1. Summary

Valve PA Amplifier.
Philips label – Model Code LBH1015/01 – Serial No 1080

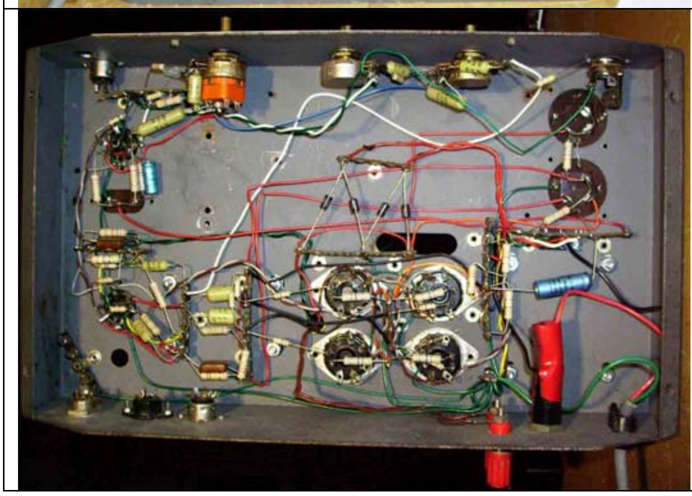
Two input, mono 60W amplifier with tone control and 50V/70V/100V line level outputs. Built circa 1970. 12AX7 preamp; 12AX7 driver/PI; quad 6CM5 push-pull output. OPT output feedback winding to driver/PI. Both triodes in preamp with common bypassed cathode resistor. Concertina splitter. Class B grid bias output stage.

Closely equivalent to 30W Philips model EV4435. Differences are no valve base selector (removed ?); Tuner socket is 5-pin DIN; splitter circuit slightly tweaked; quad (not dual) 6CM5 used; tweaked OPT feedback values; upsized transformers. The OPT has a tag strip for the isolated feedback winding, and four other line level output terminals, and another isolated winding for local monitor speaker. Parts info/markings:

Power Transformer	No markings. 220;240;260 label under tagstrip.
Output Transformer	2638.
POTs	500k CTS/IRHC 45; 500k 45; 1MEG tap 100K CTS 45
Caps	Ducon ECT148, (24uF 450V x3) x2. Ducon 26uF 450V

Purchased condition: no 12AX7 valves; 3 added front panel holes and connectors; no base plate; no screws for holding top cover; input sockets un-wired; no tuner HT parts C1, R4; no microphone transformer (removed ?); Vol 1 pot a bit scratchy.

Reference websites:
http://members.chello.nl/m.janssen36/Amplifiers-with-valves.htm
http://www.peel.dk/Philips_amplifiers/index.html
http://home.alphalink.com.au/~cambie/EL36.htm
http://ozvalveamps.elands.com/awa.htm


2. Modifications

Done:

- Added extra insulation tube to mains wiring going to Tx.
- Added 6.5mm insulated socket in LHS front panel hole for guitar input – switched short to gnd with no plug inserted.
- Added standby switch and indicator light in RHS front panel (intensity varied by bypass sw).
- Added bias protection relay (Finder 40.52 48VDC) with series 1k resistor to increase sensitivity; connected HT secondary windings. Switched by standby switch.
- Moved Input 1 volume pot to between 10nF (increased to 22nF) output of tone circuit and 47k grid input of driver/PI stage.
- Moved Input 2 volume pot to across 6CM5 grid drives.
- Added standard 68K and 1M grid input to guitar socket input.
- Added humdinger with optimised hum reduction.
- Bypassed main VS1 electrolytic with 100uF 350V.
- 1.2k resistor across output.
- Unwired input triode. Reconfigured 2nd triode as main input amp; 1.5k cathode; 135k supply; vol control 1 not in circuit. 14 Aug 09 mod.
- Made new baseplate.
- Increased screen stopper from 47R to 47R + 330R.
- Disconnected input triode – just using second triode only of input 12AX7. Reduced supply resistance from 270k to 135k. Increase cathode resistance from 1k to 1k5.
- Moved Bass Cut pull switch to second triode output and using 10nF switched with 56nF.

To do:

- Megger test on power transformer.
- Banana sockets changed to locking 6.5mm sockets (8R and 16R).

