LT1994
Low Noise, Low Distortion, Fully Differential Amplifier/Driver

DESCRIPTION

Demonstration circuit 961 features an LT®1994, low noise, low distortion, fully differential amplifier. The LT1994 is a high precision, very low noise, low distortion, fully differential input/output amplifier (see Table 1). The LT1994's output common mode voltage is independent of the input common mode voltage, and is adjustable by applying a voltage on the V_{OCM} pin. The DC961 board contains an LT1994 amplifier configured as a unity gain differential amplifier with 499Ω feedback and input resistors. Gains greater than one require changing the input resistors to a value lower than 499Ω (refer to Figure 2). In addition, DC961 has surface mount pads and traces for resistors and capacitors for building first and second order fully differential filter circuits. The differential outputs of DC961 can be configured with a first order RC network for driving the differential inputs of an analog-to-digital converter (ADC).

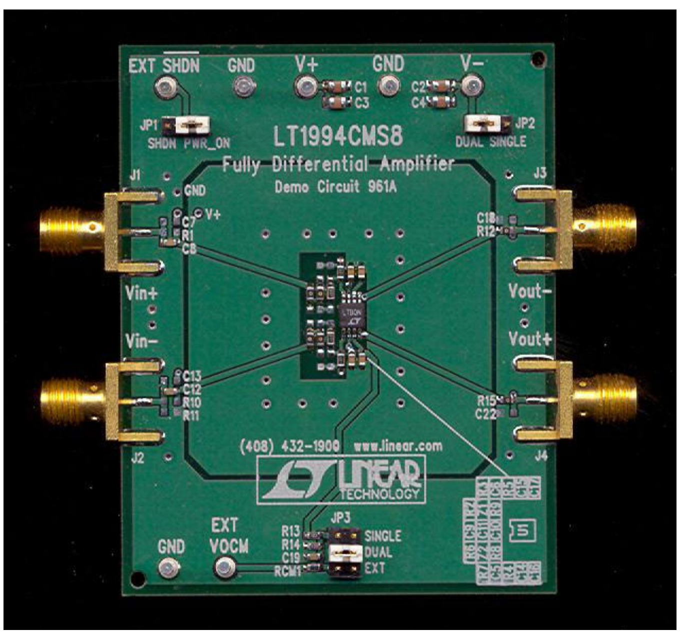

Figure 1. DC961B

Connection to the differential input and output of a DC961 is through SMA connectors. Onboard jumpers configure the DC961 for dual or single power supply operation. The differential input of a DC961 is AC coupled with 1μF capacitors for ease of use as a dual or a single supply circuit. DC coupling to the DC961 input is provided through the shorting of the input capacitors with 0Ω surface–mount resistor jumpers.

Table 1. LT1994 Noise and Distortion

Differential Input Referred Voltage Noise Density	$3nV/_{RT}Hz$
Distortion, $2V_{P-P}$ Differential Input, V_S = 3V, f_{IN} = 1MHz, R_{LOAD} = 800Ω 2nd Harmonic 3rd Harmonic	 99dBc 96dBc

Design files for this circuit board are available at http://www.linear.com/demo/DC961B

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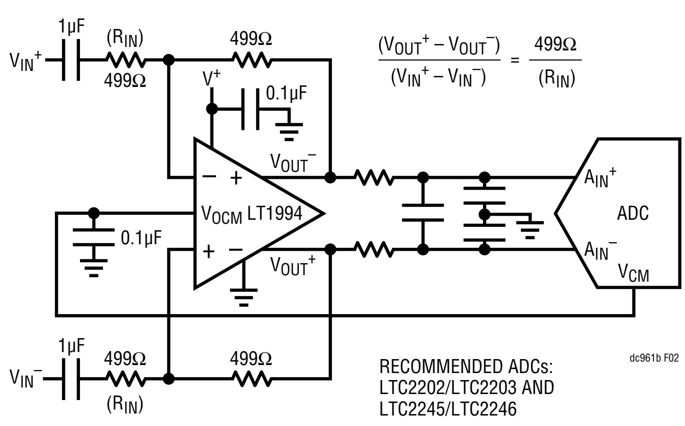

Figure 2. Typical Application for an LT1994

QUICK TEST PROCEDURE

A. Single-Ended Input to Differential Output

1. Connect to a DC961 a dual power supply, a function generator and an oscilloscope as shown in Figure 3 (the 50Ω termination on J2 input is used to balance the 50Ω generator impedance on J1 input).
2. Set the function generator for a $1V_{P-P}$, 100kHz sinewave and turn on the power supply.
3. The channel 2 input of the oscilloscope is in phase with the DC961 input and the channel 1 input is 180 degrees out of phase with the DC961 input. The single-ended output shown on channel 1 or 2 is a $0.5V_{P-P}$ sinewave (a $1V_{P-P}$ differential output).

