

### FEATURES

- Latch-up proof
- 8 kV human body model (HBM) ESD rating
- Low on resistance (13.5  $\Omega$ )
- $\pm 9$  V to  $\pm 22$  V dual-supply operation
- 9 V to 40 V single-supply operation
- 48 V supply maximum ratings
- Fully specified at  $\pm 15$  V,  $\pm 20$  V, +12 V, and +36 V
- $V_{SS}$  to  $V_{DD}$  analog signal range

### APPLICATIONS

- Relay replacement
- Automatic test equipment
- Data acquisition
- Instrumentation
- Avionics
- Audio and video switching
- Communication systems

### GENERAL DESCRIPTION

The ADG5408/ADG5409 are monolithic CMOS analog multiplexers comprising eight single channels and four differential channels, respectively. The ADG5408 switches one of eight inputs to a common output, as determined by the 3-bit binary address lines, A0, A1, and A2. The ADG5409 switches one of four differential inputs to a common differential output, as determined by the 2-bit binary address lines, A0 and A1.

An EN input on both devices enables or disables the device. When EN is disabled, all channels switch off. The on-resistance profile is very flat over the full analog input range, which ensures good linearity and low distortion when switching audio signals. High switching speed also makes the parts suitable for video signal switching.

Each switch conducts equally well in both directions when on, and each switch has an input signal range that extends to the power supplies. In the off condition, signal levels up to the supplies are blocked.

### FUNCTIONAL BLOCK DIAGRAMS

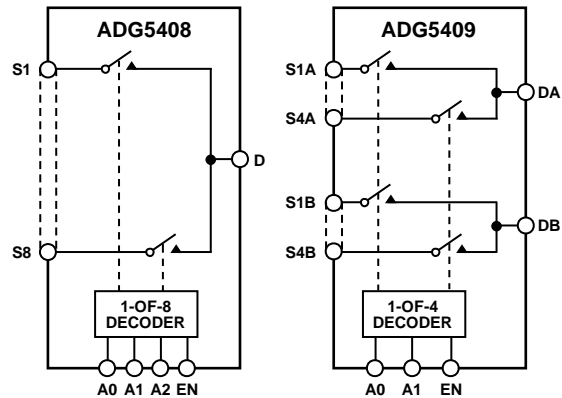


Figure 1.

The ADG5408/ADG5409 do not have  $V_L$  pins; rather, the logic power supply is generated internally by an on-chip voltage generator.

### PRODUCT HIGHLIGHTS

1. Trench isolation guards against latch-up. A dielectric trench separates the P and N channel transistors thereby preventing latch-up even under severe overvoltage conditions.
2. Low  $R_{ON}$ .
3. Dual-supply operation. For applications where the analog signal is bipolar, the ADG5408/ADG5409 can be operated from dual supplies up to  $\pm 22$  V.
4. Single-supply operation. For applications where the analog signal is unipolar, the ADG5408/ADG5409 can be operated from a single rail power supply up to 40 V.
5. 3 V logic compatible digital inputs:  $V_{INH} = 2.0$  V,  $V_{INL} = 0.8$  V.
6. No  $V_L$  logic power supply required.

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## REVISION HISTORY

### 3/13—Rev. B to Rev. C

|  |    |
|--|----|
| Changes to Table 5 and Table 6.....  | 8  |
| Changed ADG5408 Peak Current from 370 mA to 435 mA;<br>Changed ADG5409 Peak Current from 275 mA to 300 mA;<br>Changed Reflow Soldering Peak Temperature, Pb Free from<br>260(+0/-5)°C to As per JEDEC J-STD-020; Table 7 ..... | 9  |
| Changes to Figure 25, Figure 26, and Figure 29 .....   | 16 |

### 5/12—Rev. A to Rev. B

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|--|----|
| Removed Automotive Information (Throughout)..... | 1  |
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| Deleted Automotive Products Section.....         | 22 |

### 6/11—Rev. 0 to Rev. A

|   |    |
|---|----|
| Change to Features Section .....                  | 1  |
| Change to I <sub>SS</sub> Parameter, Table 2..... | 5  |
| Changes to Figure 3.....                          | 10 |
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| Updated Outline Dimensions .....                  | 21 |
| Changes to Ordering Guide .....                   | 21 |
| Added Automotive Products Section.....            | 21 |

### 7/10—Revision 0: Initial Version

## SPECIFICATIONS

## ±15 V DUAL SUPPLY

$V_{DD} = +15\text{ V} \pm 10\%$ ,  $V_{SS} = -15\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

Table 1.

| Parameter   | 25°C       | -40°C to +85°C | -40°C to +125°C      | Unit              | Test Conditions/Comments   |
|---|------------|----------------|----------------------|-------------------|--|
| <b>ANALOG SWITCH</b>                                  |            |                |                      |                   |  |
| ANALOG SIGNAL RANGE                                   |            |                | $V_{DD}$ to $V_{SS}$ | V                 |  |
| On Resistance, $R_{ON}$                               | 13.5       |                |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 26                                    |
|   | 15         | 18             | 22                   | $\Omega$ max      | $V_{DD} = +13.5\text{ V}$ , $V_{SS} = -13.5\text{ V}$  |
| On-Resistance Match Between Channels, $\Delta R_{ON}$ | 0.3        |                |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$  |
|   | 0.8        | 1.3            | 1.4                  | $\Omega$ max      |  |
| On-Resistance Flatness, $R_{FLAT(ON)}$                | 1.8        |                |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$  |
|   | 2.2        | 2.6            | 3                    | $\Omega$ max      |  |
| <b>LEAKAGE CURRENTS</b>                               |            |                |                      |                   |  |
| Source Off Leakage, $I_S$ (Off)                       | $\pm 0.05$ |                |                      | nA typ            | $V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$  |
|   | $\pm 0.25$ | $\pm 1$        | $\pm 7$              | nA max            | $V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 29                                  |
| Drain Off Leakage, $I_D$ (Off)                        | $\pm 0.1$  |                |                      | nA typ            | $V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 29                                  |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$             | nA max            |  |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)            | $\pm 0.1$  |                |                      | nA typ            | $V_S = V_D = \pm 10\text{ V}$ ; see Figure 25  |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$             | nA max            |  |
| <b>DIGITAL INPUTS</b>                                 |            |                |                      |                   |  |
| Input High Voltage, $V_{INH}$                         |            |                | 2.0                  | V min             |  |
| Input Low Voltage, $V_{INL}$                          |            |                | 0.8                  | V max             |  |
| Input Current, $I_{INL}$ or $I_{INH}$                 | 0.002      |                |                      | $\mu\text{A}$ typ | $V_{IN} = V_{GND}$ or $V_{DD}$   |
|   |            |                | $\pm 0.1$            | $\mu\text{A}$ max |  |
| Digital Input Capacitance, $C_{IN}$                   | 3          |                |                      | pF typ            |  |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>            |            |                |                      |                   |  |
| Transition Time, $t_{TRANSITION}$                     | 170        |                |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$   |
|   | 217        | 258            | 292                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 32  |
| $t_{ON}$ (EN)   | 140        |                |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$   |
|   | 175        | 213            | 242                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 34  |
| $t_{OFF}$ (EN)  | 130        |                |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$   |
|   | 161        | 183            | 198                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 34  |
| Break-Before-Make Time Delay, $t_D$                   | 50         |                |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$   |
|   |            |                | 16                   | ns min            | $V_{S1} = V_{S2} = 10\text{ V}$ ; see Figure 33  |
| Charge Injection, $Q_{INJ}$                           | 115        |                |                      | pC typ            | $V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 35                       |
| Off Isolation   | -60        |                |                      | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28                      |
| Channel-to-Channel Crosstalk                          | -60        |                |                      | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27                      |
| Total Harmonic Distortion + Noise                     | 0.01       |                |                      | % typ             | $R_L = 1\text{ k}\Omega$ , $15\text{ V p-p}$ , $f = 20\text{ Hz to }20\text{ kHz}$ ; see Figure 30 |
| -3 dB Bandwidth                                       |            |                |                      |                   | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 31   |
| ADG5408   | 50         |                |                      | MHz typ           |  |
| ADG5409   | 87         |                |                      | MHz typ           |  |
| Insertion Loss  | 0.9        |                |                      | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; Figure 31                          |
| $C_S$ (Off)   | 15         |                |                      | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| $C_D$ (Off)   |            |                |                      |                   |  |
| ADG5408   | 102        |                |                      | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| ADG5409   | 50         |                |                      | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |

| Parameter              | 25°C  | -40°C to +85°C | -40°C to +125°C | Unit              | Test Conditions/Comments           |
|------------------------|-------|----------------|-----------------|-------------------|------------------------------------|
| $C_D$ (On), $C_S$ (On) |       |                |                 |                   |                                    |
| ADG5408                | 133   |                |                 | pF typ            | $V_S = 0V, f = 1\text{ MHz}$       |
| ADG5409                | 81    |                |                 | pF typ            | $V_S = 0V, f = 1\text{ MHz}$       |
| POWER REQUIREMENTS     |       |                |                 |                   | $V_{DD} = +16.5V, V_{SS} = -16.5V$ |
| $I_{DD}$               | 45    |                | 70              | $\mu\text{A typ}$ | Digital inputs = 0V or $V_{DD}$    |
|                        | 55    |                |                 | $\mu\text{A max}$ |                                    |
| $I_{SS}$               | 0.001 |                | 1               | $\mu\text{A typ}$ | Digital inputs = 0V or $V_{DD}$    |
|                        |       |                |                 | $\mu\text{A max}$ |                                    |
| $V_{DD}/V_{SS}$        |       |                | $\pm 9/\pm 22$  | V min/V max       | GND = 0V                           |

<sup>1</sup> Guaranteed by design; not subject to production test.

