

## FEATURES

**Latch-up proof**  
**3.5 pF off source capacitance**  
**Off drain capacitance**  
**ADG5206: 64 pF**  
**ADG5207: 33 pF**  
**0.35 pC typical charge injection**  
 **$\pm 0.02$  nA on channel leakage**  
**Low on resistance: 155  $\Omega$  typical**  
 **$\pm 9$  V to  $\pm 22$  V dual-supply operation**  
**9 V to 40 V single-supply operation**  
 **$V_{SS}$  to  $V_{DD}$  analog signal range**  
**Human body model (HBM) ESD rating**  
**ADG5206: 8 kV all pins**  
**ADG5207: 8 kV I/O port to supplies**

## APPLICATIONS

**Automatic test equipment**  
**Data acquisition**  
**Instrumentation**  
**Avionics**  
**Battery monitoring**  
**Communication systems**

## GENERAL DESCRIPTION

The **ADG5206** and **ADG5207** are monolithic CMOS analog multiplexers comprising 16 single channels and 8 differential channels, respectively. The **ADG5206** switches one of sixteen inputs to a common output, as determined by the 4-bit binary address lines, A0, A1, A2, and A3. The **ADG5207** switches one of eight differential inputs to a common differential output, as determined by the 3-bit binary address lines, A0, A1, and A2.

An EN input on both devices enables or disables the device. When EN is low, the device is disabled and all channels switch off. The ultralow capacitance and charge injection of these switches make them ideal solutions for data acquisition and sample-and-hold applications, where low glitch and fast settling are required. Fast switching speed coupled with high signal bandwidth make these devices 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

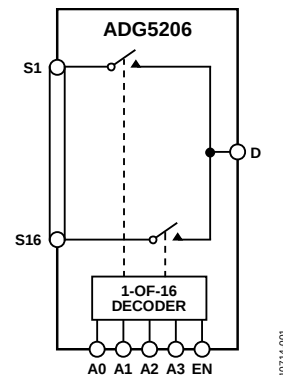


Figure 1.

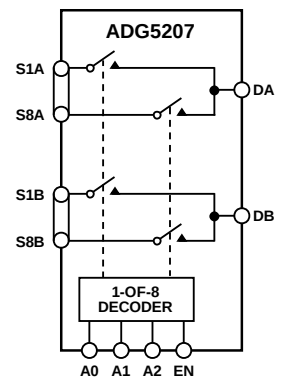


Figure 2.

The **ADG5206/ADG5207** do not have  $V_L$  pins; instead, an on-chip voltage generator generates the logic power supply internally.

## PRODUCT HIGHLIGHTS

1. Trench Isolation Guards Against Latch-Up. A dielectric trench separates the P and N channel transistors to prevent latch-up even under severe overvoltage conditions.
2. Optimal switch design for low charge injection, low switch capacitance, and low leakage currents.
3. The **ADG5206** achieves 8 kV HBM ESD specification on all external pins, while the **ADG5207** achieves 8 kV on the I/O port to supply pins, 2 kV on the I/O port to I/O port pins, and 8 kV on all other pins.
4. Dual-Supply Operation. For applications where the analog signal is bipolar, the **ADG5206/ADG5207** can be operated from dual supplies of up to  $\pm 22$  V.
5. Single-Supply Operation. For applications where the analog signal is unipolar, the **ADG5206/ADG5207** can be operated from a single rail power supply of up to 40 V.

Rev. A

Document Feedback

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## REVISION HISTORY

### 5/13—Rev. 0 to Rev. A

|                                                                                        |           |
|----------------------------------------------------------------------------------------|-----------|
| Added 32-Lead LFCSP .....                                                              | Universal |
| Changes to Features Section and Product Highlights Section .....                       | 1         |
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### 7/12—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<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C   | Unit              | Test Conditions/Comments                                                                                                      |
|----------------------------------------------------------------------------------------|--------|-------------------|-------------------|----------------------|-------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                                                   |        |                   |                   |                      |                   |                                                                                                                               |
| Analog Signal Range                                                                    |        |                   |                   | $V_{DD}$ to $V_{SS}$ | V                 |                                                                                                                               |
| On Resistance, $R_{ON}$                                                                | 155    |                   |                   |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -1\text{ mA}$ ;<br>see Figure 32                                                             |
|                                                                                        | 200    | 225               | 250               | 285                  | $\Omega$ max      | $V_{DD} = +13.5\text{ V}$ , $V_{SS} = -13.5\text{ V}$                                                                         |
| On Resistance Match Between Channels,<br>$\Delta R_{ON}$                               | 4      |                   |                   |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -1\text{ mA}$                                                                                |
|                                                                                        | 12     | 13                | 14                | 15                   | $\Omega$ max      |                                                                                                                               |
| On Resistance Flatness, $R_{FLAT(ON)}$                                                 | 48     |                   |                   |                      | $\Omega$ typ      | $V_S = \pm 10\text{ V}$ , $I_S = -1\text{ mA}$                                                                                |
|                                                                                        | 65     | 73                | 80                | 90                   | $\Omega$ max      |                                                                                                                               |
| <b>LEAKAGE CURRENTS</b>                                                                |        |                   |                   |                      |                   |                                                                                                                               |
| Source Off Leakage, $I_S$ (Off)                                                        | ±0.005 |                   |                   |                      | nA typ            | $V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$<br>$V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ;<br>see Figure 33 |
|                                                                                        | ±0.1   | ±0.15             | ±0.2              | ±0.4                 | nA max            |                                                                                                                               |
| Match Between Channels, $\Delta$ Leakage,<br>$I_S$ (Off) <sup>1</sup>                  | 0.01   |                   |                   | 0.015                | nA typ            | $V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$                                                                             |
| Drain Off Leakage, $I_D$ (Off)                                                         |        |                   |                   |                      |                   | $V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ;<br>see Figure 33                                                          |
| <a href="#">ADG5206</a>                                                                | ±0.02  |                   |                   |                      | nA typ            |                                                                                                                               |
|                                                                                        | ±0.1   | ±0.25             | ±0.6              | ±3.3                 | nA max            |                                                                                                                               |
| <a href="#">ADG5207</a>                                                                | ±0.02  |                   |                   |                      | nA typ            |                                                                                                                               |
|                                                                                        | ±0.1   | ±0.25             | ±0.4              | ±1.7                 | nA max            |                                                                                                                               |
| Match Between Channels, $\Delta$ Leakage,<br>$I_D$ (Off), <a href="#">ADG5207</a> Only | 0.015  |                   |                   | 0.015                | nA typ            | $V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$                                                                             |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)                                             |        |                   |                   |                      |                   | $V_S = V_D = \pm 10\text{ V}$ ; see Figure 34                                                                                 |
| <a href="#">ADG5206</a>                                                                | ±0.02  |                   |                   |                      | nA typ            |                                                                                                                               |
|                                                                                        | ±0.1   | ±0.25             | ±0.6              | ±3.3                 | nA max            |                                                                                                                               |
| <a href="#">ADG5207</a>                                                                | ±0.02  |                   |                   |                      | nA typ            |                                                                                                                               |
|                                                                                        | ±0.1   | ±0.2              | ±0.4              | ±1.7                 | nA max            |                                                                                                                               |
| Match Between Channels, $\Delta$ Leakage,<br>$I_D$ (On), $I_S$ (On) <sup>2</sup>       | 0.01   |                   |                   | 0.03                 | nA typ            | $V_S = V_D = \pm 10\text{ V}$                                                                                                 |
| <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 $V_{DD}$                                                                                                |
|                                                                                        |        |                   |                   | ±0.1                 | $\mu\text{A}$ max |                                                                                                                               |
| Digital Input Capacitance, $C_{IN}$                                                    | 3      |                   |                   |                      | pF typ            |                                                                                                                               |
| <b>DYNAMIC CHARACTERISTICS<sup>3</sup></b>                                             |        |                   |                   |                      |                   |                                                                                                                               |
| Transition Time, $t_{TRANSITION}$                                                      | 200    |                   |                   |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                    |
|                                                                                        | 260    | 300               | 320               | 360                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 35                                                                                           |
| $t_{ON}$ (EN)                                                                          | 180    |                   |                   |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                    |
|                                                                                        | 245    | 260               | 270               | 285                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 36                                                                                           |
| $t_{OFF}$ (EN)                                                                         | 140    |                   |                   |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                    |
|                                                                                        | 200    | 220               | 240               | 270                  | ns max            | $V_S = 10\text{ V}$ ; see Figure 36                                                                                           |
| Break-Before-Make Time Delay, $t_D$                                                    | 85     |                   |                   |                      | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                    |
|                                                                                        |        |                   |                   | 27                   | ns min            | $V_{S1} = V_{S2} = 10\text{ V}$ ; see Figure 37                                                                               |

