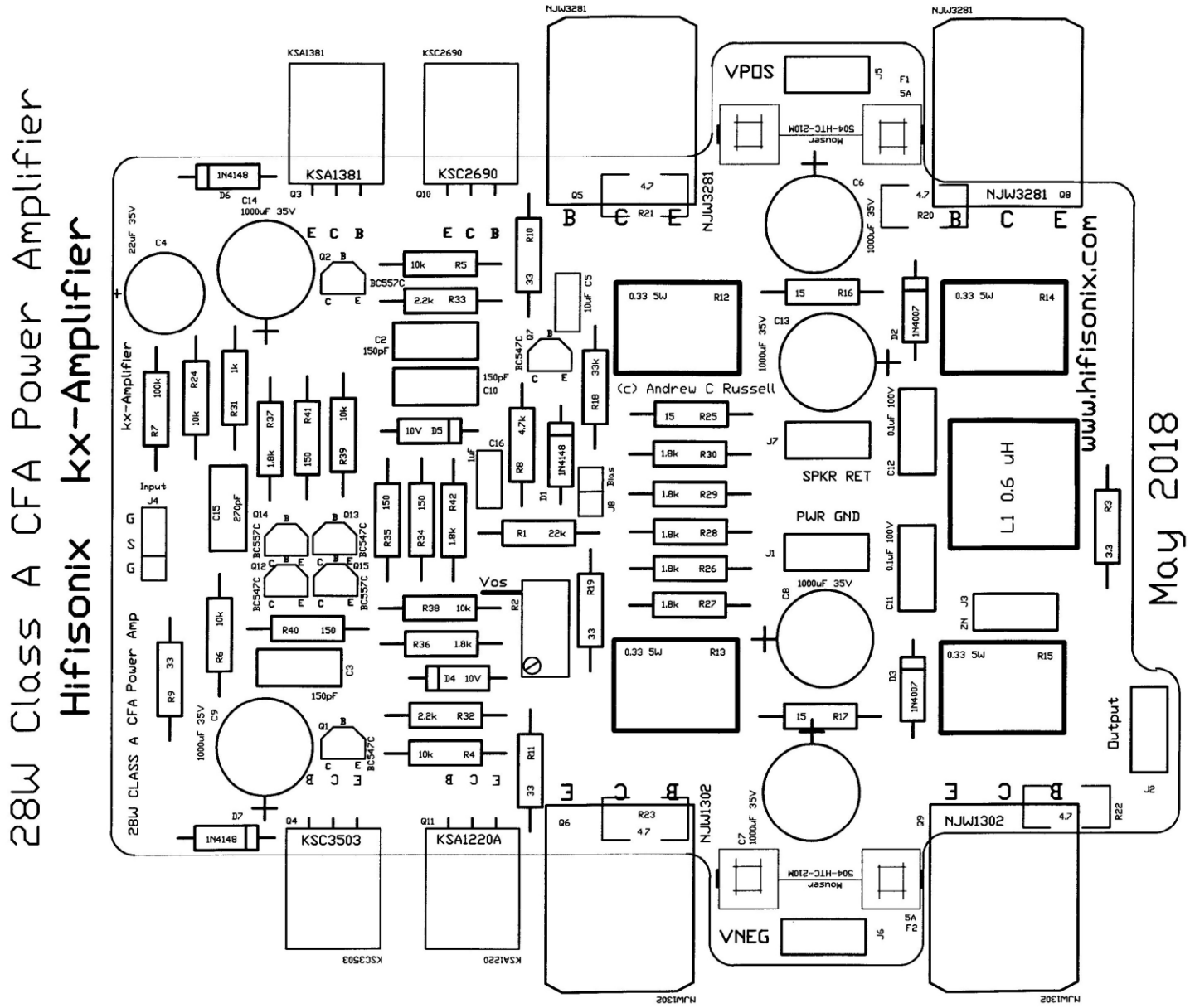
kx-Amplifier in class AAB mode 20k THD at 50W RMS Output into 8 Ωs



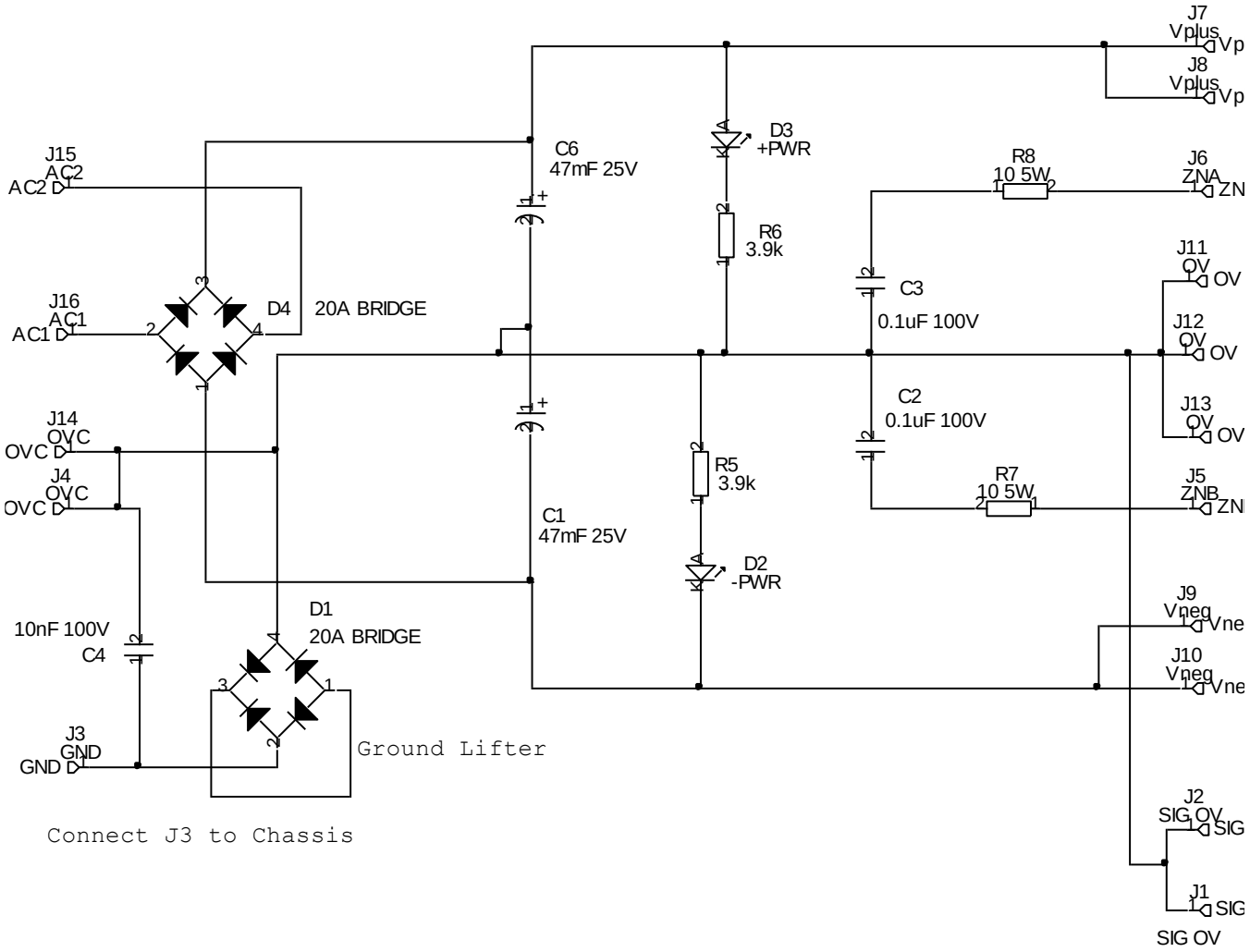
kx-Amplifier Circuit – Final May 2018



kx-Amplifier Overlay – Final May 2018



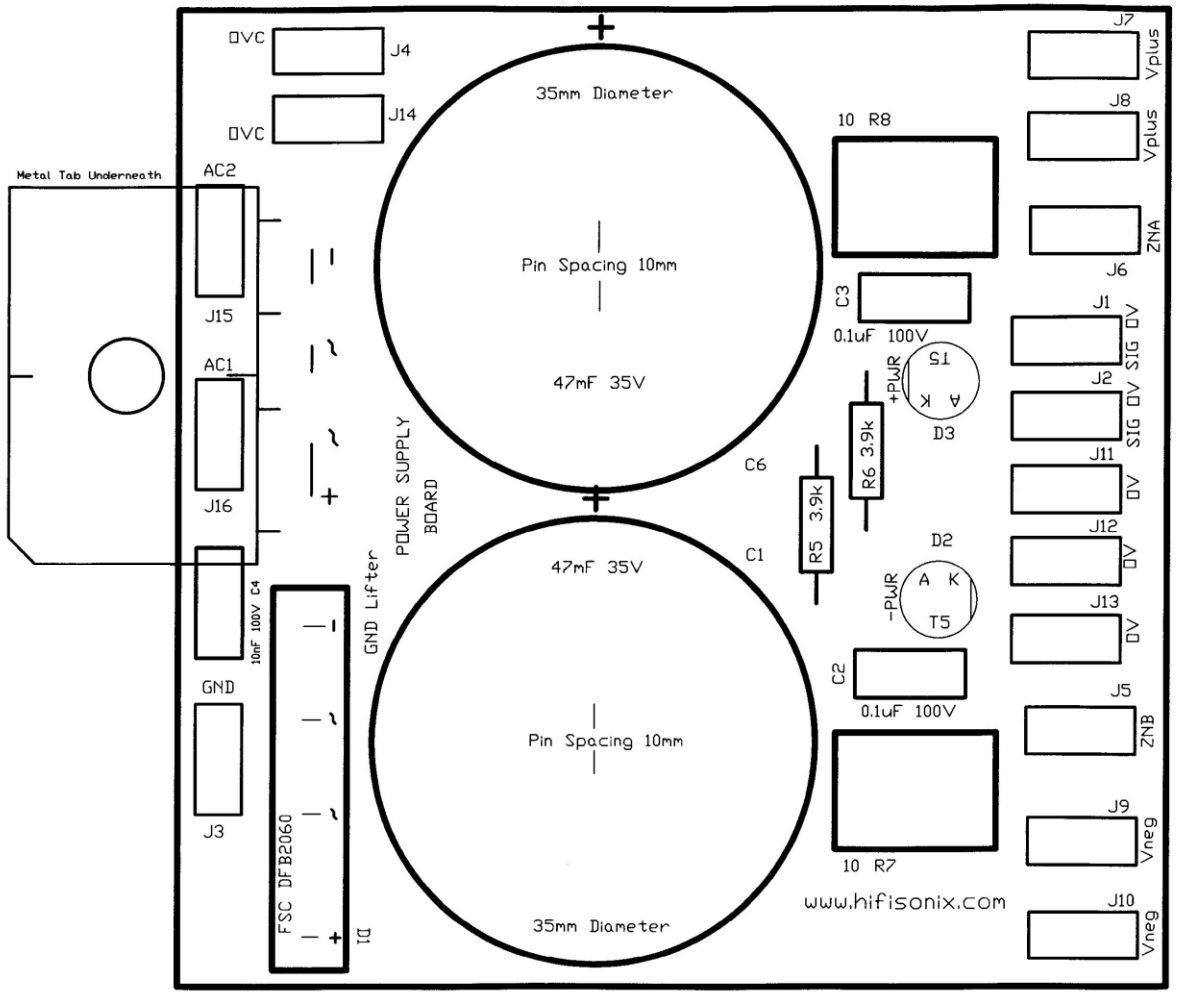
kx-Amplifier Power Supply Circuit – Final May 2018