### ±20 V DUAL SUPPLY

$V_{DD} = +20V \pm 10\%$ ,  $V_{SS} = -20V \pm 10\%$ , GND = 0V, unless otherwise noted.

Table 2.

| Parameter   | 25°C       | -40°C to +85°C | -40°C to +125°C      | Unit              | Test Conditions/Comments  |
|---|------------|----------------|----------------------|-------------------|---|
| ANALOG SWITCH   |            |                |                      |                   |   |
| Analogue Signal Range                                 |            |                | $V_{DD}$ to $V_{SS}$ | V                 |   |
| On Resistance, $R_{ON}$                               | 12.5       |                |                      | $\Omega$ typ      | $V_S = \pm 15V, I_S = -10\text{ mA}$ ; see Figure 26                  |
|   | 14         | 17             | 21                   | $\Omega$ max      | $V_{DD} = +18V, V_{SS} = -18V$  |
| On-Resistance Match Between Channels, $\Delta R_{ON}$ | 0.3        |                |                      | $\Omega$ typ      | $V_S = \pm 15V, I_S = -10\text{ mA}$                                  |
| On-Resistance Flatness, $R_{FLAT(ON)}$                | 0.8        | 1.3            | 1.4                  | $\Omega$ max      |   |
|   | 2.3        |                |                      | $\Omega$ typ      | $V_S = \pm 15V, I_S = -10\text{ mA}$                                  |
|   | 2.7        | 3.1            | 3.5                  | $\Omega$ max      |   |
| LEAKAGE CURRENTS                                      |            |                |                      |                   | $V_{DD} = +22V, V_{SS} = -22V$  |
| Source Off Leakage, $I_S$ (Off)                       | $\pm 0.1$  |                |                      | nA typ            | $V_S = \pm 15V, V_D = \mp 15V$ ; see Figure 29                        |
|   | $\pm 0.25$ | $\pm 1$        | $\pm 7$              | nA max            |   |
| Drain Off Leakage, $I_D$ (Off)                        | $\pm 0.15$ |                |                      | nA typ            | $V_S = \pm 15V, V_D = \mp 15V$ ; see Figure 29                        |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$             | nA max            |   |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)            | $\pm 0.15$ |                |                      | nA typ            | $V_S = V_D = \pm 15V$ ; see Figure 25                                 |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$             | nA max            |   |
| DIGITAL INPUTS  |            |                |                      |                   |   |
| Input High Voltage, $V_{INH}$                         |            |                | 2.0                  | V min             |   |
| Input Low Voltage, $V_{INL}$                          |            |                | 0.8                  | V max             |   |
| Input Current, $I_{INL}$ or $I_{INH}$                 | 0.002      |                |                      | $\mu\text{A typ}$ | $V_{IN} = V_{GND}$ or $V_{DD}$  |
|   |            |                | $\pm 0.1$            | $\mu\text{A max}$ |   |
| Digital Input Capacitance, $C_{IN}$                   | 3          |                |                      | pF typ            |   |
| DYNAMIC CHARACTERISTICS <sup>1</sup>                  |            |                |                      |                   |   |
| Transition Time, $t_{TRANSITION}$                     | 160        |                |                      | ns typ            | $R_L = 300\Omega, C_L = 35\text{ pF}$                                 |
|   | 207        | 237            | 262                  | ns max            | $V_S = 10V$ ; see Figure 32   |
| $t_{ON}$ (EN)   | 140        |                |                      | ns typ            | $R_L = 300\Omega, C_L = 35\text{ pF}$                                 |
|   | 165        | 194            | 218                  | ns max            | $V_S = 10V$ ; see Figure 34   |
| $t_{OFF}$ (EN)  | 133        |                |                      | ns typ            | $R_L = 300\Omega, C_L = 35\text{ pF}$                                 |
|   | 153        | 174            | 189                  | ns max            | $V_S = 10V$ ; see Figure 34   |
| Break-Before-Make Time Delay, $t_D$                   | 38         |                |                      | ns typ            | $R_L = 300\Omega, C_L = 35\text{ pF}$                                 |
|   |            |                | 11                   | ns min            | $V_{S1} = V_{S2} = 10V$ ; see Figure 33                               |
| Charge Injection, $Q_{INJ}$                           | 155        |                |                      | pC typ            | $V_S = 0V, R_S = 0\Omega, C_L = 1\text{ nF}$ ; see Figure 35          |
| Off Isolation   | -60        |                |                      | dB typ            | $R_L = 50\Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$ ; see Figure 28 |
| Channel-to-Channel Crosstalk                          | -60        |                |                      | dB typ            | $R_L = 50\Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$ ; see Figure 27 |

| Parameter                         | 25°C  | -40°C to +85°C | -40°C to +125°C | Unit              | Test Conditions/Comments   |
|-----------------------------------|-------|----------------|-----------------|-------------------|--|
| Total Harmonic Distortion + Noise | 0.012 |                |                 | % typ             | $R_L = 1\text{ k}\Omega$ , 20 V p-p, $f = 20\text{ Hz to }20\text{ kHz}$ ; see Figure 30 |
| -3 dB Bandwidth                   |       |                |                 |                   | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 31                                 |
| ADG5408                           | 50    |                |                 | MHz typ           |  |
| ADG5409                           | 88    |                |                 | MHz typ           |  |
| Insertion Loss                    | 0.8   |                |                 | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 31            |
| $C_S$ (Off)                       | 17    |                |                 | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| $C_D$ (Off)                       |       |                |                 |                   |  |
| ADG5408                           | 98    |                |                 | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| ADG5409                           | 48    |                |                 | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| $C_D$ (On), $C_S$ (On)            |       |                |                 |                   |  |
| ADG5408                           | 128   |                |                 | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| ADG5409                           | 80    |                |                 | pF typ            | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$  |
| <b>POWER REQUIREMENTS</b>         |       |                |                 |                   |  |
| $I_{DD}$                          | 50    |                |                 | $\mu\text{A typ}$ | $V_{DD} = +22\text{ V}$ , $V_{SS} = -22\text{ V}$  |
|                                   | 70    |                | 110             | $\mu\text{A max}$ | Digital inputs = 0 V or $V_{DD}$   |
| $I_{SS}$                          | 0.001 |                |                 | $\mu\text{A typ}$ | Digital inputs = 0 V or $V_{DD}$   |
|                                   |       |                | 1               | $\mu\text{A max}$ |  |
| $V_{DD}/V_{SS}$                   |       |                | $\pm 9/\pm 22$  | V min/V max       | GND = 0 V  |

<sup>1</sup> Guaranteed by design; not subject to production test.

## 12 V SINGLE SUPPLY

$V_{DD} = 12\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ , GND = 0 V, unless otherwise noted.

Table 3.

| Parameter   | 25°C       | -40°C to +85°C | -40°C to +125°C | Unit                | Test Conditions/Comments  |
|---|------------|----------------|-----------------|---------------------|---|
| <b>ANALOG SWITCH</b>                                  |            |                |                 |                     |   |
| Analog Signal Range                                   |            |                | 0 V to $V_{DD}$ | V                   |   |
| On Resistance, $R_{ON}$                               | 26         |                |                 | $\Omega\text{ typ}$ | $V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 26       |
|   | 30         | 36             | 42              | $\Omega\text{ max}$ | $V_{DD} = 10.8\text{ V}$ , $V_{SS} = 0\text{ V}$                                |
| On-Resistance Match Between Channels, $\Delta R_{ON}$ | 0.3        |                |                 | $\Omega\text{ typ}$ | $V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$                       |
|   | 1          | 1.5            | 1.6             | $\Omega\text{ max}$ |   |
| On-Resistance Flatness, $R_{FLAT(ON)}$                | 5.5        |                |                 | $\Omega\text{ typ}$ | $V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$                       |
|   | 6.5        | 8              | 12              | $\Omega\text{ max}$ |   |
| <b>LEAKAGE CURRENTS</b>                               |            |                |                 |                     |   |
| Source Off Leakage, $I_S$ (Off)                       | $\pm 0.02$ |                |                 | nA typ              | $V_{DD} = 13.2\text{ V}$ , $V_{SS} = 0\text{ V}$                                |
|   | $\pm 0.25$ | $\pm 1$        | $\pm 7$         | nA max              | $V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 29 |
| Drain Off Leakage, $I_D$ (Off)                        | $\pm 0.05$ |                |                 | nA typ              | $V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 29 |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$        | nA max              |   |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)            | $\pm 0.05$ |                |                 | nA typ              | $V_S = V_D = 1\text{ V}/10\text{ V}$ ; see Figure 25                            |
|   | $\pm 0.4$  | $\pm 4$        | $\pm 30$        | nA max              |   |
| <b>DIGITAL INPUTS</b>                                 |            |                |                 |                     |   |
| Input High Voltage, $V_{INH}$                         |            |                | 2.0             | V min               |   |
| Input Low Voltage, $V_{INL}$                          |            |                | 0.8             | V max               |   |
| Input Current, $I_{INL}$ or $I_{INH}$                 | 0.002      |                |                 | $\mu\text{A typ}$   | $V_{IN} = V_{GND}$ or $V_{DD}$  |
|   |            |                | $\pm 0.1$       | $\mu\text{A max}$   |   |
| Digital Input Capacitance, $C_{IN}$                   | 3          |                |                 | pF typ              |   |