Note 1: The LT1994 can directly drive at least a 25pF capacitive load at each output. However the LT1994 can drive directly a low frequency sinewave (100kHz or less) into a capacitive load of up to 100pF. In this Quick Test Procedure, the output signal is a sinewave and each LT1994 output drives the capacitance of a 24 inch or less cable plus the input capacitance of the oscilloscope input, a capacitive load of 70pF (30pF per foot for the coax cable and 10pF for the oscilloscope input). For testing the transient response of the LT1994 to a squarewave or a pulse, use a 10x low capacitance oscilloscope probe to monitor the DC961 output at J3 or J4.

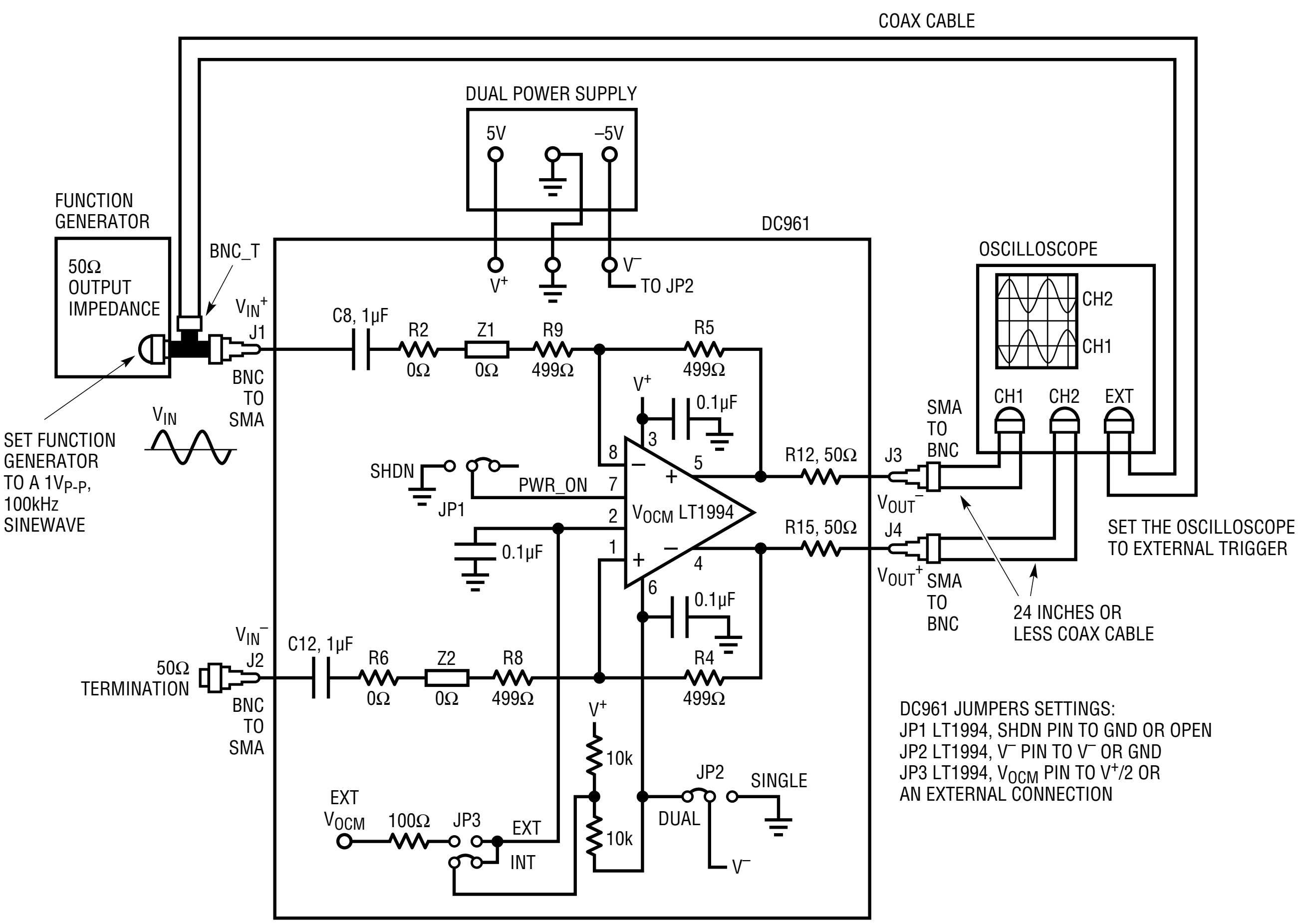

Figure 3. Single-Ended Input to Differential Output Quick Test Setup

QUICK TEST PROCEDURE

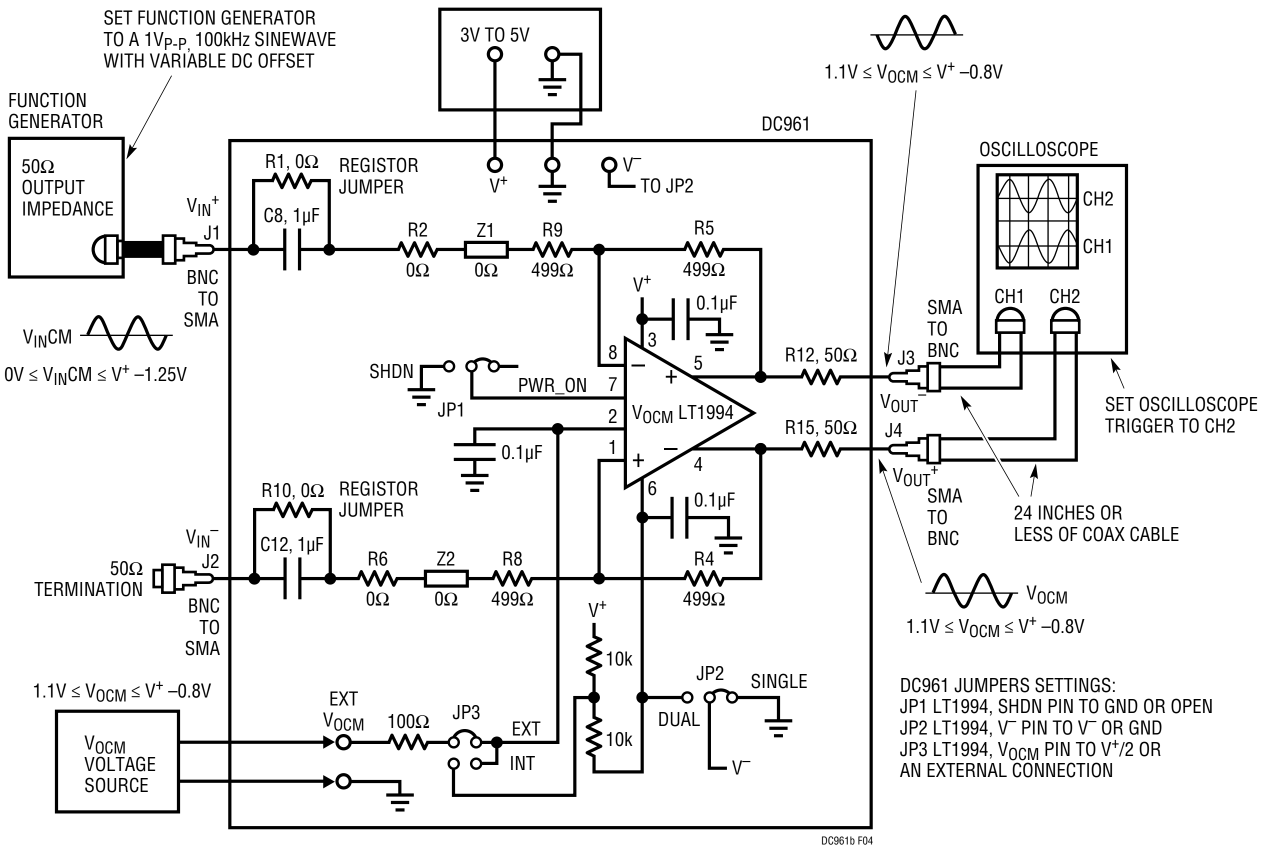

Figure 4. Input and Output Common Mode Quick Test Setup

B. DC Coupled Inputs and Output Common Mode Voltage Adjustment

1. On the DC961, install 0603 0Ω resistors at R1 and R10 to short input capacitors C8 and C12 respectively (see DC961 schematic).
2. Connect DC961 as shown in Figure 4 (JP1 to PWR_ON, JP2 to SINGLE, and JP3 to EXT V_{OCM}).
3. Apply an input signal with a DC offset ($V_{IN}CM$) 0V to V^+ –1.25V. The output common mode (V_{OCM}) can be set independently of the $V_{IN}CM$ from 1.1V to V^+ –0.8V. This adjustment is made by applying a DC voltage at EXT V_{OCM}.

QUICK TEST PROCEDURE

C. Driving the Analog Inputs of an ADC

Figure 5 shows the DC961 output components when driving an ADC. Optimum values for the DC961 output components when driving an LTC2202/LTC2203 or LTC2245/LTC2246 ADC.

