

## SSB01 Sjöström Super Buffer - Diamond buffer

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SSB-01 - The high performance SMD Diamond buffer

The picture at left shows the prototype boards, revision 0. Click on the pictures on order to get an larger view. Revision 1 with no errors. Click on the pictures on order to get an larger view.

The picture shows the buffer. Click on the picture on order to get an larger view.

The performance is very good. See technical data!

Interesting features:

- The pcb fits virtually any SOT23 small signal transistor and almost any SOT223 power transistor.
- The emitter loads have cascodes in order to increase linearity.
- SMD caps, including electrolytic caps.
- SMD parts which makes the buffer very small and thin.
- Input LP-filter if you have problems with RF interference, if not just omit it.
- Crossover distortion reducer for the opamp. This is a popular circuit in the DIY community.
- Useful for anything as long as power supply voltage is within limits and load not to heavy.
- Professional pcb with groundplane which establish good cooling and shielding. Customer review Matthias from Germany

well what can i say to the sound after 3 hours: faaaaaaaaaantastic. this is so much better than the buf634, it is stunning... i will replace the electrolytic cap though by black gates or rubycon za!  
 {mospagebreak title=The schematics}Background

This type of buffer is called "diamond buffer" but I don't where the name comes from. I have also seen the name "Jung Super Buffer" (from his article). Many IC's have this diamond buffer, LT1223, BUF634, LME49600 and many more.

This buffer can be used in a preamp as line stage without gain, as a buffer for DAC's and CD-players. You can also use it for driving headphones. The buffer is rather small and very thin so it can be placed in narrow spaces.

There are lot's of good info out there on this subject. Walter Jung has written a couple of good articles and one of them is about this particular buffer. In fact his article is THE best for a normal DIY'er. Reference articles

Realizing High Performance: Buffers (Part I)

Realizing High Performance: Buffers (Part II) <http://www.elecdesign.com/Globals/PlanetEE/Content/2800.html>

The ancient LH0002 is also a simple diamond buffer. The equally ancient LH0033 consists of a JFET buffer.

AN-47 from Linear is a big document, very well written. Look especially at page 45-47. Those pages describes a discrete diamond buffer.

AN-227 from National is also worth reading.

This Texas document has also a part about diamond buffers. The schematics

The picture shows the schematics of the amp. Of course you can't use it for anything except for an overview. Please download the pdf-file instead if you want to see the details. The design fits in only one schematic page. {mospagebreak title=Circuit description}Circuit description

I have chosen to use current generators with cascodes as emitter loads. How much good the cascodes do is unknown at the moment. The only obvious disadvantage is a little bit reduced output voltage swing, otherwise only positive things.

The current in the first stages is set by Q1, Q3 and Q2, Q4 along with R6 and R7. I have transistors as diodes just to make it simpler when it comes to ordering parts. The current is  $0.65/220 = 3 \text{ mA}$  and the output stage will have approx. 6 mA. The class A circuit will have 1.5 mA. My choice of currents is "average", because you both increase them and also decrease them. The max current is set by the max allowable power dissipation of the transistors. The small SOT23 types can take 310mW or so and the SOT223, output transistors can dissipate 1.3 W but not in this application I imagine. More current mean slightly higher speed.

The input filter R5, C1 may be necessary if you are having trouble with RF interference. The values can be set to almost anything. The frequency is calculated by  $f = 1/(2 \cdot \pi \cdot R5 \cdot C1)$ .

Please note that this buffer has no current limitation in order to protect the circuit so a short circuit may damage the output transistors. The buffer is intended to be used in controlled environments. If your load is unknown you may add a resistor at the output, 220 ohms or higher.

{mospagebreak title=The pcb layout} The pcb layout

Click on the picture to see a preview of the pcb. The component print

The picture shows the component print of the PCB. Of course you can't use it for anything except for an overview. Please download the pdf-file instead if you want to see the details.

The printed circuit board is made for one channel. It requires stabilized power supply.

The pcb have groundplane on the lower (solder) side (not shown in pictures) which is essential in order to get good results.

Almost everyone of the traces are on the solder side. The groundplane is very covering, only a few traces on the solder side. The component side

The picture shows the component side of the PCB. Of course you can't use it for anything except for an overview. Please download the pdf-file instead if you want to see the details.

Almost everyone of the traces are on the component side as you can see. The groundplane is on the solder side. Welcome to Per-Anders Sjöström's hifi pages.

{mospagebreak title=Building directions} Building directions Patch for board Revision 0.

The new boards have unfortunately two errors. Top side

Top side patch

The base of Q9 needs to be connected to the base or collector of Q5.

Solder side, bottom side

Solder side patch

The base the collector of the Q6 needs to be connected to the base of Q10. The pcb is seen from the bottom side. Building instructions for the prototype boards Since the board isn't debugged yet, build in small pieces and then test

Test supply voltage is +- 15 V. Reference voltage

Solder Q1, Q3, Q5, R4, Q6, Q4, Q2, R1, R2, R3. Then apply +- 15 volts. Measure that you have 0.6 volts between base and emitter on each transistor. PNP emitter follower

Solder R7, Q7, Q9, R9 and Q11. R5, a tin blob. Tie the input to ground. Measure that the emitter voltage to ground at Q11. Should be 0.6V. Measure the voltage across R7. Should be 0.6V. R9 27 mV.NPN emitter follower

Solder R6, Q8, Q10, R8 and Q12. Tie the input to ground. Measure that the emitter voltage to ground at Q12. Should be 0.6V. Measure the voltage across R6. Should be 0.6V. R8 27 mV.Output stage

Solder Q15, R11-R13, Q16. Tie the input to ground. Measure the output voltage. Should be i mV's. Measure the voltage across the R11-R13. Should be something. Load the outout with 1 kohms. Measure now the same thing.

This design is very easy to build. You should start with all low SMD parts. Solder in the electrolytic caps at last. For this solder job I recommend a good pair of tweezers. I use a type especially made for SMD. With this pair of tweezers I get a very good grip. You must also have a soldering iron with a small tip but.

Make sure if you want the class A circuit or not, Q13, Q14, R14, R15. Determine also if you want any of the R1, R2 or R3 resistors. If you don't want the input filter just short R5 with tin or a small wire. Start with all low SMD parts

- Resistors
- Transistors
- Capacitors, not the electrolytic ones
- Then continue with the high electrolytic caps
- Wires    Check the finished amp

Apply voltage and check the output voltage. Measure the DC voltage at the output. It should be the specified offset voltage, a couple of millivolts.

Measure the quiescent current.

The whole buffer is ready.

Good luck and happy listening.

{mospagebreak title=Technical data}Technical data

Click on the picture to see a preview of the pcb. Frequency response: 0 Hz - 100 MHz(?), more than 10 MHz Frequency response with input filter 0 Hz - 1.29 MHz, -3 dB Power bandwidth at 7 Vrms, 50 ohms: 0 Hz - 100 MHz(?), more than 10 MHz Equivalent input noise: 0,6  $\mu$ V Signal to noise ratio: 124 dB at 1 V out Dynamic headroom: 141 dB Distortion: 0,002% Slew rate:3000 V/us

Step response: Perfect without overshoot Gain: 0.999 (0 dB) Input impedance: >1 Mohms, pullup, pulldown resistors not included. Output impedance: 2.5 ohms Output current: 1 A peak Supply voltage: +- 6 to 24 V DC with chosen transistors Dimensions: 21.7 (0.852") x 32.0 (1,261") mm