

# LTC6409 High Speed, Low Noise/Distortion Differential ADC Drivers

## DESCRIPTION

Demonstration circuit 1591A features the [LTC®6409](#) differential ADC driver. It incorporates a variety of passive components to support configurations for varied applications. On this board, two amplifier circuits are provided. One is single-ended, the other is a differential input and output. There is also a calibration circuit to de-embed the effects of other circuit components.

The LTC6409 is a high-speed differential amplifier with superior distortion and low noise suitable for demanding communications transceivers, cellular base-stations, and other high-speed signal chain applications. These fully-

differential amplifiers accept single-ended or differential inputs with almost no difference in distortion performance. Each part has the ability to adjust the output common-mode voltage without any additional components and flexible input common-mode ranges, which enable input signal DC coupling and level-shifting for ADC driving applications.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC1591A>**

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## QUICK START PROCEDURE

Table 1 shows the function of each SMA connector on the board. Refer to Figure 1 for the connection diagram and follow the procedure below:

1. Connect the power supply to V+ and GND as shown in Figure 1. Typical current consumption of each LTC6409 is about 52mA. Jumper JP1 enables or shuts down the single-ended amplifier.
2. The power supply voltage range is shown in Figure 1. **Do not exceed the maximum power supply voltage rating for the parts.**
3. Apply an input signal to J1. A low distortion, low noise signal source with an external high order filter will yield the best performance. The J1 input is impedance matched to 50Ω.
4. Observe the output via J2. The output is impedance matched to 50Ω, suitable for the input of a network or spectrum analyzer.

**Table 1: DC1591A Board I/O Descriptions**

CONNECTOR	FUNCTION
J1 (IN)	Single-ended Input. Impedance matched to 50Ω, drive from a 50Ω network analyzer or signal source.
J2 (OUT)	Single-ended Output. Impedance matched to 50Ω, can be used to drive a 50Ω network/spectrum analyzer input.
J3 (CAL IN)	Calibration Input. Impedance matched to 50Ω, pairing with J4 for calibration.
J4 (CAL OUT)	Calibration Output. Impedance matched to 50Ω, pairing with J3 for calibration to de-embed the effects of other circuit components.
J5 (IN+)/ J6 (IN-)	Differential Inputs. They are impedance matched to 300Ω differentially. Signal can be driven from preceding receiver signal chain (i.e., Mixer or I/Q Demodulator).
J7 (OUT-)/ J8 (OUT+)	Differential Outputs. They are impedance matched to 100Ω differentially.
JP1 (SHDN1)	Shutdown Jumper. The lower (EN) position enables the single-ended amplifier circuit, while the upper (DIS) puts the amplifier into shutdown mode.
JP2 (SHDN2)	Shutdown Jumper. The lower (EN) position enables the differential amplifier circuit, while the upper (DIS) puts the amplifier into shutdown mode.
E4 (VOCM)	Output Common Mode Adjust. By default, this pin is self-biasing within U1 and U2. Override this voltage with other DC voltage source as required.

