For several years now, the Elekit company has carved out a respectable space in the intricate "world" of the so-called DIY audio, creating excellent products with an excellent quality / price ratio. In fact, these are equipment that masterfully combine the needs of minimalist design with sophisticated technological solutions, in perfect "made in Japan" style.

The TU-8200 certainly belongs to this category...!!!

It is a single ended stereo tube amplifier (sold as assembly kit) equipped with volume control, 2 LINE inputs + 1 auxiliary (mini jack) for portable device, the predisposition for USB-DAC, a headphone output and an impedance selector for the speakers (4-6.3 ÷ 8-16) Ω. The original layout includes 2 12AU7 (Ecc82) and 2 6L6GC that can work in ultralinear configuration, pentode and triode. However, the presence of a sophisticated active self-polarization circuit, reasonably allows to use other power tubes such as: EL34 , 7581A , KT66 , KT88 , simply exchanging them with each other, without making any adjustment on the Bias. Some components of the kit that I have made, over the years, have been "upgraded" (cathode bypass capacitors on the drivers, coupling capacitors between the stages and output transformers), as well as some changes have been made to the power supply section to allow the use of the E80cc as driver tubes.

The purpose that I set myself with this modest contribution of mine - beyond the obvious playful aspects - was to verify and / or integrate the rating data sheet provided by the manufacturer , in particular for what concerns some fundamental electrical parameters related to the operation of audio amplifiers: ***gain ; input sensitivity ; max power . ; bandwidth ; output impedance and relative damping factor.*** *The instruments used for all measurements are: digital multimeter; dual-track analog oscilloscope along with a A.F. signal generator (courtesy of a close friend); a set of ceramic resistors with a nominal value of 8.2 Ω (measured 8.6) variously connected to each other to realize a dummy load.*

- ***Input sensitivity***

With the volume in the max. position and for each of the 2 positions of the impedance selector on the output transformer (4-6.3 ÷ 8-16) on resistive load of 4.3 and 8.6 Ω respectively , I measured on the oscilloscope the max. value of the input signal with a frequency of 1*KHz* that produced the max. signal "visually undistorted" at the output. (as is known, and as it is easy to observe on the oscilloscope, in every single-ended circuit the phenomenon of clipping is "asymmetric", involving in terms of deformation of the output signal, first the positive half-wave, and then gradually continue on the negative). Therefore, having no instrument available that can measure *THD* values, ***Vin*** is always considered by me as the one that produces the max. ***Vout*** to the lower limit of the observed visual distortion of the positive half-wave***.***

- ***Gain***

  Keeping ***Vin*** constant, at this point, varying the volume potentiometer from max. to min. I get the various ***Vout*** gain for each position of the same. The measured gain values ***(Vout / Vin***) refer to the clock time in position: 9 , 12 , 3 , max.

- ***Max Power***

  The same considerations apply as for sensitivity....

  In particular, in the absence of instrumentation capable of measuring *THD*, it is quite "random" to speak of max. power on dummy load. However in the power measurements , I always and only consider the ***Vout*** max as the one available at the lower limit of the visual distortion of the positive half-wave.

