

# The First Watt B1 Buffer Preamp

Nelson Pass, June 2008

## Side A

So here we are in the New Millennium, and thanks to Tom Holman and THX we've got lots of gain in our electronics. More gain than some of us need or want. At least 10 db more.

Think of it this way: If you are running your volume control down around 9 o'clock, you are actually *throwing away* signal level so that a subsequent gain stage can make it back up.

Routinely DIYers opt to make themselves a "passive preamp" - just an input selector and a volume control.

What could be better? Hardly any noise or distortion added by these simple passive parts. No feedback, no worrying about what type of capacitors – just musical perfection.

And yet there are guys out there who don't care for the result. "*It sucks the life out of the music*", is a commonly heard refrain (really - I'm being serious here!). Maybe they are reacting psychologically to the need to turn the volume control up compared to an active preamp.

I suppose if I had to floor the accelerator to drive 55 mph, maybe I'd think the life was being sucked out of my driving. Then again, maybe I like 55. Nice and safe, good gas mileage...

Is impedance matching an issue? Passive volume controls do have to make a trade-off between input impedance and output impedance. If the input impedance is high, making the input to the volume control easy for the source to drive, then the output impedance is also high, possibly creating difficulty with the input impedance of the power amplifier. And vice versa: If your amplifier prefers low source impedance, then your signal source might have to look at low impedance in the volume control.

This suggests the possibility of using a high quality buffer in conjunction with a volume control. A buffer is still an active circuit using tubes or

transistors, but it has no voltage gain – it only interposes itself to make a low impedance into a high impedance, or vice versa.

If you put a buffer in front of a volume control, the control's low impedance looks like high impedance. If you put a buffer after a volume control, it makes the output impedance much lower. You can put buffers before and after a volume control if you want.

The thing here is to try to make a buffer that is very neutral. Given the simple task, it's pretty easy to construct simple buffers with very low distortion and noise and very wide bandwidth, *all without negative feedback*.

There are lots of different possibilities for buffers, but we are going to pick my favorite:

## Side B

Figure 1 shows the full schematic of the B1 buffered passive preamp.

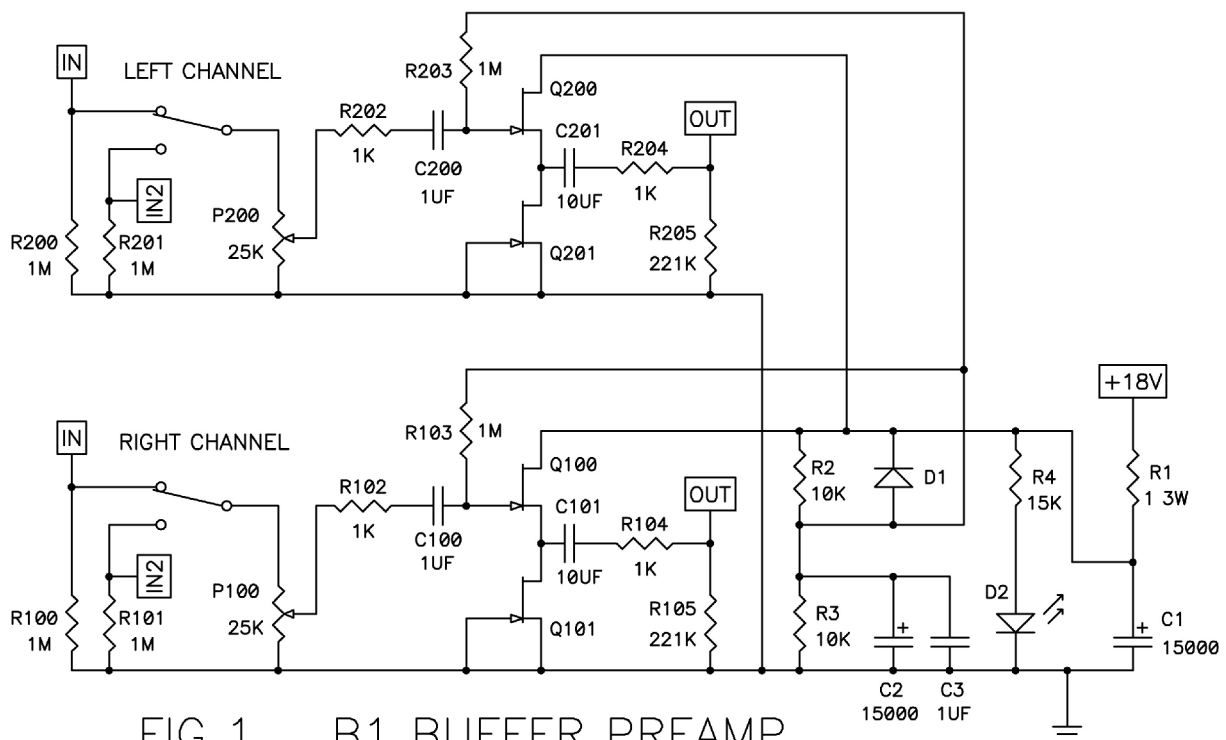


FIG 1 B1 BUFFER PREAMP

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There are two channels shown with a common power supply. Supply parts in common are numbered from 1 to 99. Parts in the right channel are 100 to 199, and the left channel is 200 to 299.