| Parameter                                  | 25°C | –40°C to +85°C | –40°C to +125°C | Unit              | Test Conditions/Comments   |
|--|------|----------------|-----------------|-------------------|--|
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b> |      |                |                 |                   |  |
| Transition Time, $t_{\text{TRANSITION}}$   | 230  |                |                 | ns typ            | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$   |
|  | 321  | 388            | 430             | ns max            | $V_S = 8 \text{ V}$ ; see Figure 32  |
| $t_{\text{ON}}$ (EN)                       | 215  |                |                 | ns typ            | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$   |
|  | 276  | 345            | 397             | ns max            | $V_S = 8 \text{ V}$ ; see Figure 34  |
| $t_{\text{OFF}}$ (EN)                      | 134  |                |                 | ns typ            | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$   |
|  | 161  | 187            | 209             | ns max            | $V_S = 8 \text{ V}$ ; see Figure 34  |
| Break-Before-Make Time Delay, $t_D$        | 118  |                |                 | ns typ            | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$   |
|  |      |                | 55              | ns min            | $V_{S1} = V_{S2} = 8 \text{ V}$ ; see Figure 33  |
| Charge Injection, $Q_{\text{INJ}}$         | 45   |                |                 | pC typ            | $V_S = 6 \text{ V}$ , $R_S = 0 \Omega$ , $C_L = 1 \text{ nF}$ ; see Figure 35                          |
| Off Isolation                              | –60  |                |                 | dB typ            | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ ; see Figure 28                         |
| Channel-to-Channel Crosstalk               | –60  |                |                 | dB typ            | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ ; see Figure 27                         |
| Total Harmonic Distortion + Noise          | 0.1  |                |                 | % typ             | $R_L = 1 \text{ k}\Omega$ , $6 \text{ V p-p}$ , $f = 20 \text{ Hz to } 20 \text{ kHz}$ ; see Figure 30 |
| –3 dB Bandwidth                            |      |                |                 |                   | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ ; see Figure 31   |
| ADG5408                                    | 35   |                |                 | MHz typ           |  |
| ADG5409                                    | 74   |                |                 | MHz typ           |  |
| Insertion Loss                             | –1.8 |                |                 | dB typ            | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ ; see Figure 31                         |
| $C_S$ (Off)                                | 22   |                |                 | pF typ            | $V_S = 6 \text{ V}$ , $f = 1 \text{ MHz}$  |
| $C_D$ (Off)                                |      |                |                 |                   |  |
| ADG5408                                    | 119  |                |                 | pF typ            | $V_S = 6 \text{ V}$ , $f = 1 \text{ MHz}$  |
| ADG5409                                    | 59   |                |                 | pF typ            | $V_S = 6 \text{ V}$ , $f = 1 \text{ MHz}$  |
| $C_D$ (On), $C_S$ (On)                     |      |                |                 |                   |  |
| ADG5408                                    | 146  |                |                 | pF typ            | $V_S = 6 \text{ V}$ , $f = 1 \text{ MHz}$  |
| ADG5409                                    | 86   |                |                 | pF typ            | $V_S = 6 \text{ V}$ , $f = 1 \text{ MHz}$  |
| <b>POWER REQUIREMENTS</b>                  |      |                |                 |                   |  |
| $I_{\text{DD}}$                            | 40   |                |                 | $\mu\text{A typ}$ | $V_{\text{DD}} = 13.2 \text{ V}$   |
|  | 50   |                | 65              | $\mu\text{A max}$ | Digital inputs = $0 \text{ V}$ or $V_{\text{DD}}$  |
| $V_{\text{DD}}$                            |      |                | 9/40            | V min/V max       | $\text{GND} = 0 \text{ V}$ , $V_{\text{SS}} = 0 \text{ V}$   |

<sup>1</sup> Guaranteed by design; not subject to production test.

### 36 V SINGLE SUPPLY

$V_{\text{DD}} = 36 \text{ V} \pm 10\%$ ,  $V_{\text{SS}} = 0 \text{ V}$ ,  $\text{GND} = 0 \text{ V}$ , unless otherwise noted.

Table 4.

| Parameter  | 25°C       | –40°C to +85°C | –40°C to +125°C                 | Unit         | Test Conditions/Comments  |
|--|------------|----------------|---------------------------------|--------------|---|
| <b>ANALOG SWITCH</b>   |            |                |                                 |              |   |
| Analog Signal Range  |            |                | $0 \text{ V to } V_{\text{DD}}$ | V            |   |
| On Resistance, $R_{\text{ON}}$                               | 14.5       |                |                                 | $\Omega$ typ | $V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -10 \text{ mA}$ ; see Figure 26       |
| On-Resistance Match Between Channels, $\Delta R_{\text{ON}}$ | 0.3        | 19             | 23                              | $\Omega$ max | $V_{\text{DD}} = 32.4 \text{ V}$ , $V_{\text{SS}} = 0 \text{ V}$                    |
| On-Resistance Flatness, $R_{\text{FLAT (ON)}}$               | 0.8        | 1.3            | 1.4                             | $\Omega$ max | $V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -10 \text{ mA}$                       |
|  | 3.5        |                |                                 | $\Omega$ typ |   |
|  | 4.3        | 5.5            | 6.5                             | $\Omega$ max | $V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -10 \text{ mA}$                       |
| <b>LEAKAGE CURRENTS</b>                                      |            |                |                                 |              |   |
| Source Off Leakage, $I_S$ (Off)                              | $\pm 0.1$  |                |                                 | nA typ       | $V_{\text{DD}} = 39.6 \text{ V}$ , $V_{\text{SS}} = 0 \text{ V}$                    |
|  | $\pm 0.25$ | $\pm 1$        | $\pm 7$                         | nA max       | $V_S = 1 \text{ V}/30 \text{ V}$ , $V_D = 30 \text{ V}/1 \text{ V}$ ; see Figure 29 |

| Parameter                                  | 25°C    | –40°C to +85°C | –40°C to +125°C | Unit             | Test Conditions/Comments   |
|--|---------|----------------|-----------------|------------------|--|
| Drain Off Leakage, $I_D$ (Off)             | ±0.15   |                |                 | nA typ           | $V_S = 1\text{ V}/30\text{ V}$ , $V_D = 30\text{ V}/1\text{ V}$ ; see Figure 29  |
| Channel On Leakage, $I_D$ (On), $I_S$ (On) | ±0.4    | ±4             | ±30             | nA max           | $V_S = V_D = 1\text{ V}/30\text{ V}$ ; see Figure 25                             |
|  | ±0.15   |                |                 | nA typ           |  |
|  | ±0.4    | ±4             | ±30             | nA max           |  |
| <b>DIGITAL INPUTS</b>                      |         |                |                 |                  |  |
| Input High Voltage, $V_{INH}$              |         |                | 2.0             | V min            | $V_{IN} = V_{GND}$ or $V_{DD}$   |
| Input Low Voltage, $V_{INL}$               |         |                | 0.8             | V max            |  |
| Input Current, $I_{INL}$ or $I_{INH}$      | 0.002   |                |                 | μA typ           |  |
| Digital Input Capacitance, $C_{IN}$        | 3       |                | ±0.1            | μA max<br>pF typ |  |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b> |         |                |                 |                  |  |
| Transition Time, $t_{TRANSITION}$          | 187     |                |                 | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                       |
|  | 242     | 257            | 281             | ns max           | $V_S = 18\text{ V}$ ; see Figure 32  |
| $t_{ON}$ (EN)                              | 160     |                |                 | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                       |
|  | 195     | 219            | 237             | ns max           | $V_S = 18\text{ V}$ ; see Figure 34  |
| $t_{OFF}$ (EN)                             | 147     |                |                 | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                       |
|  | 184     | 184            | 190             | ns max           | $V_S = 18\text{ V}$ ; see Figure 34  |
| Break-Before-Make Time Delay, $t_D$        | 53      |                |                 | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                       |
| Charge Injection, $Q_{INJ}$                | 150     |                | 17              | ns min           | $V_{S1} = V_{S2} = 18\text{ V}$ ; see Figure 33                                  |
| Off Isolation                              | –60     |                |                 | pC typ           | $V_S = 18\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 35    |
| Channel-to-Channel Crosstalk               | –60     |                |                 | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28    |
| Total Harmonic Distortion + Noise          | 0.4     |                |                 | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27    |
| –3 dB Bandwidth                            |         |                |                 | % typ            | $R_L = 1\text{ k}\Omega$ , 18 V p-p, $f = 20\text{ Hz}$ to 20 kHz; see Figure 30 |
|  | ADG5408 |                |                 | MHz typ          | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 31                         |
| ADG5409                                    | 45      |                |                 | MHz typ          |  |
| Insertion Loss                             | 76      |                |                 | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 31    |
|  | –1      |                |                 | dB typ           |  |
| $C_S$ (Off)                                | 18      |                |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
| $C_D$ (Off)                                |         |                |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
|  | ADG5408 | 120            |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
| ADG5409                                    | 60      |                |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
| $C_D$ (On), $C_S$ (On)                     |         |                |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
|  | ADG5408 | 137            |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
| ADG5409                                    | 80      |                |                 | pF typ           | $V_S = 18\text{ V}$ , $f = 1\text{ MHz}$   |
| <b>POWER REQUIREMENTS</b>                  |         |                |                 |                  |  |
| $I_{DD}$                                   | 80      |                |                 | μA typ           | $V_{DD} = 39.6\text{ V}$   |
|  | 100     |                | 130             | μA max           | Digital inputs = 0 V or $V_{DD}$   |
| $V_{DD}$                                   |         |                | 9/40            | V min/V max      | $GND = 0\text{ V}$ , $V_{SS} = 0\text{ V}$                                       |

<sup>1</sup> Guaranteed by design; not subject to production test.