$$P_{max} = \frac{(Vout_{max})^2}{R_{load}}$$

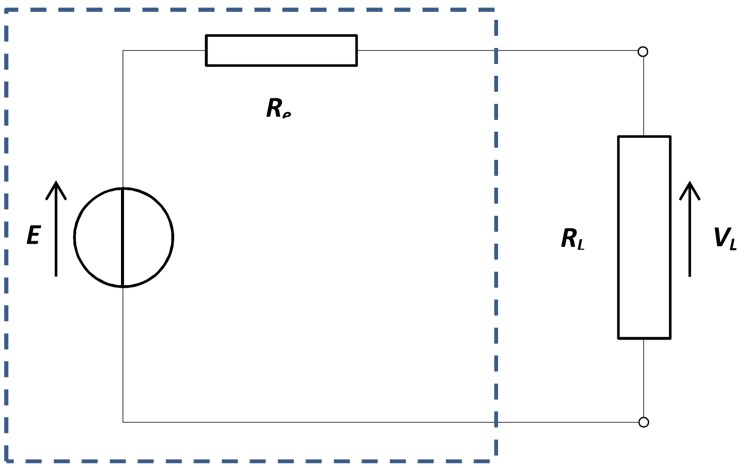
- ***BandWidth***

With ***Vin*** equal to the sensitivity and established an arbitrary value of ***Vout*** for a frequency of *1Khz* on resistive load, I gradually varied the *Freq*. of the input signal, measuring the $\boldsymbol{Freq_{min}}$ and $\boldsymbol{Freq_{max}}$ that produce an attenuation of -3dB on ***Vout***. For completeness of calculation, I also added the band values to 0dB and -1dB.

$$BW = [freq_{min}(Vout_{-3dB}) \dots freq_{max}(Vout_{-3dB})]$$

- ***Output impedance***

By applying the linear model it is possible, within certain limits, to assimilate the electrical behavior of the entire amplification circuit to that of a real voltage generator. Based on Thevenin's theorem, in fact we can consider the elementary network in which we have:



E = e.m.f. of voltage generator

$\boldsymbol{R_e}$ = equivalent resistance

$\boldsymbol{R_L}$ = load resistance

$\boldsymbol{V_L}$ = load voltage

I = circulating electric current

Under these conditions, $\boldsymbol{R_L}$ "sees" as an equivalent circuit just what is graphically represented within the box.Therefore: $V_L = E - R_e \cdot I$ where $\boldsymbol{R_e}$ represents the output impedance of the circuit "seen" by the load in which flows $I = \frac{E}{R_e+R_L}$ As a result, both $\boldsymbol{V_L}$ and ***I*** vary as $\boldsymbol{R_L}$ vary. Suppose we attribute to $\boldsymbol{R_L}$ a known value that e.g. I will call ***R1***. You will have: $V_{L_1} = E - Re \cdot I_1$ → first degree equation with 2 unknowns (***E*** ;$\boldsymbol{R_e}$);

but if I consider any other working point of the circuit,or else I always give to $\boldsymbol{R_L}$ another value ***R2***, at the equilibrium will have:

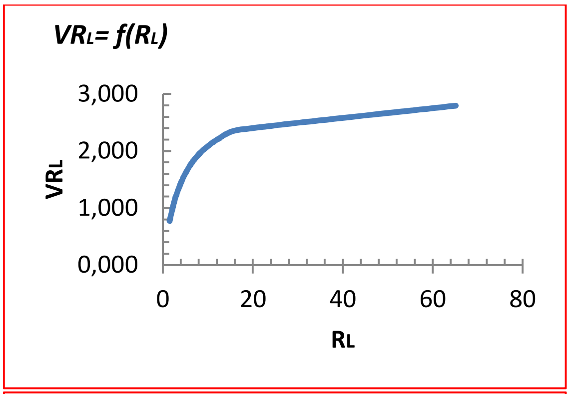
$$\begin{cases} V_{L1} = E - R_e \cdot I_1 \\ V_{L2} = E - R_e \cdot I_2 \end{cases} \rightarrow V_{L1} - V_{L2} = R_e \cdot (I_2 - I_1) \quad \rightarrow \quad R_e = \frac{\Delta V}{\Delta I}$$

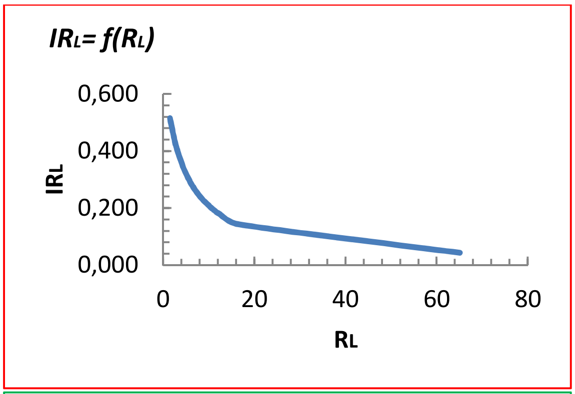
As the load changes, the current and voltage are expressed by:

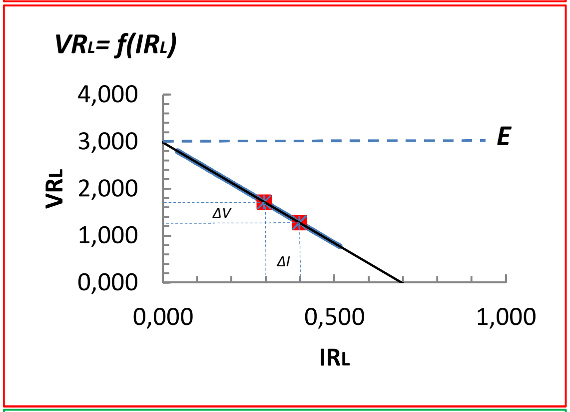
$$I_{RL} = \frac{E}{R_e + R_L} \qquad V_{RL} = E - R_e\left(\frac{E}{Re + R_L}\right)$$

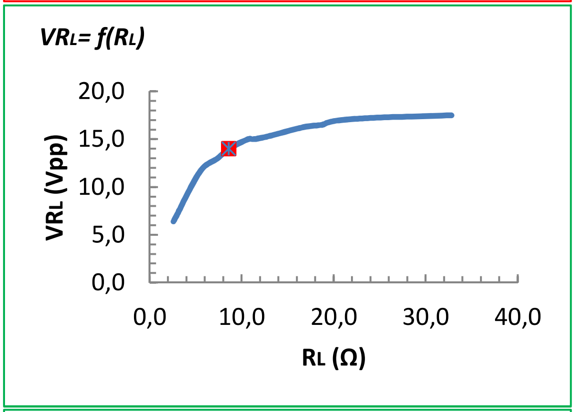
The conditions at the limit: $\begin{cases} R_L \to 0 \\ I_{RL} \to \frac{E}{R_e} \\ V_{RL} \to 0 \end{cases}$ $\begin{cases} R_L \to \infty \\ I_{RL} \to 0 \\ V_{RL} \to E \end{cases}$