Compared to the original sx-Amplifier PSU, the Zobel resistors have been upgraded to 10 Watt types and C4 has been added across the ground lifter (D1) to improve RFI immunity.

kx-Amplifier PSU Overlay – May 2018

Mount from underside with rectifier metal tab facing down. Screw rectifier to metal chassis and use thermal grease



kx-Amplifier Transistor Options

Some of the TO-92 transistors used in the original sx-Amplifier became obsolete over the last few years – one example being the excellent BC547C and BC557C which are now only available in their SMD guise as the BC847 and BC857 types. Additionally, there were a lot of problems trying to source matched gain grades for the TIS transistors – in the sx-Amp you really needed to have these matched for the best performance. Hopefully, these sourcing problems will be less apparent with the kx-Amplifier.

Q12, Q13, Q14, Q15: For the small signal TO-92 devices, refer to this document https://docs-emea.rs-online.com/webdocs/14a5/0900766b814a51bf.pdf

Any of these complementary devices with a Vce rating of >40V will work satisfactorily in the kx-Amp in either class A mode or class AAB mode with +-35V rails (see slide 12).*

Other complementary small signal transistors are available, but the pin-outs are not the same as the recommended types:-

Any device with low Cob, hFE >200 and a Vc rating of =>40V will suffice. Some examples are ON KSC1008C and its complement KSA708C (G gain grades only); ON KSD1616 and its complement KSB1116 gain grades G or L (*don't mix the gain grades if using these devices*). You can also consider KSA992 (PNP) and its complement KSC1845 (Japanese versions 2SA992 and 2SC1845). Note that you must use devices from the same hFE grouping with these last transistors as the spread is quite wide.

Q3 and Q4: For the VAS transistor, use KSA1381 and KSC3503 or 2SA1381 and 2SC3503. You do *NOT* need to have the gain grades matched to meet the specified performance. *All the kx-Amplifier prototypes were built with gain grade E and F mixed*. So the measured performance is with mixed gain grades. If you do match the grain grades, you will not notice any improvements in the measured performance. The reason for this is that the TIS helper transistor + the main TIS transistor composite gain is high and it swamps any gain differences.

Q10 and Q11: Driver transistors – use KSA1220A and KSC2690A. These are generally readily available. However, you can also use BD139/BD140. I recommend ON or ST devices only and you should match the gain grades. Important: make sure you use the -16 gain grade suffix if going down this route. *Please note, I did not try the BD139/140 in a build*. If you run into problems, let me know – I will help you sort it out.

Q5, Q6, Q8, Q9: Output transistors – NJW3281/NJW1302. Use the recommended devices since the hFE linearity and SOA are superb and go a long way to underpinning the overall kx-Amplifier performance.

Some Notes on Class A Amplifiers

Over the last 40 years, three class A DIY amplifiers stand out in the popularity stakes:- (1) JLH's 10 Watt Class A design published in 1969 in Wireless World, (2) Jean Hiraga's 20W amplifier published in the French DIY magazine l'Audiophile in the 1980's. Remarkably, JLH's design used only 4 transistors (optionally increased to 5 to improve the current control of the upper output transistor), while Hiraga's used 8, although it delivered double the rated output power. Both Hiraga and JLH's designs are wide bandwidth* – using modern transistors, the JLH amp is flat out to 100's of kHz with attendant high slew rates. (3) Nelson Pass's DIY class A amplifiers, (many different designs over a 25 year period) are another popular choice amongst DIY'ers, feature mosfet output stages and have included both push pull and single ended current source loaded OPS designs with low or no global feedback.

The sx-Amplifier, which I first published in 2012 on diyaudio.com, used 11 transistors and delivered 15W RMS class A power into 8 Ωs, or stated differently, about 28 Watts peak class A power into 8 Ωs on +-22V supply rails. I think with class A amplifiers, its better to talk about peak class A power, since what we are really interested in is 'up until what point does the output stage remain in class A'. Distortion levels on all three amplifiers (JLH, Hiraga and sx-Amp) are about -60 dB down on the 20 kHz test signal fundamental. The sx-amp and Hiraga are DC coupled although this is on the assumption that the source has no DC offset, or its output is capacitively coupled (same for the 100W class AB nx-Amp by the way). The thermal management on the sx-Amp is considerably better than both JLH and Hiraga's designs since in both the sx-Amp and the new kx-Amp, two pairs of output devices are used, allowing the heat dissipation to be more easily spread on the heatsink. This means the output devices are less stressed and the result is a more reliable amplifier. Pass's high power class A designs often use paralleled output mosfets in order to address the thermal management challenges, but matching mosfets is not an undertaking for the faint-hearted, or those with DIY budgetary challenges. Some of Pass's designs, feature 15 to 20A OPS standing current – also not something to take lightly in terms of heatsink requirements and transformer ratings.

JLH's 10 Watter is a bit like a tube amplifier in that it has to be configured for the speaker load impedance – in a tube amp, you usually have to select a speaker impedance tap on the output transformer. In JLH's design, R1, R2 and C1 are changed to suit the speaker load impedance. The sx and kx-amplifiers fair much better in this regard, and simply transition from class A to class AB mode, where they will deliver about 50W RMS class AB into a 4 Ω load. However, on the sx-Amplifier, the distortion increases rapidly at low speaker impedance loads primarily due to the lack of current gain in the OPS – an area addressed in the kx-Amplifier through the addition of a driver stage. Clipping behaviour on both amplifiers is soft with no overhang or rail sticking, and in this regard, considerably better than the JLH and Hiraga amplifiers.

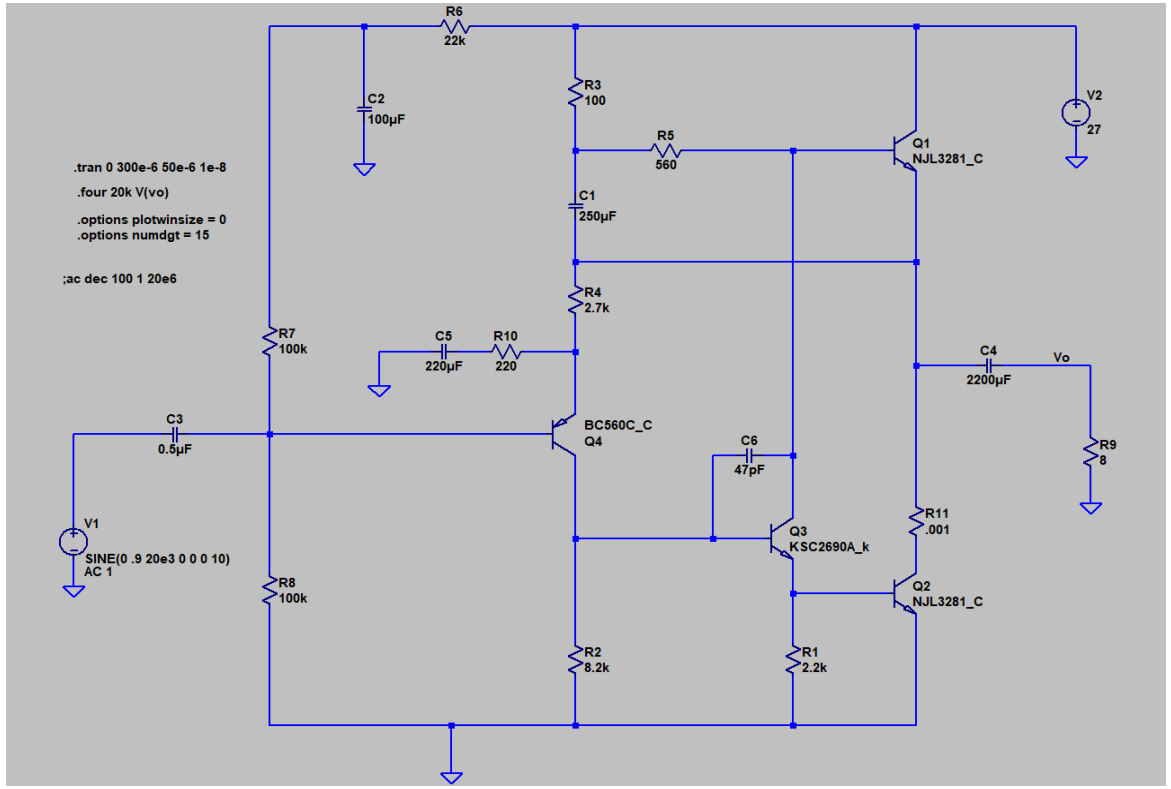
A comparison of the harmonic structure of the distortion components on the sx-Amp, JLH and Hiraga designs is given in the pages that follow (LTspice simulations)

