EB-107/309 ALL-FET LINE/HEADPHONE AMPLIFIER.

The EB-107/309 is Top-of-the-Line ALL-FET line amplifier with exceptional resolution, and dynamics. Its natural and transparent sound makes it equally applicable in high-end home systems as in studio monitor and recording applications. The EB-107/309 outperforms most high-end line and headphone amps on the market in terms of sonic quality, irrespective of price.

Only FETs (JFETs and MOSFETs) are used as active elements in the amplifier. The resistors are all high quality Caddock and Vishay-Dale or PRP. All electrolytic caps are Nichicon FINE GOLD MUSE or ELNA CERAFINE/SILMIC II. The compensation caps are MICA or polystyrene. The EB-107/309 is only available on Teflon PCB.

Two amplifiers are laid out on one board (the size is 145x145mm), but they can be used independently. This facilitates testing and trouble-shooting. Two of the 309 boards can be connected to provide a fully balanced line amplifier.

Circuit description.

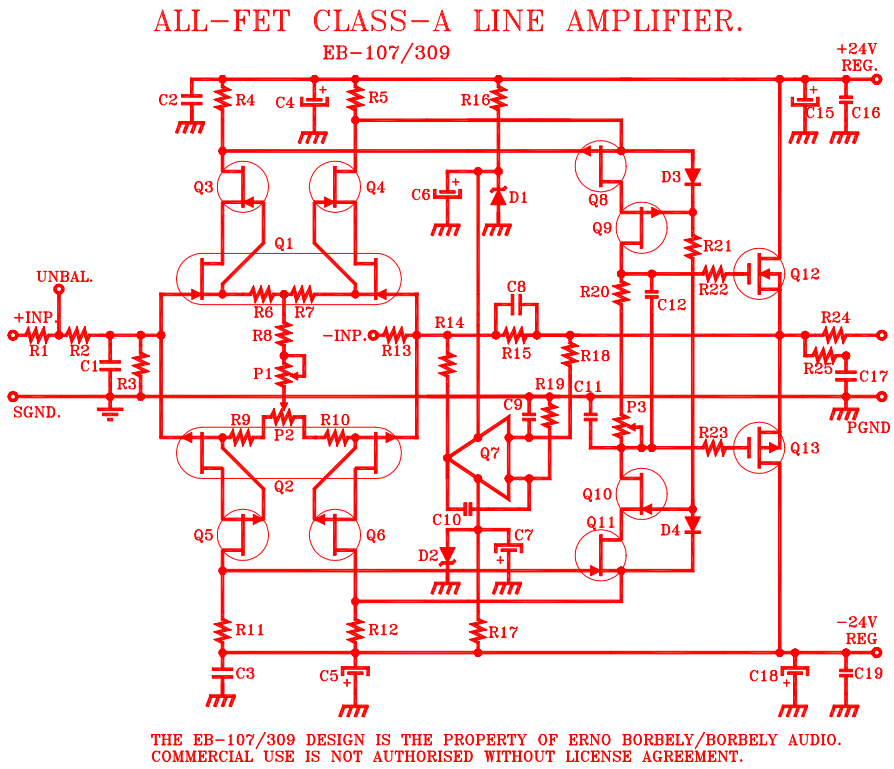

Fig. 1.

The schematic of the ALL-FET 309 is shown in fig. 1. The complementary differential input consists of the dual monolithic JFETs: Q1 and Q2, cascoded with Q3/Q4 and Q5/Q6 respectively. The second stage, consisting of JFETs Q8/Q9 and Q10/Q11, are operating at just below 10mA. The blue LEDs D3 and D4 provide the necessary bias (approx. 3.2V) for the cascode JFETs Q9 and Q10. The output devices: Q12/Q13 are Hitachi TO-220 MOSFETs. They are operating in Class-A at approx. 70mA; proper heat sinking is therefore mandatory.

Q7 is a JFET-input servo amplifier, providing tracking of the output offset to less than 1mV. D1 and D2 are IC shunt regulators, supplying Q7 with ±10 Volt to Q7.

