

### 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/LFCSP packages

### APPLICATION

LCD line inversion gamma references

### 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. The 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, Pb-free TSSOP packages in tape and reel. Additionally, the AD8511 is available in a 48-lead, Pb-free LFCSP package.

### FUNCTIONAL BLOCK DIAGRAM

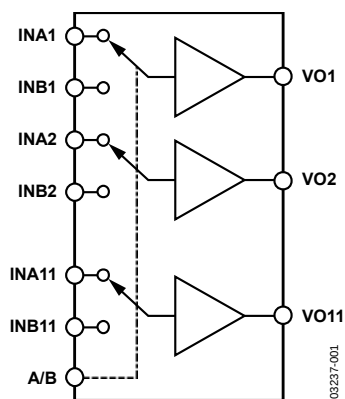


Figure 1.

### PIN CONFIGURATIONS

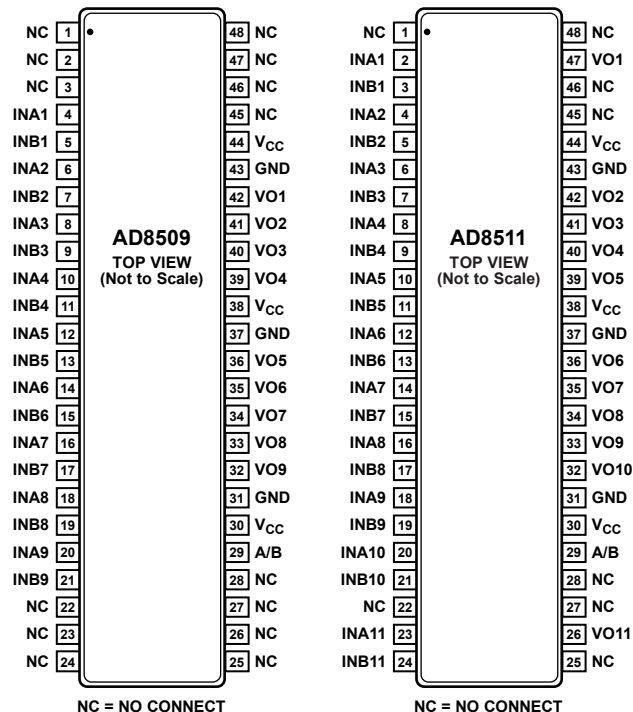


Figure 2. AD8509 and AD8511 48-Lead TSSOP (RV Suffix)

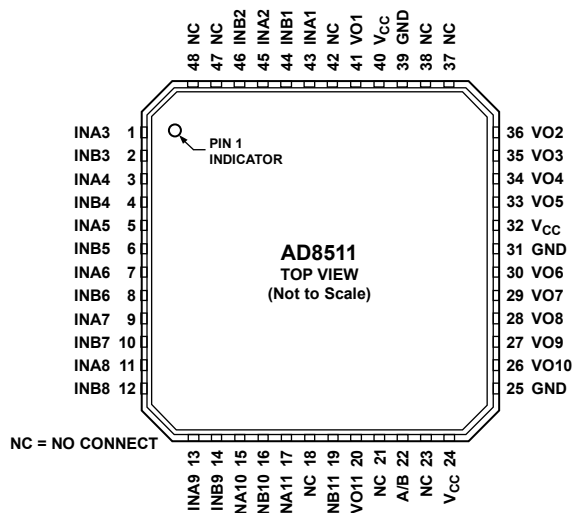


Figure 3. AD8511 48-Lead LFCSP

### Rev. C

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REVISION HISTORY

2/06—Rev. C

|                                                                |           |
|----------------------------------------------------------------|-----------|
| Added LFCSP Package .....                                      | Universal |
| Added Pin Configurations and Function Descriptions Section ... | 5         |
| Updated Outline Dimensions .....                               | 9         |
| Changes to Ordering Guide .....                                | 9         |