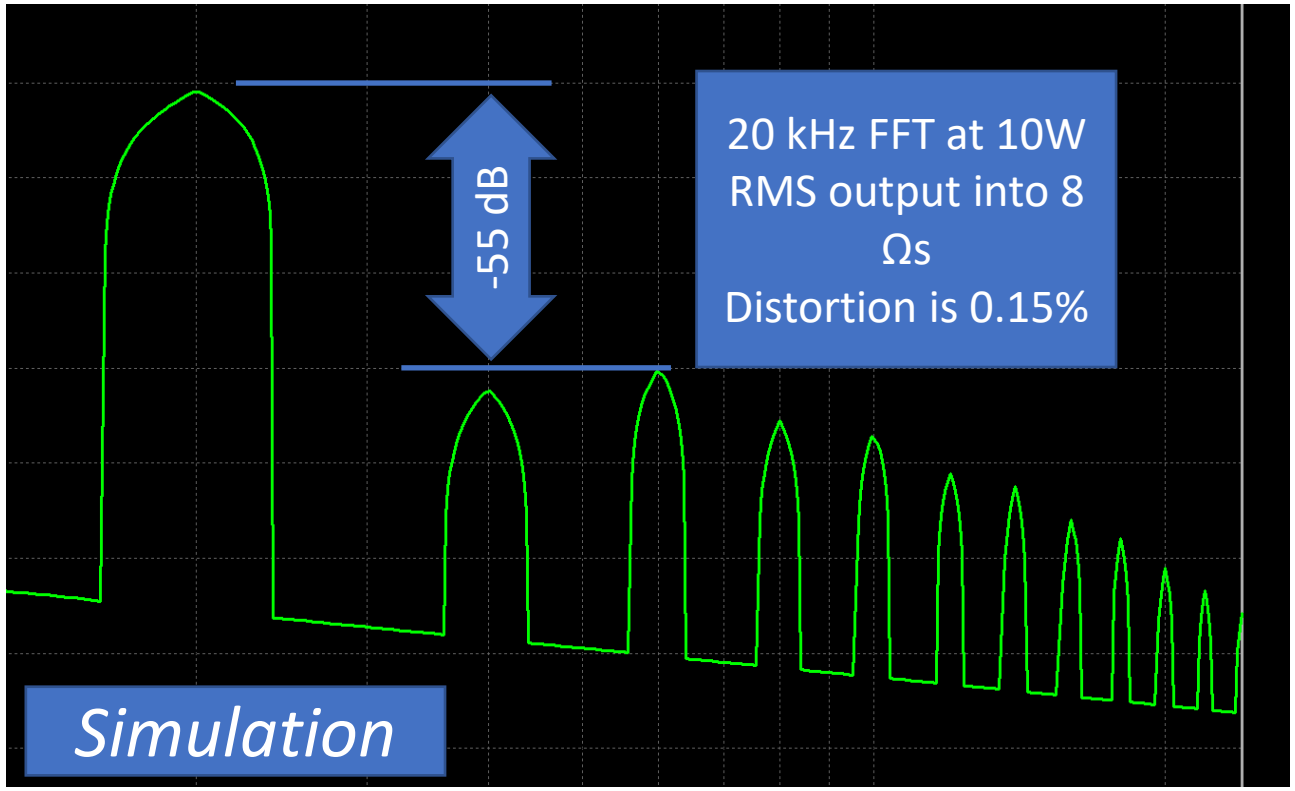
The kx-Amplifier is somewhat different to all of the other amplifiers. It is undoubtedly the most complex of the designs considered here because of the added OPS driver and the beta enhancer transistors used in the VAS (i.e. TIS) which provide a 30 dB increase in loop gain. Further, TPC compensation is used which provides an additional ~20 dB loop gain at HF compared to standard single pole compensation. However, the result of this added complexity is that 20k *simulated* distortion goes from about 1000 ppm (0.1%) at rated power on the older designs (JLH, Hiraga, sx-Amp) to about 15ppm – so a 60 fold improvement. At output power levels below about 8 watts, the 20 kHz distortion is at the single digit ppm level i.e. <0.001% . All THD components are well below 90 dB ref rated output power, and they remain low order. At >95 W RMS class AB into 2 Ωs, the simulated distortion is about 76ppm, so heavy speaker loads are handled with ease. This, coupled to the high slew rates and wide bandwidth results in a superlative sounding amplifier in my view, not matched by any of the older designs.

Most of my assessment has been done with a pair of Kef LS50's and a B&W sub-bass to augment the LS50's low end (down by 3 dB at 79 Hz), which in an small listening environment, make for a wonderfully immersive experience. The kx-amplifier is very smooth and euphonic, but above all, its also a very accurate amplifier. On B&W 703's (nice easy load to drive), the kx-Amplifier has a wonderfully relaxed sound with plenty of beautifully articulated bass.

*note: this assumes that in a practical amplifier using modern devices, no additional compensation is required

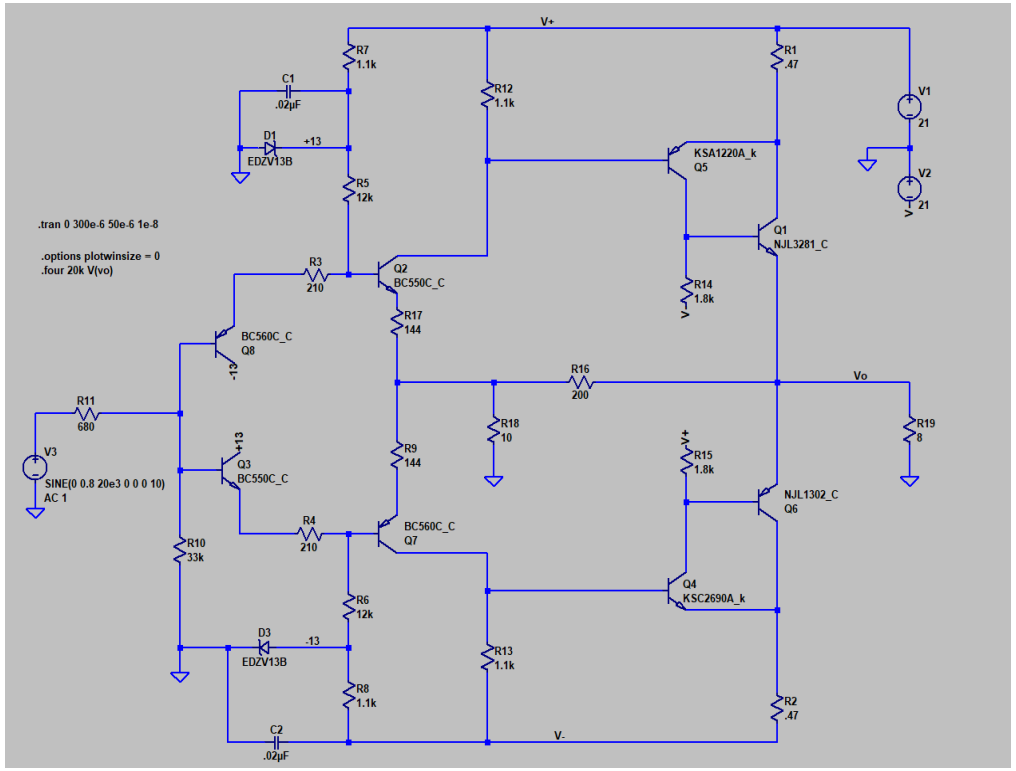
JLH 10 Watt 8 Ωs Performance at 20 kHz

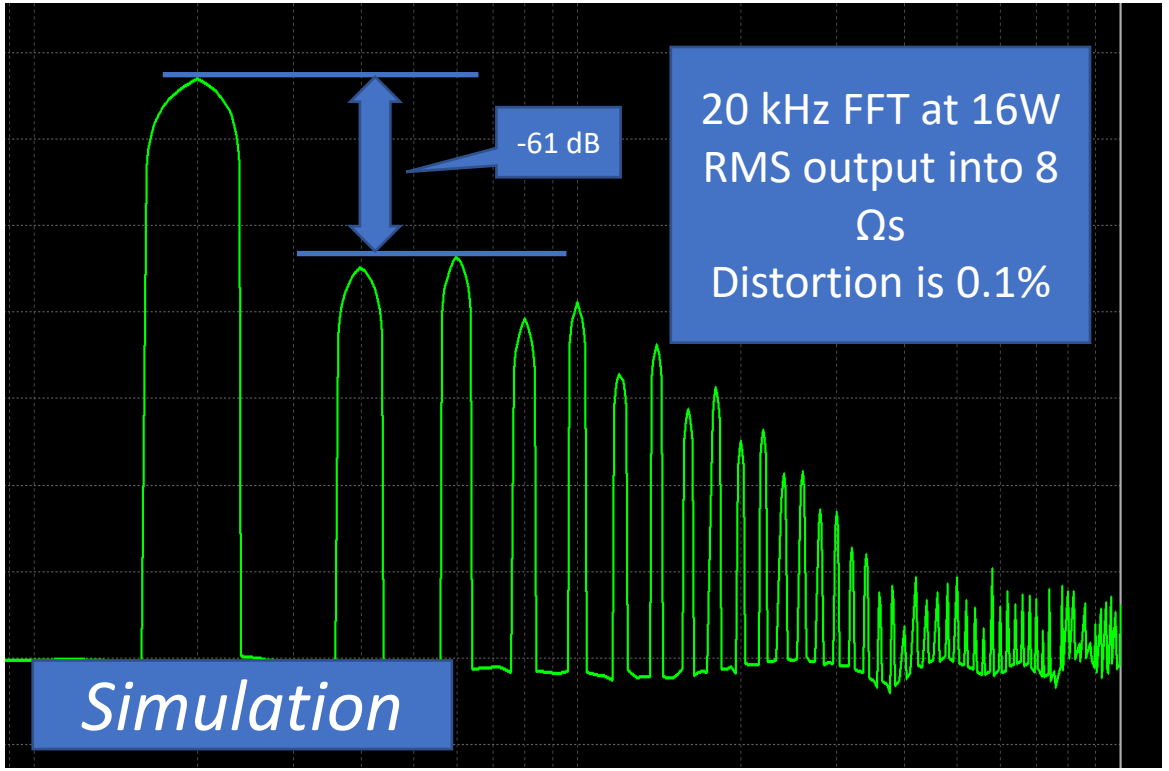




The original JLH 10 Watt amplifier set up for 8 Ωs on a 27V supply rail. Distortion is typically 0.15% at 20 kHz and about 0.06% at 1 kHz with a monotonic decline in distortion harmonics after H3. R11 is not part of the original design, but included to measure the OPS standing current, which is 1.2A for the 8 Ω version shown here. The JLH amplifier clips more cleanly than Hiraga's, but not as cleanly as either the sx or kx-Amplifier. This is one of the simplest 'hi fi' designs you will find anywhere and a testament to JLH's design skills.

