Using BA2018 Line Stage with MUSES Volume Controls

By Dr. Lenny Novikov

Building a good audio line stage is an art of its own. No wonder, the great sounding fast discrete opamp presented by Wayne Colburn at the BA 2018 event was immediately embraced by the DIY community.

Those familiar with the transparency and purity of the High-End audio sound also know how much it depends on the quality volume control. One of the great solutions would be to use a resistive ladder with a multi-position rotary switch. While it provides ultimate sonic purity, the large physical size, high cost and the lack of reasonable remote control options renders this solution impractical.

A great audio volume control chip from the NJR MUSES team provides a dual channel resistive ladder with 0.5dB steps and a digital control. It was highly praised and successfully used by Nelson Pass in several highly acclaimed preamps. The VCU and VCM modules from AcademyAudio.com make use of the MUSES72320 chip the most clean way with no extra elements in the audio path, and provide Volume, Balance and Mute functions from a single knob and a dedicated IR remote control unit.

It is not a coincidence that the BA2018 circuit presents the best match for the MUSES volume control chip. The BA2018 circuit has a JFET input and an exceptional linearity that allows taking full advantage of the low noise and high linearity of the MUSES volume control. This Application Note provides guidelines on how to integrate the MUSES Volume Control boards with the BA2018 line stage.

The original BA2018 Circuit

The original BA2018 Line Stage circuit as published by Mr. Colburn is shown below at Figure 1.

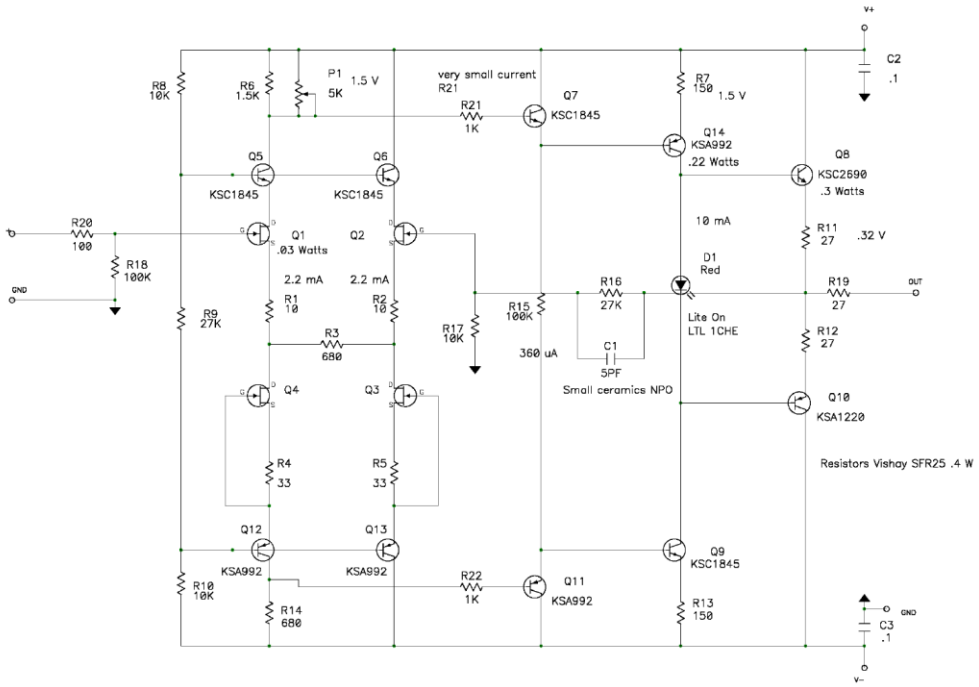

Figure 1. Original BA2018 Line Stage circuit.

Matching the MUSES Volume Control

A MUSES Volume control chip can be presented as a dual 20K digitally controlled potentiometer with a precise logarithmic taper. To preserve the precision of the logarithmic control curve, the input impedance of the circuit immediately following the volume control chip shall be sufficiently high. The table of Figure 2 shows an error magnitude depending on the value of the loading impedance.

R_load, kOhm	Volume Control Position	
	0dB to -32dB	-32dB to -112dB
	Error, dB	**Error, dB**
10	-4.08	-2.28
20	-2.28	-1.21
47	-1.04	-0.54
100	-0.51	-0.26
200	-0.26	-0.13
1000	-0.05	-0.03

Figure 2. Volume Control Error.

