



# 9- and 11-Channel, Muxed Input LCD Reference Buffers

## AD8509/AD8511

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### FEATURES

Single-supply operation: 3.3 V to 6.5 V  
High output current: 300 mA  
Low supply current: 6 mA  
Stable with 1000 pF loads  
Pin-compatible with LMC6009  
Pin-compatible with CL-FP6131  
48-lead, Pb-free, TSSOP package

### APPLICATION

LCD line inversion gamma references

### FUNCTIONAL BLOCK DIAGRAM

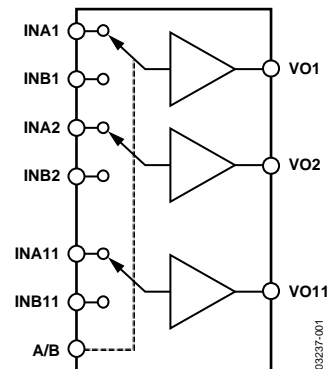


Figure 1.

### GENERAL DESCRIPTION

The AD8509 and AD8511 are 9-channel and 11-channel LCD reference buffers, respectively, designed to drive 64 gray scale column drivers. Each buffer has an A/B input to select between two voltages for LCD displays. These buffers drive the resistor ladders of LCD column drivers for gamma correction. These LCD drivers have higher slew rates and higher output drive currents than similar competitive parts. This increases the stability of the reference ladder, resulting in better gray scale and visual performance.

The AD8509 and AD8511 are specified over the  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range. They are available in 48-lead, thin shrink small outline (TSSOP), surface-mount, Pb-free packages in tape and reel.

### PIN CONFIGURATIONS

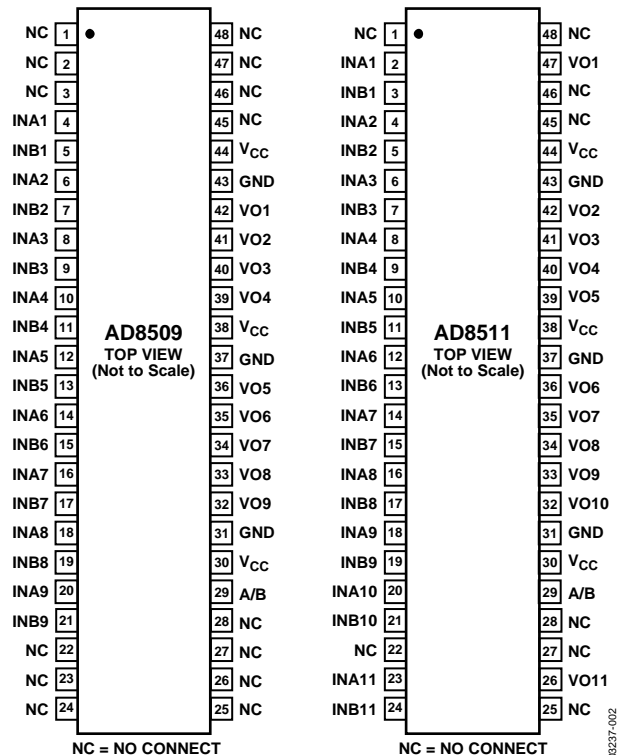


Figure 2. AD8509 and AD8511 48-Lead TSSOP (RU Suffix)

### Rev. B

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## REVISION HISTORY

### 1/05—Rev. A to Rev. B

Changed Maximum Operating Voltage.....	Universal
Change to Features List.....	1
Changes to Specifications Table.....	3
Changes to Ordering Guide .....	8

### 9/04—Rev. 0 to Rev. A

Format Updated.....	Universal
Added Pb-Free Part.....	Universal
Changed Temperature Range.....	Universal
Changed Applications Section.....	1
Changes to Ordering Guide .....	8