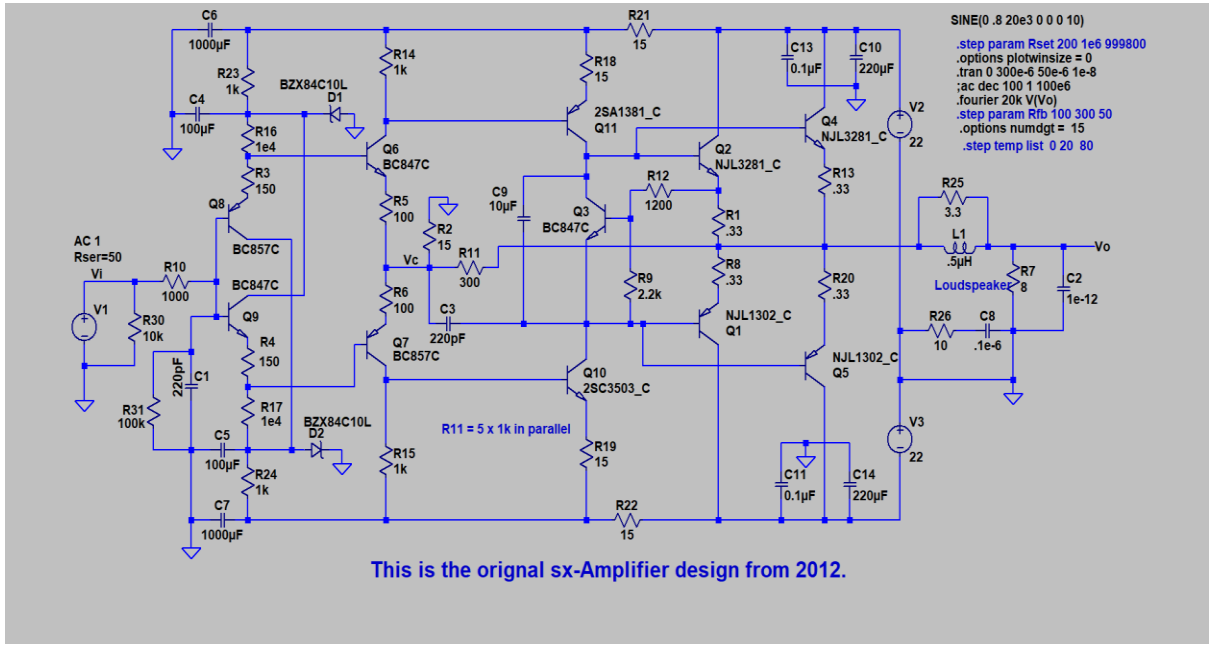
Hiraga 20 Watt 8 Ωs Performance at 20 kHz

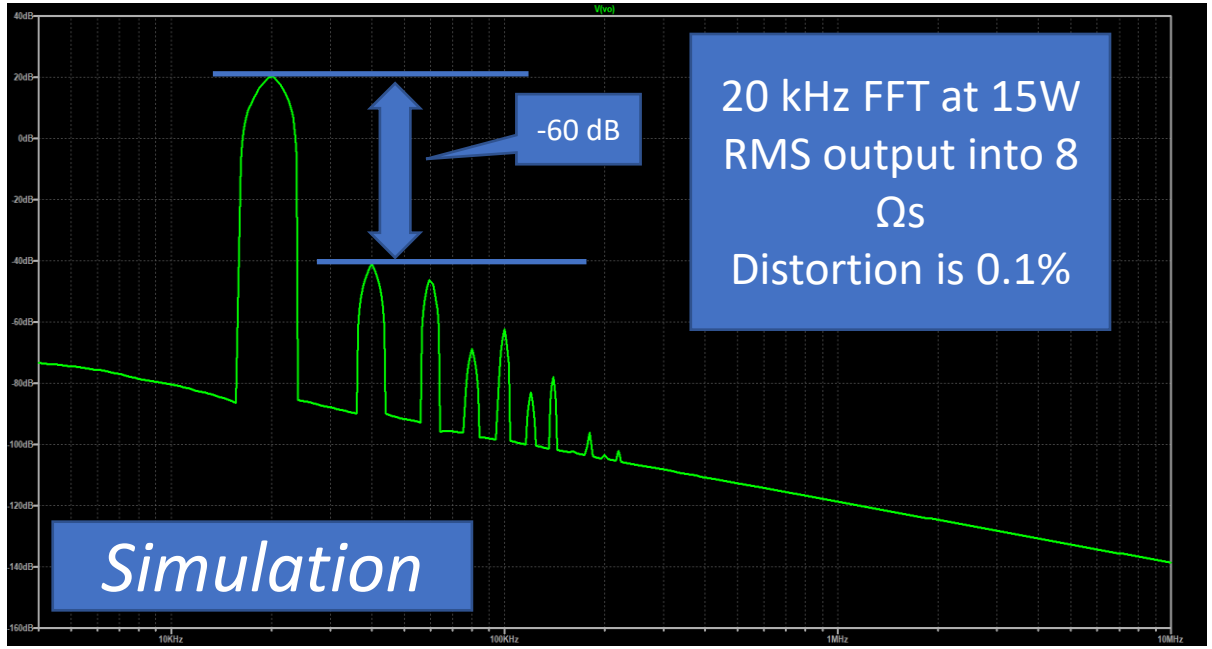




The Hiraga 20 Watt amplifier set up for 8 Ωs. The distortion plot was done with +-23V rails. This amplifier has very high distortion, which seems not to have bothered Hiraga who was happy with the fact that it rose with output power without initially declining and rising steeply at or near full power. This was due to the fact that the baseline distortion is high and well above the noise floor of any reasonable test instrument – at 0.75W output its 20k THD is already 100ppm. The Hiraga amp does not clip as cleanly as the sx-Amplifier. Very high harmonics give this amplifier a sweet, rich sound not too dissimilar to a tube amplifier.

sx-Amplifier 15 Watt 8 Ωs Performance at 20 kHz

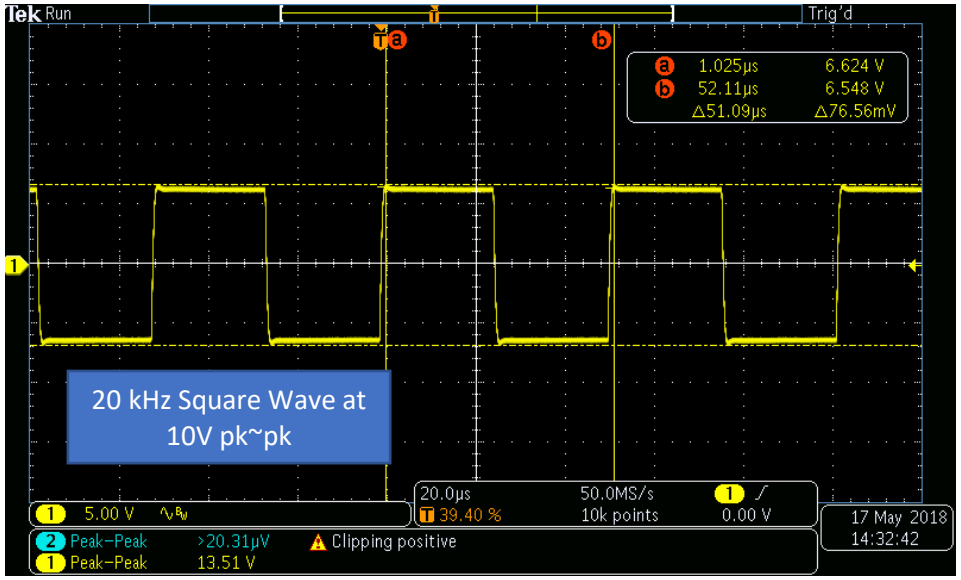


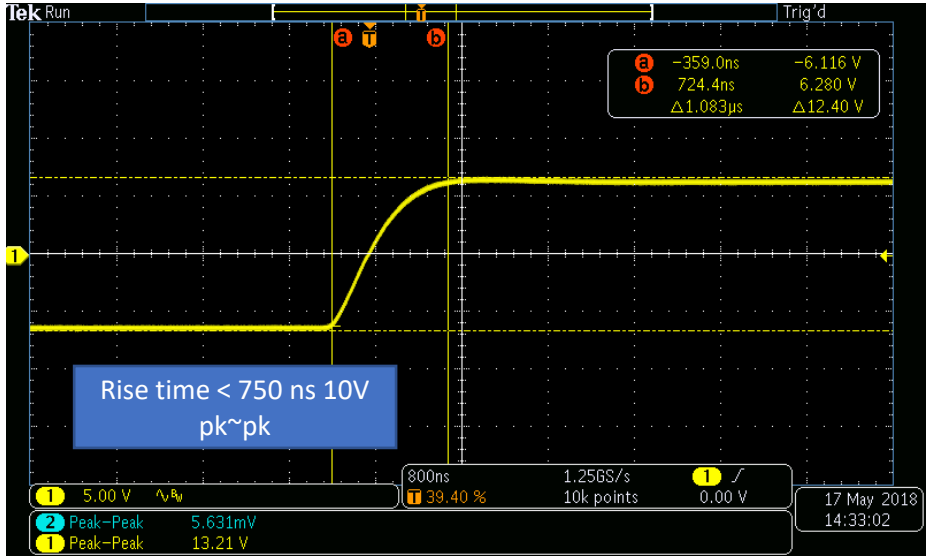


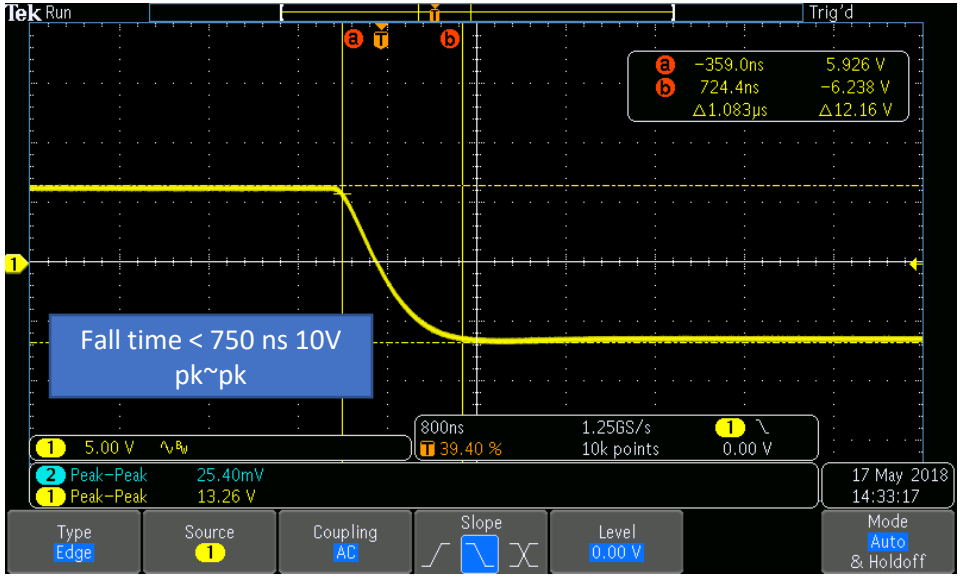
The 15 W sx-Amplifier produces 0.1% distortion at 20 kHz and harmonic components are primarily 2nd and 3rds. This design clips softly and exits clipping cleanly without rail sticking or any current and voltage anomalies. It is considerably faster (slew rate and bandwidth) than the previous designs in their original forms owing to the use of fast modern power devices and LTspice to optimize the loop compensation design – both not available to JLH or Hiraga given the vintage of those designs.

