Simple DC buffer/amplifier circuit

**Purpose:**
Enables simultaneous measurements of sample voltage and noise, where the latter is made using either a SR550 or SR552 preamp. Using this buffer/amplifier one can decouple noise (60Hz, rf, etc) present on the inputs of a DAQ card or a multimeter that would otherwise corrupt the noise measurement.

**Layout and Integration:**
Assemble circuit on a breadboard with a DIP socket for convenient swapping of the AD620 in event of failure. Use +-20 V supply voltage used to power the SR preamps. This power supply can be from either home-made power supplies or the power output from the SR lockin or the SR spectrum analyzer. Circuit board must fit inside the iron-box. Add holes to back panel of iron box for an isolated BNC for circuit output and a 9-pin D-SUB connector for supplying power to circuit board. Connections between circuit board and BNC and 9-pin D-SUB are made using a terminal block mounted onto the circuit board. The circuit board is 2.75 wide, 2.0 inches deep, and rests on 1 inch tall ceramic standoffs. See figures below and separate circuit diagram.
AD620 on DIP socket

rotary switch

voltage regulators w/ electrolytic input capacitors

Terminal block

Voltage regulator output decoupling caps
Components:
AD620AN: Analog Devices instrumentation amplifier
LT7812: +12 Volt regulator (TO-220 package)
LT7912: -12 Volt negative voltage regulator (TO-220 package)
3.3 microFarad, 25 Volt electrolytic for 7812 series input
0.1 microFarad, bipolar metal film for 7812 series output
10 microFarad, 35 Volt electrolytic for 7912 series input
1 microFarad, bipolar metal film for 7912 series output
49.9 kOhm resistor for gain
Miniature rotary switch for changing gain (e.g. Alcoswitch brand)
8 or 16 pin DIP socket
8 position screw terminal block connector
Isolated BNC and 9-pin DSUB connector for iron box
GAIN SELECTION
The AD620’s gain is resistor programmed by \( R_G \), or more precisely, by whatever impedance appears between Pins 1 and 8. The AD620 is designed to offer accurate gains using 0.1%–1% resistors. Table II shows required values of \( R_G \) for various gains. Note that for \( G = 1 \), the \( R_G \) pins are unconnected (\( R_G = \infty \)). For any arbitrary gain \( R_G \) can be calculated by using the formula:

\[
R_G = \frac{49.4 \, k\Omega}{G - 1}
\]

To minimize gain error, avoid high parasitic resistance in series with \( R_G \); to minimize gain drift, \( R_G \) should have a low TC—less than 10 ppm/°C—for the best performance.

<table>
<thead>
<tr>
<th>1% Std Table Value of ( R_G ), ( \Omega )</th>
<th>Calculated Gain</th>
<th>0.1% Std Table Value of ( R_G ), ( \Omega )</th>
<th>Calculated Gain</th>
</tr>
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<tr>
<td>49.9 k</td>
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<td>49.3 k</td>
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<td>49.9</td>
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</tr>
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</table>
7800 series voltage regulator shown above. I increased the input cap to 3.3 microFarad. Output cap remained the same.
7900 series voltage regulator shown above. I increased the input cap to 10 microFarad. The output cap stayed the same.

Lessons learned:
1. Metal film (bipolar) caps are needed on the outputs of the voltage regulators to prevent AD620 amplifier from oscillating. This is standard practice. Strangely, the caps are essential only on the negative voltage regulator in my circuit layout.
2. Be sure to scrap off residual flux between adjacent solder pads on circuit board.
3. Be sure the negative terminal of the electrolytic cap is connected to the Vinput terminal of the 7900 voltage regulator. This is the correct polarity configuration since Vinput is negative.

Revision History:
February 01, 2007  original