3. Measurements

Voltage rail regulation – no modifications.

Rail	No valves	No valves; 1k2 on V1	Valves in; idle
VS1	364V	335V (280mA; 93W)	349V
VS2	182V	171V	175V
VS3			328V
VS4			288V
VS5			297V
Heater 1	7.0Vrms		6.5Vrms
Sec HT	260Vrms		

Output power into 16.6Ω resistive load, sinewave input, modified circuit 14 Aug 09:
50Wrms before gross clipping. 95Wrms gross clipping.

Modified version:
Tone boy’s comment was positive - “Like an old Marshall amp”. Enough power to stress 2x Vintage 30’s – so preferably needs quad of Vintage 30’s or similar.

12VAC 50Hz nominal applied to output transformer

Winding	Voltage rms	Turns ratio; Impedance for 1K8 pri; Spec level; Notes
Pri P-P: BLU to BRN	190	325V full output swing for 50/70/100V line outputs
Sec: WH to WH (flying)	0.31	613; Ω; 0.5V nominal level
Sec: 100V line (2-5)	58.2	3.26; 170 Ω;
Sec: 70V line (4-5)	41.5	4.585; 86 Ω;
Sec: Top (4-5)	16.6	11.45; 13.7 Ω;
Sec: Mid (3-4)	12.30	15.45; 7.5 Ω;
Sec: 50V line (2-3)	28.8	6.6; 41 Ω;
Sec: Feedback 10V, BLK to GRN (1-2)	6.00	31.67; 1.8 Ω;

If the full output was “100V” then the P-P input level would be 325V. The next output appears to be “70V”, and the smallest tapping is nominal “50V”.

The available pk voltage swing of the output primary appears to be about 300V for a 340VDC supply. This would imply about 210Vrms P-P, and hence a “100V” output of 65Vrms, with “70V” output of 45Vrms, and the “50V” tapping of 32Vrms.

Output transformer primary DC resistance: 62Ω plate-to-plate.

Power transformer primary DC resistance: 7.5Ω, 0-240V.
Power transformer secondary DC resistance: 6 + 6Ω.

Dating:
The resistors and front panel label appear to indicate to me late 1960’s build timing, although I don’t have a good date for when that resistor type was first manufactured. The type/serial number label has hand written type number which appears to be LBH1015/01, but this could be inaccurate as the marking is poor. I see a listing for a Philips transistor amplifier with LBH 0251/10 dated 1975.