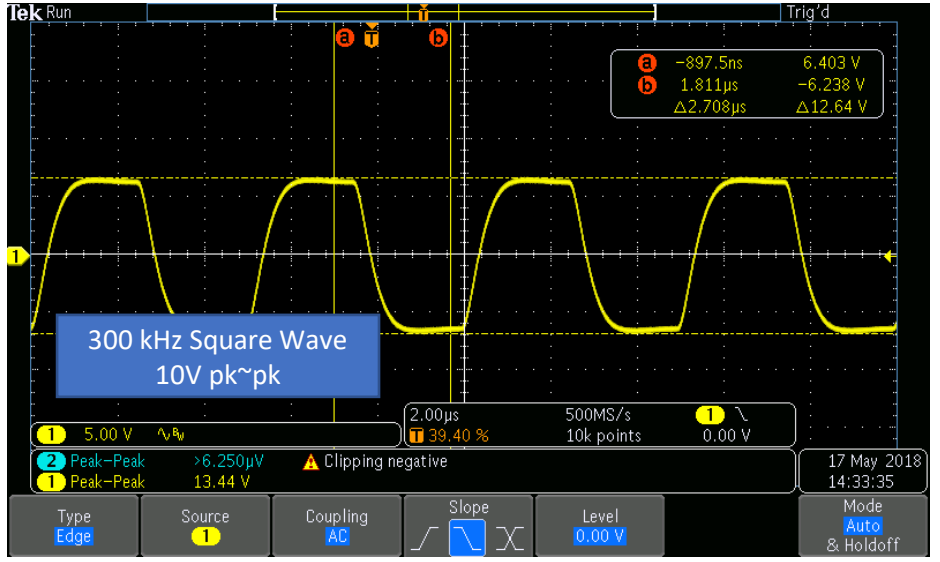
kx-Amplifier Measurements

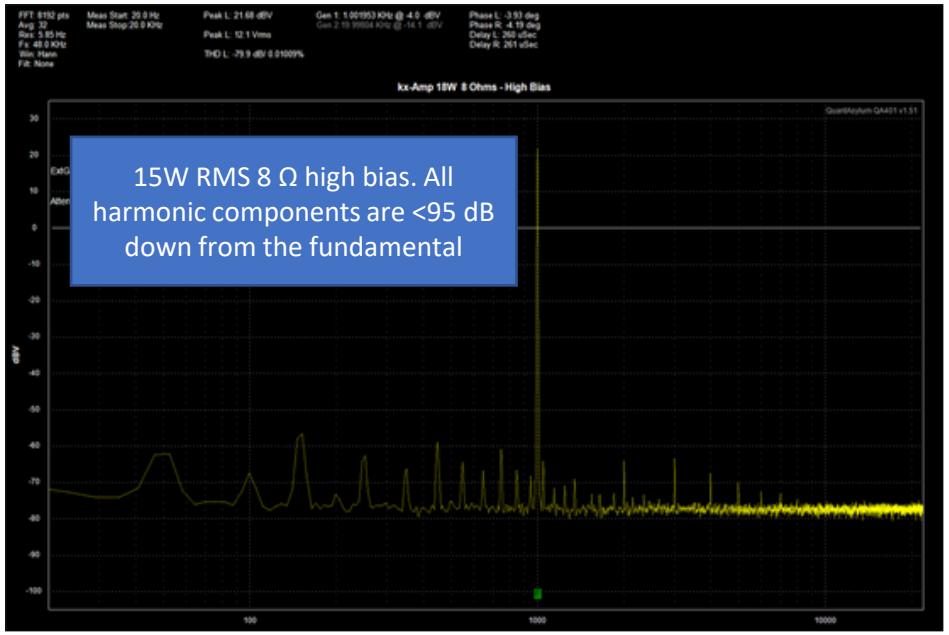
These were taken with the original sx-Amplifier Power supply that measured +-24VDC during the tests

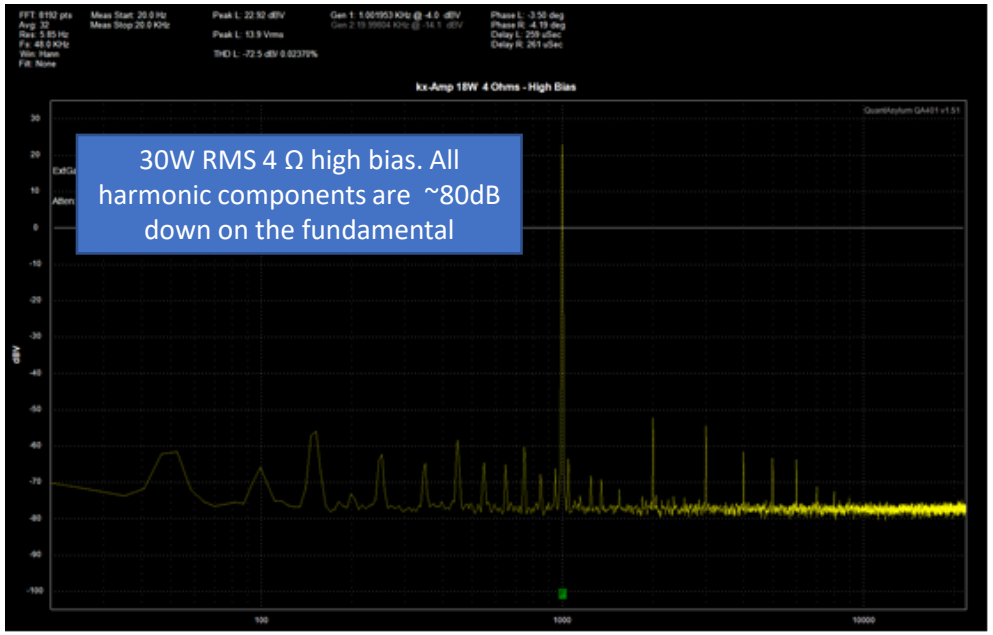

Tek Run
Trig'd
a 1.025µs 6.624 V
b 52.11µs 6.548 V
Δ51.09µs Δ76.56mV
20 kHz Square Wave at 10V pk~pk
20.0µs 50.0MS/s
39.40 % 10k points
5.00 V 0.00 V
Peak-Peak >20.31µV
Peak-Peak 13.51 V
Clipping positive
17 May 2018
14:32:42

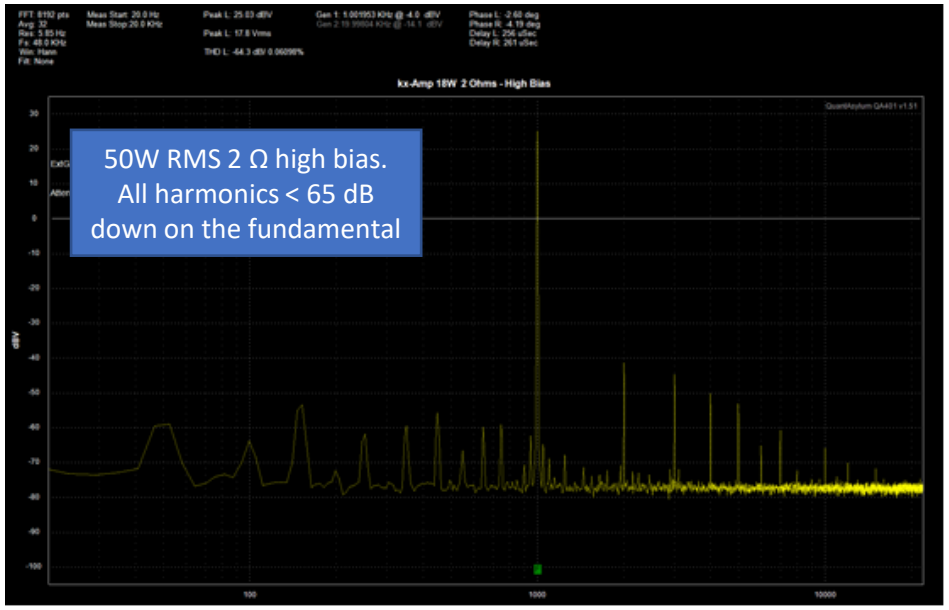

Tek Run
Trig'd
a -359.0ns -6.116 V
b 724.4ns 6.280 V
Δ1.083µs Δ12.40 V
Rise time < 750 ns 10V pk~pk
800ns 1.25GS/s
39.40 % 10k points
5.00 V 0.00 V
Peak-Peak 5.631mV
Peak-Peak 13.21 V
17 May 2018
14:33:02

