

## Interfacing the **ADL5375** I/Q Modulator to the **AD9779A** Dual-Channel, 1 GSPS High Speed DAC

### CIRCUIT FUNCTION AND BENEFITS

This circuit provides a simple, elegant interface between the **ADL5375** I/Q modulator and the **AD9779A** high speed digital-to-analog converter (DAC). The **ADL5375** and the **AD9779A** are well matched devices because they have the same bias levels and similarly high signal-to-noise ratios (SNRs). The matched bias levels of 500 mV allow a glueless interface—there is no

requirement for a level shifting network, which adds noise and insertion loss along with extra components. The addition of the swing limiting resistors (RSLI, RSLQ) allows the DAC swing to be scaled appropriately without loss of resolution or of the 0.5 V bias level. The high SNR of each device preserves a high SNR through the circuit.

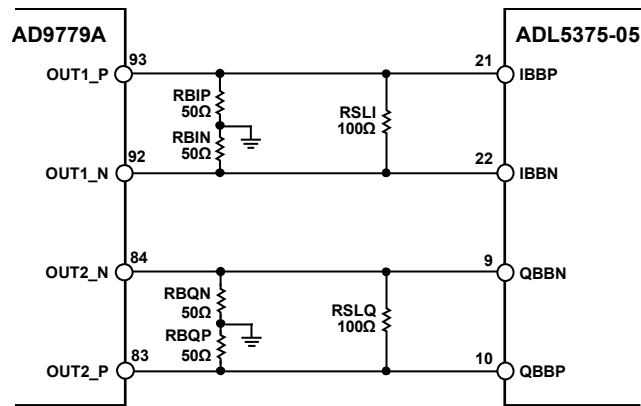


Figure 1. Interface Between the **AD9779A** and **ADL5375** with 50 Ω Resistors to Ground to Establish the 500 mV DC Bias for the **ADL5375** Baseband Inputs (Simplified Schematic)

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**REVISION HISTORY**

**10/2016—Rev. A to Rev. B**

Document Title Changed from CN0021 to AN-1425..... Universal  
Changes to Circuit Description Section..... 3

**5/2009—Rev. 0 to Rev. A**

Updated Format..... Universal

**10/2008—Revision 0: Initial Version**

**CIRCUIT DESCRIPTION**

The [ADL5375](#) is designed to interface with minimal components to members of the Analog Devices, Inc., family of TxDAC® converters. The baseband inputs of the [ADL5375](#) require a dc common-mode bias voltage of 500 mV. With each [AD9779A](#) output swinging from 0 mA to 20 mA, a single 50 Ω resistor to ground from each of the DAC outputs provides the desired 500 mV dc bias. With only the four 50 Ω resistors in place, the voltage swing on each pin is 1 V p-p, which results in a differential voltage swing of 2 V p-p on each input pair.

By adding the RSLI and RSLQ resistors to the interface, the output swing of the DAC can be reduced without any loss of DAC resolution. The resistor is placed as a shunt between each side of the differential pair, as shown in Figure 1. It has the effect of reducing the ac swing without changing the dc bias already established by the 50 Ω resistors.

The value of this ac swing limiting resistor is chosen based on the desired ac voltage swing. Figure 2 shows the relationship between the swing limiting resistor and the peak-to-peak ac swing that it produces when 50 Ω bias setting resistors are used. Note that all Analog Devices I/Q modulators present a relatively high input impedance on their baseband inputs (typically >1 kΩ). As a result, the input impedance of the I/Q modulator has no effect on the scaling of the DAC output signal.

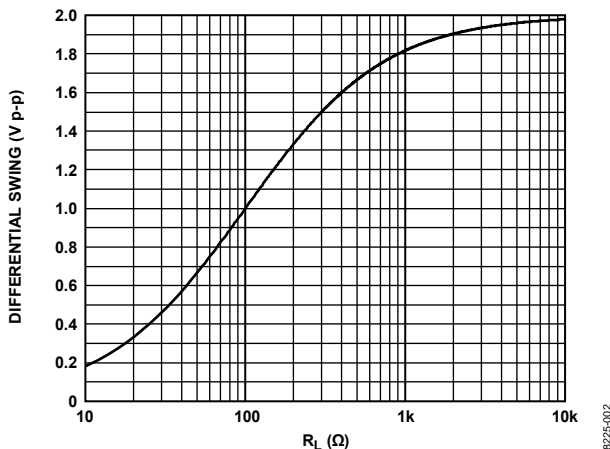


Figure 2. Relationship Between the AC Swing Limiting Resistor and the Peak-to-Peak Voltage Swing with 50 Ω Bias Setting Resistors

It is generally necessary to low-pass filter the DAC outputs to remove image frequencies when driving a modulator. The previously mentioned interface lends itself well to the introduction of such a filter. The filter can be inserted between the dc bias setting resistors and the ac swing limiting resistor. Doing so establishes the input and output impedances for the filter.