| Parameter                    | 25°C             | –40°C to<br>+60°C | –40°C to<br>+85°C | –40°C to<br>+125°C | Unit                                   | Test Conditions/Comments                                                                                                                                |
|------------------------------|------------------|-------------------|-------------------|--------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| Charge Injection, $Q_{INJ}$  | 0.35             |                   |                   |                    | pC typ                                 | $V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ;<br>see Figure 38                                                                         |
| Off Isolation                | $\pm 1.8$<br>–90 |                   |                   | $\pm 2$            | pC typ<br>dB typ                       | $V_S = \pm 10\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ;<br>$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ;<br>see Figure 39 |
| Channel-to-Channel Crosstalk | –76              |                   |                   |                    | dB typ                                 | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ;<br>see Figure 40                                                                        |
| –3 dB Bandwidth              |                  |                   |                   |                    |                                        | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ;<br>see Figure 41                                                                                             |
| ADG5206                      | 60               |                   |                   |                    | MHz typ                                |                                                                                                                                                         |
| ADG5207                      | 140              |                   |                   |                    | MHz typ                                |                                                                                                                                                         |
| Insertion Loss               | 6.4              |                   |                   |                    | dB typ                                 | $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ;<br>see Figure 41                                                                        |
| $C_S$ (Off)                  | 3.5              |                   |                   |                    | pF typ                                 | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                                 |
| $C_D$ (Off)                  |                  |                   |                   |                    |                                        |                                                                                                                                                         |
| ADG5206                      | 64               |                   |                   |                    | pF typ                                 | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                                 |
| ADG5207                      | 33               |                   |                   |                    | pF typ                                 | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                                 |
| $C_D$ (On), $C_S$ (On)       |                  |                   |                   |                    |                                        |                                                                                                                                                         |
| ADG5206                      | 68               |                   |                   |                    | pF typ                                 | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                                 |
| ADG5207                      | 36               |                   |                   |                    | pF typ                                 | $V_S = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                                 |
| POWER REQUIREMENTS           |                  |                   |                   |                    |                                        |                                                                                                                                                         |
| $I_{DD}$                     | 45<br>55         |                   |                   | 70                 | $\mu\text{A typ}$<br>$\mu\text{A max}$ | $V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$<br>Digital inputs = 0 V or $V_{DD}$                                                               |
| $I_{SS}$                     | 0.001            |                   |                   | 1                  | $\mu\text{A typ}$<br>$\mu\text{A max}$ | Digital inputs = 0 V or $V_{DD}$                                                                                                                        |
| $V_{DD}/V_{SS}$              |                  |                   |                   | $\pm 9/\pm 22$     | V min/V max                            | GND = 0 V                                                                                                                                               |

<sup>1</sup> The off channel leakage delta is calculated using the maximum of  $V_S = +10\text{ V}$  and  $V_D = -10\text{ V}$ , or  $V_S = -10\text{ V}$  and  $V_D = +10\text{ V}$ .

<sup>2</sup> The on channel leakage delta is calculated using the maximum of  $V_S = V_D = +10\text{ V}$ , or  $V_S = V_D = -10\text{ V}$ .

<sup>3</sup> Guaranteed by design; not subject to production test.

## ±20 V DUAL SUPPLY

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

Table 2.

| Parameter                                             | 25°C | –40°C to<br>+60°C | –40°C to<br>+85°C | –40°C to<br>+125°C   | Unit         | Test Conditions/Comments                                          |
|-------------------------------------------------------|------|-------------------|-------------------|----------------------|--------------|-------------------------------------------------------------------|
| ANALOG SWITCH                                         |      |                   |                   |                      |              |                                                                   |
| Analog Signal Range                                   |      |                   |                   | $V_{DD}$ to $V_{SS}$ | V            |                                                                   |
| On Resistance, $R_{ON}$                               | 130  |                   |                   |                      | $\Omega$ typ | $V_S = \pm 15\text{ V}$ , $I_S = -1\text{ mA}$ ;<br>see Figure 32 |
|                                                       | 160  | 180               | 200               | 230                  | $\Omega$ max | $V_{DD} = +18\text{ V}$ , $V_{SS} = -18\text{ V}$                 |
| On-Resistance Match Between Channels, $\Delta R_{ON}$ | 4    |                   |                   |                      | $\Omega$ typ | $V_S = \pm 15\text{ V}$ , $I_S = -1\text{ mA}$                    |
|                                                       | 12   | 13                | 14                | 15                   | $\Omega$ max |                                                                   |
| On-Resistance Flatness, $R_{FLAT(ON)}$                | 35   |                   |                   |                      | $\Omega$ typ | $V_S = \pm 15\text{ V}$ , $I_S = -1\text{ mA}$                    |
|                                                       | 50   | 58                | 65                | 75                   | $\Omega$ max |                                                                   |

| Parameter                                                                                  | 25°C          | −40°C to<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C | Unit             | Test Conditions/Comments                                                                                                                         |
|--------------------------------------------------------------------------------------------|---------------|-------------------|-------------------|--------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| LEAKAGE CURRENTS                                                                           |               |                   |                   |                    |                  |                                                                                                                                                  |
| Source Off Leakage, I <sub>S</sub> (Off)                                                   | ±0.005        |                   |                   |                    | nA typ           | V <sub>DD</sub> = +22 V, V <sub>SS</sub> = −22 V<br>V <sub>S</sub> = ±15 V, V <sub>D</sub> = ∓ 15 V;<br>see Figure 33                            |
| Match Between Channels, ΔLeakage, I <sub>S</sub> (Off) <sup>1</sup>                        | ±0.1<br>0.01  | ±0.15             | ±0.2              | ±0.4<br>0.015      | nA max<br>nA typ | V <sub>S</sub> = ±15 V, V <sub>D</sub> = ∓ 15 V;<br>see Figure 33                                                                                |
| Drain Off Leakage, I <sub>D</sub> (Off)                                                    |               |                   |                   |                    |                  |                                                                                                                                                  |
| ADG5206                                                                                    | ±0.02         |                   |                   |                    | nA typ           | V <sub>S</sub> = V <sub>D</sub> = ±15 V;<br>see Figure 34                                                                                        |
| ADG5207                                                                                    | ±0.1<br>±0.02 | ±0.25             | ±0.6              | ±3.3               | nA max<br>nA typ |                                                                                                                                                  |
| Match Between Channels, ΔLeakage,<br>I <sub>D</sub> (Off), ADG5207 Only                    | ±0.1<br>0.015 | ±0.25             | ±0.4              | ±1.7<br>0.015      | nA max<br>nA typ |                                                                                                                                                  |
| Channel On Leakage, I <sub>D</sub> (On), I <sub>S</sub> (On)                               |               |                   |                   |                    |                  |                                                                                                                                                  |
| ADG5206                                                                                    | ±0.02         |                   |                   |                    | nA typ           |                                                                                                                                                  |
| ADG5207                                                                                    | ±0.1<br>±0.02 | ±0.25             | ±0.6              | ±3.3               | nA max<br>nA typ |                                                                                                                                                  |
| Match Between Channels, ΔLeakage,<br>I <sub>D</sub> (On), I <sub>S</sub> (On) <sup>2</sup> | ±0.1<br>0.01  | ±0.2              | ±0.4              | ±1.7<br>0.03       | nA max<br>nA typ |                                                                                                                                                  |
|                                                                                            |               |                   |                   |                    |                  |                                                                                                                                                  |
| DIGITAL INPUTS                                                                             |               |                   |                   |                    |                  |                                                                                                                                                  |
| Input High Voltage, V <sub>INH</sub>                                                       |               |                   |                   | 2.0                | V min            | V <sub>IN</sub> = V <sub>GND</sub> or V <sub>DD</sub>                                                                                            |
| Input Low Voltage, V <sub>INL</sub>                                                        |               |                   |                   | 0.8                | V max            |                                                                                                                                                  |
| Input Current, I <sub>INL</sub> or I <sub>INH</sub>                                        | ±0.002        |                   |                   | ±0.1               | μA typ<br>μA max |                                                                                                                                                  |
| Digital Input Capacitance, C <sub>IN</sub>                                                 | 3             |                   |                   |                    | pF typ           |                                                                                                                                                  |
| DYNAMIC CHARACTERISTICS <sup>3</sup>                                                       |               |                   |                   |                    |                  |                                                                                                                                                  |
| Transition Time, t <sub>TRANSITION</sub>                                                   | 185           |                   |                   |                    | ns typ           | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                                                                   |
| t <sub>ON</sub> (EN)                                                                       | 240<br>175    | 270               | 290               | 320                | ns max<br>ns typ | V <sub>S</sub> = 10 V; see Figure 35<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                           |
| t <sub>OFF</sub> (EN)                                                                      | 230<br>135    | 245               | 255               | 270                | ns max<br>ns typ | V <sub>S</sub> = 10 V; see Figure 36<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                           |
| Break-Before-Make Time Delay, t <sub>D</sub>                                               | 185<br>75     | 205               | 220               | 245                | ns max<br>ns typ | V <sub>S</sub> = 10 V; see Figure 36<br>R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                           |
| Charge Injection, Q <sub>INJ</sub>                                                         |               |                   |                   | 27                 | ns min           | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S1</sub> = V <sub>S2</sub> = 10 V; see Figure 37                                        |
|                                                                                            | 0.45          |                   |                   |                    | pC typ           | V <sub>S</sub> = 0 V, R <sub>S</sub> = 0 Ω, C <sub>L</sub> = 1 nF;<br>see Figure 38                                                              |
| Off Isolation                                                                              | ±4<br>−90     |                   |                   | ±4                 | pC typ<br>dB typ | V <sub>S</sub> = ±10 V, R <sub>S</sub> = 0 Ω, C <sub>L</sub> = 1 nF<br>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF,<br>f = 1 MHz; see Figure 39 |
| Channel-to-Channel Crosstalk                                                               | −76           |                   |                   |                    | dB typ           | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF,<br>f = 1 MHz; see Figure 40                                                                        |
| −3 dB Bandwidth                                                                            |               |                   |                   |                    |                  | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF;<br>see Figure 41                                                                                   |
| ADG5206                                                                                    | 65            |                   |                   |                    | MHz typ          | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF,<br>f = 1 MHz; see Figure 41                                                                        |
| ADG5207                                                                                    | 145           |                   |                   |                    | MHz typ          |                                                                                                                                                  |
| Insertion Loss                                                                             | 5.6           |                   |                   |                    | dB typ           |                                                                                                                                                  |
| C <sub>S</sub> (Off)                                                                       | 3.3           |                   |                   |                    | pF typ           | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                  |