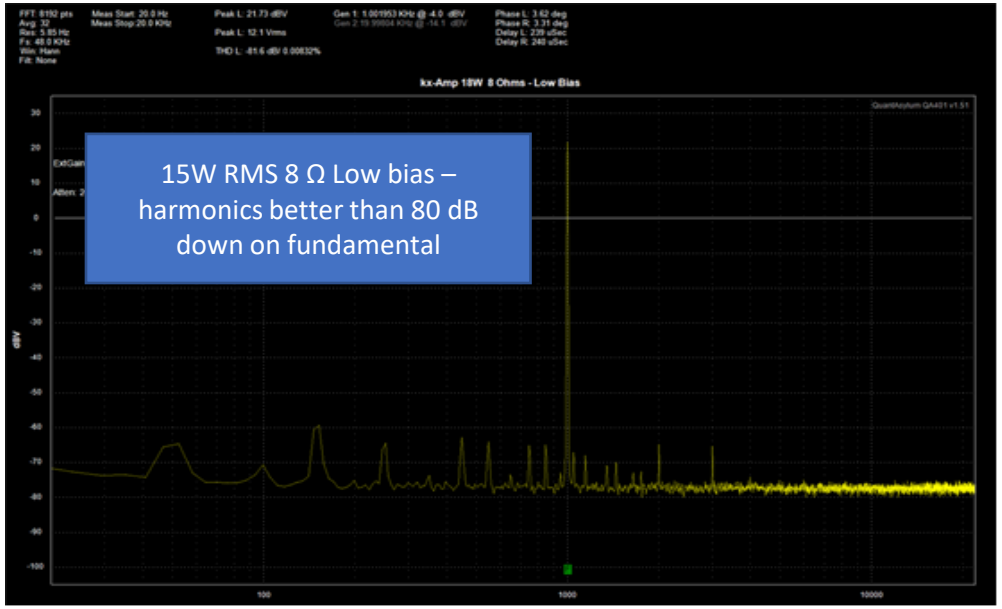

Tek Run
Trig'd
a -359.0ns 5.926 V
b 724.4ns -6.238 V
Δ1.083µs Δ12.16 V
Fall time < 750 ns 10V pk~pk
800ns 1.25GS/s
39.40 % 10k points
5.00 V 0.00 V
Peak-Peak 25.40mV
Peak-Peak 13.26 V
17 May 2018
14:33:17
Type Edge
Source 1
Coupling AC
Slope
Level 0.00 V
Mode Auto & Holdoff

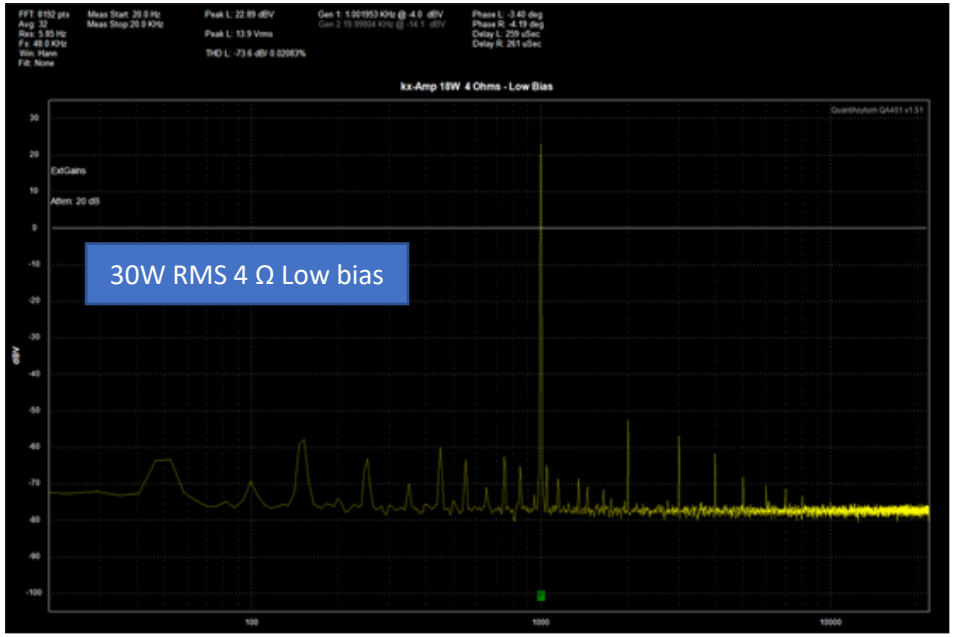

Tek Run
Trig'd
a -897.5ns 6.403 V
b 1.811µs -6.238 V
Δ2.708µs Δ12.64 V
300 kHz Square Wave 10V pk~pk
2.00µs 500MS/s
39.40 % 10k points
5.00 V 0.00 V
Peak-Peak >6.250µV
Peak-Peak 13.44 V
Clipping negative
17 May 2018
14:33:35
Type Edge
Source 1
Coupling AC
Slope
Level 0.00 V
Mode Auto & Holdoff

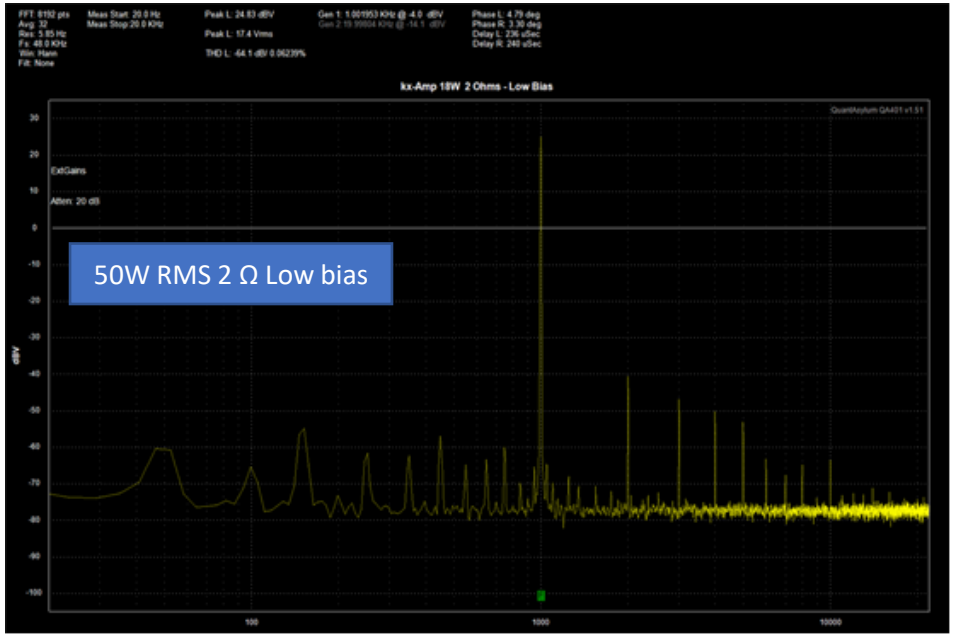

kx-Amp 18W 8 Ohms - High Bias
15W RMS 8 Ω high bias. All harmonic components are <95 dB down from the fundamental

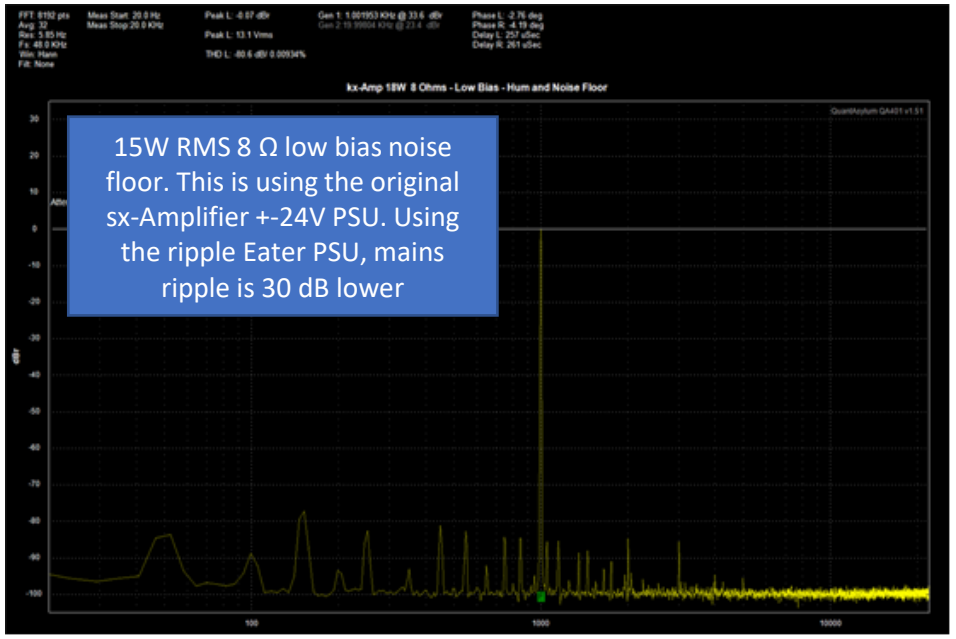

kx-Amp 18W 4 Ohms - High Bias
30W RMS 4 Ω high bias. All harmonic components are ~80dB down on the fundamental

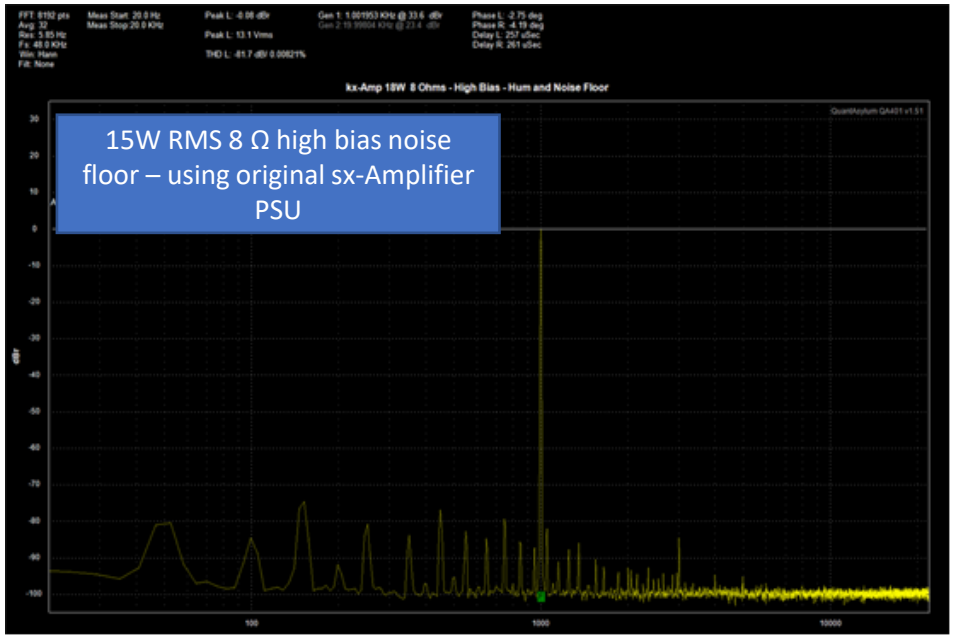

kx-Amp 18W 2 Ohms - High Bias
50W RMS 2 Ω high bias. All harmonics < 65 dB down on the fundamental


kx-Amp 18W 8 Ohms - Low Bias
15W RMS 8 Ω Low bias – harmonics better than 80 dB down on fundamental


kx-Amp 18W 4 Ohms - Low Bias
30W RMS 4 Ω Low bias


kx-Amp 18W 2 Ohms - Low Bias
50W RMS 2 Ω Low bias


kx-Amp 18W 8 Ohms - Low Bias - Hum and Noise Floor
15W RMS 8 Ω low bias noise floor. This is using the original sx-Amplifier +-24V PSU. Using the ripple Eater PSU, mains ripple is 30 dB lower


kx-Amp 18W 8 Ohms - High Bias - Hum and Noise Floor
15W RMS 8 Ω high bias noise floor – using original sx-Amplifier PSU