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              |          | $V_{IN} = 0.5\text{ V to }4.5\text{ V}$ , $I_{SOURCE} = 20\text{ mA}$ |       | 7   |     | mV               |
|                              |          | $V_{IN} = 0.5\text{ V to }4.5\text{ V}$ , $I_{SINK} = 20\text{ mA}$   |       | 7   |     | mV               |
| Supply Current               | $I_{SY}$ | AD8509, $V_{IN} = 2.5\text{ V}$                                       |       |     | 8.5 | mA               |
|                              | $I_{SY}$ | AD8511, $V_{IN} = 2.5\text{ V}$                                       |       |     | 10  | mA               |
| Supply Voltage Range         | $V_S$    |                                                                       | 3.3   |     | 6.5 | V                |
| DYNAMIC PERFORMANCE          |          |                                                                       |       |     |     |                  |
| Slew Rate                    |          | $C_L = 15\text{ pF}$                                                  |       | 7   |     | V/ $\mu\text{s}$ |
|                              |          | $R_L = 250\ \Omega$                                                   |       | 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<br>TSSOP (RV-48)          | –65°C to +150°C |
| Operating Temperature Range                         | –40°C to +85°C  |
| Junction Temperature Range<br>TSSOP (RV-48) Package | –65°C to +150°C |
| Lead Temperature Range<br>(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; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## THERMAL RESISTANCE

$\theta_{JA}$  is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 3. Thermal Resistance

| Package Type                     | $\theta_{JA}$ | $\theta_{JC}$ | Unit |
|----------------------------------|---------------|---------------|------|
| 48-Lead, Pb-Free SSOP (RV-48)    | 115           | 42            | °C/W |
| 48-Lead, Pb-Free LFCSP (CP-48-1) | 125           | 29            | °C/W |

Table 4. MUX Function

| A/B Select | 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.



## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

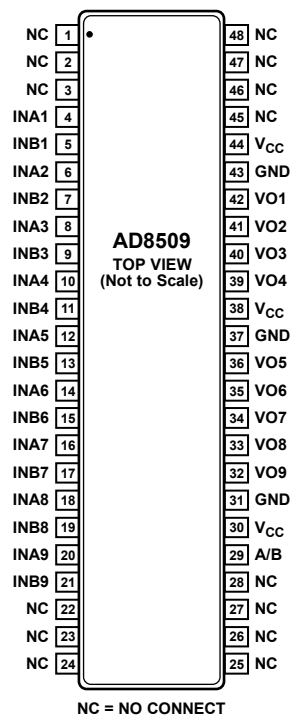


Figure 4. AD8509  
48-Lead TSSOP (RV Suffix)

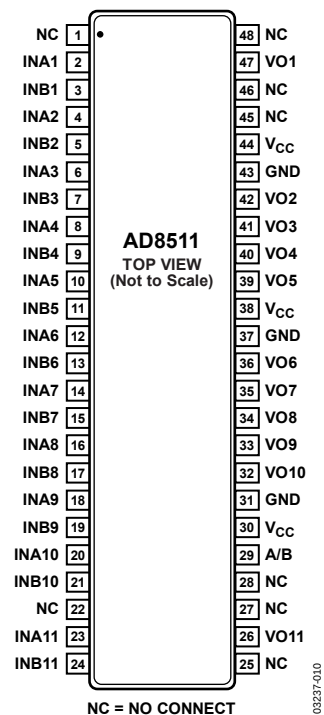


Figure 5. AD8511  
48-Lead TSSOP (RV Suffix)

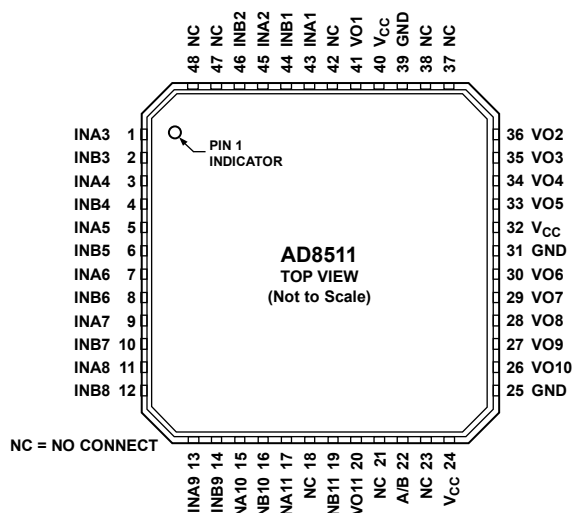


Figure 6. AD8511 (48-Lead LFCSP)