## QUICK START PROCEDURE

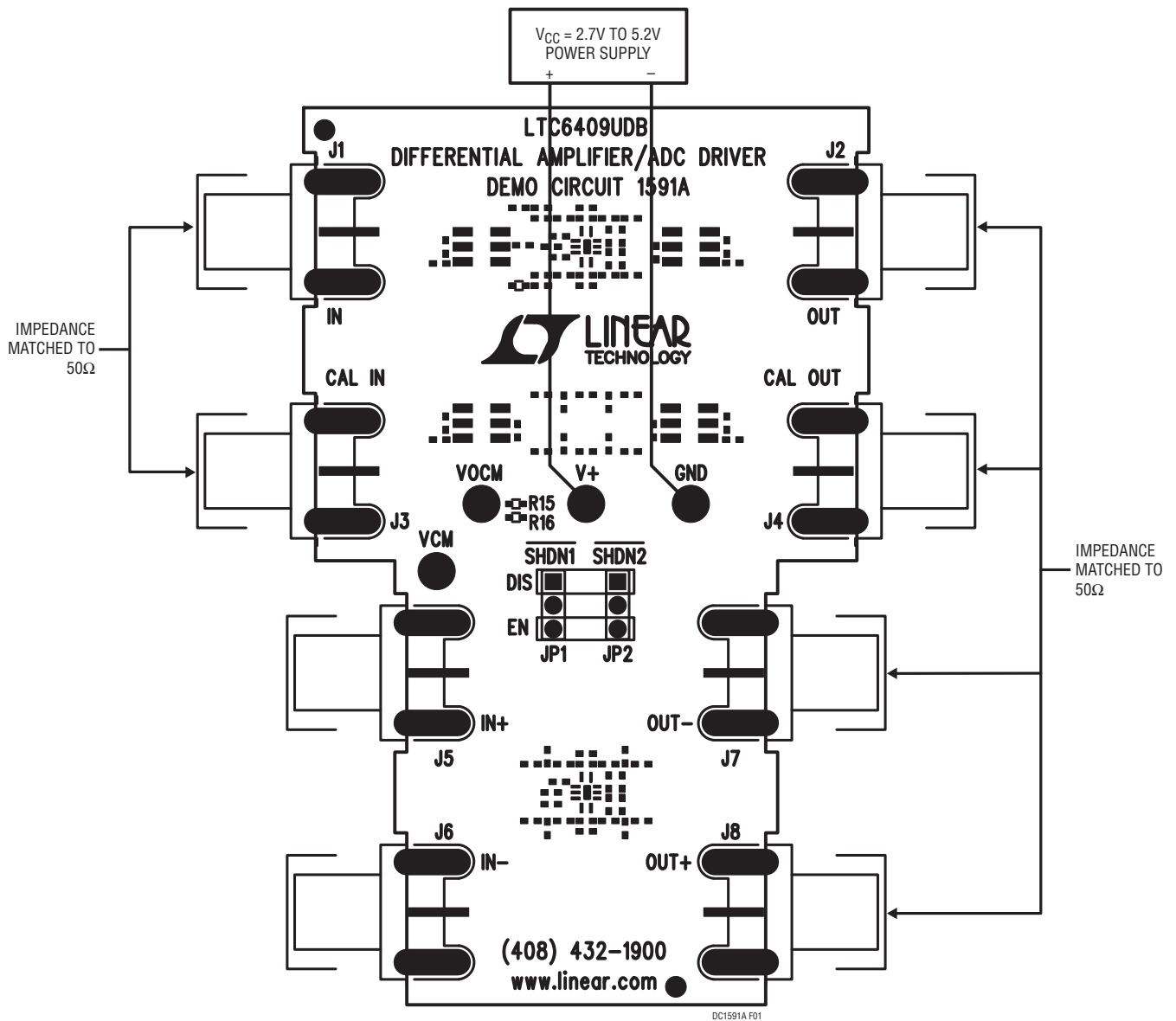


Figure 1. Proper Measurement Equipment Setup

## ADDITIONAL INFORMATION

The DC1591A demo board is ready for use out of the box. A single-ended and a differential amplifier circuit are provided for ease of use and with minimum modification.

### DEMO BOARD VERSIONS

#### Single-Ended Input and Output Configuration

**J1:** The single-ended input can be driven from a 50 $\Omega$  signal source or network analyzer (usually port 1).

**J2:** The single-ended output can be connected to spectrum analyzer or network analyzer (usually port 2).

#### Differential Inputs and Outputs Configuration

**J5 and J6:** Differential inputs. Typically, signal input to these ports are from a receiver signal chain such as a mixer or I/Q demodulator.

**J7 and J8:** Differential outputs. These ports can drive directly into the differential inputs of an ADC.

### DRIVING THE INPUTS DC-COUPLED

It is possible to configure the DC1591A inputs differentially with DC coupling. Transformer T1 should be removed, and C23 and C24 connections should be replaced with 0 $\Omega$  resistors. The inputs are now DC-coupled and can be driven single-ended or differentially (resistor values may be changed to balance the source impedances, et cetera). See the product data sheet for more information. Note input bias currents will flow through the amplifier's input resistors if DC1591A is driven DC-coupled.

### CHANGING THE OUTPUT COMMON-MODE VOLTAGE

Turret E4 (VOCM) controls the output common mode voltage of U1 and U2. E4 can be used to level-shift the DC output voltage for optimum system performance. If used for this purpose, transformer T2 should be removed, and C18 and C19 connections can be replaced by 0 $\Omega$  resistors to allow the DC bias to reach the output. By default, the VOCM voltage is self-biased through resistors internal to the IC's (U1 and U2).

### OUTPUT DRIVE

Each amplifier circuit on the demo board is designed to have a 50 $\Omega$  source impedance at its output to facilitate direct connections to 50 $\Omega$  terminated test instruments.