With the exception of R1, all the resistors are ¼ watt – I used RN55D types, but you can use whatever you like. C1 and C2 are big electrolytic types, with a nominal rating of 15000 uF at 25 Volts. C100, 200, 101 and 201 are high quality film capacitors. You can use these values or substitute in your favorites.

For C1 and C2 I used Digikey P6890-ND. The value is not critical, and you can use as low as 1,000 uF at 25V. C3, C100 AND C200 are 1 uF metallized polypropylene film capacitors (Digikey BC2076-ND) C101 and C201 are 10 uF polyester film capacitors (I used Axon 10 uF metallized polypropylene from Orca Design). Feel free to use any comparable types.

D1 is a generic 1N914 type diode, and D2 is a generic LED for indicating power the board.

All of the transistors are N channel JFETs. The stock parts are 2SK170's, LSK170's or 2SK370's, and you can use substitutes having Idss between than 5 and 10 milli-Amps and transconductance numbers from 5 to 30 milli-Siemens.

The potentiometers are linear taper at 25 Kohm, but again you can easily use higher or lower values as you like.

The buffer uses an external power supply from 18 to 24 Volts DC. You can power it with batteries, but most convenient is an external regulated supply running off the wall. The preamp typically draws fewer than 0.02 Amps, so current is not much of an issue. A regulated supply is better, but the circuit is pretty good at ignoring noise on the supply and minor fluctuations.

The design uses RCA input and output connectors, and a DPDT switch for selecting one of two inputs. You are, of course, free to use a switch with many more inputs.

For a fact this circuit can be easily constructed with perf-board and point-to-point wiring. I know, however, that many people won't start a project like this without a circuit board. The Gerber artwork is posted at [www.passdiy.com](http://www.passdiy.com) and I have arranged to have finished PC boards available at cost around the time you read this.

## Side C

Let's talk about what some of these parts do.

The input switch selects one of the two input signals, routing it to the top (clockwise position) of potentiometers P100 or P200. A divided input signal appears on the wiper. This signal goes to the Gates of Q100 and Q200 through a resistor R102, R202 and capacitor C100, C200. As a practical matter, the input impedance of this preamp is determined by this volume control potentiometer. A 25 K Ohm pot gives 25 K Ohm input impedance.

R102 and R202 are there to prevent parasitic oscillation with the very wide bandwidth JFETs. C100 and C200 are there because the Gate of the JFETs needs to be set at  $\frac{1}{2}$  the DC voltage of the power supply – a voltage delivered to the buffer inputs by R2, R3, and C2 through R103 or R203.

D1 performs the service of drawing down this DC voltage with the power supply when the power is turned off, otherwise C2 may hold a charge for a long enough time to give you a turn-on thump when powered back on. By the way, the time constant of R2, R3, and C2 are long enough that it takes a minute or two for the circuit to reach normal operating values, so don't get excited if there's no sound for a few seconds when you turn it on.

R1 and C1 filter noise coming from the external supply.

Q100 and Q200 are JFETs operated as follower transistors. The Source pins of these transistors follow the voltage at the Gates. The input impedance of the Gate is exceedingly high – many millions of ohms, and the output impedance at the Source pin is about 50 ohms.

Q101 and Q201 are constant current sources formed by simply attaching the Gate pins of the JFETs to the Drain pins. They provide without loading them down or creating significant distortion.

The best performance generally comes from matching the  $I_{dss}$  of Q100 and Q101, and also Q200 and Q201. The  $I_{dss}$  is simply the current that flows through the JFET when the Gate and Source are grounded and +10 volts or so is applied to the Drain. Often when you buy JFETs you can get them in  $I_{dss}$  grades. I use GR or BL grades for this project.

The Source DC voltage of the JFETs Q100 and Q200 is about the same as the Gate DC voltage (1/2 the supply voltage), and the output from the Source needs to have the DC voltage removed by C101 or C201, leaving the AC output signal, which passes through another safety resistor R104 or R204.

Resistors R100, R200, R105, R205 are there to prevent the various potential thumps from switching inputs and turn-on transients.

## Side D

The circuit of Figure 1 has quite good performance specifications.

Figure 2 shows the distortion at 1KHz. Below a volt, the distortion comes in at about .0007%, and about the time your amp is clipping, it measures about .003%

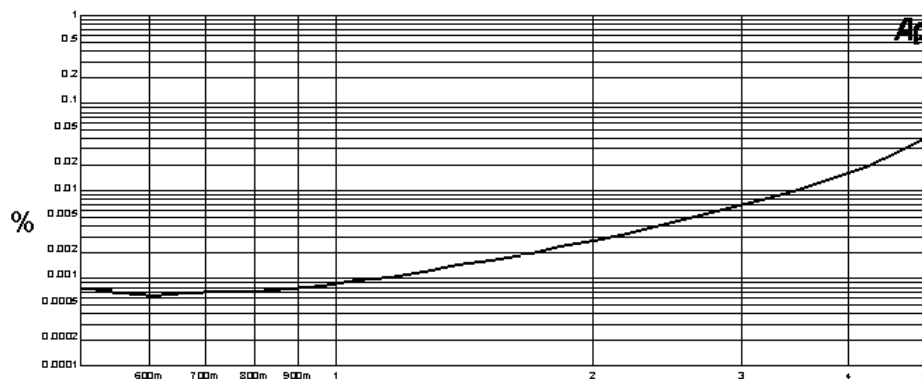


FIG 2 DISTORTION VS OUTPUT VOLTAGE

Figure 3 shows the .0007% distortion waveform at 1 Volt and 1 Khz.