| Parameter                                | 25°C  | −40°C to<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C | Unit        | Test Conditions/Comments                         |
|------------------------------------------|-------|-------------------|-------------------|--------------------|-------------|--------------------------------------------------|
| C <sub>D</sub> (Off)                     |       |                   |                   |                    |             |                                                  |
| ADG5206                                  | 62    |                   |                   |                    | pF typ      | V <sub>S</sub> = 0 V, f = 1 MHz                  |
| ADG5207                                  | 32    |                   |                   |                    | pF typ      | V <sub>S</sub> = 0 V, f = 1 MHz                  |
| C <sub>D</sub> (On), C <sub>S</sub> (On) |       |                   |                   |                    |             |                                                  |
| ADG5206                                  | 67    |                   |                   |                    | pF typ      | V <sub>S</sub> = 0 V, f = 1 MHz                  |
| ADG5207                                  | 35    |                   |                   |                    | pF typ      | V <sub>S</sub> = 0 V, f = 1 MHz                  |
| POWER REQUIREMENTS                       |       |                   |                   |                    |             | V <sub>DD</sub> = +22 V, V <sub>SS</sub> = −22 V |
| I <sub>DD</sub>                          | 50    |                   |                   |                    | μA typ      | Digital inputs = 0 V or V <sub>DD</sub>          |
|                                          | 70    |                   |                   | 110                | μA max      |                                                  |
| I <sub>SS</sub>                          | 0.001 |                   |                   |                    | μA typ      | Digital inputs = 0 V or V <sub>DD</sub>          |
|                                          |       |                   |                   | 1                  | μA max      |                                                  |
| V <sub>DD</sub> /V <sub>SS</sub>         |       |                   |                   | ±9/±22             | V min/V max | GND = 0 V                                        |

<sup>1</sup> The off channel leakage delta is calculated using the maximum of V<sub>S</sub> = +15 V and V<sub>D</sub> = −15 V, or V<sub>S</sub> = −15 V and V<sub>D</sub> = +15 V.

<sup>2</sup> The on channel leakage delta is calculated using the maximum of V<sub>S</sub> = V<sub>D</sub> = +15 V, or V<sub>S</sub> = V<sub>D</sub> = −15 V.

<sup>3</sup> Guaranteed by design; not subject to production test.

## 12 V SINGLE SUPPLY

V<sub>DD</sub> = 12 V ± 10%, V<sub>SS</sub> = 0 V, GND = 0 V, unless otherwise noted.

Table 3.

| Parameter                                                                                  | 25°C   | −40°C to<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C     | Unit   | Test Conditions/Comments                                               |
|--------------------------------------------------------------------------------------------|--------|-------------------|-------------------|------------------------|--------|------------------------------------------------------------------------|
| ANALOG SWITCH                                                                              |        |                   |                   |                        |        |                                                                        |
| Analog Signal Range                                                                        |        |                   |                   | 0 V to V <sub>DD</sub> | V      |                                                                        |
| On Resistance, R <sub>ON</sub>                                                             | 350    |                   |                   |                        | Ω typ  | V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA;<br>see Figure 32 |
|                                                                                            | 500    | 560               | 610               | 700                    | Ω max  | V <sub>DD</sub> = 10.8 V, V <sub>SS</sub> = 0 V                        |
| On-Resistance Match Between<br>Channels, ΔR <sub>ON</sub>                                  | 5      |                   |                   |                        | Ω typ  | V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA                   |
|                                                                                            | 20     | 21                | 22                | 24                     | Ω max  |                                                                        |
| On-Resistance Flatness, R <sub>FLAT</sub> (ON)                                             | 170    |                   |                   |                        | Ω typ  | V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA                   |
|                                                                                            | 280    | 310               | 335               | 370                    | Ω max  |                                                                        |
| LEAKAGE CURRENTS                                                                           |        |                   |                   |                        |        | V <sub>DD</sub> = +13.2 V, V <sub>SS</sub> = 0 V                       |
| Source Off Leakage, I <sub>S</sub> (Off)                                                   | ±0.005 |                   |                   |                        | nA typ | V <sub>S</sub> = 1 V/10 V, V <sub>D</sub> = 10 V/1 V;<br>see Figure 33 |
|                                                                                            | ±0.1   | ±0.15             | ±0.2              | ±0.4                   | nA max |                                                                        |
| Match Between Channels, ΔLeakage,<br>I <sub>S</sub> (Off) <sup>1</sup>                     | 0.01   |                   |                   | 0.015                  | nA typ |                                                                        |
| Drain Off Leakage, I <sub>D</sub> (Off)                                                    |        |                   |                   |                        |        | V <sub>S</sub> = 1 V/10 V, V <sub>D</sub> = 1 V/10 V;<br>see Figure 33 |
| ADG5206                                                                                    | ±0.02  |                   |                   |                        | nA typ |                                                                        |
|                                                                                            | ±0.1   | ±0.25             | ±0.6              | ±3.3                   | nA max |                                                                        |
| ADG5207                                                                                    | ±0.02  |                   |                   |                        | nA typ |                                                                        |
|                                                                                            | ±0.1   | ±0.25             | ±0.4              | ±1.7                   | nA max |                                                                        |
| Match Between Channels, ΔLeakage,<br>I <sub>D</sub> (Off), ADG5207 Only                    | 0.015  |                   |                   | 0.015                  | nA typ |                                                                        |
| Channel On Leakage, I <sub>D</sub> (On), I <sub>S</sub> (On)                               |        |                   |                   |                        |        | V <sub>S</sub> = V <sub>D</sub> = 1 V/10 V; see Figure 34              |
| ADG5206                                                                                    | ±0.02  |                   |                   |                        | nA typ |                                                                        |
|                                                                                            | ±0.1   | ±0.25             | ±0.6              | ±3.3                   | nA max |                                                                        |
| ADG5207                                                                                    | ±0.02  |                   |                   |                        | nA typ |                                                                        |
|                                                                                            | ±0.1   | ±0.2              | ±0.4              | ±1.7                   | nA max |                                                                        |
| Match Between Channels, ΔLeakage,<br>I <sub>D</sub> (On), I <sub>S</sub> (On) <sup>2</sup> | 0.01   |                   |                   | 0.03                   | nA typ |                                                                        |