**CONTINUOUS CURRENT PER CHANNEL, Sx OR D**

**Table 5. ADG5408**

| <b>Parameter</b>                                | <b>25°C</b> | <b>85°C</b> | <b>125°C</b> | <b>Unit</b> |
|---|-------------|-------------|--------------|-------------|
| CONTINUOUS CURRENT, Sx OR D                     |             |             |              |             |
| $V_{DD} = +15\text{ V}, V_{SS} = -15\text{ V}$  |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 120         | 78          | 50           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 207         | 113         | 60           | mA maximum  |
| $V_{DD} = +20\text{ V}, V_{SS} = -20\text{ V}$  |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 127         | 81          | 51           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 218         | 117         | 61           | mA maximum  |
| $V_{DD} = 12\text{ V}, V_{SS} = 0\text{ V}$     |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 97          | 66          | 44           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 168         | 99          | 57           | mA maximum  |
| $V_{DD} = 36\text{ V}, V_{SS} = 0\text{ V}$     |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 125         | 80          | 50           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 214         | 116         | 61           | mA maximum  |

**Table 6. ADG5409**

| <b>Parameter</b>                                | <b>25°C</b> | <b>85°C</b> | <b>125°C</b> | <b>Unit</b> |
|---|-------------|-------------|--------------|-------------|
| CONTINUOUS CURRENT, Sx OR D                     |             |             |              |             |
| $V_{DD} = +15\text{ V}, V_{SS} = -15\text{ V}$  |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 90          | 62          | 43           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 156         | 95          | 55           | mA maximum  |
| $V_{DD} = +20\text{ V}, V_{SS} = -20\text{ V}$  |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 95          | 65          | 44           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 165         | 98          | 56           | mA maximum  |
| $V_{DD} = 12\text{ V}, V_{SS} = 0\text{ V}$     |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 71          | 51          | 35           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 126         | 81          | 50           | mA maximum  |
| $V_{DD} = 36\text{ V}, V_{SS} = 0\text{ V}$     |             |             |              |             |
| TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ ) | 92          | 64          | 43           | mA maximum  |
| LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )  | 161         | 97          | 56           | mA maximum  |



## ABSOLUTE MAXIMUM RATINGS

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

Table 7.

| Parameter                                     | Rating   |
|---|--|
| $V_{DD}$ to $V_{SS}$                          | 48 V   |
| $V_{DD}$ to GND                               | -0.3 V to +48 V  |
| $V_{SS}$ to GND                               | +0.3 V to -48 V  |
| Analog Inputs <sup>1</sup>                    | $V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or<br>30 mA, whichever occurs first |
| Digital Inputs <sup>1</sup>                   | $V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or<br>30 mA, whichever occurs first |
| Peak Current, Sx or D Pins                    |  |
| ADG5408                                       | 435 mA (pulsed at 1 ms, 10%<br>duty cycle maximum)                                     |
| ADG5409                                       | 300 mA (pulsed at 1 ms, 10%<br>duty cycle maximum)                                     |
| Continuous Current, Sx or D <sup>2</sup>      | Data + 15%   |
| Temperature Range                             |  |
| Operating                                     | -40°C to +125°C  |
| Storage                                       | -65°C to +150°C  |
| Junction Temperature                          | 150°C  |
| Thermal Impedance, $\theta_{JA}$              |  |
| 16-Lead TSSOP (4-Layer<br>Board)              | 112.6°C/W  |
| 16-Lead LFCSP (4-Layer<br>Board)              | 30.4°C/W   |
| Reflow Soldering Peak<br>Temperature, Pb Free | As per JEDEC J-STD-020   |

<sup>1</sup> Overvoltages at the Ax, EN, Sx, and D pins are clamped by internal diodes. Limit current to the maximum ratings given.

<sup>2</sup> See Table 5.

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.

Only one absolute maximum rating can be applied at any one time.

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

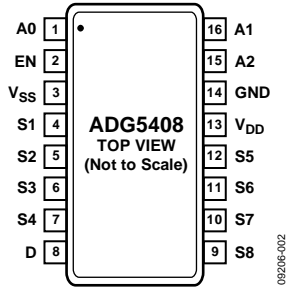
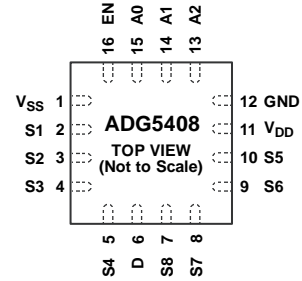


Figure 2. ADG5408 Pin Configuration (TSSOP)



**NOTES**  
 1. THE EXPOSED PAD IS CONNECTED INTERNALLY. FOR INCREASED RELIABILITY OF THE SOLDER JOINTS AND MAXIMUM THERMAL CAPABILITY, IT IS RECOMMENDED THAT THE PAD BE SOLDERED TO THE SUBSTRATE, V<sub>SS</sub>.

Figure 3. ADG5408 Pin Configuration (LFCSP)

Table 8. ADG5408 Pin Function Descriptions

| Pin No. |       | Mnemonic        | Description  |
|---------|-------|-----------------|--|
| TSSOP   | LFCSP |                 |  |
| 1       | 15    | A0              | Logic Control Input.   |
| 2       | 16    | EN              | Active High Digital Input. When low, the device is disabled and all switches are off. When high, Ax logic inputs determine on switches.  |
| 3       | 1     | V <sub>SS</sub> | Most Negative Power Supply Potential. In single-supply applications, this pin can be connected to ground.  |
| 4       | 2     | S1              | Source Terminal 1. This pin can be an input or an output.  |
| 5       | 3     | S2              | Source Terminal 2. This pin can be an input or an output.  |
| 6       | 4     | S3              | Source Terminal 3. This pin can be an input or an output.  |
| 7       | 5     | S4              | Source Terminal 4. This pin can be an input or an output.  |
| 8       | 6     | D               | Drain Terminal. This pin can be an input or an output.   |
| 9       | 7     | S8              | Source Terminal 8. This pin can be an input or an output.  |
| 10      | 8     | S7              | Source Terminal 7. This pin can be an input or an output.  |
| 11      | 9     | S6              | Source Terminal 6. This pin can be an input or an output.  |
| 12      | 10    | S5              | Source Terminal 5. This pin can be an input or an output.  |
| 13      | 11    | V <sub>DD</sub> | Most Positive Power Supply Potential.  |
| 14      | 12    | GND             | Ground (0 V) Reference.  |
| 15      | 13    | A2              | Logic Control Input.   |
| 16      | 14    | A1              | Logic Control Input.   |
|         | EP    | Exposed Pad     | The exposed pad is connected internally. For increased reliability of the solder joints and maximum thermal capability, it is recommended that the pad be soldered to the substrate, V <sub>SS</sub> . |

Table 9. ADG5408 Truth Table

| A2 | A1 | A0 | EN | On Switch |
|----|----|----|----|-----------|
| X  | X  | X  | 0  | None      |
| 0  | 0  | 0  | 1  | 1         |
| 0  | 0  | 1  | 1  | 2         |
| 0  | 1  | 0  | 1  | 3         |
| 0  | 1  | 1  | 1  | 4         |
| 1  | 0  | 0  | 1  | 5         |
| 1  | 0  | 1  | 1  | 6         |
| 1  | 1  | 0  | 1  | 7         |
| 1  | 1  | 1  | 1  | 8         |

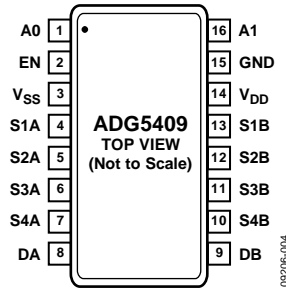
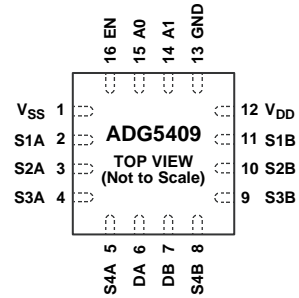


Figure 4. ADG5409 Pin Configuration (TSSOP)



NOTES  
 1. THE EXPOSED PAD IS CONNECTED INTERNALLY. FOR INCREASED RELIABILITY OF THE SOLDER JOINTS AND MAXIMUM THERMAL CAPABILITY, IT IS RECOMMENDED THAT THE PAD BE SOLDERED TO THE SUBSTRATE, V<sub>SS</sub>.

Figure 5. ADG5409 Pin Configuration (LFCSP)

Table 10. ADG5409 Pin Function Descriptions

| Pin No. |       | Mnemonic        | Description  |
|---------|-------|-----------------|--|
| TSSOP   | LFCSP |                 |  |
| 1       | 15    | A0              | Logic Control Input.   |
| 2       | 16    | EN              | Active High Digital Input. When low, the device is disabled and all switches are off. When high, Ax logic inputs determine on switches.  |
| 3       | 1     | V <sub>SS</sub> | Most Negative Power Supply Potential. In single-supply applications, this pin can be connected to ground.  |
| 4       | 2     | S1A             | Source Terminal 1A. This pin can be an input or an output.   |
| 5       | 3     | S2A             | Source Terminal 2A. This pin can be an input or an output.   |
| 6       | 4     | S3A             | Source Terminal 3A. This pin can be an input or an output.   |
| 7       | 5     | S4A             | Source Terminal 4A. This pin can be an input or an output.   |
| 8       | 6     | DA              | Drain Terminal A. This pin can be an input or an output.   |
| 9       | 7     | DB              | Drain Terminal B. This pin can be an input or an output.   |
| 10      | 8     | S4B             | Source Terminal 4B. This pin can be an input or an output.   |
| 11      | 9     | S3B             | Source Terminal 3B. This pin can be an input or an output.   |
| 12      | 10    | S2B             | Source Terminal 2B. This pin can be an input or an output.   |
| 13      | 11    | S1B             | Source Terminal 1B. This pin can be an input or an output.   |
| 14      | 12    | V <sub>DD</sub> | Most Positive Power Supply Potential.  |
| 15      | 13    | GND             | Ground (0 V) Reference.  |
| 16      | 14    | A1              | Logic Control Input.   |
|         | EP    | Exposed Pad     | The exposed pad is connected internally. For increased reliability of the solder joints and maximum thermal capability, it is recommended that the pad be soldered to the substrate, V <sub>SS</sub> . |