Table 5. Pin Function Descriptions

| Pin No.                         |                                        |                                        | Mnemonic | Description         |
|---------------------------------|----------------------------------------|----------------------------------------|----------|---------------------|
| AD8509 (TSSOP)                  | AD8511 (TSSOP)                         | AD8511 (LFCSP)                         |          |                     |
| 4, 6, 8, 10, 12, 14, 16, 18, 20 | 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 23 | 1, 3, 5, 7, 9, 11, 13, 15, 17, 43, 45  | INAx     | MUX Input           |
| 5, 7, 9, 11, 13, 15, 17, 19, 21 | 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 24 | 2, 4, 6, 8, 10, 12, 14, 16, 19, 44, 46 | INBx     | MUX Input           |
| 32 to 36, 39 to 42              | 26, 32 to 36, 39 to 42, 47             | 20, 26 to 30, 33 to 36, 41             | VOx      | MUX Output          |
| 29                              | 29                                     | 22                                     | A/B      | Input Selection Pin |
| 30, 38, 44                      | 30, 38, 44                             | 24, 32, 40                             | Vcc      | Bias                |
| 31, 37, 43                      | 31, 37, 43                             | 25, 31, 39                             | GND      | Ground              |
| 1 to 3, 22 to 28, 45 to 48      | 1, 22, 25, 27, 28, 45, 46, 48          | 18, 21, 23, 37, 38, 42, 47, 48         | NC       | No Connection       |