| Parameter                             | 25°C  | −40°C to<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C | Unit             | Test Conditions/Comments                                                           |
|---------------------------------------|-------|-------------------|-------------------|--------------------|------------------|------------------------------------------------------------------------------------|
| DIGITAL INPUTS                        |       |                   |                   |                    |                  |                                                                                    |
| 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 |                   |                   | ±0.1               | μA typ<br>μA max |                                                                                    |
| Digital Input Capacitance, $C_{IN}$   | 3     |                   |                   |                    | pF typ           |                                                                                    |
| DYNAMIC CHARACTERISTICS <sup>3</sup>  |       |                   |                   |                    |                  |                                                                                    |
| Transition Time, $t_{TRANSITION}$     | 290   |                   |                   |                    | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$                                        |
|                                       | 290   | 440               | 480               | 550                | ns max           | $V_S = 8\ \text{V}$ ; see Figure 35                                                |
| $t_{ON}$ (EN)                         | 230   |                   |                   |                    | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$                                        |
|                                       | 290   | 320               | 340               | 370                | ns max           | $V_S = 8\ \text{V}$ ; see Figure 36                                                |
| $t_{OFF}$ (EN)                        | 230   |                   |                   |                    | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$                                        |
|                                       | 315   | 360               | 390               | 450                | ns max           | $V_S = 8\ \text{V}$ ; see Figure 36                                                |
| Break-Before-Make Time Delay, $t_D$   | 170   |                   |                   |                    | ns typ           | $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$                                        |
|                                       |       |                   |                   | 45                 | ns min           | $V_{S1} = V_{S2} = 8\ \text{V}$ ; see Figure 37                                    |
| Charge Injection, $Q_{INJ}$           | 0.25  |                   |                   |                    | pC typ           | $V_S = 6\ \text{V}$ , $R_S = 0\ \Omega$ , $C_L = 1\ \text{nF}$ ;<br>see Figure 38  |
|                                       | ±0.6  |                   |                   | ±0.7               | pC typ           | $V_S = 0\ \text{V}$ to $10\ \text{V}$ , $R_S = 0\ \Omega$ , $C_L = 1\ \text{nF}$   |
| Off Isolation                         | −90   |                   |                   |                    | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 39 |
| Channel-to-Channel Crosstalk          | −76   |                   |                   |                    | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 40 |
| −3 dB Bandwidth                       |       |                   |                   |                    |                  | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; see Figure 41                          |
| ADG5206                               | 50    |                   |                   |                    | MHz typ          |                                                                                    |
| ADG5207                               | 105   |                   |                   |                    | MHz typ          |                                                                                    |
| Insertion Loss                        | 8.55  |                   |                   |                    | dB typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 41 |
| $C_S$ (Off)                           | 3.6   |                   |                   |                    | pF typ           | $V_S = 6\ \text{V}$ , $f = 1\ \text{MHz}$                                          |
| $C_D$ (Off)                           |       |                   |                   |                    |                  |                                                                                    |
| ADG5206                               | 71    |                   |                   |                    | pF typ           | $V_S = 6\ \text{V}$ , $f = 1\ \text{MHz}$                                          |
| ADG5207                               | 36    |                   |                   |                    | pF typ           | $V_S = 6\ \text{V}$ , $f = 1\ \text{MHz}$                                          |
| $C_D$ (On), $C_S$ (On)                |       |                   |                   |                    |                  |                                                                                    |
| ADG5206                               | 75    |                   |                   |                    | pF typ           | $V_S = 6\ \text{V}$ , $f = 1\ \text{MHz}$                                          |
| ADG5207                               | 40    |                   |                   |                    | pF typ           | $V_S = 6\ \text{V}$ , $f = 1\ \text{MHz}$                                          |
| POWER REQUIREMENTS                    |       |                   |                   |                    |                  |                                                                                    |
| $I_{DD}$                              | 40    |                   |                   |                    | μA typ           | $V_{DD} = 13.2\ \text{V}$                                                          |
|                                       | 50    |                   |                   | 65                 | 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> The off channel leakage delta is calculated using the maximum of  $V_S = 1\ \text{V}$  and  $V_D = 10\ \text{V}$ , or  $V_S = 10\ \text{V}$  and  $V_D = 1\ \text{V}$ .

<sup>2</sup> The on channel leakage delta is calculated using the maximum of  $V_S = V_D = 1\ \text{V}$ , or  $V_S = V_D = 10\ \text{V}$ .

<sup>3</sup> Guaranteed by design; not subject to production test.