Note the 100K value of the BA2018 input resistor **R18**. According to Table 2, it will produce an error of more than 0.5dB. We recommend changing the **R18** resistor value to **470K**. This change does not affect either the noise floor or the linearity of the BA2018 circuit.

The other recommended change concerns the power supply voltage.

The original BA2018 line stage is powered from a dual +/-15… +/-22Vdc power supply. Our MUSES enabled modules require +/-10…+/-16Vdc to operate.

While it looks natural to power both circuits from a dual +/-15Vdc power supply, it was noted that the BA 2018 provides better performance at +/-18…+/-20Vdc. To move the “sweet spot” operation point to +/-13…+/-15V we changed the **R15** value to **68K** to keep the standing current through Q9 and Q14 at 10mA, and through Q8 and Q10 at about 12mA.

The new values for **R15** and **R18** must be implemented for both Left and Right channels.

Referring to Figure 3 below, note extra components added to the positive and negative power rails of each BA2018 board. Referring to the Left channel, the RC filter **R101 C14** on the **V+** rail, and the **R103 C15** on the **V-** rail improve transient response of the line stage and increase channel separation. Some of the available PCBs for 2018 may already have these components installed. There is no need to duplicate them.

Final BA2018 + VCU/VCX Circuit

The circuits of **Fig. 3** and **Fig.4** present complete ultra linear dual channel audio preamp solutions.

The resulting preamp circuit is DC coupled, providing low distortion performance from DC to 100kHz. If optional DC blocking capacitors C10 and C11 are installed, the -3dB frequency range is 0.2Hz – 100kHz.