A simulated filter example is shown in Figure 3 with a third-order elliptical filter with a 3 dB frequency of 10 MHz. Matching input and output impedances makes the filter design easier; therefore, the shunt resistor chosen is 100 Ω, producing an ac swing of 1 V p-p differential for a 0 mA to 20 mA DAC full-scale output current.

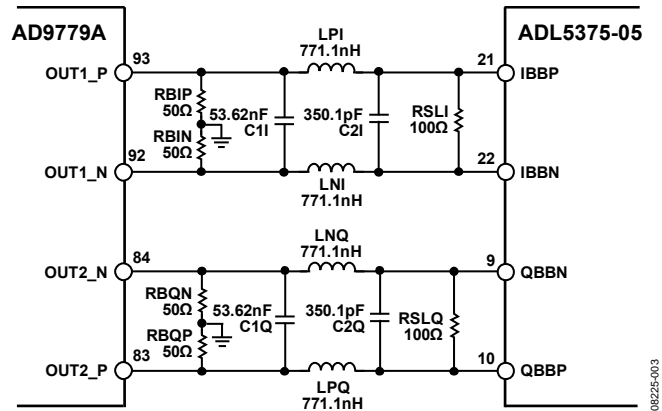


Figure 3. DAC Modulator Interface with 3 MHz Third-Order, Low-Pass Filter (Calculated Component Values)

The simulated frequency response of this filter is shown in Figure 4. In a practical application, the use of standard value components along with the input impedance of the I/Q modulator (2900 kΩ in parallel with a few picofarads of input capacitance) slightly changes the frequency response.

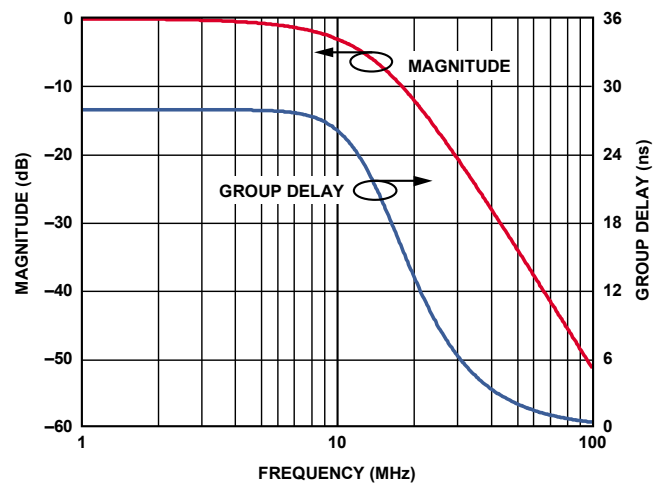


Figure 4. Simulated Frequency Response for DAC Modulator Interface with 10 MHz Third-Order Bessel Filter

All the power supply pins of the [ADL5375](#) must be connected to the same 5 V source. Adjacent pins of the same name can be tied together and decoupled to a large area ground plane with a 0.1 μF capacitor. These capacitors must be located as close as possible to the device. The power supply can range between 4.75 V and 5.25 V.

The COMM pins must be tied to the same ground plane through low impedance paths. The exposed paddle on the underside of the package must also be soldered to a low thermal and electrical impedance ground plane. If the ground plane spans multiple layers on the circuit board, they must be stitched together with nine vias under the exposed paddle. The [AN-772 Application Note](#) discusses the thermal and electrical grounding of the LFCSP in greater detail.

## COMMON VARIATIONS

The interface described in this application note can be used to interface any TxDAC converter with ground referenced 0 mA to 20 mA output currents to any I/Q modulator with a 0.5 V input bias level. For zero-IF applications, the [AD9783](#) dual DAC provides an LVDS interface, while the CMOS driven [AD9788](#) dual DAC can generate a fine resolution complex IF input to the I/Q modulator. The [ADL5370/ADL5371/ADL5372/ADL5373](#) family of I/Q modulators provides narrow-band operation with high output 1 dB compression point and OIP3, whereas the [ADL5375](#) provides broadband high performance operation from 400 MHz to 6 GHz. The [ADL5385](#) I/Q modulator uses a  $2 \times$  LO and operates from 50 MHz to 2.2 GHz.

## REFERENCES

- [AN-772](#) Application Note. *A Design and Manufacturing Guide for the Lead Frame Chip Scale Package (LFCSP)*. Analog Devices.
- [MT-016](#) Tutorial. *Basic DAC Architectures III: Segmented DACs*. Analog Devices.
- [MT-017](#) Tutorial. *Oversampling Interpolating DACs*. Analog Devices.
- [MT-031](#) Tutorial. *Grounding Data Converters and Solving the Mystery of 'AGND' and 'DGND'*. Analog Devices.
- [MT-080](#) Tutorial. *Mixers and Modulators*. Analog Devices.
- [MT-101](#) Tutorial. *Decoupling Techniques*. Analog Devices.
- Zumbahlen, Hank. Chapter 4 and Chapter 11, in *Basic Linear Design*. Analog Devices, 2006. ISBN 0915550281.  
(Also available as Chapter 4 and Chapter 11, in *Linear Circuit Design Handbook*. Elsevier-Newnes, 2008. ISBN 0750687037.)