### ENABLE (SHUTDOWN)

Jumper JP1 and JP2 control the enable function of U1 and U2, respectively, on DC1591A. When set to the EN position, the part will be on and draws normal operating current. In the DIS position, the part will be in shutdown and draws a very small amount of leakage current.

### GROUND AND V<sub>CC</sub> CONNECTIONS

DC1591A's GND connector is not only connected to V– of the LTC6409, it also serves as the demo board ground. For best result, a low impedance return path to the power supply from GND is recommended. Short, low impedance wires to the V+ and GND connectors of DC1591A will yield the best performance from the LTC6409.

### SCHEMATIC NOTES

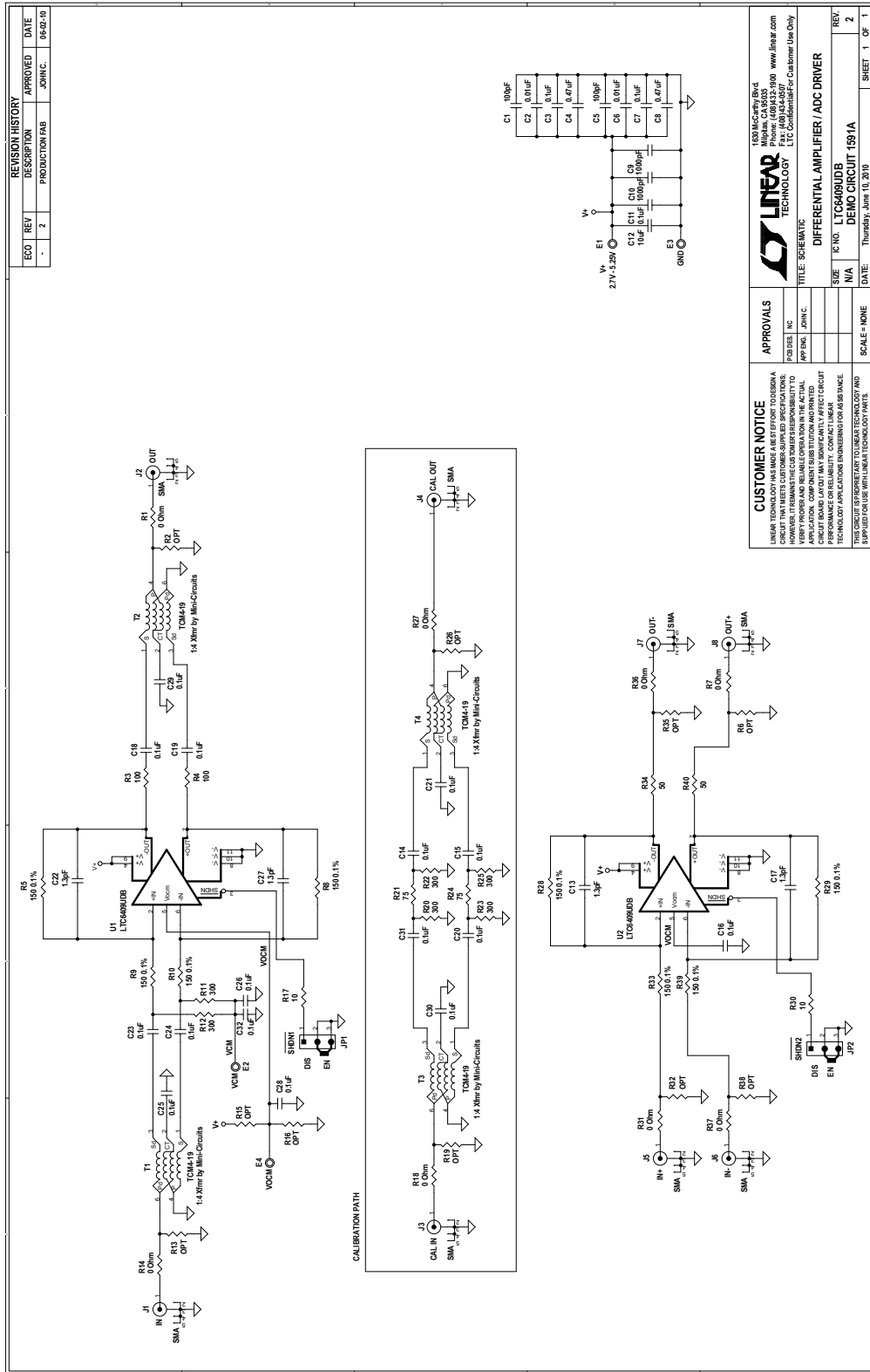
Note that transformer T2 and the series resistors at the amplifier outputs form a 12.6dB attenuation (if the output has a 50 $\Omega$  load) that will affect the measured gain of the demo board. This is done so that the output of DC1591A can plug directly into a 50 $\Omega$  network/spectrum analyzer input, while the amplifier sees a higher 400 $\Omega$  load impedance.