Construction and BOM Details

Please download the BOM here kx-Amplifier BOM

Construction Details – 1 of 2

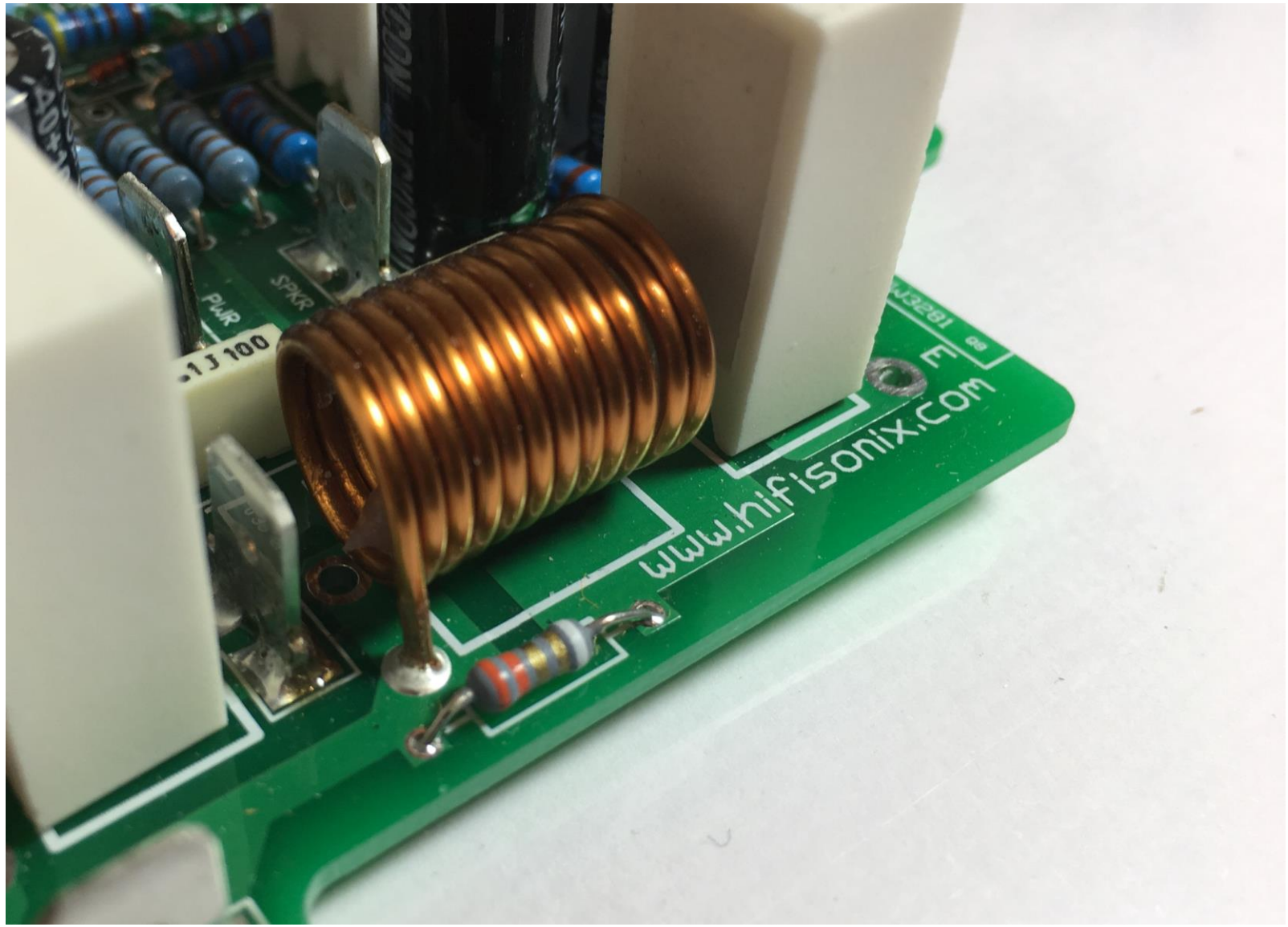
1. Stick to the recommended wiring shown on slide 33. Do not be tempted to try any other wiring schemes. For some insight into good wiring practices, see this write up
2. A 300 to 500 VA transformer is recommended for this project. The AC *loaded voltage* for class A operation should be 19 to 21 volts. After rectification and wiring voltage drops, this should provide 28 VDC max under load.
   - It is highly recommended that you specify a transformer with a flux band. This will trap any radiated leakage flux from the transformer, and therefore reduce hum and noise from the speaker output. ***Remember, the load current on a class A amplifier is high (about 2.5A for 2 channels on this design) so the radiated magnetic fields are large.***
   - If you are having your transformer custom would, get an inter-winding screen included as well. This will help reduce mains borne borne noise coupling through into the secondary circuit.
3. In the hook-up drawing, I have not shown the cables twisted together in order to make wiring clearer. However, note carefully the points below:-
   - Keep input wiring well away from the power cables.
   - Make sure the power supply cables (-, + and 0V) from the PSU to the amplifier modules are ***tightly coupled (twisted) together***. Cable tie the twisted wires every 1.5 inches.
   - Make sure the speaker output cable and the return to and from the amplifier module to the speaker connectors ***are tightly twisted together.*** Cable tie the wires every 1.5 inches.
   - Make sure the secondary wires from the transformer to the PSU PCB are tightly twisted together.
4. When operated in class A mode, the kx-amplifer requires a heatsink of 0.3 deg C/watt per amplifier module. This is a LARGE heatsink and will weigh at least 1.5 kg per channel. Do not skimp on the heatsink – if you do it will lead to reliability issues, overheating and the early demise of your amplifier.

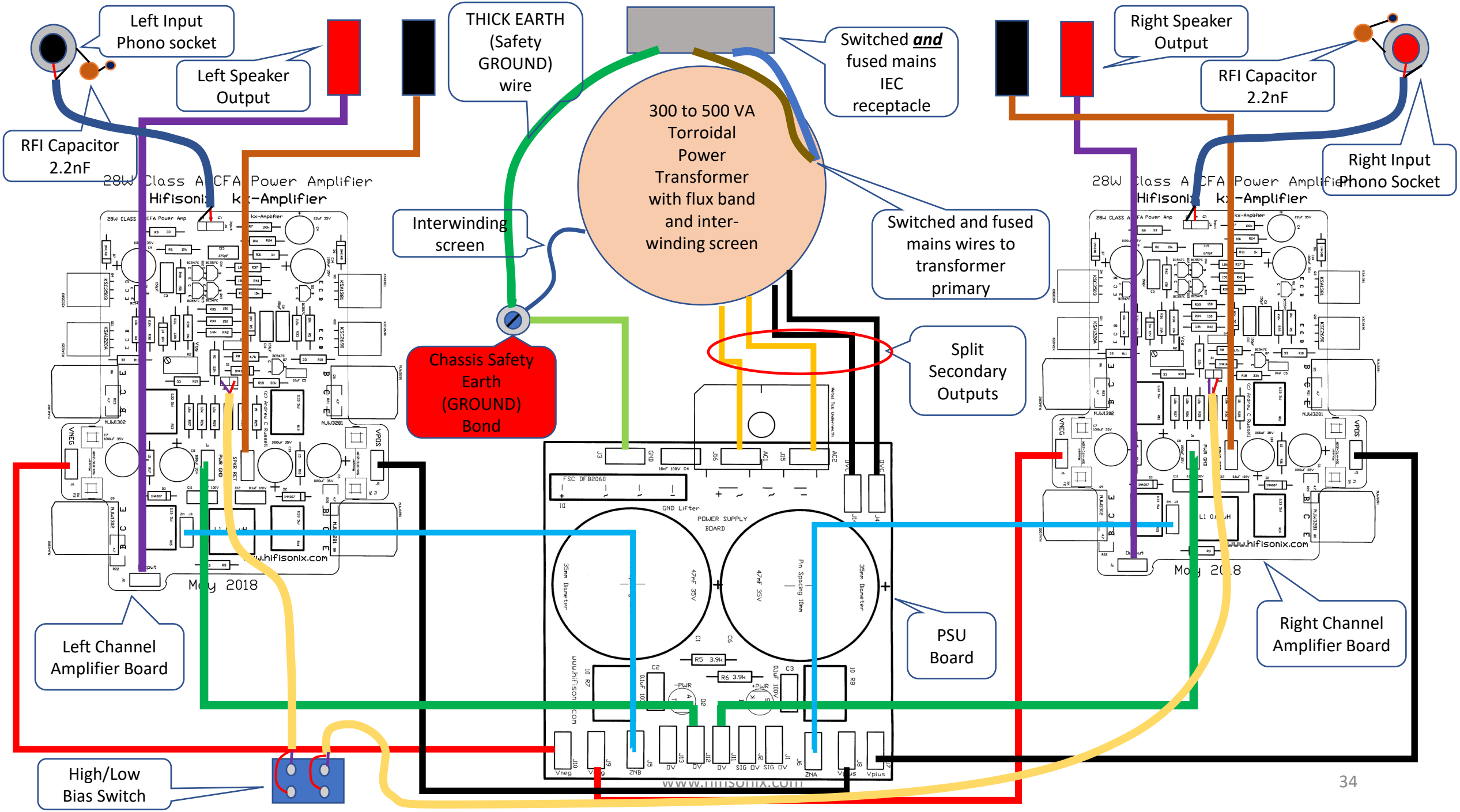
Construction Details – 2 of 2

7. The input phono sockets must be insulated from the metal chassis. Wire a 2.2nF 100V or higher voltage ceramic capacitor from the screen terminal on each phono socket directly to the chassis. Keep the capacitor leads SHORT. This will prevent RFI ingress via the input cables.
8. Use 10mm stand-offs underneath the PSU PCB to attach it to the chassis.
9. Mount the main rectifier bridge (D4) on the bottom side of the PCB as shown in the layout drawing. Bend the leads upright at 90 degrees and then solder them directly to the PSU PCB. You should make sure the rectifier screws down firmly onto the chassis and you have used some thermal grease between the bridge and the chassis. The rectifier will run VERY HOT and will FAIL after a short while if you do not heatsink it. Do not mount the rectifier remotely and run long wires to it – there are very large current pulses into the rectifier diodes which will radiate a substantial EM field, causing hum.
10. DO NOT omit to earth (in USA called 'SAFETY GROUND') the amplifier chassis. Use a good quality 3 pin IEC mains receptacle and run a thick wire from the receptacle earth pin to the amplifier metal chassis. Run a thick wire from J3 GND on the PSU board to the chassis bonding point. Screw both wires to the chassis using closed lugs and a serrated washer and associated screw and nut. Use an ohmmeter and check that every part of the metal chassis is connected to the IEC earth pin.