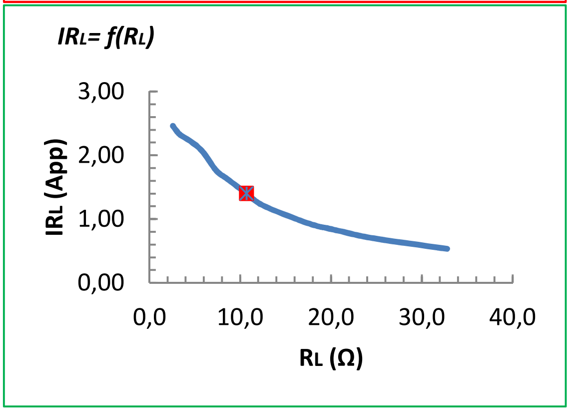
Theoretical model **Experimental data**

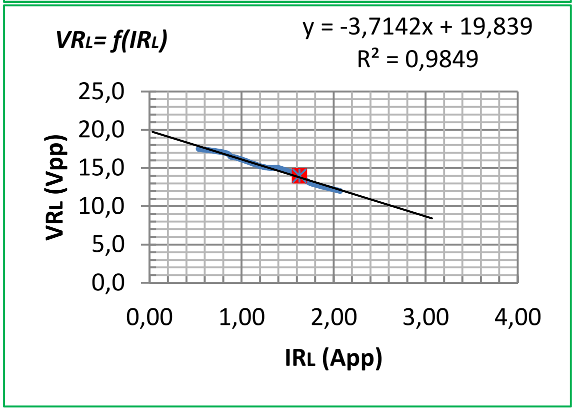


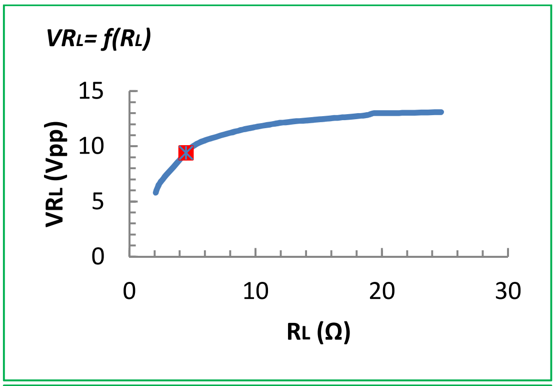


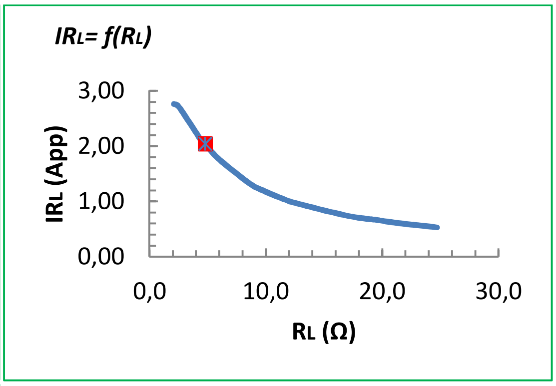


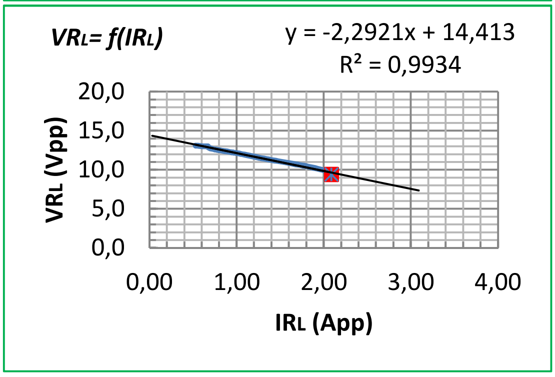












Freq.	Imp.sel.	Vin	Vout	R_L	R_e
1Khz	*4-6.3 Ω*	*355 mVpp*	*9.4 Vpp*	*4.5 Ω*	***2.3 Ω***
"	*8-16 Ω*	*360 mVpp*	*14 Vpp*	*8.6 Ω*	***3.7 Ω***

The analysis of the experimental data confirms the response of the theoretical model, suggesting its correctness within the real limits of use.

MEASUREMENTS

6L6GC (EH) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		8÷16
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		14
Vin (*input sensitivity*) **(Vpp)**		0,35
Gain (*clock time position*)	9 →	0,35 Vpp / 0dB
	12 →	1,95 Vpp / 15dB
	3 →	7,8 Vpp / 27dB
	max. →	14 Vpp / 32dB
Bandwidth (Hz)		24 ÷ 24,5K [0dB]
		22 ÷ 28K [-1dB]
		15 ÷ 58K [-3dB]
Max.Power (*before clipping*)		(24+24) Wpp
		(6+6) Wp
		(3+3) WRMS

6L6GC (EH) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		4÷6,3
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		13
Vin (*input sensitivity*) **(Vpp)**		0,38
Gain (*clock time position*)	9 →	0,34 Vpp / -1dB
	12 →	1,90 Vpp / 14dB
	3 →	7,10 Vpp / 25dB
	max. →	13 Vpp / 31dB
Bandwidth (Hz)		22 ÷ 24K [0dB]
		20,5 ÷ 27K [-1dB]
		14,25 ÷ 60K [-3dB]
Max.Power (*before clipping*)		(20+20) Wpp
		(5+5) Wp
		(2,6+2,6) WRMS