**36 V SINGLE SUPPLY**

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

**Table 4.**

| Parameter                                                                              | 25°C        | −40°C to<br>+60°C | −40°C to<br>+85°C | −40°C to<br>+125°C | Unit              | Test Conditions/Comments                                                                                                               |
|----------------------------------------------------------------------------------------|-------------|-------------------|-------------------|--------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                                                   |             |                   |                   |                    |                   |                                                                                                                                        |
| Analog Signal Range                                                                    |             |                   |                   | 0 V to $V_{DD}$    | V                 |                                                                                                                                        |
| On Resistance, $R_{ON}$                                                                | 140         |                   |                   |                    | $\Omega$ typ      | $V_S = 0\text{ V to } 30\text{ V}$ , $I_S = -1\text{ mA}$ ;<br>see Figure 32                                                           |
|                                                                                        | 170         | 195               | 215               | 245                | $\Omega$ max      | $V_{DD} = 32.4\text{ V}$ , $V_{SS} = 0\text{ V}$                                                                                       |
| On-Resistance Match Between Channels, $\Delta R_{ON}$                                  | 4           |                   |                   |                    | $\Omega$ typ      | $V_S = 0\text{ V to } 30\text{ V}$ , $I_S = -1\text{ mA}$                                                                              |
|                                                                                        | 12          | 13                | 14                | 15                 | $\Omega$ max      |                                                                                                                                        |
| On-Resistance Flatness, $R_{FLAT(ON)}$                                                 | 40          |                   |                   |                    | $\Omega$ typ      | $V_S = 0\text{ V to } 30\text{ V}$ , $I_S = -1\text{ mA}$                                                                              |
|                                                                                        | 55          | 63                | 70                | 80                 | $\Omega$ max      |                                                                                                                                        |
| <b>LEAKAGE CURRENTS</b>                                                                |             |                   |                   |                    |                   |                                                                                                                                        |
| Source Off Leakage, $I_S$ (Off)                                                        | $\pm 0.005$ |                   |                   |                    | nA typ            | $V_{DD} = 39.6\text{ V}$ , $V_{SS} = 0\text{ V}$<br>$V_S = 1\text{ V}/30\text{ V}$ , $V_D = 30\text{ V}/1\text{ V}$ ;<br>see Figure 33 |
|                                                                                        | $\pm 0.1$   | $\pm 0.15$        | $\pm 0.2$         | $\pm 0.4$          | nA max            |                                                                                                                                        |
| Match Between Channels, $\Delta$ Leakage, $I_S$ (Off) <sup>1</sup>                     | 0.01        |                   |                   | 0.015              | nA typ            |                                                                                                                                        |
| Drain Off Leakage, $I_D$ (Off)                                                         |             |                   |                   |                    |                   | $V_S = 1\text{ V}/30\text{ V}$ , $V_D = 30\text{ V}/1\text{ V}$ ;<br>see Figure 33                                                     |
| <a href="#">ADG5206</a>                                                                | $\pm 0.02$  |                   |                   |                    | nA typ            |                                                                                                                                        |
|                                                                                        | $\pm 0.1$   | $\pm 0.25$        | $\pm 0.6$         | $\pm 3.3$          | nA max            |                                                                                                                                        |
| <a href="#">ADG5207</a>                                                                | $\pm 0.02$  |                   |                   |                    | nA typ            |                                                                                                                                        |
|                                                                                        | $\pm 0.1$   | $\pm 0.25$        | $\pm 0.4$         | $\pm 1.7$          | nA max            |                                                                                                                                        |
| Match Between Channels, $\Delta$ Leakage,<br>$I_D$ (Off), <a href="#">ADG5207</a> Only | 0.015       |                   |                   | 0.015              | nA typ            |                                                                                                                                        |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)                                             |             |                   |                   |                    |                   | $V_S = V_D = 1\text{ V}/30\text{ V}$ ;<br>see Figure 34                                                                                |
| <a href="#">ADG5206</a>                                                                | $\pm 0.02$  |                   |                   |                    | nA typ            |                                                                                                                                        |
|                                                                                        | $\pm 0.1$   | $\pm 0.25$        | $\pm 0.6$         | $\pm 3.3$          | nA max            |                                                                                                                                        |
| <a href="#">ADG5207</a>                                                                | $\pm 0.02$  |                   |                   |                    | nA typ            |                                                                                                                                        |
|                                                                                        | $\pm 0.1$   | $\pm 0.2$         | $\pm 0.4$         | $\pm 1.7$          | nA max            |                                                                                                                                        |
| Match Between Channels, $\Delta$ Leakage,<br>$I_D$ (On), $I_S$ (On) <sup>2</sup>       | 0.01        |                   |                   | 0.03               | nA typ            |                                                                                                                                        |
| <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>3</sup></b>                                             |             |                   |                   |                    |                   |                                                                                                                                        |
| Transition Time, $t_{TRANSITION}$                                                      | 225         |                   |                   |                    | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                             |
|                                                                                        | 290         | 310               | 320               | 350                | ns max            | $V_S = 18\text{ V}$ ; see Figure 35                                                                                                    |
| $t_{ON(EN)}$                                                                           | 215         |                   |                   |                    | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                             |
|                                                                                        | 265         | 285               | 285               | 295                | ns max            | $V_S = 18\text{ V}$ ; see Figure 36                                                                                                    |
| $t_{OFF(EN)}$                                                                          | 170         |                   |                   |                    | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                             |
|                                                                                        | 215         | 230               | 245               | 270                | ns max            | $V_S = 18\text{ V}$ ; see Figure 36                                                                                                    |
| Break-Before-Make Time Delay, $t_D$                                                    | 90          |                   |                   |                    | ns typ            | $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$                                                                                             |
|                                                                                        |             |                   |                   | 28                 | ns min            | $V_{S1} = V_{S2} = 18\text{ V}$ ; see Figure 37                                                                                        |
| Charge Injection, $Q_{INJ}$                                                            | 0.7         |                   |                   |                    | pC typ            | $V_S = 18\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ;<br>see Figure 38                                                       |
|                                                                                        | $\pm 3$     |                   |                   | $\pm 3$            | pC typ            | $V_S = 0\text{ V to } 30\text{ V}$ , $R_S = 0\ \Omega$ ,<br>$C_L = 1\text{ nF}$                                                        |

| Parameter                    | 25°C | –40°C to<br>+60°C | –40°C to<br>+85°C | –40°C to<br>+125°C | Unit              | Test Conditions/Comments                                                           |
|------------------------------|------|-------------------|-------------------|--------------------|-------------------|------------------------------------------------------------------------------------|
| Off Isolation                | –90  |                   |                   |                    | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 39 |
| Channel-to-Channel Crosstalk | –76  |                   |                   |                    | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 40 |
| –3 dB Bandwidth              |      |                   |                   |                    |                   | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ;<br>see Figure 41                       |
| ADG5206                      | 55   |                   |                   |                    | MHz typ           |                                                                                    |
| ADG5207                      | 115  |                   |                   |                    | MHz typ           |                                                                                    |
| Insertion Loss               | 5.65 |                   |                   |                    | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ;<br>see Figure 41 |
| $C_S$ (Off)                  | 3.4  |                   |                   |                    | pF typ            | $V_S = 18\ \text{V}$ , $f = 1\ \text{MHz}$                                         |
| $C_D$ (Off)                  |      |                   |                   |                    |                   |                                                                                    |
| ADG5206                      | 62   |                   |                   |                    | pF typ            | $V_S = 18\ \text{V}$ , $f = 1\ \text{MHz}$                                         |
| ADG5207                      | 32   |                   |                   |                    | pF typ            | $V_S = 18\ \text{V}$ , $f = 1\ \text{MHz}$                                         |
| $C_D$ (On), $C_S$ (On)       |      |                   |                   |                    |                   |                                                                                    |
| ADG5206                      | 66   |                   |                   |                    | pF typ            | $V_S = 18\ \text{V}$ , $f = 1\ \text{MHz}$                                         |
| ADG5207                      | 35   |                   |                   |                    | pF typ            | $V_S = 18\ \text{V}$ , $f = 1\ \text{MHz}$                                         |
| POWER REQUIREMENTS           |      |                   |                   |                    |                   | $V_{DD} = 3.9.6\ \text{V}$                                                         |
| $I_{DD}$                     | 80   |                   |                   |                    | $\mu\text{A typ}$ | Digital inputs = 0 V or $V_{DD}$                                                   |
|                              | 100  |                   |                   | 130                | $\mu\text{A max}$ |                                                                                    |
| $V_{DD}$                     |      |                   |                   | 9/40               | V min/V max       | GND = 0 V, $V_{SS} = 0\ \text{V}$                                                  |

<sup>1</sup> The off channel leakage delta is calculated using the maximum of  $V_S = 1\ \text{V}$  and  $V_D = 30\ \text{V}$ , or  $V_S = 30\ \text{V}$  and  $V_D = 1\ \text{V}$ .

<sup>2</sup> The on channel leakage delta is calculated using the maximum of  $V_S = V_D = 1\ \text{V}$ , or  $V_S = V_D = 30\ \text{V}$ .

<sup>3</sup> Guaranteed by design; not subject to production test.

**CONTINUOUS CURRENT PER CHANNEL, Sx, D, OR Dx****Table 5. ADG5206**

| Parameter                                         | 25°C | 60°C | 85°C | 125°C | Unit       |
|---------------------------------------------------|------|------|------|-------|------------|
| CONTINUOUS CURRENT, Sx OR D                       |      |      |      |       |            |
| $V_{DD} = +15\text{ V}$ , $V_{SS} = -15\text{ V}$ |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 44   | 32   | 23   | 12    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 62   | 42   | 28   | 13    | mA maximum |
| $V_{DD} = +20\text{ V}$ , $V_{SS} = -20\text{ V}$ |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 47   | 33   | 24   | 12    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 66   | 44   | 29   | 13    | mA maximum |
| $V_{DD} = 12\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 31   | 24   | 19   | 11    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 45   | 33   | 24   | 12    | mA maximum |
| $V_{DD} = 36\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 46   | 33   | 24   | 12    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 65   | 43   | 28   | 13    | mA maximum |

**Table 6. ADG5207**

| Parameter                                         | 25°C | 60°C | 85°C | 125°C | Unit       |
|---------------------------------------------------|------|------|------|-------|------------|
| CONTINUOUS CURRENT, Sx OR Dx                      |      |      |      |       |            |
| $V_{DD} = +15\text{ V}$ , $V_{SS} = -15\text{ V}$ |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 33   | 25   | 19   | 11    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 48   | 34   | 24   | 12    | mA maximum |
| $V_{DD} = +20\text{ V}$ , $V_{SS} = -20\text{ V}$ |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 35   | 27   | 20   | 11    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 51   | 36   | 25   | 12    | mA maximum |
| $V_{DD} = 12\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 23   | 19   | 15   | 12    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 34   | 26   | 20   | 12    | mA maximum |
| $V_{DD} = 36\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |      |       |            |
| TSSOP ( $\theta_{JA} = 67.7^\circ\text{C/W}$ )    | 34   | 26   | 20   | 11    | mA maximum |
| LFCSP ( $\theta_{JA} = 27.27^\circ\text{C/W}$ )   | 50   | 35   | 25   | 12    | 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, D, or Dx Pins<br>ADG5206            | 140 mA (pulsed at 1 ms, 10%<br>duty cycle maximum)                                     |
| ADG5207                                               | 105 mA (pulsed at 1 ms, 10%<br>duty cycle maximum)                                     |
| Continuous Current, Sx, D, or Dx<br>Pins <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, $\theta_{JA}$                      |                                                                                        |
| 28-Lead TSSOP (4-Layer Board)                         | 67.7°C/W                                                                               |
| 32-Lead LFCSP (4-Layer Board)                         | 27.27°C/W                                                                              |
| Reflow Soldering Peak<br>Temperature, Pb Free         | As per JEDEC J-STD-020                                                                 |
| HBM ESD<br>(ESDA/JEDEC JS-001-2011)                   |                                                                                        |
| ADG5206                                               |                                                                                        |
| All Pins                                              | 8 kV                                                                                   |
| ADG5207                                               |                                                                                        |
| I/O Port to Supplies                                  | 8 kV                                                                                   |
| I/O Port to I/O Port                                  | 2 kV                                                                                   |
| All Other Pins                                        | 8 kV                                                                                   |

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

<sup>2</sup> See Table 5 and Table 6.