Table 11. ADG5409 Truth Table

| A1 | A0 | EN | On Switch Pair |
|----|----|----|----------------|
| X  | X  | 0  | None           |
| 0  | 0  | 1  | 1              |
| 0  | 1  | 1  | 2              |
| 1  | 0  | 1  | 3              |
| 1  | 1  | 1  | 4              |

TYPICAL PERFORMANCE CHARACTERISTICS

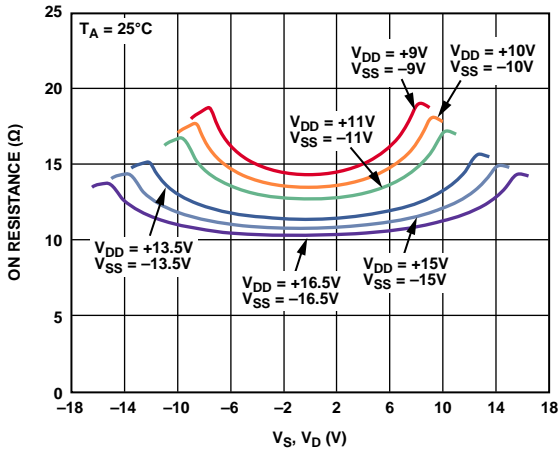


Figure 6.  $R_{ON}$  as a Function of  $V_S, V_D$  (Dual Supply)

09206-028

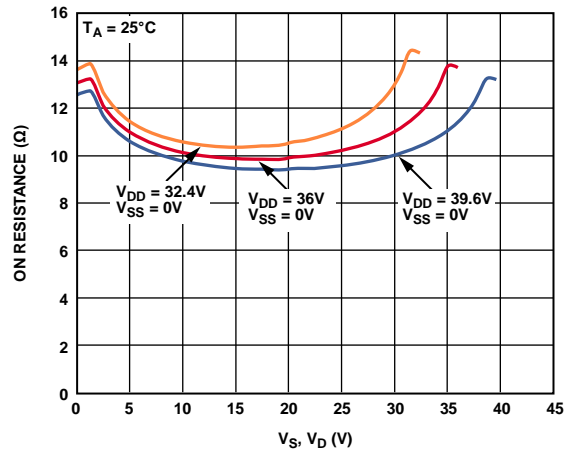


Figure 9.  $R_{ON}$  as a Function of  $V_S, V_D$  (Single Supply)

09206-027

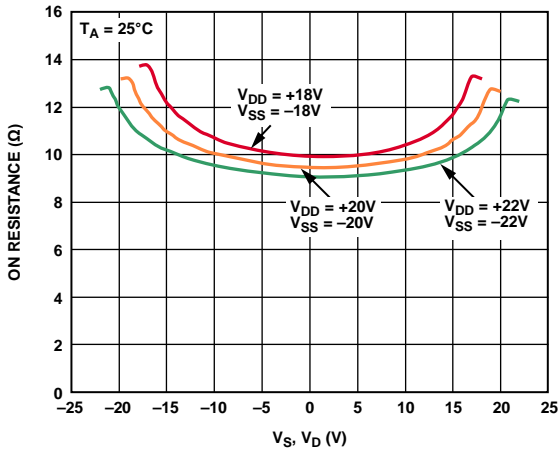


Figure 7.  $R_{ON}$  as a Function of  $V_S, V_D$  (Dual Supply)

09206-029

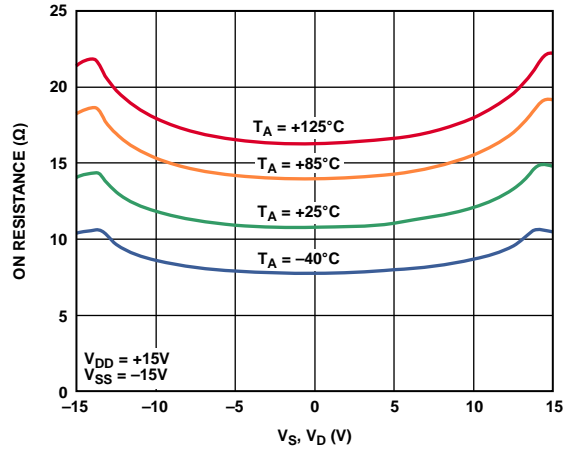


Figure 10.  $R_{ON}$  as a Function of  $V_S (V_D)$  for Different Temperatures,  $\pm 15V$  Dual Supply

09206-030

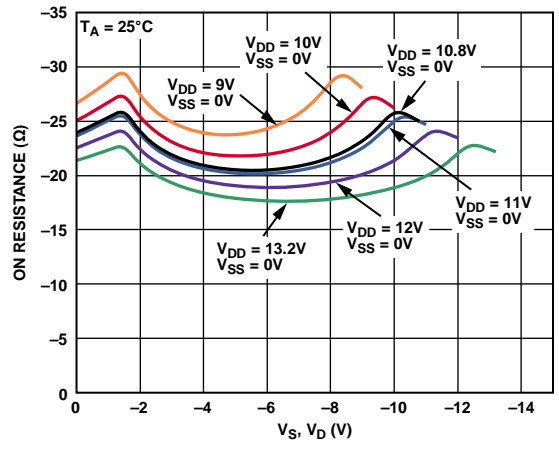


Figure 8.  $R_{ON}$  as a Function of  $V_S, V_D$  (Single Supply)

09206-023

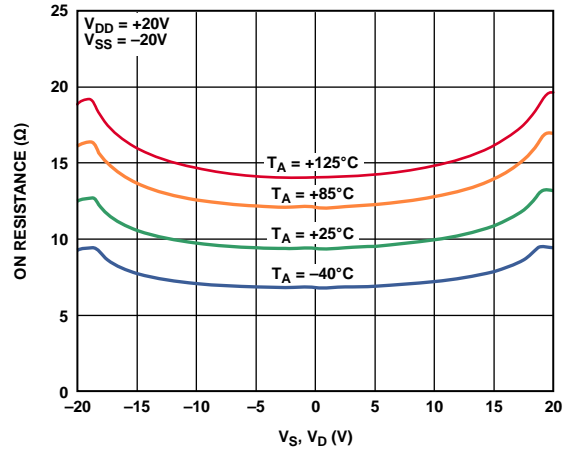


Figure 11.  $R_{ON}$  as a Function of  $V_S (V_D)$  for Different Temperatures,  $\pm 20V$  Dual Supply

09206-024

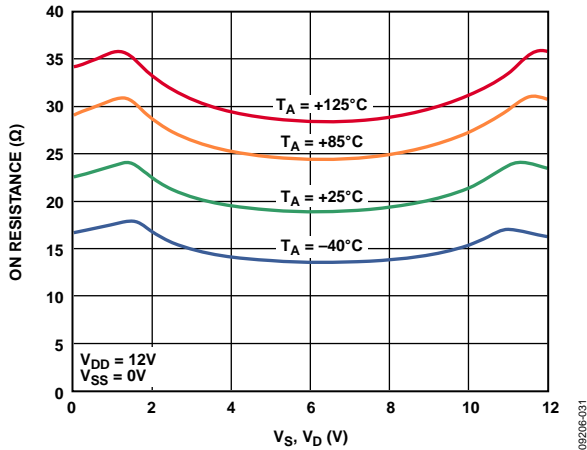


Figure 12.  $R_{ON}$  as a Function of  $V_S$  ( $V_D$ ) for Different Temperatures, 12 V Single Supply

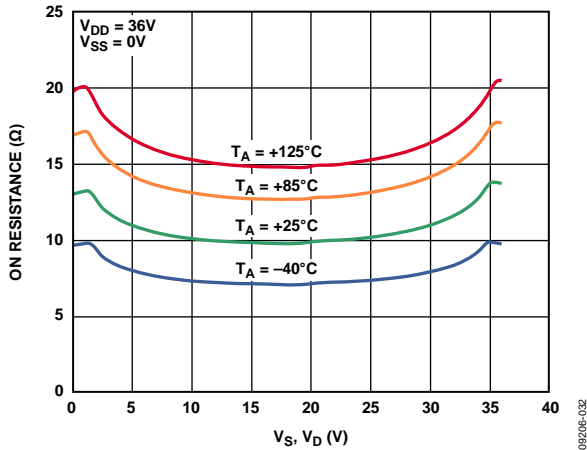


Figure 13.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures, 36 V Single Supply