The amplifier is using the best components available today. The resistors are Vishay-Dale, PRP and Caddock. The frequency compensating capacitors are polystyrene or Mica caps, the electrolytics C4,

C5, C15 and C18 are Nichicon FINE GOLD MUSE or ELNA CERAFINE/SILMIC II, and the rest of the caps are PP film caps.

The open loop linearity of the amplifier is exceptionally good; THD is <0.05% at 1 kHz, 3VRMS. This is reduced to below the measurement limit of the HP 339A distortion analyzer when feedback is applied with resistors R15-R13. Normally R15 is 10k and R13 is 1k1. This gives a closed loop gain of 20 dB. The rise time of the amplifier is about 200 nanoseconds for an output of +10V and the closed loop frequency response is close to 1 MHz! Output impedance is less than 1 Ohm, so resistor R24 determines the actual output impedance seen by the outside world.

The closed loop gain can be reduced by changing the value of R13, however, at lower gain the compensation cap C11 has to be changed as well. These are the necessary changes for lower gain settings:

16dB: R13=1k82 (No other change)
12dB: R13=3k32. C11=330pF
6dB: R13=10k, C11=470pF

NOTE: the 309 in Not Unity Gain Stable (NUGS), and it should not be considered for unity gain buffer operation.

REGULATORS AND POWER SUPPLY.

In order to preserve the low noise capability of the 309, the regulator also has to have very low noise. Recommended regulators for the 309 are the 418 ALL-FET series regulators and the 255 super shunt regs. The EB-208/418 consists of two dual wide-band, low-noise regulators, using only FETs (JFETs and MOSFETs) as active elements. The + and – phase are completely independent of each other to avoid cross modulation. Maximum input voltage is ±45V and maximum output voltage is ±40V. Maximum output current with 5V input/output voltage difference is ±200mA. The 418 regulator has less than 5µV noise over the audio bandwidth.

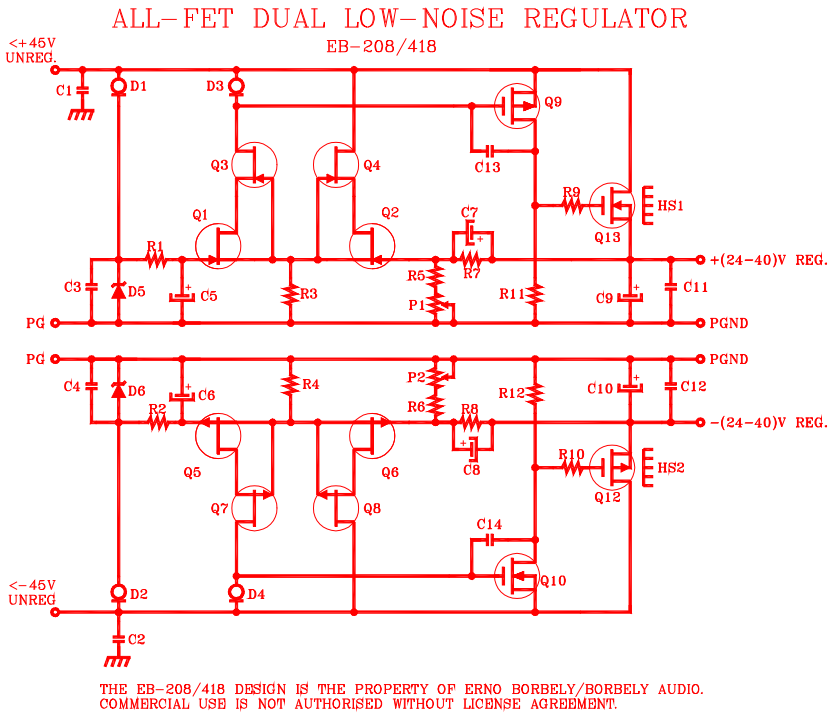

Fig. 2. The EB-208/418 ALL-FET Wide-band, Low-noise regulator.