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

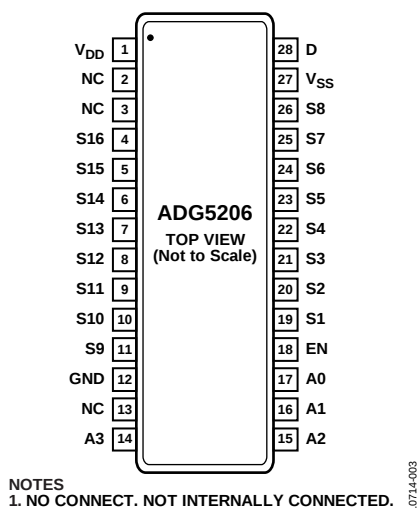


Figure 3. ADG5206 Pin Configuration (TSSOP)

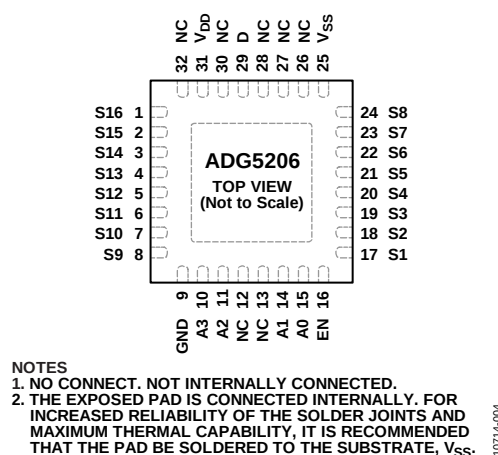


Figure 4. ADG5206 Pin Configuration (LFCSP)

Table 8. ADG5206 Pin Function Descriptions

| Pin No.  |                            | Mnemonic        | Description                                                                                                                                                                                            |
|----------|----------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSSOP    | LFCSP                      |                 |                                                                                                                                                                                                        |
| 1        | 31                         | V <sub>DD</sub> | Most Positive Power Supply Potential.                                                                                                                                                                  |
| 2, 3, 13 | 12, 13, 26, 27, 28, 30, 32 | NC              | No Connect. Not internally connected.                                                                                                                                                                  |
| 4        | 1                          | S16             | Source Terminal 16. This pin can be an input or an output.                                                                                                                                             |
| 5        | 2                          | S15             | Source Terminal 15. This pin can be an input or an output.                                                                                                                                             |
| 6        | 3                          | S14             | Source Terminal 14. This pin can be an input or an output.                                                                                                                                             |
| 7        | 4                          | S13             | Source Terminal 13. This pin can be an input or an output.                                                                                                                                             |
| 8        | 5                          | S12             | Source Terminal 12. This pin can be an input or an output.                                                                                                                                             |
| 9        | 6                          | S11             | Source Terminal 11. This pin can be an input or an output.                                                                                                                                             |
| 10       | 7                          | S10             | Source Terminal 10. This pin can be an input or an output.                                                                                                                                             |
| 11       | 8                          | S9              | Source Terminal 9. This pin can be an input or an output.                                                                                                                                              |
| 12       | 9                          | GND             | Ground (0 V) Reference.                                                                                                                                                                                |
| 14       | 10                         | A3              | Logic Control Input.                                                                                                                                                                                   |
| 15       | 11                         | A2              | Logic Control Input.                                                                                                                                                                                   |
| 16       | 14                         | A1              | Logic Control Input.                                                                                                                                                                                   |
| 17       | 15                         | A0              | Logic Control Input.                                                                                                                                                                                   |
| 18       | 16                         | EN              | Active High Digital Input. When this pin is low, the device is disabled and all switches are turned off. When this pin is high, the Ax logic inputs determine which switch is turned on.               |
| 19       | 17                         | S1              | Source Terminal 1. This pin can be an input or an output.                                                                                                                                              |
| 20       | 18                         | S2              | Source Terminal 2. This pin can be an input or an output.                                                                                                                                              |
| 21       | 19                         | S3              | Source Terminal 3. This pin can be an input or an output.                                                                                                                                              |
| 22       | 20                         | S4              | Source Terminal 4. This pin can be an input or an output.                                                                                                                                              |
| 23       | 21                         | S5              | Source Terminal 5. This pin can be an input or an output.                                                                                                                                              |
| 24       | 22                         | S6              | Source Terminal 6. This pin can be an input or an output.                                                                                                                                              |
| 25       | 23                         | S7              | Source Terminal 7. This pin can be an input or an output.                                                                                                                                              |
| 26       | 24                         | S8              | Source Terminal 8. This pin can be an input or an output.                                                                                                                                              |
| 27       | 25                         | V <sub>SS</sub> | Most Negative Power Supply Potential. In single-supply applications, this pin can be connected to ground.                                                                                              |
| 28       | 29                         | D               | Drain Terminal. This pin can be an input or an output.                                                                                                                                                 |
| NA       | 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. [ADG5206](#) Truth Table

| A3 | A2 | A1 | A0 | EN | On Switch |
|----|----|----|----|----|-----------|
| X  | X  | X  | X  | 0  | None      |
| 0  | 0  | 0  | 0  | 1  | 1         |
| 0  | 0  | 0  | 1  | 1  | 2         |
| 0  | 0  | 1  | 0  | 1  | 3         |
| 0  | 0  | 1  | 1  | 1  | 4         |
| 0  | 1  | 0  | 0  | 1  | 5         |
| 0  | 1  | 0  | 1  | 1  | 6         |
| 0  | 1  | 1  | 0  | 1  | 7         |
| 0  | 1  | 1  | 1  | 1  | 8         |
| 1  | 0  | 0  | 0  | 1  | 9         |
| 1  | 0  | 0  | 1  | 1  | 10        |
| 1  | 0  | 1  | 0  | 1  | 11        |
| 1  | 0  | 1  | 1  | 1  | 12        |
| 1  | 1  | 0  | 0  | 1  | 13        |
| 1  | 1  | 0  | 1  | 1  | 14        |
| 1  | 1  | 1  | 0  | 1  | 15        |
| 1  | 1  | 1  | 1  | 1  | 16        |

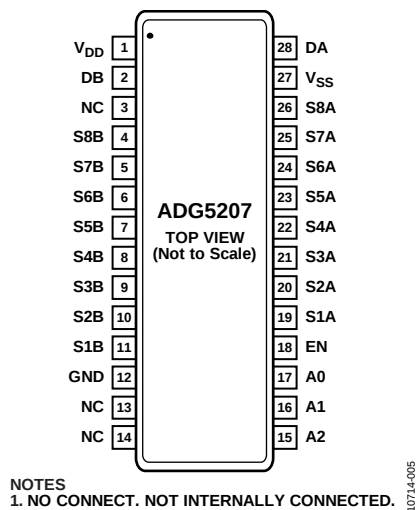


Figure 5. ADG5207 Pin Configuration (TSSOP)