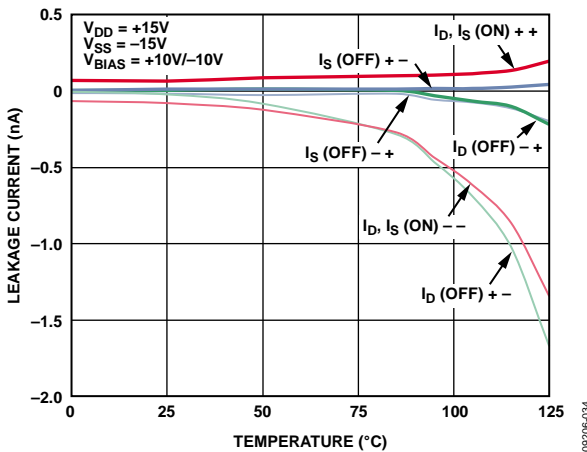


Figure 14. Leakage Currents vs. Temperature,  $\pm 15\text{V}$  Dual Supply

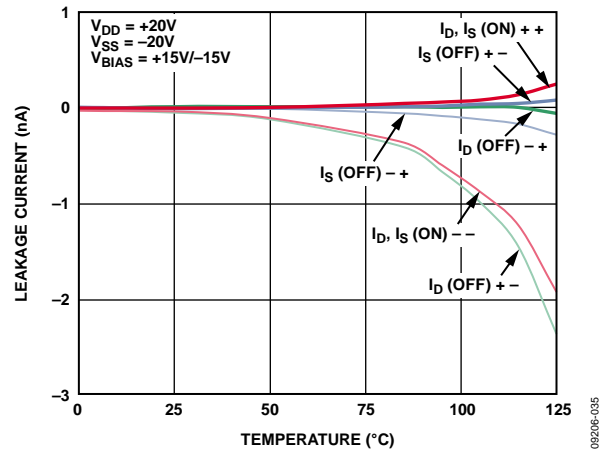


Figure 15. Leakage Currents vs. Temperature,  $\pm 20\text{V}$  Dual Supply

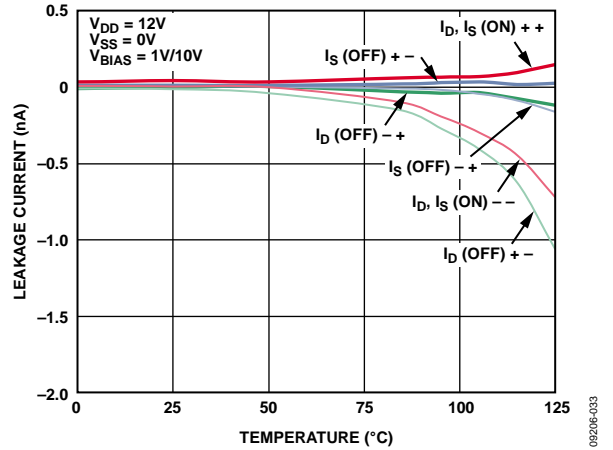


Figure 16. Leakage Currents vs. Temperature, 12 V Single Supply

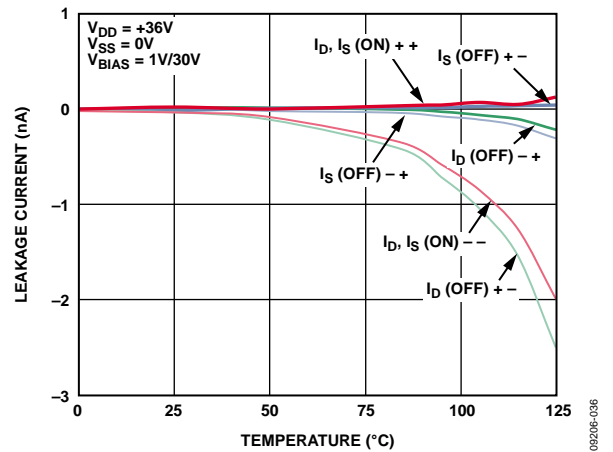


Figure 17. Leakage Currents vs. Temperature, 36 V Single Supply

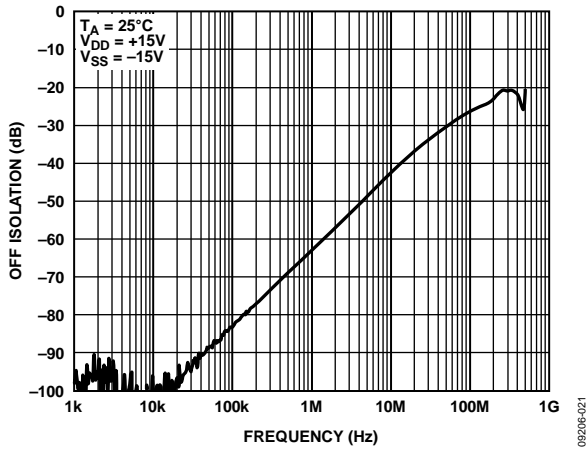


Figure 18. Off Isolation vs. Frequency, ±15 V Dual Supply

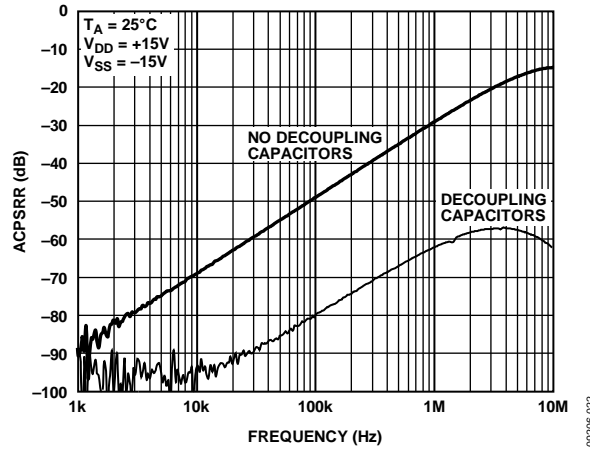


Figure 21. ACPSRR vs. Frequency, ±15 V Dual Supply

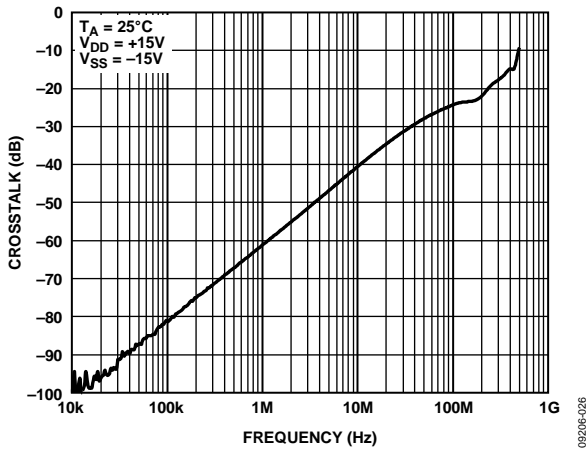


Figure 19. Crosstalk vs. Frequency, ±15 V Dual Supply

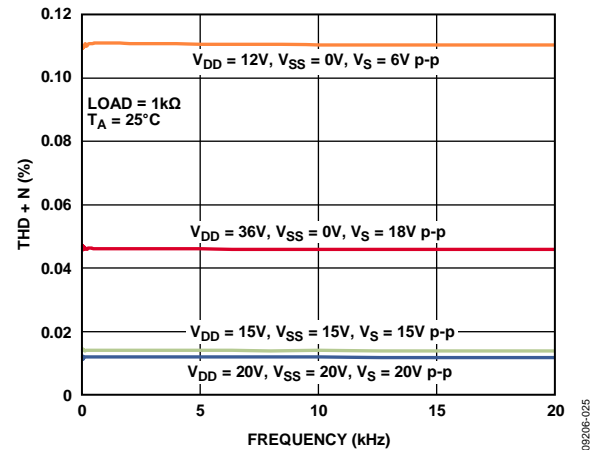


Figure 22. THD + N vs. Frequency

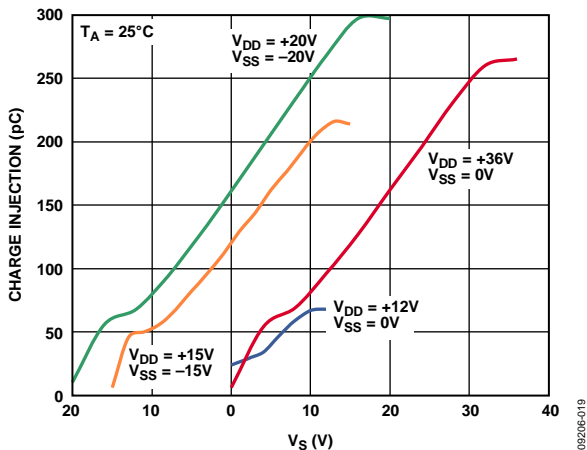


Figure 20. Charge Injection vs. Source Voltage

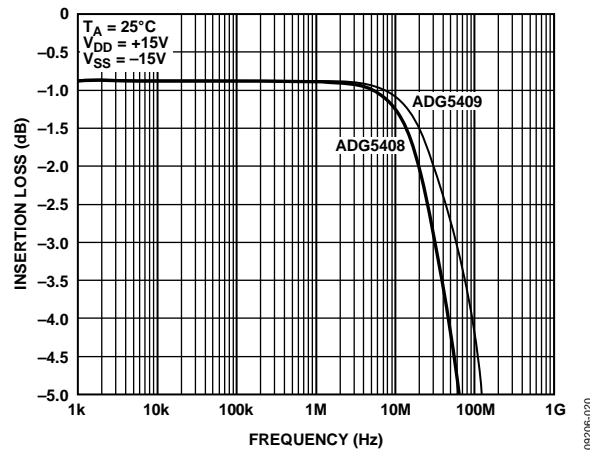


Figure 23. Bandwidth

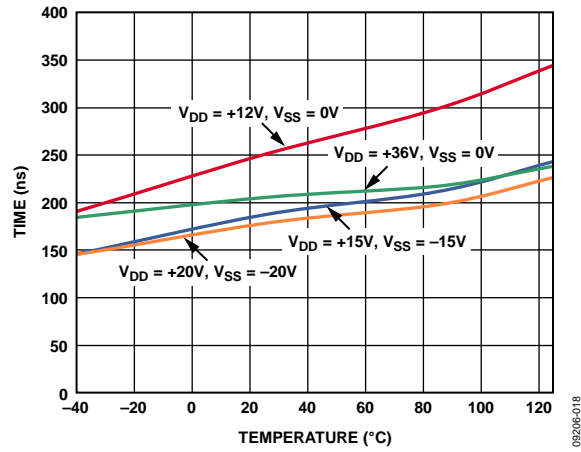


Figure 24.  $t_{TRANSITION}$  Times vs. Temperature

09208-018

TEST CIRCUITS

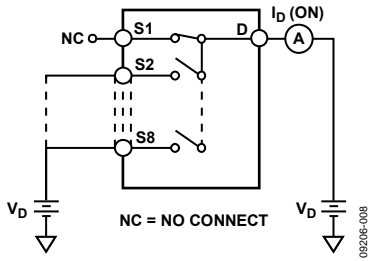


Figure 25. On Leakage