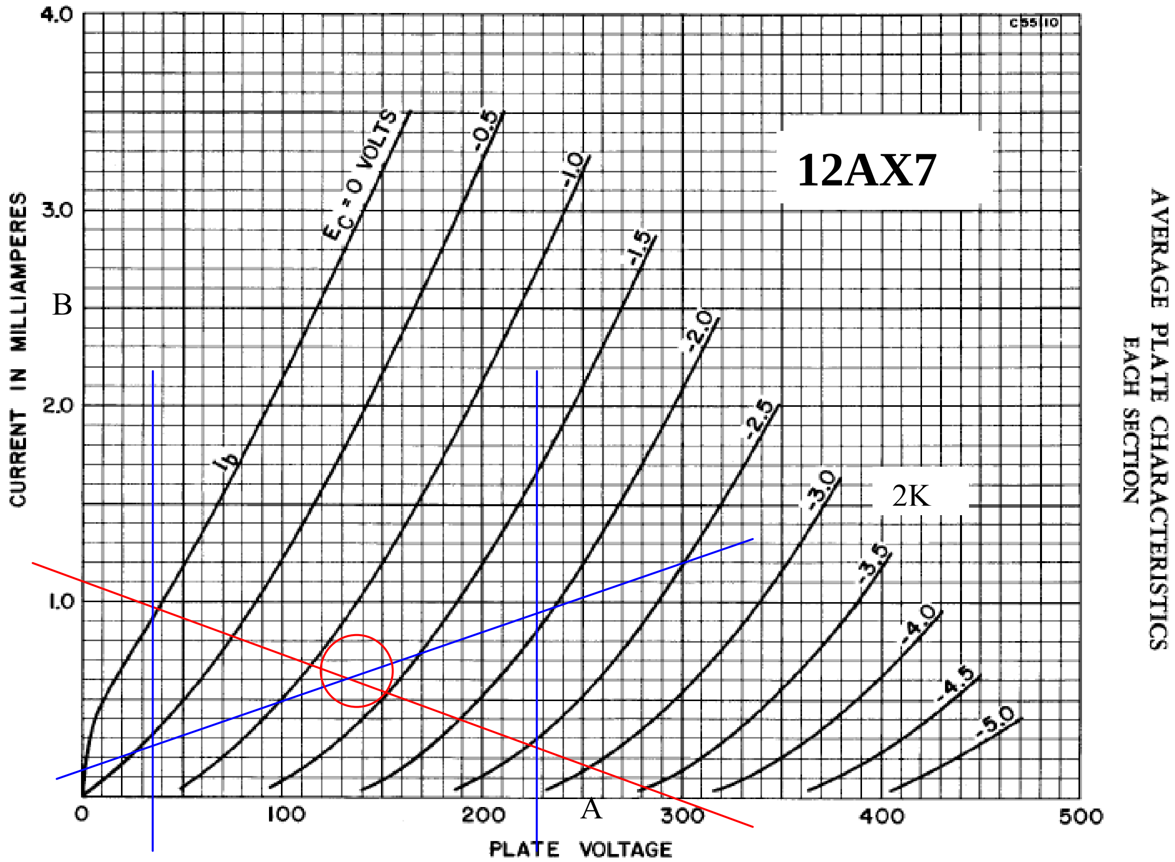
4. Design Info

4.1 Input Gain Stage

For the first half 12AX7, V1A, we know plate voltage Vp = 300V; Va=140V; Rk=1k; Vk=1.1V; Ia=0.6mA; RLdc=270k. Hence the anode resistance Ra = (300V/0.6mA) – 1k(u+1) -270k ~ 130k for u=100.

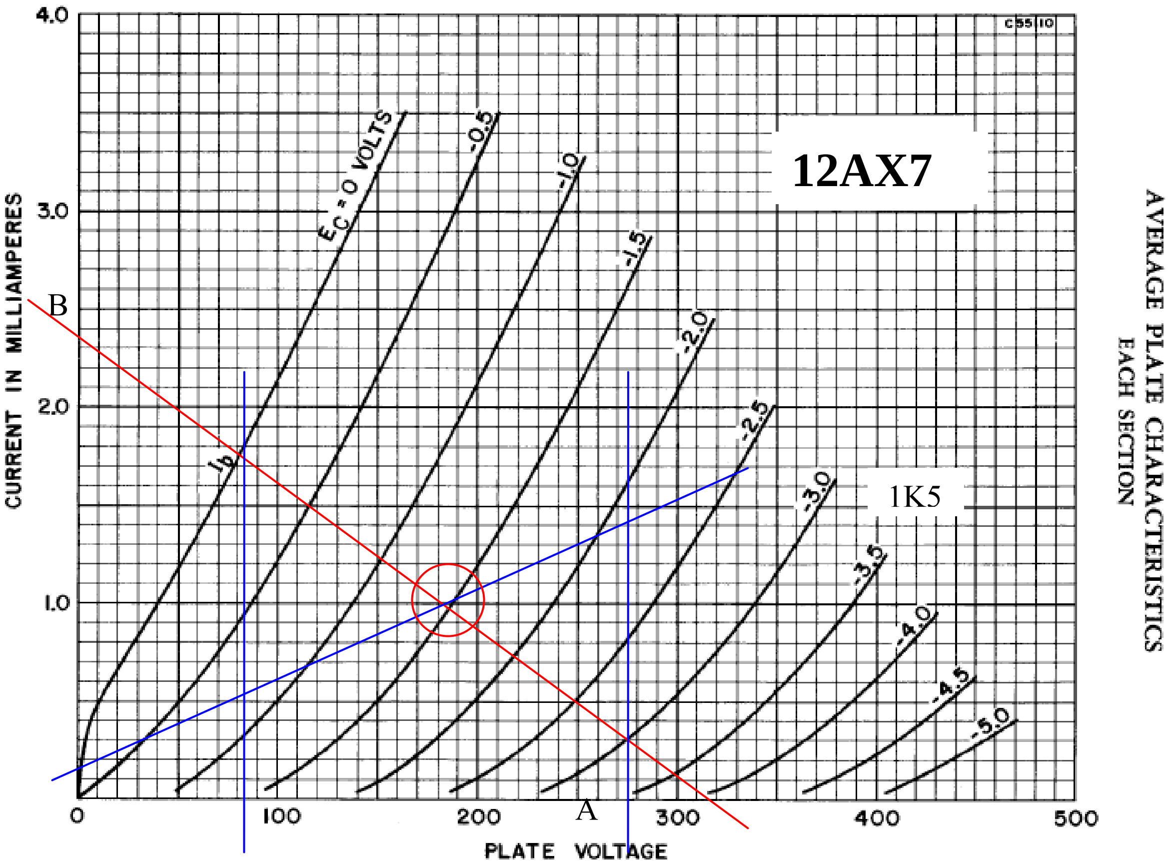
Voltage gain = u RL / (RL + Ra) = 100 x 80k / (80k + 130k) = 38; where RL ~80k (100k paralleled with 500k).