### 10/97—Revision 0: Initial Version

## SPECIFICATIONS

### ELECTRICAL CHARACTERISTICS

$V_S = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	$V_{OS}$				20	mV
Input Bias Current	$I_B$				50	nA
Voltage Gain	$A_{VO}$		0.985			V/V
OUTPUT CHARACTERISTICS						
Output Voltage High	$V_{OH}$	$I_{LOAD} = +20\text{ mA}$	4.8			V
Output Voltage Low	$V_{OL}$	$I_{LOAD} = -20\text{ mA}$			200	mV
Output Short-Circuit Current	$I_{SC}$		120	350		mA
POWER SUPPLY						
Load Regulation		$V_{IN} = 0.5\text{ V} - 4.5\text{ V}$ , $I_{SOURCE} = 20\text{ mA}$ $V_{IN} = 0.5\text{ V} - 4.5\text{ V}$ , $I_{SINK} = 20\text{ mA}$		7		mV
Supply Current	$I_{SY}$	AD8509, $V_{IN} = 2.5\text{ V}$ AD8511, $V_{IN} = 2.5\text{ V}$		7		mV
	$I_{SY}$				8.5	mA
	$I_{SY}$				10	mA
Supply Voltage Range	$V_S$		3.3		6.5	V
DYNAMIC PERFORMANCE						
Slew Rate		$C_L = 15\text{ pF}$ $R_L = 250\ \Omega$		7		V/ $\mu\text{s}$
				6.2		V/ $\mu\text{s}$
Settling Time	$t_S$	IDC = 13 mA (sink/source)		3	6	$\mu\text{s}$
LOGIC INPUT CHARACTERISTICS						
Input Current Low	$I_{IL}$				1.0	$\mu\text{A}$
Input Current High	$I_{IH}$				1.5	$\mu\text{A}$
Input Voltage Low	$V_{IL}$				0.8	V
Input Voltage High	$V_{IH}$		2.0			V

## ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Supply Voltage	7 V
Input Voltage	GND to $V_S$
Storage Temperature Range	
RU Package	–65°C to +150°C
Operating Temperature Range	–40°C to +85°C
Junction Temperature Range	
RU Package	–65°C to +150°C
Lead Temperature Range (Soldering, 60 sec)	300°C

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; the functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 3.

Package Type	$\theta_{JA}$ <sup>1</sup>	$\theta_{JC}$	Unit
48-lead Pb-free TSSOP (RU)	115	42	°C/W

<sup>1</sup>  $\theta_{JA}$  is specified for the worst-case conditions, that is,  $\theta_{JA}$  is specified for devices soldered in circuit boards for surface-mount packages.

