Technical White Paper on C325BEE improvements

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1. The most important improvements in distortion, channel interaction and sound quality are achieved by major layout changes in the supply, supply routing, output stage and voltage amp.

Moving the toroid to the back and the powerboard very close to the output stage has enabled very short DC connections to the output stages, reducing resistance and the density of class B electromagnetic field. The latter is in most amplifiers the dominant distortion mechanism at high frequencies and low impedances. The voltage amp is now reduced in area, and on a vertical smd module for lower loop capture area for distorted electromagnetic leakage fields.

2. The second largest contributor to lower distortion is the lower impedance feedback network with added damped inductor phase compensation of the feedback loop.

3. Another 5-6 dB reduction of 20k thd in low impedance loads was achieved by adding error feedforward to the output stage. Out patented output stage topology permits the simple addition of error feedforward from the predriver stage to the output stage. The predriver already creates an error signal by subtracting the input from the voltage amp, from the output signal, and this is then fed forward to the bases of the o/p stage. This does not reduce the stability margin.

4. The idling current stability and accuracy of setting have been improved. By additional negative feedback from the varying main DC supply, the idling current regulator now keeps the current within +/- 1mA for a supply variation of +/- 12V, thus practically eliminating dynamic crossover distortion.

5. DC servos were added to eliminate slight DC drift (40mV over a typical temp range) in the C320BEE which was set by trimpot , a fairly critical setting. And the servo enabled us to remove a large value electrolytic from the feedback signal path.

6. The Tone control topology of all 300 series amps is chosen for its much lower noise than a Baxandall tone control , and for being non inverting . It uses logarithmic (or strictly 2 slope linear) pots ,and even the best Alps pots have fairly large tolerances both on overall value and the ratio of the two track sections either side of 12 o'clock. The trimpots are only there to compensate for these tolerances and get the response in mid positions flat within +/- 0.5 dB with tone control active. (we have not changed that spec: up to now we used different capacitor values for different batches of pots, pre-measured for their ratios, not very practical in mass production.)

7. The volume control has fairly low impedance, and about 5 dB of the preamp gain is before it in the signal path . The best Alps volume pots unfortunately still have a finite resistance between wiper and the ground pin at min vol rotation, guaranteed to < 10 ohms, and typically <2 ohms.

Across those 10 ohms of a 20k pot there will be a voltage of -66 dB relative to the input to the volume/tone control , or -61 db relative to the line- input. That is amplified up by 5+29 dB so ends up , for a 2 V input signal ,as -30dB or 60mV in speaker. Typically it is about 14 dB lower, but that is still 12mV and can be heard in a sensitive speaker in a quiet room.

In the 370 we used 10k vol pots for even lower noise, and that made it typically 24mV leakage at speakerlevel which several customers complained about.

For the C372, the C720 and now the C325BEE, we reduce this leakage by feeding in a small amount of signal in opposite phase to the preamp's output buffer amp to cancel the leakage. It is in practice done by connecting the feedback network instead of directly to gnd, to the output of an adjustable attenuator , approx 70-80 dB. This signal, fed to the negative input, is equal to the leakage to the positive input, so the two cancel. Thus we get a minimum of 10 dB reduction of the minimum volume signal leakage or breakthrough.

8. The output inductors were halved in inductance and resistance value and repositioned for reduced interaction. It had been a long standing conviction by some of our distributors that this improves the sound and it does increase the hf damping factor. The stability remains unconditional in capacitive loads.

9. The BEE Clamp or Adaptive Antisaturation Clamp, shortens hf overload recovery time, and improves the clipping behaviour in low impedances at high frequencies. It senses the supply voltage and adjusts the clamping point according the load impedance. The traditionally used Baker clamp has a fixed clipping margin regardless of load so it throws away valuable output swing /dynamic power in medium and high impedance speakers by clamping before it really has to. There is a small loss of peak clipping power but the clipping is a lot cleaner.

10. The binding posts were improved to give smoother access to various banana plugs at the upper limit of outer diameter, and the fixing was much improved to reduce flexing of the assembly.

11. The rear panel /top cover fixing has been modified by additional screws so its solidity and rigidity is much improved for better feel, also when inserting oversize banana plugs. The last two points were in response to disappointing " build quality" notes from somecritics, somwehat justified in this specific area.

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