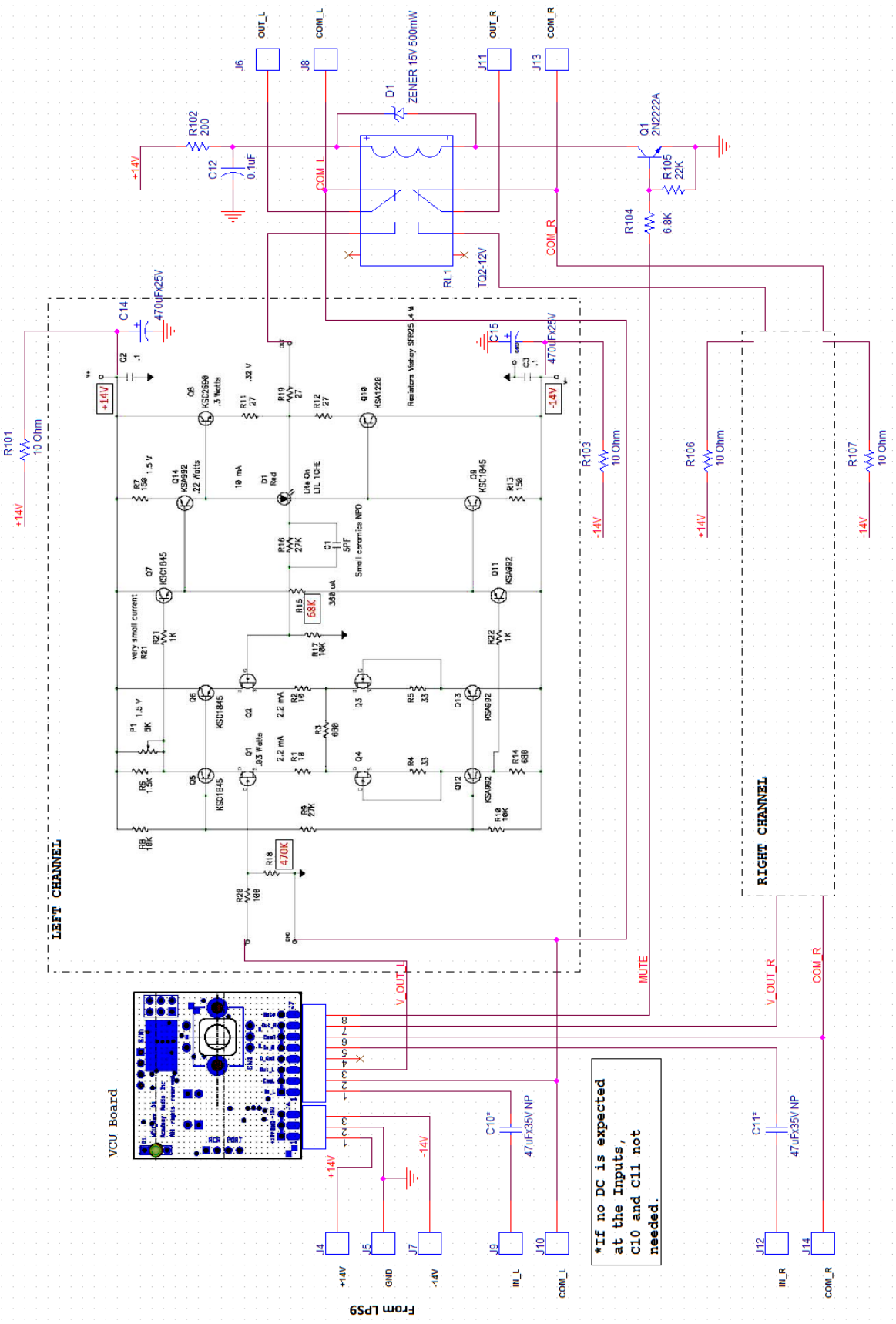

Figure 3. Complete BA2018 + VCU Circuit.