Table 4. MUX Function

A/B Select (Pin 29)	Input
Logic High	INAx
Logic Low	INBx

## ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



## TYPICAL PERFORMANCE CHARACTERISTICS

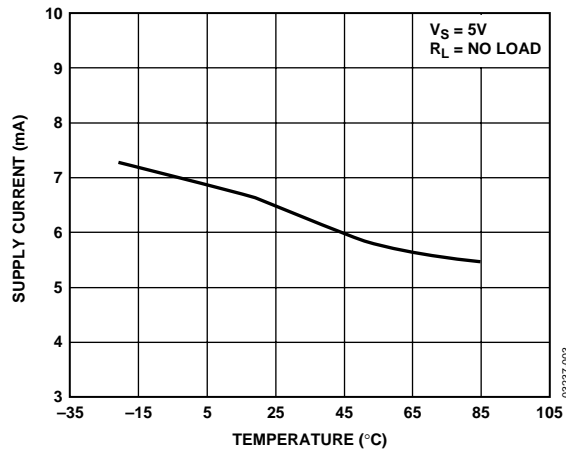


Figure 3. Supply Current vs. Temperature

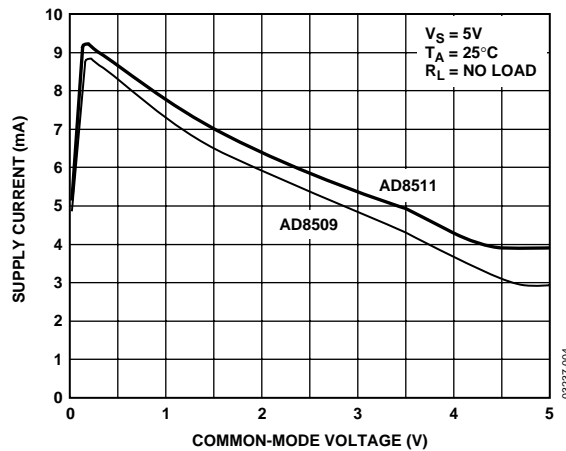


Figure 4. Supply Current vs. Common-Mode Voltage

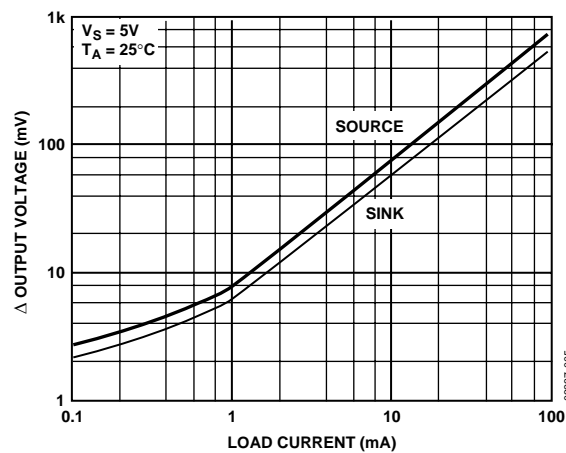


Figure 5. Output Voltage to Supply Rail vs. Load Current

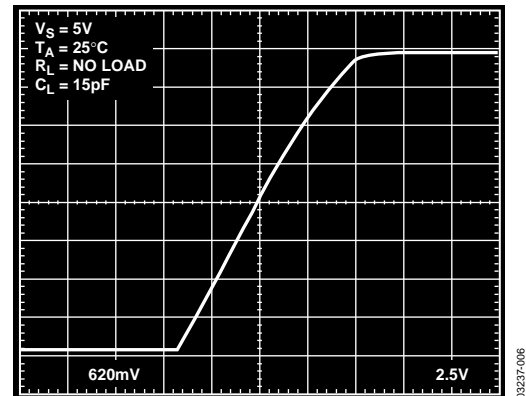


Figure 6. Large Signal Transient Response—Rising

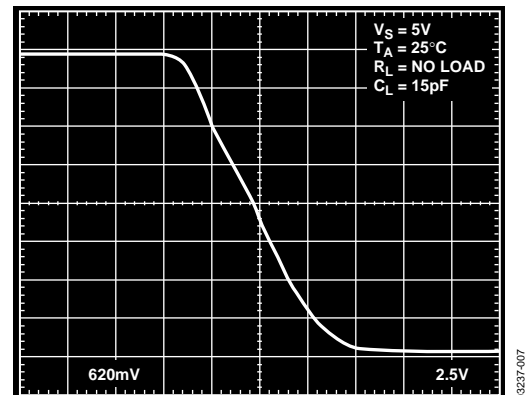


Figure 7. Large Signal Transient Response—Falling

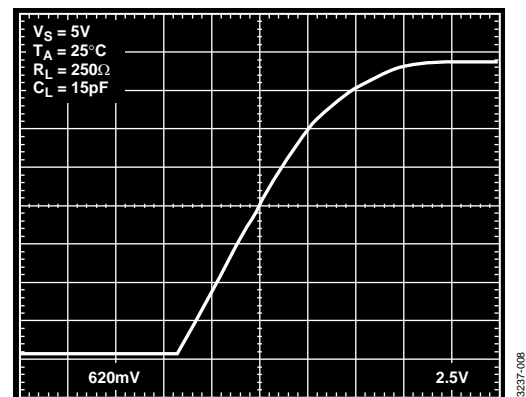


Figure 8. Large Signal Transient Response—Rising

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AD8509/AD8511

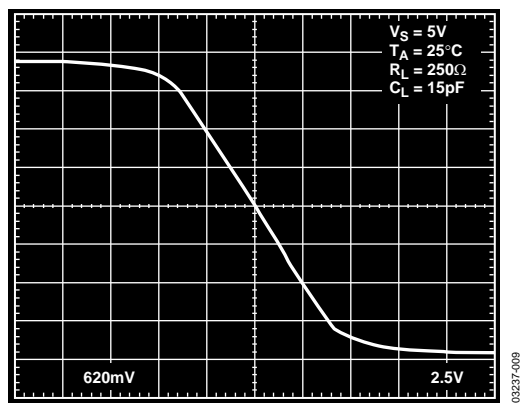


Figure 9. Large Signal Transient Response—Falling

## APPLICATIONS

The AD8509 and AD8511 are CMOS buffers with A/B inputs, which are used to select between two different reference voltages set up by an external resistor ladder. Input bias currents are orders of magnitude less than competitive parts. This allows very large resistor ladders to be used to save supply current. A guaranteed value of 50 nA is much higher than actual values and is limited by leakage in the test system.

Buffer outputs are designed to drive resistive loads. They are also stable with capacitive loads, so no resistors should be used in series with these outputs to attain the best display performance. Outputs have high slew rates and 6  $\mu$ s settling times. Each output can deliver a minimum of 120 mA, assuring fast response to varying loads.