6L6GC (EH) + E80cc (Tungsram) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		8÷16
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		14,25
Vin (*input sensitivity*) **(Vpp)**		0,27
	9 →	0,31 Vpp / 1,2dB
Gain (*clock time position*)	12 →	2,05 Vpp / 17,6dB
	3 →	8,20 Vpp / 30dB
	max. →	14,25 Vpp / 34dB
		15,25 ÷ 16K [0dB]
Bandwidth (Hz)		13,25 ÷ 27K [-1dB]
		10,75 ÷ 70K [-3dB]
		(25+25) Wpp
Max.Power (*before clipping*)		(6,2+6,2) Wp
		(3+3) WRMS

6L6GC (EH) + E80cc (Tungsram) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		4÷6,3
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		13
Vin (*input sensitivity*) **(Vpp)**		0,30
	9 →	0,30 Vpp / 0dB
Gain (*clock time position*)	12 →	1,90 Vpp / 16dB
	3 →	7,60 Vpp / 28dB
	max. →	13 Vpp / 33dB
		14 ÷ 14,5K [0dB]
Bandwidth (Hz)		12,25 ÷ 27K [-1dB]
		10,75 ÷ 62K [-3dB]
		(20,6+20,6) Wpp
Max.Power (*before clipping*)		(5,2+5,2) Wp
		(2,6+2,6) WRMS

7581A (Tungsol) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		8÷16
Freq. (Hz)		1000
Vout (max.vol. before clipping*)* **(Vpp)**		15
Vin (*input sensitivity*) **(Vpp)**		0,36
	9 →	0,36 Vpp / 0dB
Gain (*clock time position*)	12 →	2,10 Vpp / 15dB
	3 →	8,10 Vpp / 27dB
	max. →	15 Vpp / 32dB
		28 ÷ 20K [0dB]
Bandwidth (Hz)		19 ÷ 27K [-1dB]
		13,5 ÷ 60K [-3dB]
		(27+27) Wpp
Max.Power (*before clipping*)		(6,8+6,8) Wp
		(3,4+3,4) WRMS

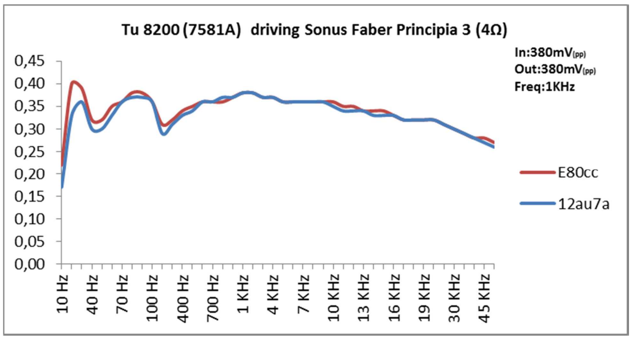
7581A (Tungsol) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		4÷6,3
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		13,5
Vin (*input sensitivity*) **(Vpp)**		0,385
	9 →	0,37 Vpp / -0,3dB
Gain (*clock time position*)	12 →	2 Vpp / 14,3dB
	3 →	7,6 Vpp / 26dB
	max. →	13,5 Vpp / 31dB
		23 ÷ 21K [0dB]
Bandwidth (Hz)		18 ÷ 28K [-1dB]
		13 ÷ 60K [-3dB]
		(22+22) Wpp
Max.Power (*before clipping*)		(5,5+5,5) Wp
		(2,8+2,8) WRMS

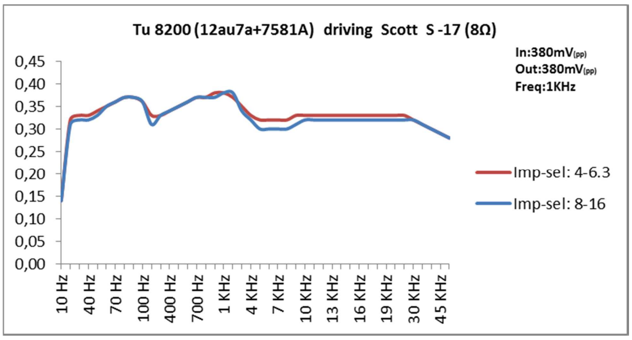
7581A (Tungsol)) + E80cc (Tungsram) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		8÷16
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		15,2
Vin (*input sensitivity*) **(Vpp)**		0,285
	9 →	0,285 Vpp / 0dB
Gain (*clock time position*)	12 →	2,20 Vpp / 17,8dB
	3 →	8 Vpp / 29dB
	max. →	15,2 Vpp / 34,5dB
		13,25 ÷ 21K [0dB]
Bandwidth (Hz)		11,5 ÷ 29K [-1dB]
		10 ÷ 70K [-3dB]
		(28+28) Wpp
Max.Power (*before clipping*)		(7+7) Wp
		(3,5+3,5) WRMS