# DEMO MANUAL DC1591A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	2	C1, C5	CAP. CHIP, X7R, 100pF, 50V, 10%, 0402	AVX, 04025C101KAT
2	2	C2, C6	CAP. CHIP, X7R, 0.01μF, 16V, 10%, 0402	AVX, 0402YC103KAT
3	19	C3, C7, C11, C14, C15, C16, C18, C19, C20, C21, C23, C24, C25, C26, C28, C29, C30, C31, C32	CAP. CHIP, X7R, 0.1μF, 16V, 10%, 0402	AVX, 0402YC104KAT
4	2	C4, C8	CAP. CHIP, X5R, 0.47μF, 10V, 10%, 0402	MURATA, GRM155R61A474KE15D
5	2	C9, C10	CAP. CHIP, X7R, 1000pF, 25V, 10%, 0402	AVX, 04023C102KAT
6	1	C12	CAP. CHIP, X5R, 10μF, 10V, 10%, 0805	AVX, 0805ZD106KAT
7	4	C13, C17, C22, C27	CAP. CHIP, X7R, 1.3pF, 25V, 10%, 0402	AVX, 04023J1R3ABWTR
8	3	E1, E3, E4	TESTPOINT, TURRET, 0.065" PBF	MILL-MAX, 2308-2-00-80-00-00-07-0
9	0	E2 (OPT)	TESTPOINT, TURRET, 0.065" PBF	MILL-MAX, 2308-2-00-80-00-00-07-0
10	2	JP1, JP2	HEADER, 3 PINS, 2mm	SAMTEC, TMM-103-02-L-S
11	2	JP1, JP2	SHUNT, 2mm CENTER	SAMTEC, 2SN-BK-G
12	8	J1, J2, J3, J4, J5, J6, J7, J8	CON., SMA 50Ω EDGE-LANCH	CONNEX, 132357 / 142-0701-851
13	8	R1, R7, R14, R18, R27, R31, R36, R37	RES., CHIP, 0Ω 1/16W, 1%, 0402	YAGEO, RC0402FR-070RL
14	0	R2, R6, R13, R15, R16, R19, R26, R32, R35, R38	RES., CHIP, 0402 (OPT)	
15	2	R3, R4	RES., CHIP, 100Ω 1/16W, 1%, 0402	YAGEO, RC0402FR-07100RL
16	8	R5, R8, R9, R10, R28, R29, R33, R39	RES., CHIP, 150Ω 1/16W, 0.1%, 0402	YAGEO, RT0402BRE07150RL
17	6	R11, R12, R20, R22, R23, R25,	RES., CHIP, 300Ω 1/16W, 1%, 0402	YAGEO, RC0402FR-07300RL
18	2	R17, R30	RES., CHIP, 10Ω 1/16W, 1%, 0402	YAGEO, RC0402FR-0710RL
19	2	R21, R24	RES., CHIP, 75Ω 1/16W, 1%, 0402	YAGEO, RC0402FR-0775RL
20	2	R34, R40	RES., CHIP, 49.9Ω, 1/16W, 1% 0402	VISHAY, CRCW040249R9FKED
21	4	T1, T2, T3, T4	TRANS., TCM4-19 SURFACE MOUNT	MINI CIRCUITS, TCM4-19
22	2	U1, U2	DIFFERENTIAL AMPLIFIER/ADC DRIVER	LINEAR TECH., LTC6409UDB
23	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT # DC1591A
24	2		STENCIL – TOP & BOTTOM	DC1591A

## SCHEMATIC DIAGRAM



**CUSTOMER NOTICE**  
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**TITLE: SCHEMATIC**  
**DIFFERENTIAL AMPLIFIER / ADC DRIVER**

SIZE: 12 IN. x 18 IN.  
 DATE: Thursday, June 10, 2010  
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# DEMO MANUAL DC1591A

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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