The input voltage swing limit is from the bias point at Vgk=-1.1V to Vgk=0V, which is about 2.2Vpp or 0.8Vrms. Referring to the loadline, the plate voltage would swing about 140V, from about 40V to 210V, with a mid point of 140V [230-140=90V; 140-40=100V] which indicates a reasonable amount of 2nd harmonic distortion. This gives a nominal gain of 100/2.2 = 45, which correlates with analysis above.



However the two 12AX7 halves have a common cathode resistance, bypassed, which I think provides a level of NFB. The second half also has NFB from plate to grid via a 4M7 resistor.
above. Need to do a simulation.

Modified input stage with half the 12AX7 disconnected and the other half changed to 1.5k cathode bias and 135k anode load, and no feedback 4M7.



4.2 Drive and Splitter Stage

A concertina splitter, with direct coupled drive from first half triode. Gain of PI is a bit under one. Gain of driver has NFB to cathode from OPT output. The change from 22nF to 47nF coupling is probably due to the different drive characteristics of the bottom and top halves of the PI. The 1M5 direct coupling is just for dc biasing.

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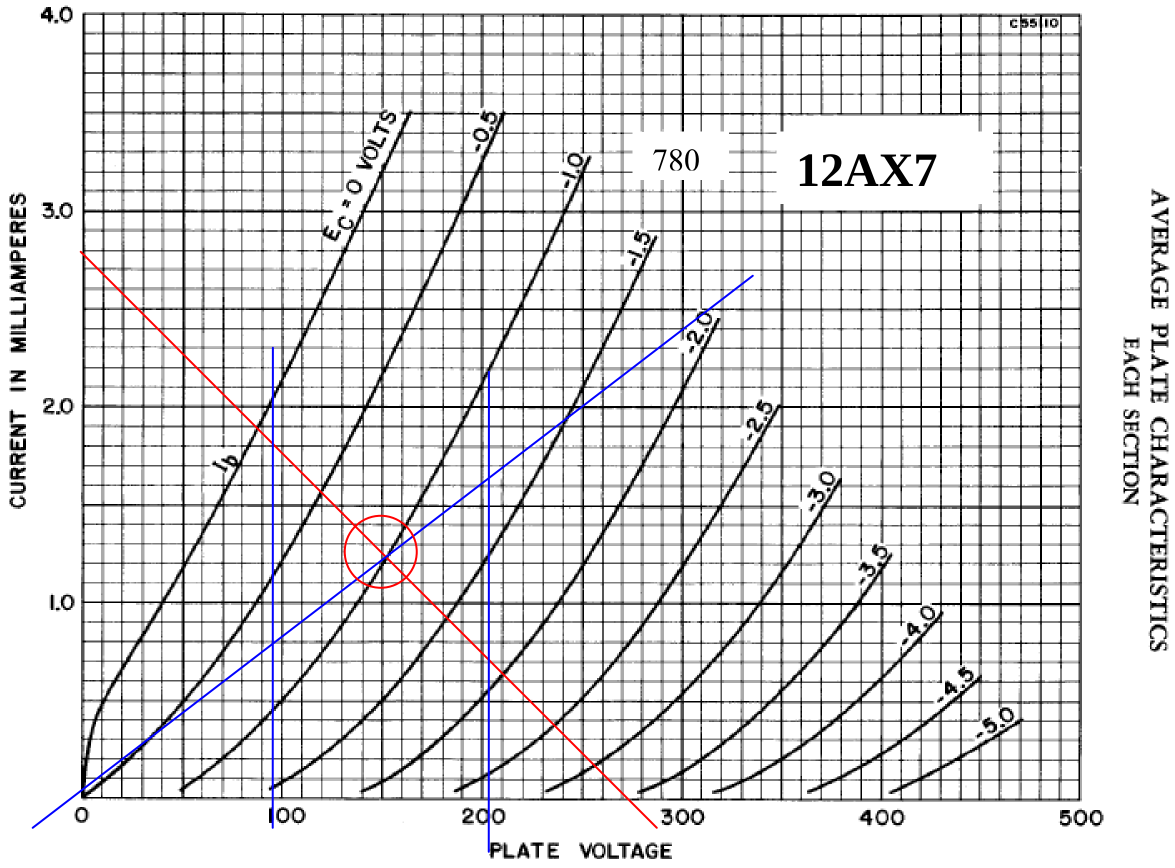
The voltage swing from the driver is up to about 50-60Vpk from quiescent 140-150V, which exceeds the 38V required for grid bias excursion to 0V for the output tubes. So this driver shouldn't be overdriven first.