TYPICAL PERFORMANCE CHARACTERISTICS

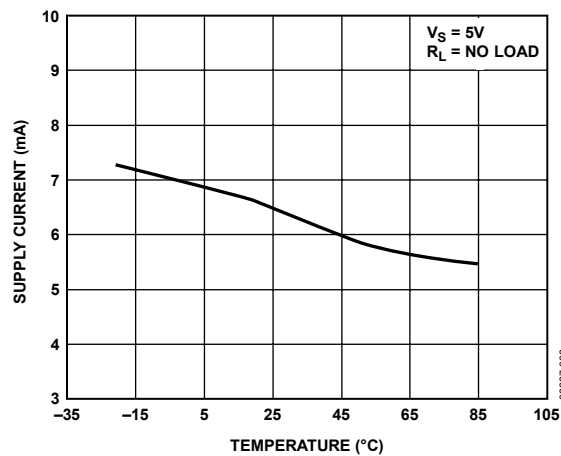


Figure 7. Supply Current vs. Temperature

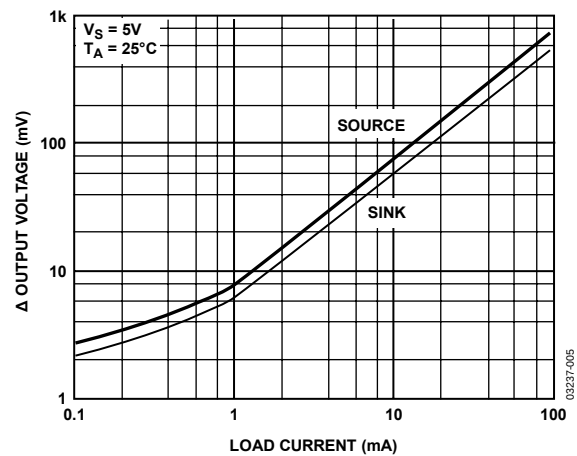


Figure 9. Output Voltage to Supply Rail vs. Load Current

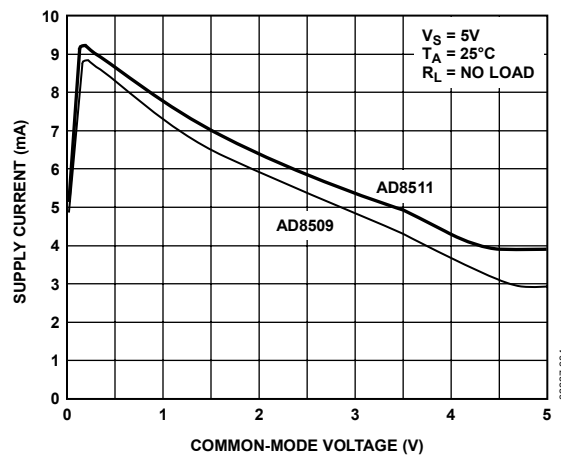


Figure 8. Supply Current vs. Common-Mode Voltage

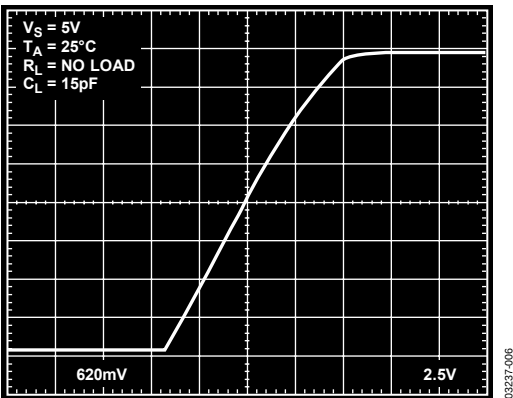


Figure 10. Large Signal Transient Response—Rising

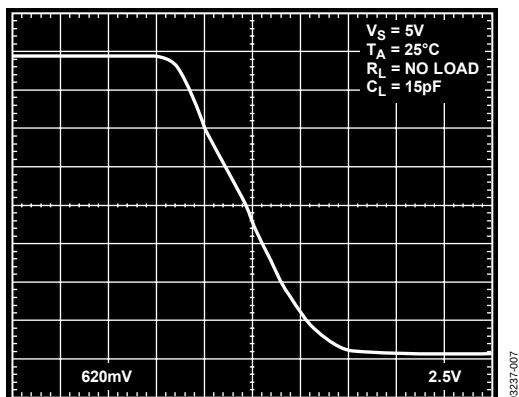


Figure 11. Large Signal Transient Response—Falling

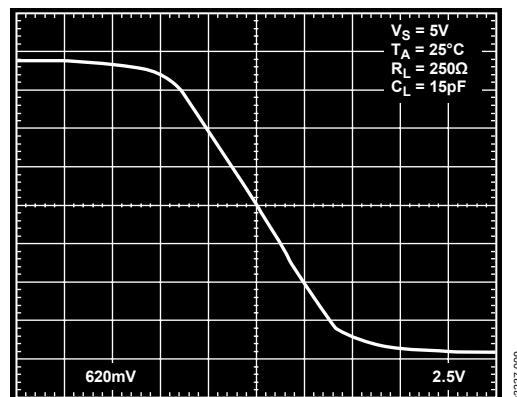


Figure 13. Large Signal Transient Response—Falling

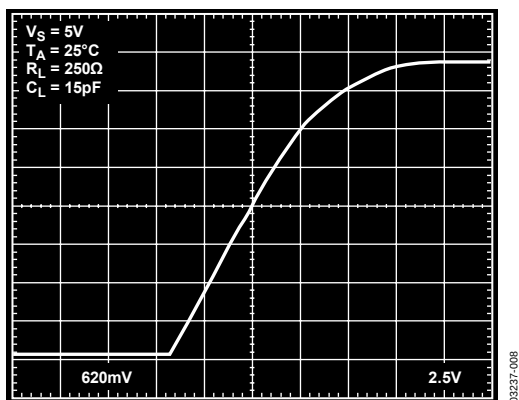


Figure 12. Large Signal Transient Response—Rising

### APPLICATIONS

The AD8509 and AD8511 are CMOS buffers with A/B inputs that 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 to connect all of the ground and  $V_{CC}$  pins, and suitably bypass the  $V_{CC}$  pins.