Also the power supply has to be a high quality one. The recommended PS is the EB-108/291 with 4-pole Jensen capacitors and L-C-filters. The + and – phase are independent of each other like in the 418 regulator. Note that there is a voltage drop across the chokes, and the initial raw rectified voltage has to be higher than without the chokes, i.e. the transformer secondary has to be increased. If a 4-5H choke with 60 Ohm DC resistance is used for the 309/418 (100mA per channel) then the secondary should be

39V. The 291 should then be tested with 270 Ohm/5W resistors to simulate the 100mA load. (See the description of the EB-108/291 PS.)

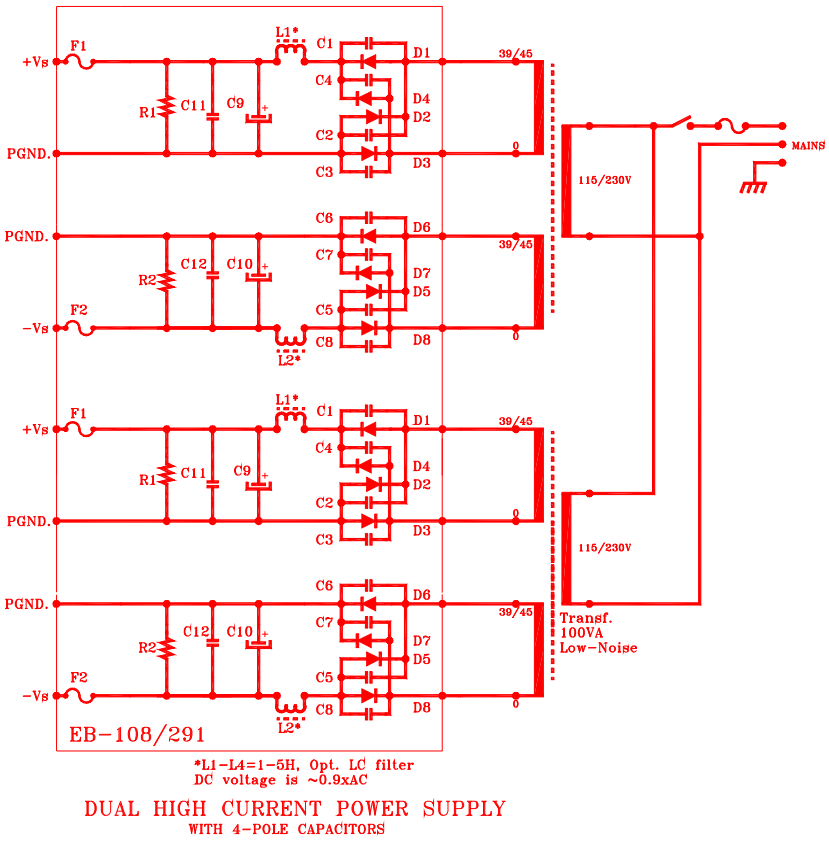

Fig. 3. The EB-108/291 High Current Power Supply.

Application notes.

For normal, non-inverting lineamp application the source is connected to the +INP, and the –INP is grounded to SGND. This will give the normal lineamp gain of 20dB. If a shunt attenuator is used with the amp, the proper value of R1 has to be installed (normally 10k). If a normal potentiometer or DACT stepped attenuator is used R1 has to be shorted.

The output is capable of driving loads down to 30 Ohm in Class-A. Consequently, you can use the amplifier as headphone amplifier. Reduce R24 to 10 Ohm in this case (the 10 Ohm is serving as a short circuit protection). The amp can also be used with terminated cables. If you are using a 50-Ohm coax cable, insert a 50-Ohm resistor for R24 and terminate the cable at the other end (normally at the input of the power amplifier) also with 50 Ohm. Use 75-Ohm resistors at both ends if the cable is a 75-Ohm coax. In case of terminated cables the proper BNC connector (50 or 75 Ohm) has to be used instead of the RCA connectors.