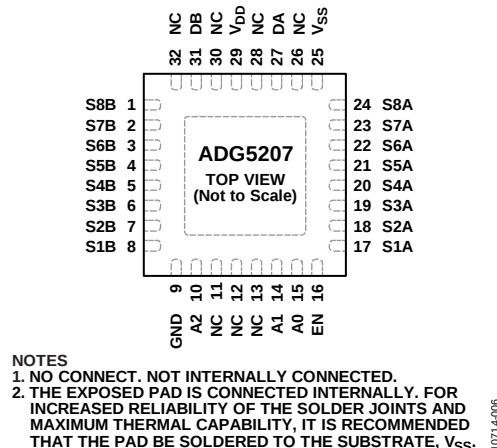


Figure 6. ADG5207 Pin Configuration (LFCSP)

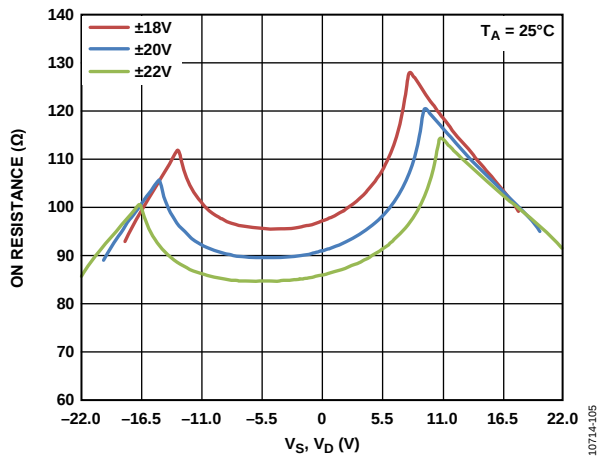
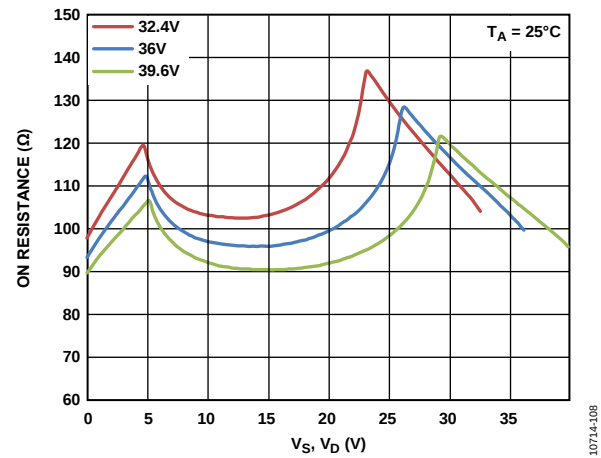
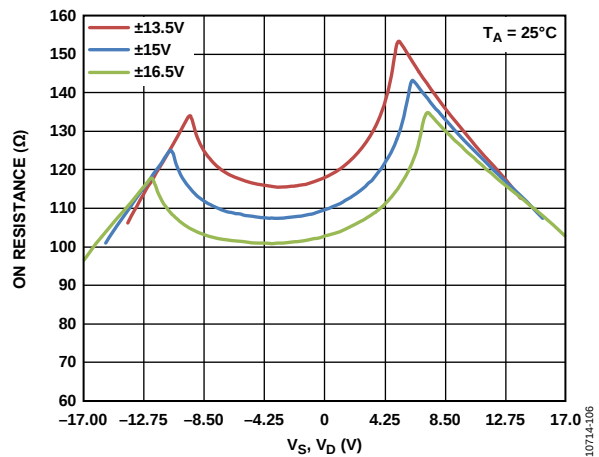
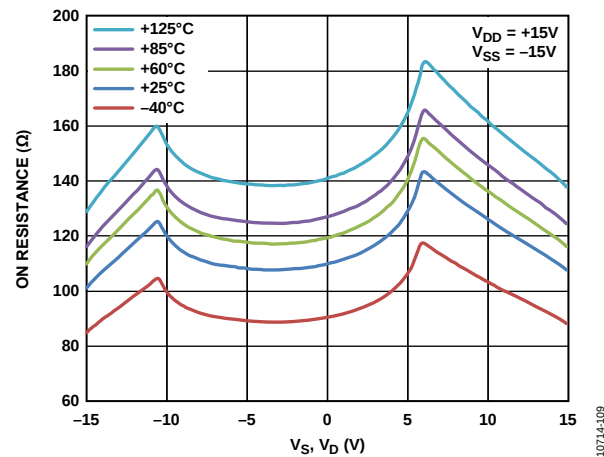
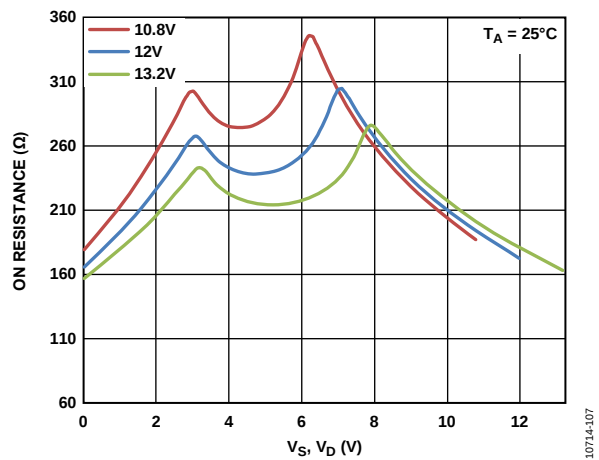
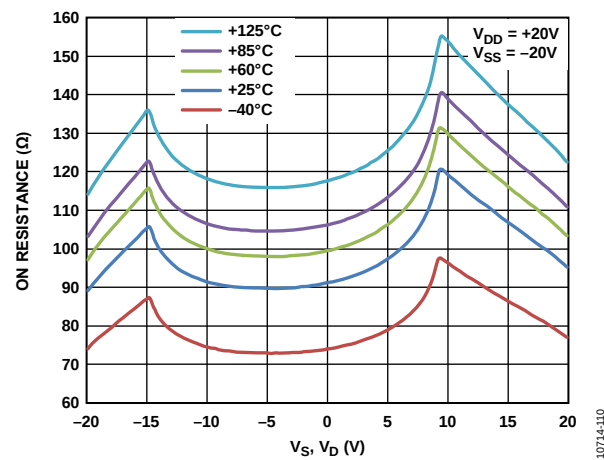
Table 10. ADG5207 Pin Function Descriptions

| Pin No.   |                            | Mnemonic | Description                                                                                                                                                                                     |
|-----------|----------------------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSSOP     | LFCSP                      |          |                                                                                                                                                                                                 |
| 1         | 29                         | $V_{DD}$ | Most Positive Power Supply Potential.                                                                                                                                                           |
| 2         | 31                         | DB       | Drain Terminal B. This pin can be an input or an output.                                                                                                                                        |
| 3, 13, 14 | 11, 12, 12, 26, 28, 30, 32 | NC       | No Connect. Not internally connected.                                                                                                                                                           |
| 4         | 1                          | S8B      | Source Terminal 8B. This pin can be an input or an output.                                                                                                                                      |
| 5         | 2                          | S7B      | Source Terminal 7B. This pin can be an input or an output.                                                                                                                                      |
| 6         | 3                          | S6B      | Source Terminal 6B. This pin can be an input or an output.                                                                                                                                      |
| 7         | 4                          | S5B      | Source Terminal 5B. This pin can be an input or an output.                                                                                                                                      |
| 8         | 5                          | S4B      | Source Terminal 4B. This pin can be an input or an output.                                                                                                                                      |
| 9         | 6                          | S3B      | Source Terminal 3B. This pin can be an input or an output.                                                                                                                                      |
| 10        | 7                          | S2B      | Source Terminal 2B. This pin can be an input or an output.                                                                                                                                      |
| 11        | 8                          | S1B      | Source Terminal 1B. This pin can be an input or an output.                                                                                                                                      |
| 12        | 9                          | GND      | Ground (0 V) Reference.                                                                                                                                                                         |
| 15        | 10                         | A2       | Logic Control Input.                                                                                                                                                                            |
| 16        | 14                         | A1       | Logic Control Input.                                                                                                                                                                            |
| 17        | 15                         | A0       | Logic Control Input.                                                                                                                                                                            |
| 18        | 16                         | EN       | Active High Digital Input. When this pin is low, the device is disabled and all switches are turned off. When this pin is high, the Ax logic inputs determine which switch is turned on.        |
| 19        | 17                         | S1A      | Source Terminal 1A. This pin can be an input or an output.                                                                                                                                      |
| 20        | 18                         | S2A      | Source Terminal 2A. This pin can be an input or an output.                                                                                                                                      |
| 21        | 19                         | S3A      | Source Terminal 3A. This pin can be an input or an output.                                                                                                                                      |
| 22        | 20                         | S4A      | Source Terminal 4A. This pin can be an input or an output.                                                                                                                                      |
| 23        | 21                         | S5A      | Source Terminal 5A. This pin can be an input or an output.                                                                                                                                      |
| 24        | 22                         | S6A      | Source Terminal 6A. This pin can be an input or an output.                                                                                                                                      |
| 25        | 23                         | S7A      | Source Terminal 7A. This pin can be an input or an output.                                                                                                                                      |
| 26        | 24                         | S8A      | Source Terminal 8A. This pin can be an input or an output.                                                                                                                                      |
| 27        | 25                         | $V_{SS}$ | Most Negative Power Supply Potential. In single-supply applications, this pin can be connected to ground.                                                                                       |
| 28        | 27                         | DA       | Drain Terminal A. This pin can be an input or an output.                                                                                                                                        |
| NA        | 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, $V_{SS}$ . |