4.3 Output Stage

Class B push-pull output stage with little if any region of overlap where both tube pairs conduct. The 1.8KΩ impedance plate-to-plate OPT (best estimate), presents each tube pair with 450Ω, and each tube with a 900Ω load impedance for effectively all signal currents.

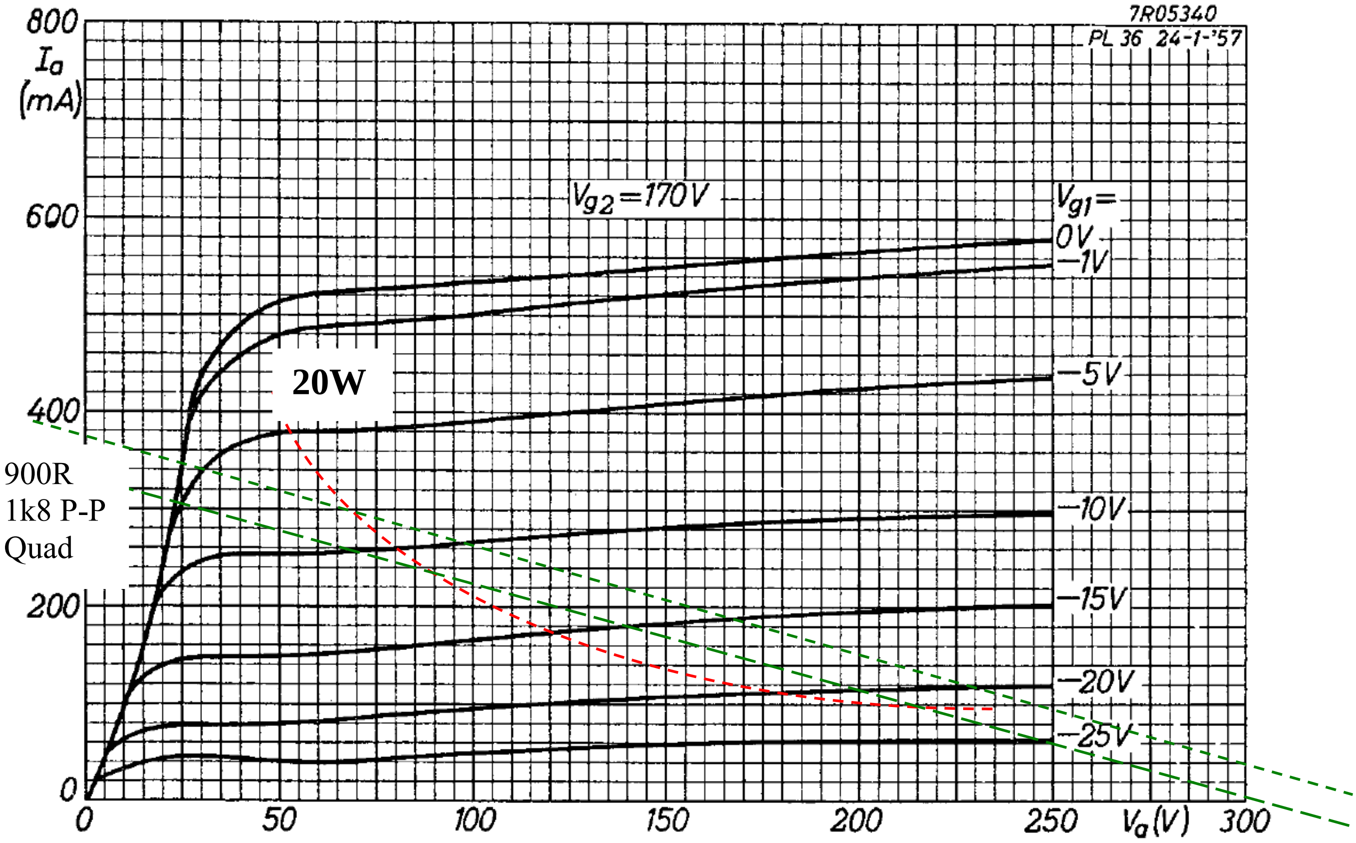
As the output loading increases, the plate supply voltage VS1 sags from 350V, due to supply regulation (335V @ 90W loading on VS1). The voltage at the plate will be effectively lower than VS1 at high output loading by an amount up to ~20V due to OPT half resistance of about 31Ω (ie. peak current of up to about 0.7A).