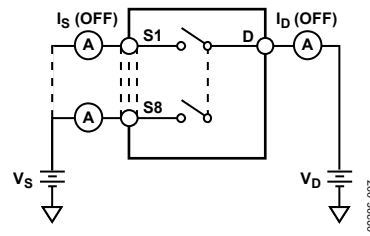


Figure 29. Off Leakage

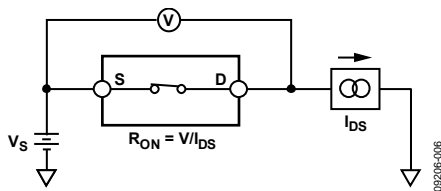


Figure 26. On Resistance

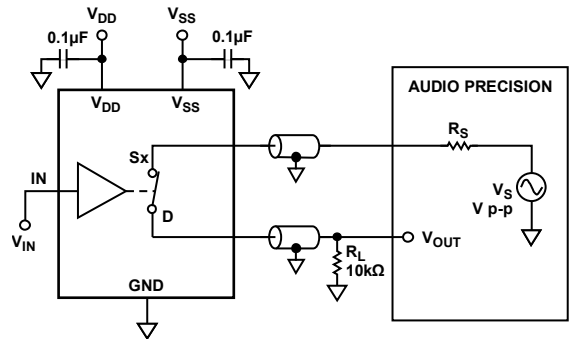
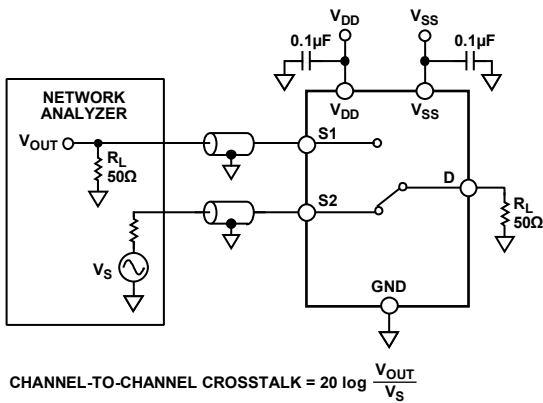
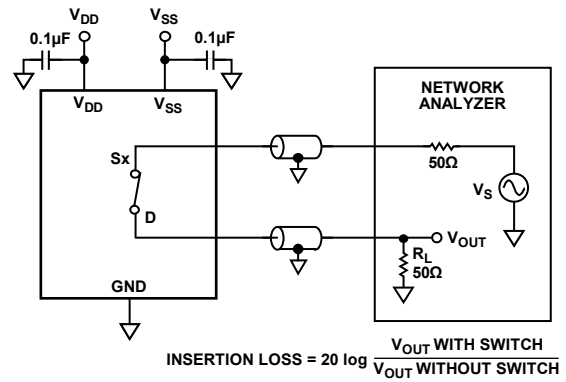


Figure 30. THD + Noise Figure



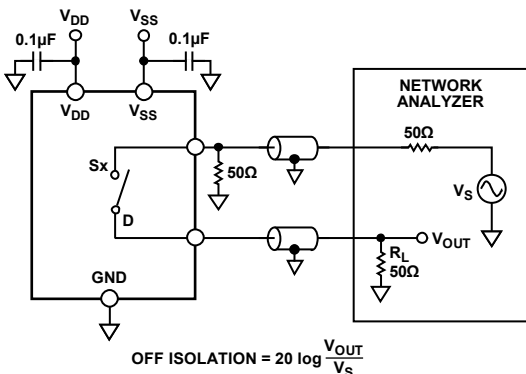
$$\text{CHANNEL-TO-CHANNEL CROSSTALK} = 20 \log \frac{V_{OUT}}{V_S}$$

Figure 27. Channel-to-Channel Crosstalk



$$\text{INSERTION LOSS} = 20 \log \frac{V_{OUT \text{ WITH SWITCH}}}{V_{OUT \text{ WITHOUT SWITCH}}}$$

Figure 31. Bandwidth



$$\text{OFF ISOLATION} = 20 \log \frac{V_{OUT}}{V_S}$$

Figure 28. Off Isolation



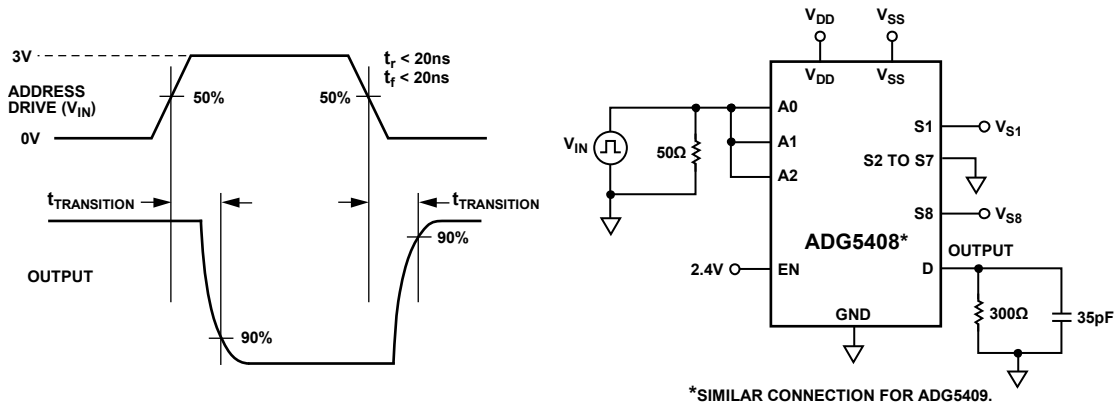


Figure 32. Address to Output Switching Times,  $t_{\text{TRANSITION}}$

09206-009

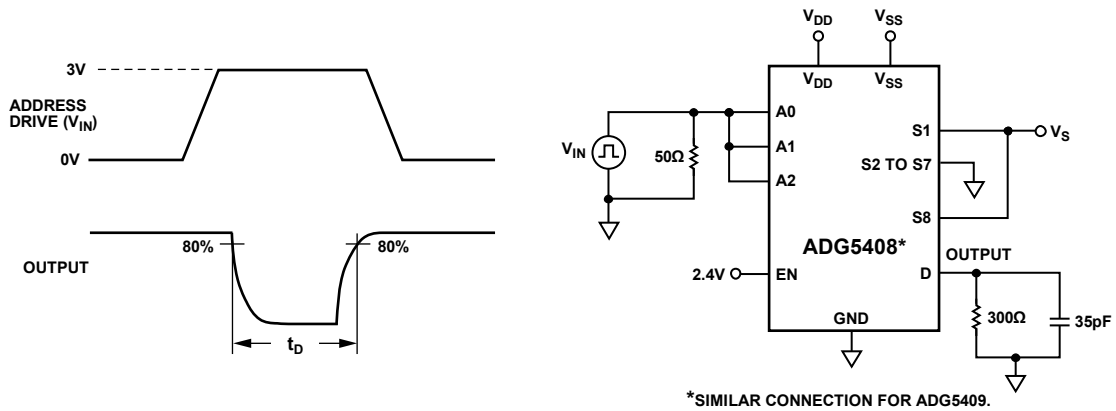


Figure 33. Break-Before-Make Delay,  $t_D$

09206-010

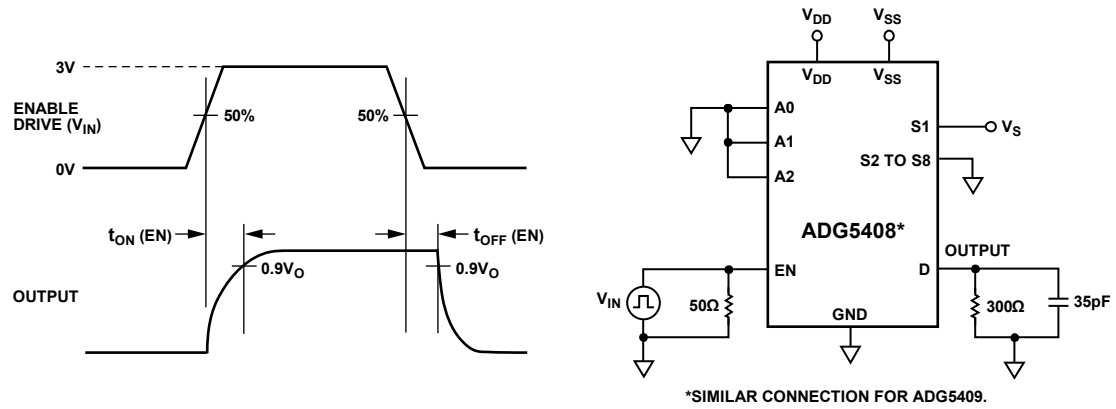


Figure 34. Enable Delay,  $t_{\text{ON}}(\text{EN})$ ,  $t_{\text{OFF}}(\text{EN})$

09206-011

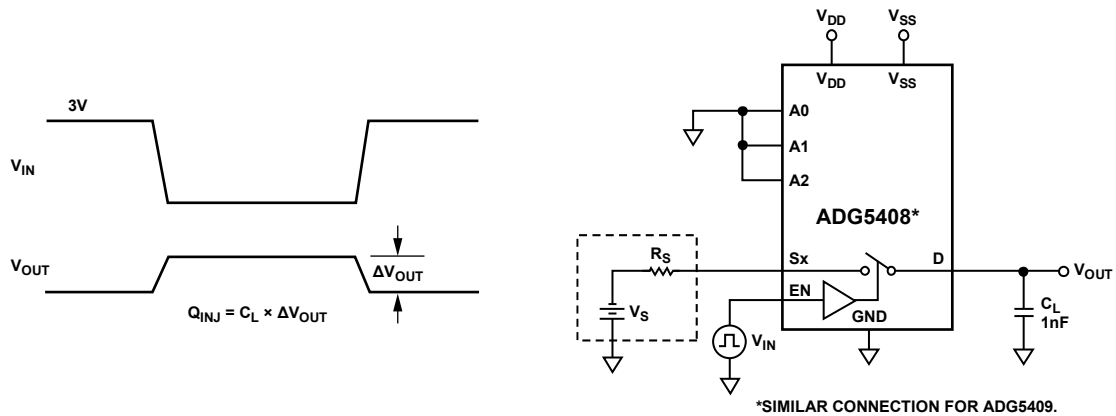


Figure 35. Charge Injection

09206-012

## TERMINOLOGY

### $I_{DD}$

$I_{DD}$  represents the positive supply current.