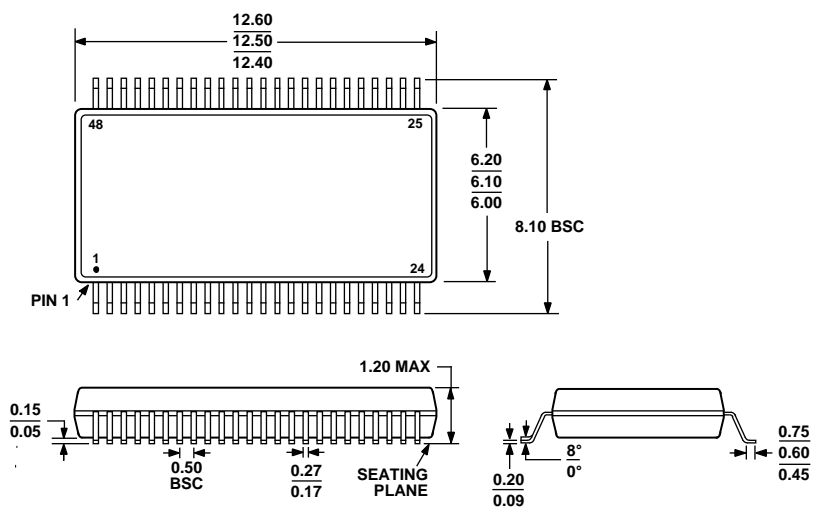
The AD8509 is a 9-channel buffer and is similar to the LMC6009 in functionality. The AD8511 is an 11-channel buffer similar to the CL-FP6131. However, the control to select either 9- or 11-channel operation, the EN\_11 pin of the CL-FP6131, is not available on the AD8511. If 9-channel operation is desired, use the AD8509.

Power supply pins on the AD8509 and AD8511 have multiple ground and  $V_{CC}$  connections. Because of the high peak currents that these buffers can deliver, it is strongly recommended that all of the ground and  $V_{CC}$  pins be connected, and that the  $V_{CC}$  pins be suitably bypassed.

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## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153ED

Figure 10. 48-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-48)  
Dimensions shown in millimeters

## ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
AD8509ARU-REEL	−40°C to +85°C	48-Lead Thin Shrink Small Outline Package	RU-48
AD8509ARUZ-REEL <sup>2</sup>	−40°C to +85°C	48-Lead Thin Shrink Small Outline Package	RU-48
AD8511ARU-REEL	−40°C to +85°C	48-Lead Thin Shrink Small Outline Package	RU-48
AD8511ARUZ-REEL <sup>2</sup>	−40°C to +85°C	48-Lead Thin Shrink Small Outline Package	RU-48

<sup>1</sup> All models only available in 2,500-piece reels.  
<sup>2</sup> Z = Pb-free part.