The screen supply voltage VS2 is nominally 50% of VS1, and will also sag under screen current loading at high output loading. Screen current level increases as Vg approaches 0V, possibly to over 40mA, but additional drop across each screen stopper resistor is < 2V.

Each valve has an 'off' period for 50% of time where the average plate dissipation is approaching zero W. As such for design, the max average dissipation during the 'on' period can target up to 2 x 10 = 20W per tube, and can extend dynamically beyond 20W level if needed. Assessing the EL36/PL36 plate curves, as no known 6CM5 curves are available, shows the simple plate load line starting at crossover of 0mA at VS1=340V (nominal level), and experiencing plate loss extending dynamically above 20W, and extending to the knee for gate voltage about -5V and anode current of 340mA. This loadline will move lower under heavy loading as VS1 sags and OPT resistive loss increases. The plate curves may compress a bit more from the 170V screen level.

Assuming the loadline sags to about 300V level (from 340V) and a peak plate current of 300mA is achieved, then the nominal output power of the amplifier would be: $(Ipk)^2$ x Rpp / 8 = 0.6 x 0.6 x 1k8 / 8 = 81W. For this maximum signal condition, the rms OPT current draw is likely about 2 x 190mA

(64% of peak), and the average VS1 power consumed is 320x0.38 =122W, and the OPT loss is $(0.38)^2$ x 62Ω = 9W, so the tube plates dissipate 122 - 81 - 9W = 32W, or just under 10W each.



4.4 Power Supplies

The power supply is full-bridge silicon diode BY127/800 and a 260-130-0 VAC centre-tapped secondary. 3x24uF capacitor input filter for V1. Centre-tap 130VAC to 24uF capacitor input filter for screen V2, but uses half the full-bridge to provide a full-wave rectified output.

The 37-0-37VAC bias supply now has a 48V relay load, so extra diode added from un-used secondary half winding to give full-wave rectifier output. Original 37.5VDC bias level increases to 42.8V, but this reduces to 38.0V with standby relay on, and hence there is no change to operating bias level, and ripple should be reduced.