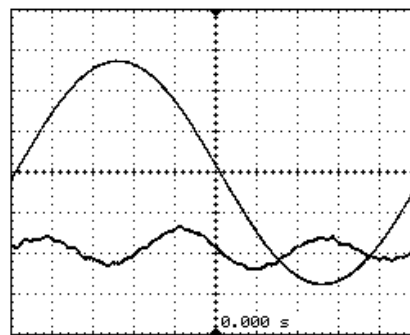


FIG 3 DISTORTION WAVEFORM  
1 VOLT, 1 KHZ, 0.0007%

Figure 4 shows the distortion vs frequency. It does not alter over the audio band.

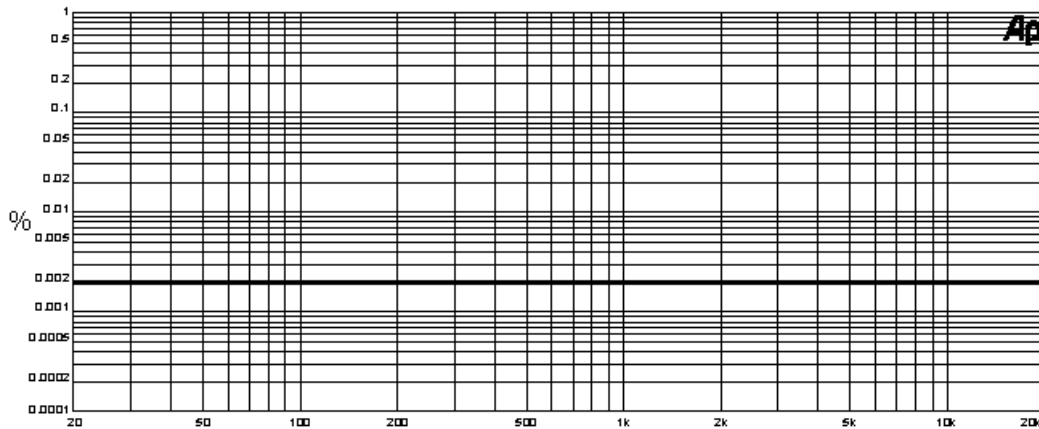


FIG 4 DISTORTION VS FREQUENCY

Figure 5 shows a 100 KHz square wave at 1 volt at the output. The bandwidth of the preamp is -3dB at about 700 KHz. On the bottom end, the low frequency roll-off is about 1.5 Hz into a 10 Kohm load and about 0.3 Hz into 47 Kohm.

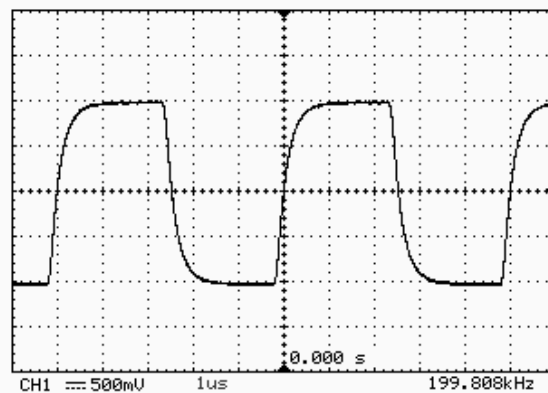


FIG 5 200 KHZ SQUARE WAVE

## Side E

So how does it sound? Well, no suckage here. I've noticed that simple no-feedback circuits have tremendous clarity if the circuit has wide bandwidth and really low distortion.

At the moment I'm driving a pair of Lowther DX55's with some passive baffle-step correction (6 dB loss there) and an F3 amp with only 12.5 dB voltage gain. The preamp is fed by an Xono phono stage with a low output cartridge (Grado Statement).

The sound is extremely neutral without being clinical - just about what you were looking for when you were thinking about a passive preamp. A teensy bit of second harmonic and no noise at all.

There's just enough gain. If you were using any other power amp, you'd get 8 to 18 dB more gain, and would be able to break your lease or the speaker, or both.

Do I feel like the *pedal's to the metal* and I'm only doing 55?

No - I'm listening as loud as I want and I sleep soundly at night, knowing that I'm not throwing away signal with my volume control.

## **Side F**

Have you noticed that they're putting out some LP's with not just 2, not just 4, but with 6 sides holding the content of a CD?

It's *Sweeeet*. Two cuts to a side, and when you look at the grooves you can see the land area between them. Right now I'm listening to "High Fidelity Lounge", vol 4, Side F.