## OUTLINE DIMENSIONS

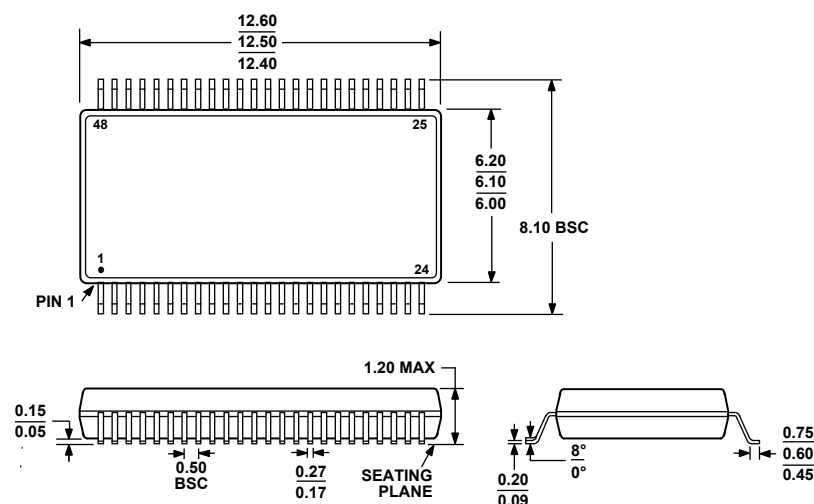


Figure 14. 48-Lead Thin Shrink Small Outline Package [TSSOP]  
(RV-48)  
Dimensions shown in millimeters

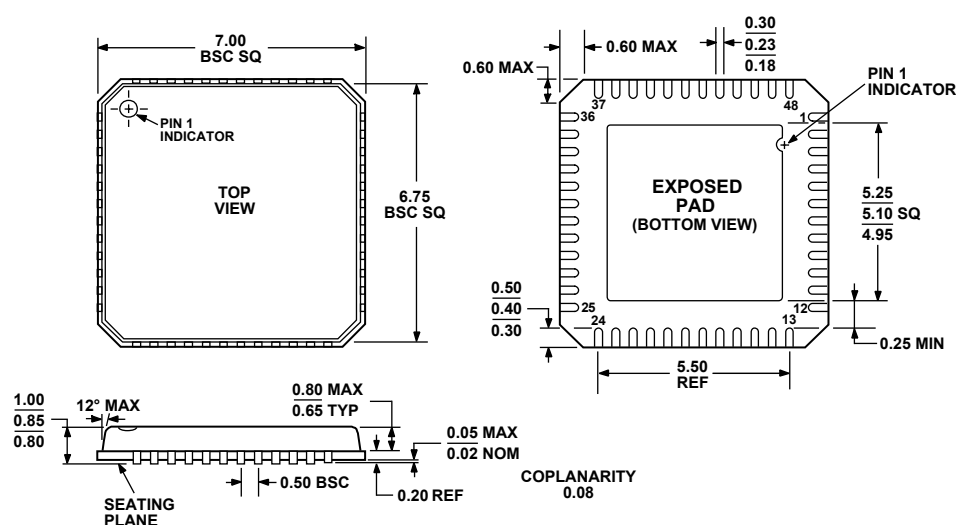


Figure 15. 48-Lead Lead Frame Chip Scale Package [LFCSP\_VQ]  
7 mm x 7 mm Body, Very Thin Quad  
(CP-48-1)  
Dimensions shown in millimeters

## 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 [TSSOP] | RV-48          |
| AD8509ARUZ-REEL <sup>2</sup> | -40°C to +85°C    | 48-Lead Thin Shrink Small Outline Package [TSSOP] | RV-48          |
| AD8511ARU-REEL               | -40°C to +85°C    | 48-Lead Thin Shrink Small Outline Package [TSSOP] | RV-48          |
| AD8511ARUZ-REEL <sup>2</sup> | -40°C to +85°C    | 48-Lead Thin Shrink Small Outline Package [TSSOP] | RV-48          |
| AD8511ACPZ-REEL <sup>2</sup> | -40°C to +85°C    | 48-Lead Lead Frame Chip Scale Package [LFCSP_VQ]  | CP-48-1        |

<sup>1</sup> All models only available in 2,500-piece reels.

<sup>2</sup> Z = Pb-free part.

**NOTES**

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