### $I_{SS}$

$I_{SS}$  represents the negative supply current.

### $V_D, V_S$

$V_D$  and  $V_S$  represent the analog voltage on Terminal D and Terminal S, respectively.

### $R_{ON}$

$R_{ON}$  is the ohmic resistance between Terminal D and Terminal S.

### $\Delta R_{ON}$

$\Delta R_{ON}$  represents the difference between the  $R_{ON}$  of any two channels.

### $R_{FLAT(ON)}$

The difference between the maximum and minimum value of on resistance as measured over the specified analog signal range is represented by  $R_{FLAT(ON)}$ .

### $I_S$ (Off)

$I_S$  (Off) is the source leakage current with the switch off.

### $I_D$ (Off)

$I_D$  (Off) is the drain leakage current with the switch off.

### $I_D$ (On), $I_S$ (On)

$I_D$  (On) and  $I_S$  (On) represent the channel leakage currents with the switch on.

### $V_{INL}$

$V_{INL}$  is the maximum input voltage for Logic 0.

### $V_{INH}$

$V_{INH}$  is the minimum input voltage for Logic 1.

### $I_{INL}, I_{INH}$

$I_{INL}$  and  $I_{INH}$  represent the low and high input currents of the digital inputs.

### $C_D$ (Off)

$C_D$  (Off) represents the off switch drain capacitance, which is measured with reference to ground.

### $C_S$ (Off)

$C_S$  (Off) represents the off switch source capacitance, which is measured with reference to ground.

### $C_D$ (On), $C_S$ (On)

$C_D$  (On) and  $C_S$  (On) represent on switch capacitances, which are measured with reference to ground.

### $C_{IN}$

$C_{IN}$  represents digital input capacitance.

### $t_{ON(EN)}$

$t_{ON(EN)}$  represents the delay time between the 50% and 90% points of the digital input and switch on condition.

### $t_{OFF(EN)}$

$t_{OFF(EN)}$  represents the delay time between the 50% and 90% points of the digital input and switch off condition.

### $t_{TRANSITION}$

Delay time between the 50% and 90% points of the digital inputs and the switch on condition when switching from one address state to another.

### $t_D$

$t_D$  represents the off time measured between the 80% point of both switches when switching from one address state to another.

### Off Isolation

Off isolation is a measure of unwanted signal coupling through an off channel.

### Charge Injection

Charge injection is a measure of the glitch impulse transferred from the digital input to the analog output during switching.

### Crosstalk

Crosstalk is a measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.

### Bandwidth

Bandwidth is the frequency at which the output is attenuated by 3 dB.

### On Response

On response is the frequency response of the on switch.

### Total Harmonic Distortion + Noise (THD + N)

The ratio of the harmonic amplitude plus noise of the signal to the fundamental is represented by THD + N.

### AC Power Supply Rejection Ratio (ACPSRR)

ACPSRR is a measure of the ability of a part to avoid coupling noise and spurious signals that appear on the supply voltage pin to the output of the switch. The dc voltage on the device is modulated by a sine wave of 0.62 V p-p. The ratio of the amplitude of signal on the output to the amplitude of the modulation is the ACPSRR.

## TRENCH ISOLATION

In the ADG5408/ADG5409, an insulating oxide layer (trench) is placed between the NMOS and the PMOS transistors of each CMOS switch. Parasitic junctions, which occur between the transistors in junction isolated switches, are eliminated, and the result is a completely latch-up proof switch.

In junction isolation, the N and P wells of the PMOS and NMOS transistors form a diode that is reverse-biased under normal operation. However, during overvoltage conditions, this diode can become forward-biased. A silicon controlled rectifier (SCR) type circuit is formed by the two transistors causing a significant amplification of the current that, in turn, leads to latch-up. With trench isolation, this diode is removed, and the result is a latch-up proof switch.

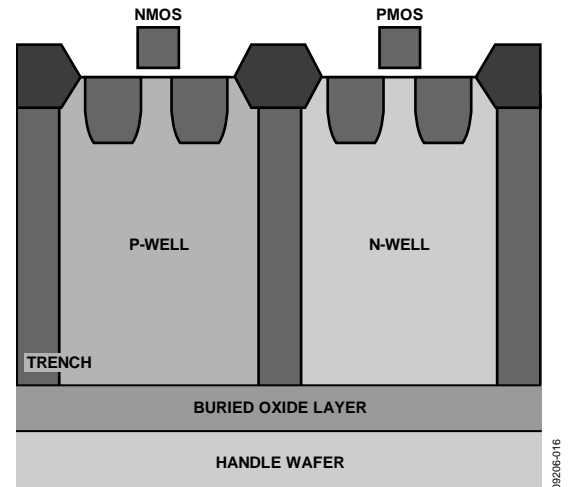


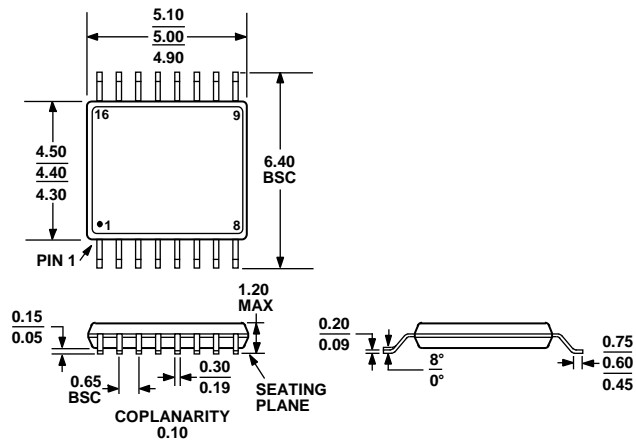
Figure 36. Trench Isolation

## **APPLICATIONS INFORMATION**

The ADG54xx family switches and multiplexers provide a robust solution for instrumentation, industrial, aerospace, and other harsh environments that are prone to latch-up, which is an undesirable high current state that can lead to device failure and persist until the power supply is turned off. The ADG5408/ADG5409 high voltage switches allow single-supply operation

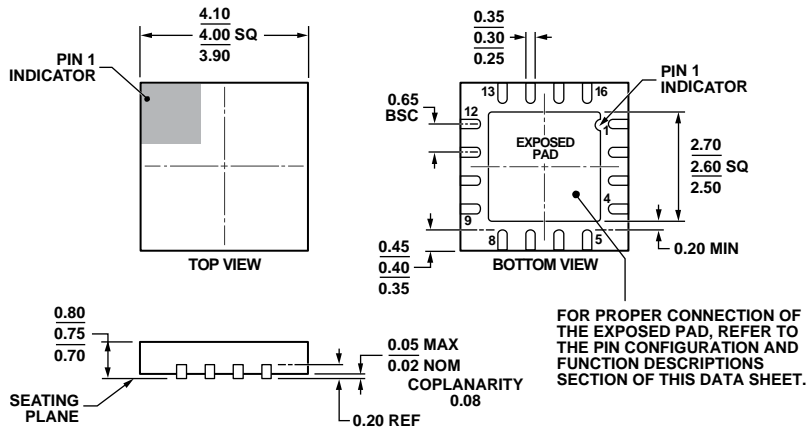
from 9 V to 40 V and dual-supply operation from  $\pm 9$  V to  $\pm 22$  V. The ADG5408/ADG5409 (as well as select devices within the same family) achieve an 8 kV human body model ESD rating that provides a robust solution eliminating the need for separate protect circuitry designs in some applications.

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

Figure 37. 16-Lead Thin Shrink Small Outline Package [TSSOP] (RU-16)  
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-WGGC.

Figure 38. 16-Lead Lead Frame Chip Scale Package [LFCSF\_WQ]  
4 mm × 4 mm Body, Very Very Thin Quad (CP-16-17)  
Dimensions shown in millimeters

08-16-2010C

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                               | Package Option |
|--------------------|-------------------|---|----------------|
| ADG5408BRUZ        | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG5408BRUZ-REEL7  | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG5408BCPZ-REEL7  | −40°C to +125°C   | 16-Lead Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-16-17       |
| ADG5409BRUZ        | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG5409BRUZ-REEL7  | −40°C to +125°C   | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16          |
| ADG5409BCPZ-REEL7  | −40°C to +125°C   | 16-Lead Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-16-17       |

<sup>1</sup> Z = RoHS Compliant Part.

**NOTES**

**NOTES**