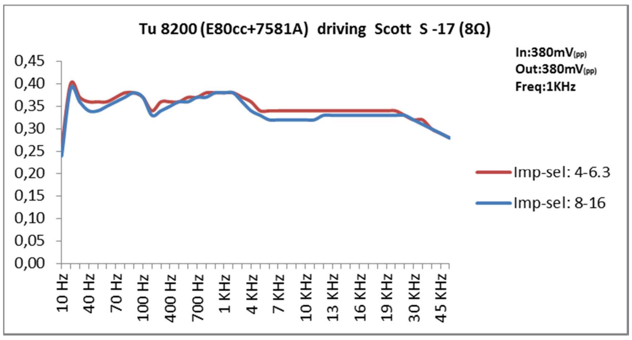
7581A (Tungsol)) + E80cc (Tungsram) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		4÷6,3
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		13,75
Vin (*input sensitivity*) **(Vpp)**		0,305
	9 →	0,28 Vpp / -0,7dB
Gain (*clock time position*)	12 →	1,95 Vpp / 16dB
	3 →	7 Vpp / 27dB
	max. →	13,75 Vpp / 33dB
		12,5 ÷ 18,5K [0dB]
Bandwidth (Hz)		11 ÷ 26K [-1dB]
		9,6 ÷ 62K [-3dB]
		(23+23) Wpp
Max.Power (*before clipping*)		(5,8+5,8) Wp
		(2,9+2,9) WRMS

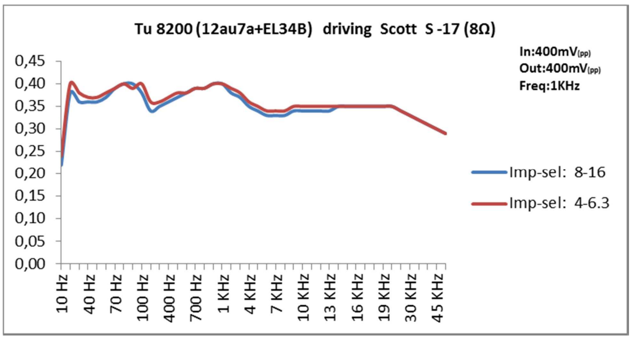
EL 34 B (Shu-guang) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		8÷16
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		18,5
Vin (*input sensitivity*) **(Vpp)**		0,4
	9 →	0,4 Vpp / 0dB
Gain (*clock time position*)	12 →	2,70 Vpp / 16,6dB
	3 →	9,80 Vpp / 28dB
	max. →	18,5 Vpp / 33,3dB
		17 ÷ 12,5K [0dB]
Bandwidth (Hz)		13,5 ÷ 27K [-1dB]
		11 ÷ 60K [-3dB]
		(41,7+41,7) Wpp
Max.Power (*before clipping*)		(10,4+10,4) Wp
		(5,2+5,2) WRMS