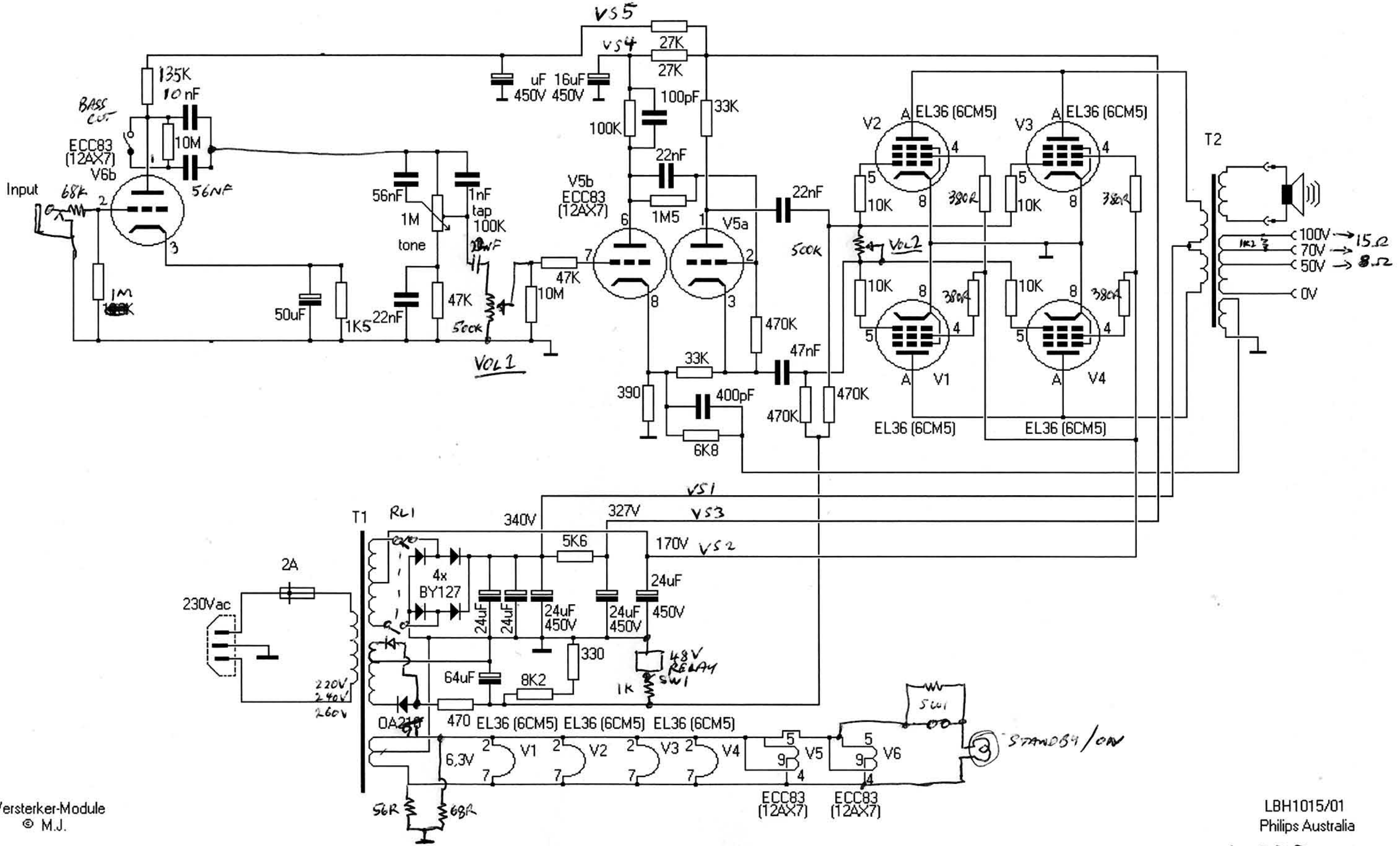
A standby relay provides inherent bias failure protection, and switches the two outer secondary winding connections to the full-bridge. 470k resistors are placed across each relay contact to pre-charge the main supply capacitors (about 45V reached) – should change to 330k.

4.5 HV breakdown

If the B+ rail shorts to ground, due to a flashover, or insulation breakdown, then 1A fuses in the transformer outer secondary windings would provide gross failure protection by de-energising VS1, and possibly VS2.

4.6 Output open circuit

Add a 1k2 2W resistor to the 15Ω output tap, to act as a high resistance limit in case the speaker load goes open circuit. The 6.5mm output jack should have the tip switch connected to 0V, to short the output if no speaker is connected – this is a much more acceptable loading for pentodes than an open circuit.



Versterker-Module
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LBH1015/01
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MODIFIED
FOR GUITAR I/P
60-80W O/P.
8/2009.