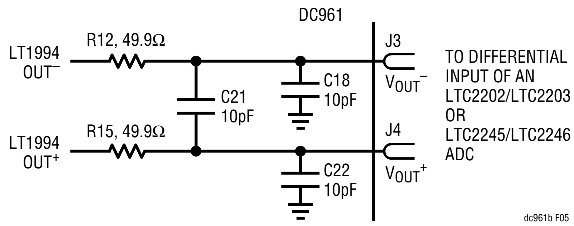

Figure 5. DC961 Output Component Values

D. Using a DC961 to Implement a Fully Differential, Second Order Lowpass Filter.

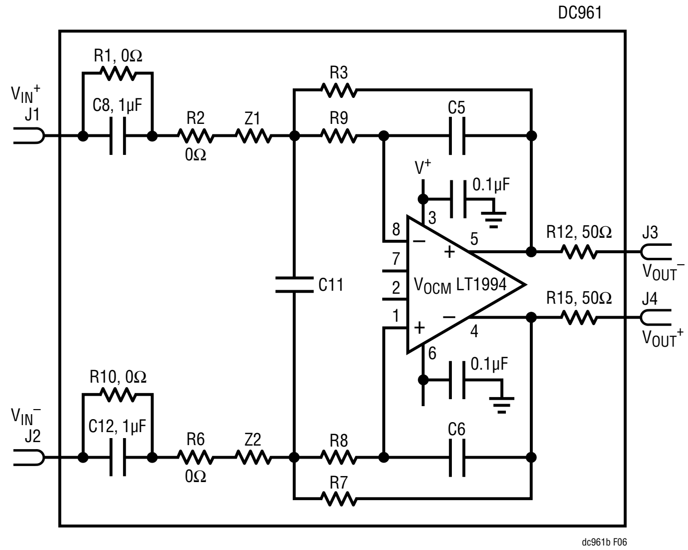

Figure 6. A DC961 Configured as a Second Order Lowpass Filter

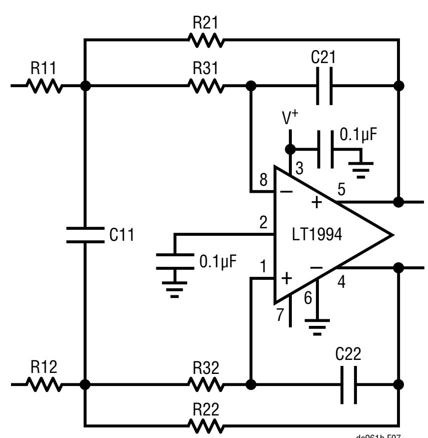

Figure 7. Fully Differential, 2nd Order, Lowpass Filter Design Schematic

QUICK TEST PROCEDURE

Design Procedure

The following procedure is from the LT1994 data sheet. The design schematic resistor and capacitor designators have the following correspondence with the DC961 resistor and capacitor designators:

Design Schematic	DC961
R11	Z1
R21	R3
R31	R9
C11	C11
C21	C5
C22	C6
R12	Z2
R22	R7
R32	R8

Differential 2nd Order Butterworth Lowpass Filter

$$f_{3dB} \le 2.5\text{MHz and Gain} \le 8.8 \text{ or Gain} \le \frac{2.5\text{MHz}}{f_{3dB}}$$

Component Calculation:
R11 = R12, R21 = R22, R31 = R32, C21 = C22, C11 = 10 • C21, R1 = R11, R2 = R21, R3 = R31, C2 = C21 and C1 = C11

1. Calculate an absolute value for C2 ($C2_{abs}$) using a specified –3dB frequency

$$C2_{abs} = \frac{4 \bullet 10^5}{f_{3dB}} \left(C2_{abs} \text{ IN pF AND } f_{3dB} \text{ IN kHz}\right)$$

2. Select a standard 5% capacitor value nearest the absolute value for C2(C1 = 10 • C2)

3. Calculate R3, R2 and R1 using the standard 5% C2 value, the specified f_{3dB} and the specified passband gain (G_N):

   R1, R2 and R3 equations (C2 in pF and f_{3dB} in kHz)

$$R3 = \frac{\left(1.121 - \sqrt{(1.131 - 0.127 \bullet G_N)}\right) \bullet 10^8}{(G_N + 1) \bullet C2 \bullet f_{3dB}}$$

$$R2 = \frac{1.266 \bullet 10^{15}}{R3 \bullet C2^2 \bullet f_{3dB}^2} \qquad R1 = \frac{R2}{G_N}$$

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