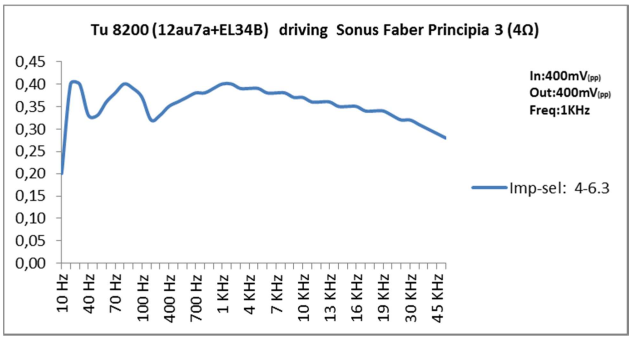
EL 34 B (Shu-guang) + 12AU7A (TAD) + Opt Lundahl UL mode		
Rload (Ω)		8,6
Imp.Sel. (Ω)		4÷6,3
Freq. (Hz)		1000
Vout (*max.vol. before clipping*) **(Vpp)**		15,75
Vin (*input sensitivity*) **(Vpp)**		0,4
	9 →	0,4 Vpp / 0dB
Gain (*clock time position*)	12 →	2,40 Vpp / 15,5dB
	3 →	8,90 Vpp / 27dB
	max. →	15,75 Vpp / 32dB
		14,5 ÷ 11K [0dB]
Bandwidth (Hz)		12,5 ÷ 27K [-1dB]
		10,5 ÷ 60K [-3dB]
		(30,2+30,2) Wpp
Max.Power (*before clipping*)		(7,6+7,6) Wp
		(3,8+3,8) WRMS

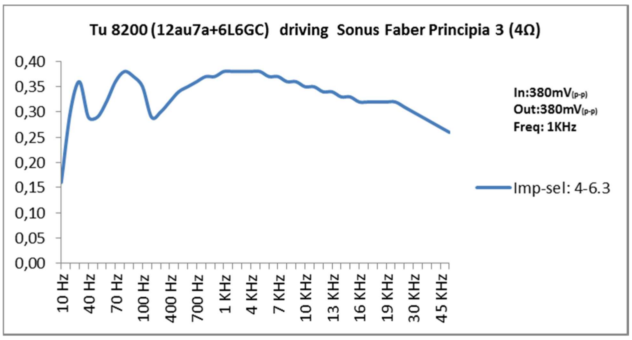


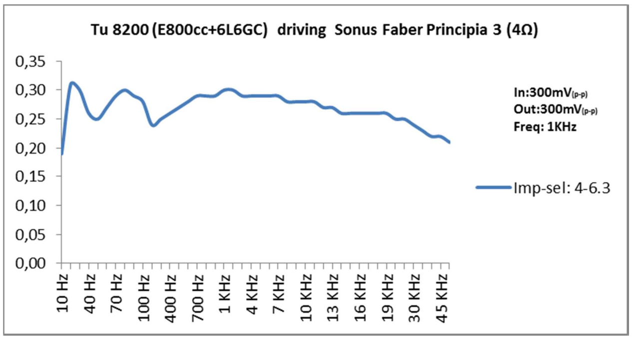







Tu 8200 (12au7a+EL34B) driving Sonus Faber Principia 3 (4Ω)
In:400mV(pp)
Out:400mV(pp)
Freq:1KHz
Imp-sel: 4-6.3
0,45
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
10 Hz
40 Hz
70 Hz
100 Hz
400 Hz
700 Hz
1 KHz
4 KHz
7 KHz
10 KHz
13 KHz
16 KHz
19 KHz
30 KHz
45 KHz


Tu 8200 (12au7a+6L6GC) driving Sonus Faber Principia 3 (4Ω)
In:380mV(p-p)
Out:380mV(p-p)
Freq: 1KHz
Imp-sel: 4-6.3
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
10 Hz
40 Hz
70 Hz
100 Hz
400 Hz
700 Hz
1 KHz
4 KHz
7 KHz
10 KHz
13 KHz
16 KHz
19 KHz
30 KHz
45 KHz


Tu 8200 (E800cc+6L6GC) driving Sonus Faber Principia 3 (4Ω)
In:300mV(p-p)
Out:300mV(p-p)
Freq: 1KHz
Imp-sel: 4-6.3
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
10 Hz
40 Hz
70 Hz
100 Hz
400 Hz
700 Hz
1 KHz
4 KHz
7 KHz
10 KHz
13 KHz
16 KHz
19 KHz
30 KHz
45 KHz