The two amplifiers can be connected for balanced operation. Remove the ground wire from both –INP and connect them together. The +/- balanced inputs are then connected to the two +INP of the two amps. The output of the amps that amplifies the + signal becomes the +output and the one amplifying the –signal is the –output. Both inputs and outputs have to be connected through XLR connectors. Note that if you use an unbalanced source with this setup, the input of the –AMP has to be grounded, see block schematic in fig. 4!

Terminated cables can also be used with balanced operation. The Neutrik XLR connectors have a characteristic impedance of 110 Ohm; consequently balanced 110 Ohm cables can be used. Use 110 Ohm for R24 in both amplifiers and terminate the cable with two 110-Ohm resistors at the other end.

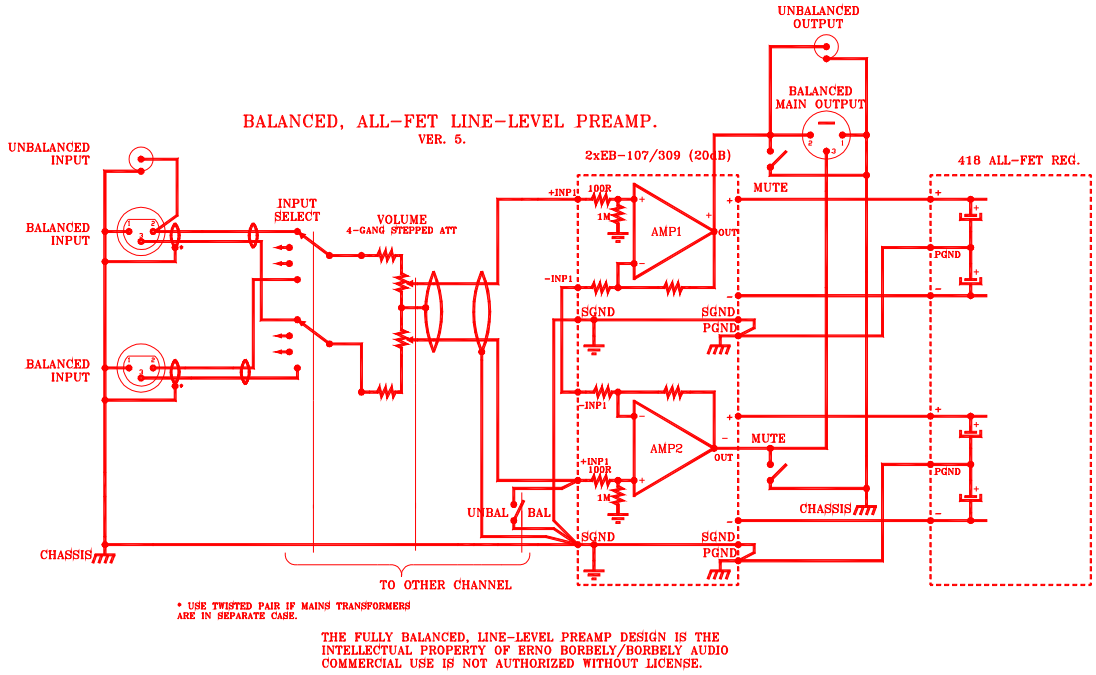

Fig. 4. Two EB-107/309 amps wired for balanced operation, using 4-gang stepped attenuator

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Fig 4 shows a balanced setup with 4-gang stepped attenuators. The two amps are fed from separate 418 ALL-FET regulators. Both balanced and unbalanced sources can be connected at the input, assuming that the input of AMP2 is grounded when unbalanced sources are used. The unbalanced output is taken from the output of AMP1. Optional mute circuit is shown at the output to avoid DC thumps at turn-on and turn-off.

The vertical ground wire on the left-hand side of fig. 4 is a bus bar connecting all pin 1's of the XLR's and the groundside of the RCA connectors together. This is grounded to the chassis, normally on the back panel. A single insulated wire is then connected from this point to the SGND of AMP2. Shielded wiring is indicated in fig. 4, however, if the mains transformer(s) are mounted in a separate box (strongly recommended!!), the wiring can be done with twisted wires. Teflon insulated silver plated copper wires or pure silver wires are recommended for internal signal wiring!