L1 Winding Details

- Use a cylindrical former of 10mm diameter
- Use 1.2~1.25 mm diameter insulated copper wire
- Wind 12 turns on the former
- The finished coil should measure between 0.6uH and 0.8uH.




Left Input Phono socket
Left Speaker Output
RFI Capacitor 2.2nF
THICK EARTH (Safety GROUND) wire
Switched and fused mains IEC receptacle
300 to 500 VA Torroidal Power Transformer with flux band and inter-winding screen
Interwinding screen
Switched and fused mains wires to transformer primary
Chassis Safety Earth (GROUND) Bond
Split Secondary Outputs
Right Speaker Output
RFI Capacitor 2.2nF
Right Input Phono Socket
28W Class A CFA Power Amplifier
Hifisonix kx-Amplifier
May 2018
Left Channel Amplifier Board
PSU Board
Right Channel Amplifier Board
High/Low Bias Switch
www.hifisonix.com

Listening Evaluation

A subjective View on the kx-Amplifier Sonic Performance

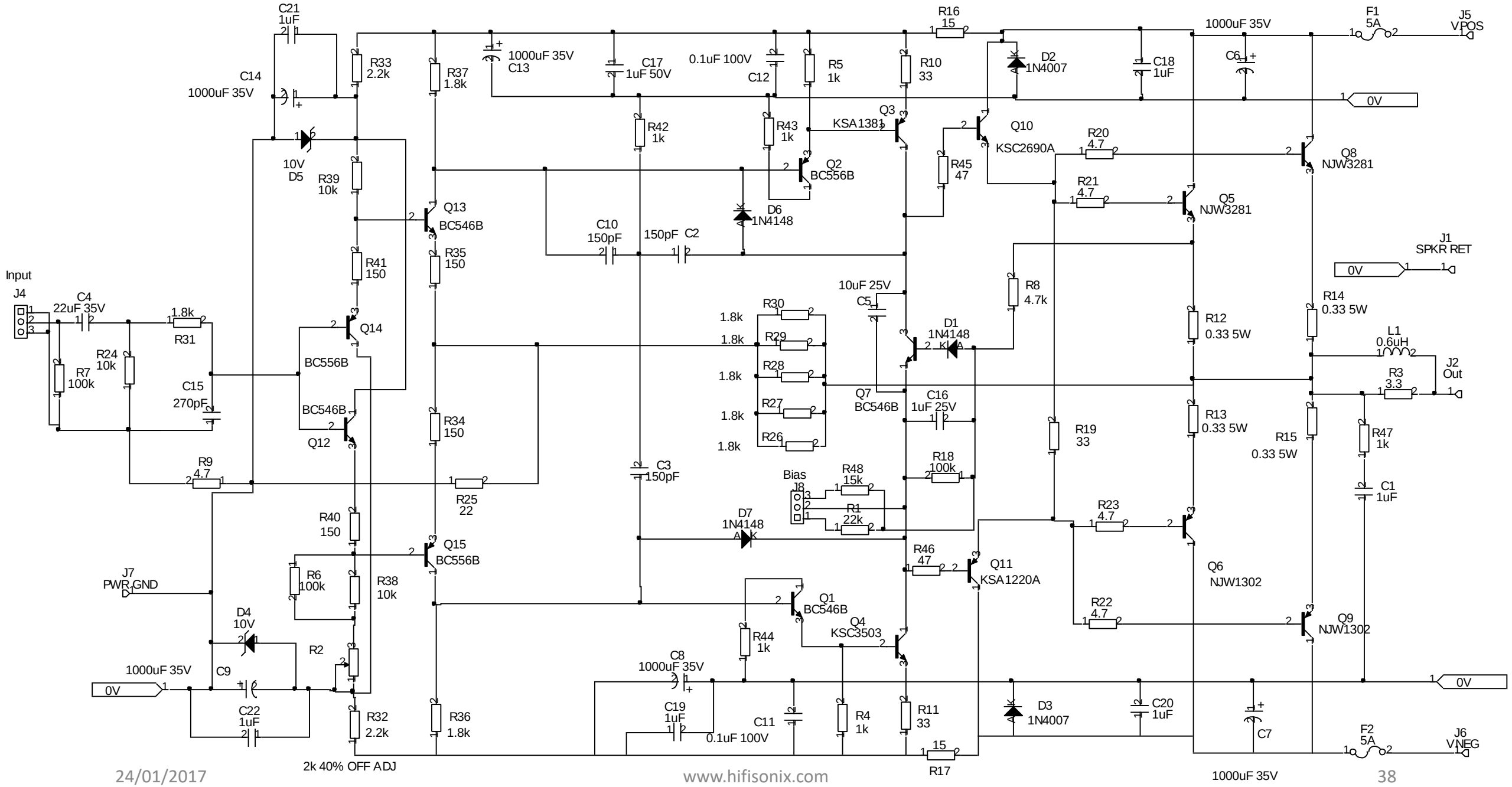
The original sx-Amplifier came about because I offered to repair an ancient Musical Fidelity A1 class A amplifier for a friend while I was resident in Taiwan. The repair job was simple, and afterwards I decided to give the A-1 a spin on my B&W 703's, not expecting much. Despite the low output power, I was struck by the smoothness and sheer musicality of the A1 and decided to investigate further. None of the designs on the internet featured ultra low distortion, but everyone raved about the sound (Hiraga, JLH, Pass et al). Some months later in 2012, the sx-Amplifier emerged and I was not disappointed with the result. I was struck by the sound and the imaging and ended up using it for close on 6 years, finally retiring it to use part of the housing and power supply for the kx –Amplifier (I replaced to top plate and had a 'kx-Amplifier badge machined at Front Panel Express). So, indeed, I discovered that there was something in the 'class A magic' claim.

I listened to a variety of classical and jazz music (vinyl and CD) on my B&W 703's and my Kef LS50's – Ella Fitzgerald, Leonard Bernstein's George Gershwin recordings, Steve Gadd, Fourplay and the Berlin Philharmonic's Swan Lake and Sleeping Beauty in amongst others. The kx-Amplifier retains the warmth and 'liquidity' of the sx-Amplifier, but my impressions are that the top end is cleaner (cymbals, strings) and better bass performance – its almost as if it was slightly more boosted than the sx-Amp and the notes better articulated. The mid range to my ears is cleaner – and I think this has to do with the dramatically lower (measured) distortion. On 4 ohms and higher at full power, the kx-Amp produces no more than about 0.01% distortion, which is about 60x lower than the sx-Amplifier and it will happily drive a 2 Ohm load– obviously in class AB mode - with commendably low distortion.

Imaging remains outstanding, and particularly enjoyable on the KEF's which really excel in this department. The left to right and sound stage depth are the best out of all the amplifiers I use. This characteristic seems to be a particular feature of class A amps – I have no explanation as to why – it's a matter that needs some investigation in my view. I used a B&W sub-bass with the KEF's on some material but as I remarked elsewhere, this was simply to augment the lower end of these speakers which drop off rapidly below about 70 Hz. On the 703's the bass is superb and extends very low with fabulous articulation.

Used with the appropriate speakers (either 90 dB+ efficiency, or if lower, in a small listening space), the kx-Amplifier delivers an outstanding listening experience. The classic class A smoothness, lack of any glare and the effortless mid-range are available in bucketloads. The bass performance in my view is a significant improvement as well and I put that down to the more capable EF2 output stage.


hifisonix


C21 1uF
R33 2.2k
R37 1.8k
C14 1000uF 35V
10V D5
R39 10k
R41 150
R35 150
R34 150
R25 22
R40 150
R32 2.2k
R36 1.8k
2k 40% OFF ADJ
Input
J4
C4 22uF 35V
R31 1.8k
R24 10k
R7 100k
C15 270pF
BC556B
BC546B
Q14
Q12
R9 4.7
Q13 BC546B
Q15 BC556B
J7 PWR GND
R6 100k
R38 10k
D4 10V
R2
C9 1000uF 35V
0V
C22 1uF
1000uF 35V C13
C17 1uF 50V
0.1uF 100V C12
R42 1k
R43 1k
D6 1N4148
C10 150pF
150pF C2
R5 1k
R16 15
R10 33
D2 1N4007
C18 1uF
1000uF 35V C6
F1 5A
J5 VPOS
0V
Q3 KSA1381
Q2 BC556B
R45 47
Q10 KSC2690A
R20 4.7
Q8 NJW3281
R21 4.7
Q5 NJW3281
J1 SPKR RET
0V
R8 4.7k
10uF 25V C5
R30 1.8k
R29 1.8k
R28 1.8k
R27 1.8k
R26 1.8k
D1 1N4148
R14 0.33 5W
L1 0.6uH
J2 Out
R3 3.3
R12 0.33 5W
Q7 BC546B
C16 1uF 25V
R19 33
R13 0.33 5W
R15 0.33 5W
R47 1k
C1 1uF
C3 150pF
Bias
R48 15k
R1 22k
D7 1N4148
R18 100k
R23 4.7
R46 47
Q11 KSA1220A
Q6 NJW1302
R22 4.7
Q9 NJW1302
Q1 BC546B
Q4 KSC3503
R44 1k
C8 1000uF 35V
C19 1uF
C11 0.1uF 100V
R4 1k
R11 33
R17 15
D3 1N4007
C20 1uF
C7 1000uF 35V
F2 5A
J6 VNEG
0V