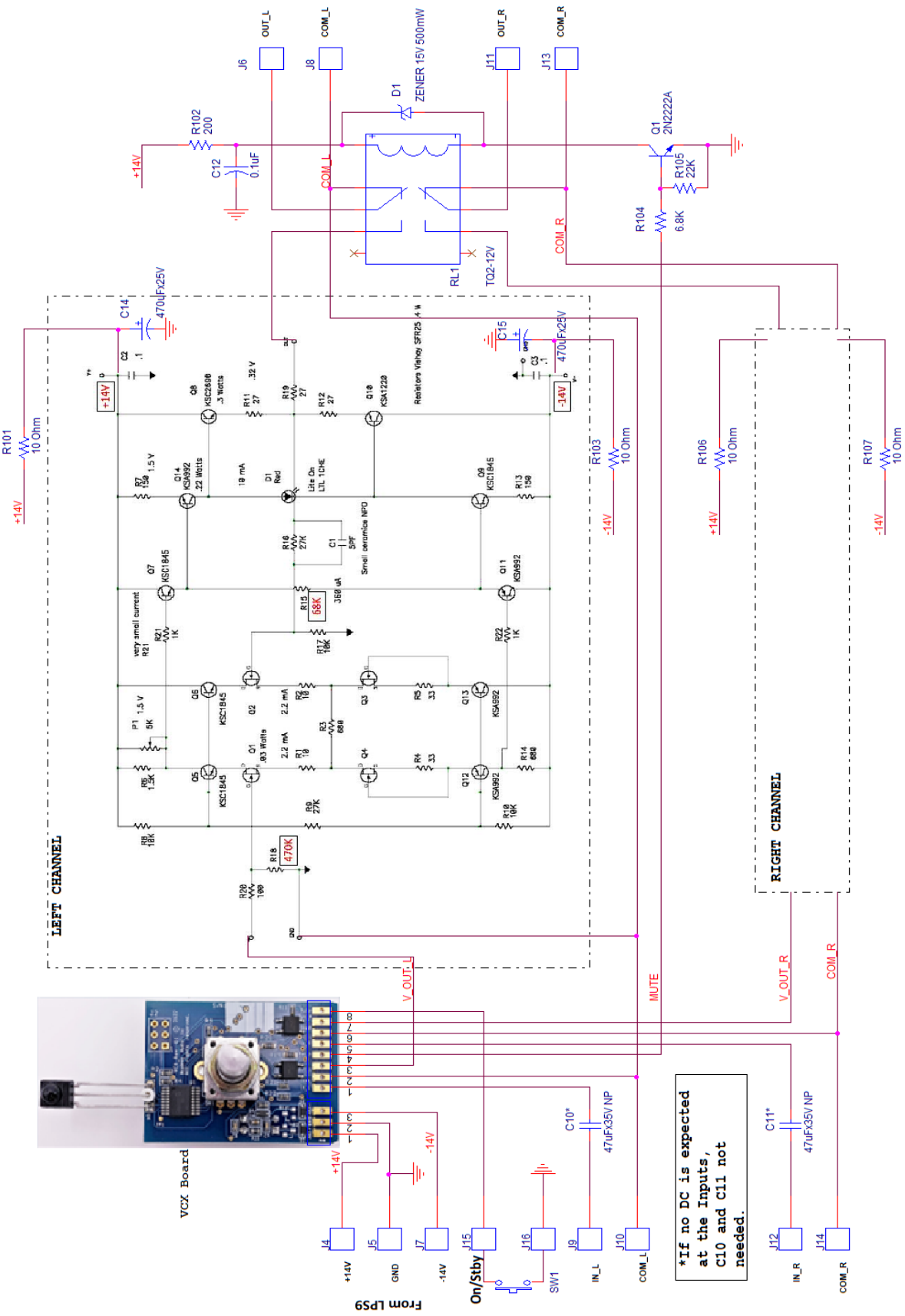

Figure 4. Complete BA2018 + VCX Circuit. Note the On/Standby switch (optional).

Muting Relay Circuit

A Muting relay with a delayed turn on is provided to eliminate possible power-up/power-down noises.

The VCU board provides a control signal (active High) for the Muting relay with a 1.5 seconds delay at start-up and turns off the relay immediately when powered down. Any good quality 12V rated signal relay can be used as RL1. The TQ2-12V non-latching signal relay from Panasonic is widely available and proven to work well for this application. The relay takes less then 12mA to operate and does not degrade sound quality. The proposed circuit was calculated for this particular relay type.

A low power NPN transistor Q1 drives the Muting relay RL1 from the +14V power through the voltage drop resistor R18. A Zener diode D1 with a capacitor C14 take care of the inductive properties of the relay coil.

Any 12Vdc DPDT signal relay with working current less than 60mA can be used in this circuit. R18 value should be adjusted to accommodate the relay current change as follows:

$$R18(\text{Ohms}) = 2V/(\text{relay current, Amp})$$

The muting relay circuitry is optional and may be omitted if no power-up/power-down noises are observed.

Note on Power Supply

Two BA2018 circuits required for the dual channel audio application, draw about 70mA total per rail. The VCU volume control board with an LED display draws about 25mA from a positive rail, and less than 10mA from the negative one.

Some of the LPS9 low noise power supply properties make it a great match for this application. It provides sufficient current in excess of 300mA per rail, while keeping the noise below 10uV and providing very low output impedance in the audio frequency range. Any electromagnetic artifacts that may be picked up by the audio circuitry lie well above 200 kHz, and do not affect sonic quality.
Any substitute power supply should provide similar specs to achieve comparable sonic results.

Using BA2018 with Preamps

The BA2018 circuits modified as described above may be used to upgrade the opamps used in the line stage of the SE and Balanced preamps offered by Academy Audio. The corresponding **ISS** and **ISB** boards provide convenient solder pads to connect an outboard line stage.

To use the BA2018 with the ISS board:

1. Remove the opamp U2 from the socket.
2. Remove resistors R28, R30, R38 and R39 from the ISS board
3. Connect two BA2018 boards to the ISS board test points as follows.

ISS Board	BA2018 Boards
TP10	+Vcc, Both Channels
TP11	-Vcc, Both Channels
TP2	Left Channel Input
TP1	Left Channel Output
TP12	Left Channel Common
TP4	Right Channel Input
TP5	Right Channel Output
TP13	Right Channel Common

To use the BA2018 with the ISB board:

1. Remove the opamp U12 from the socket.
2. Remove resistors R86 and R93 from the ISB board.
3. Connect two BA2018 boards to the ISB board test points as follows.

ISB Board	BA2018 Boards
TP8	+Vcc, Both Channels
TP13	-Vcc, Both Channels
TP10	Left Channel Input
TP9	Left Channel Output
TP14	Left Channel Common
TP11	Right Channel Input
TP12	Right Channel Output
TP15	Right Channel Common

Conclusion

The BA2018 line stage offers a great way to step up the performance of the audio preamps, when combined with a MUSES enabled volume control and an ultra low noise power supply.

Happy Listening!