Table 11. [ADG5207](#) Truth Table

| A2 | A1 | A0 | EN | On Switch Pair |
|----|----|----|----|----------------|
| 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              |

## TYPICAL PERFORMANCE CHARACTERISTICS

Figure 7.  $R_{ON}$  as a Function of  $V_S, V_D$  ( $\pm 20$  V Dual Supply)Figure 10.  $R_{ON}$  as a Function of  $V_S, V_D$  (36 V Single Supply)Figure 8.  $R_{ON}$  as a Function of  $V_S, V_D$  ( $\pm 15$  V Dual Supply)Figure 11.  $R_{ON}$  as a Function of  $V_S, V_D$  for Different Temperatures,  $\pm 15$  V Dual SupplyFigure 9.  $R_{ON}$  as a Function of  $V_S, V_D$  (12 V Single Supply)Figure 12.  $R_{ON}$  as a Function of  $V_S, V_D$  for Different Temperatures,  $\pm 20$  V Dual Supply

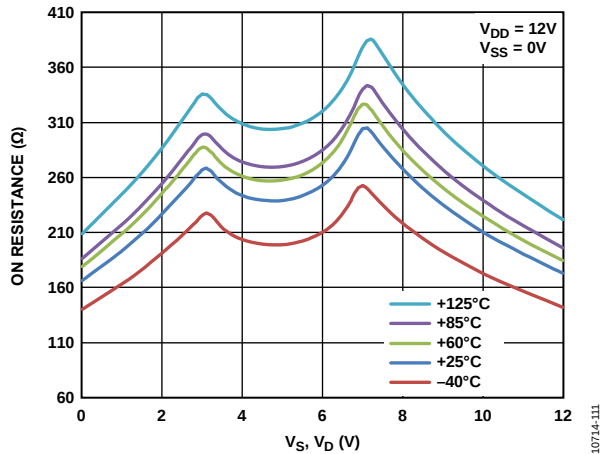


Figure 13.  $R_{ON}$  as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 12 V Single Supply

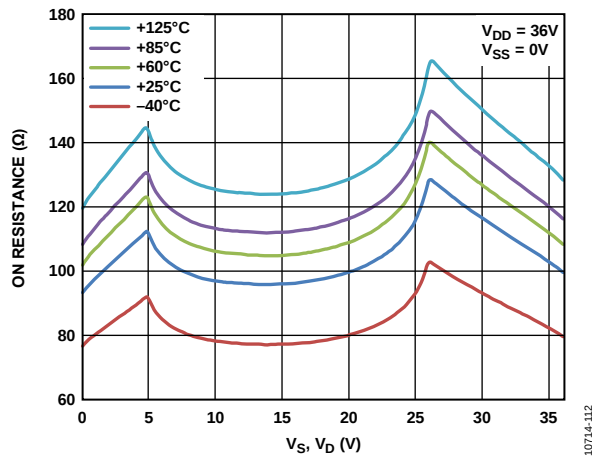


Figure 14.  $R_{ON}$  as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 36 V Single Supply

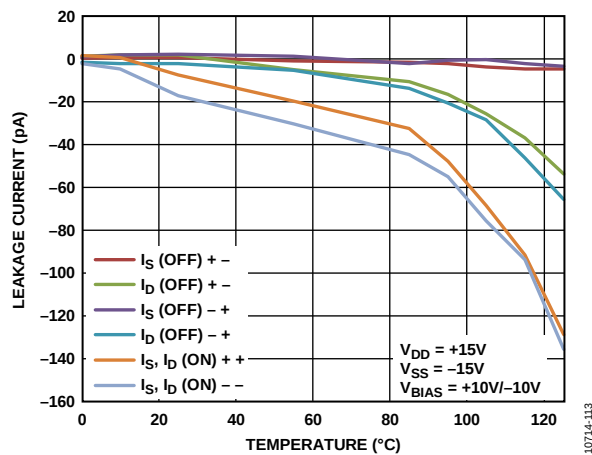


Figure 15. Leakage Currents vs. Temperature,  $\pm 15$  V Dual Supply

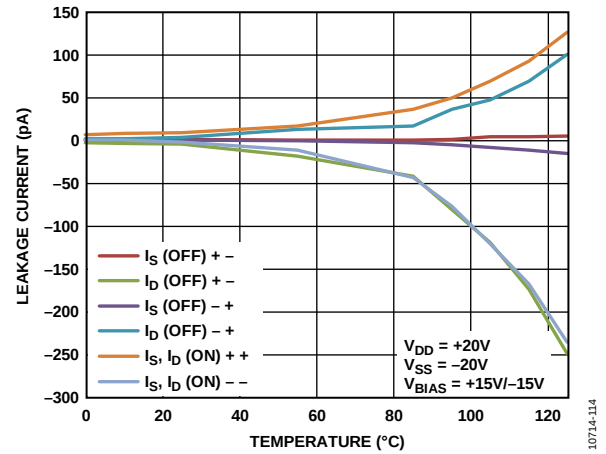


Figure 16. Leakage Currents vs. Temperature,  $\pm 20$  V Dual Supply

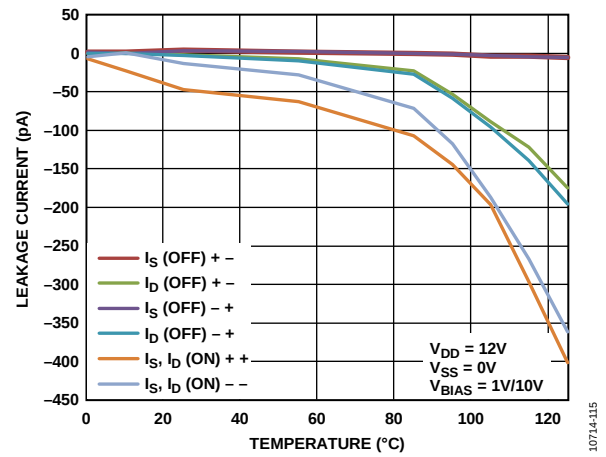


Figure 17. Leakage Currents vs. Temperature, 12 V Single Supply

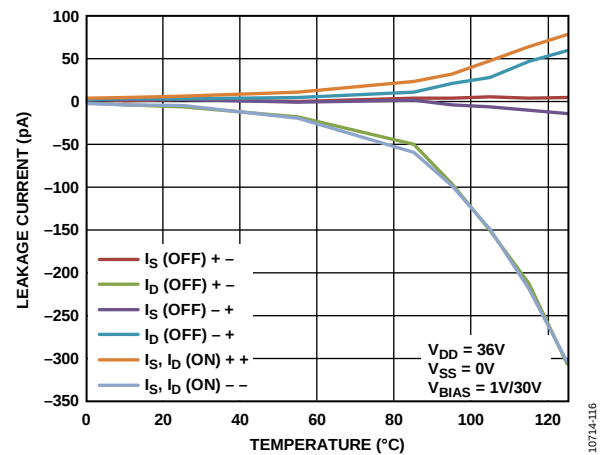


Figure 18. Leakage Currents vs. Temperature, 36 V Single Supply

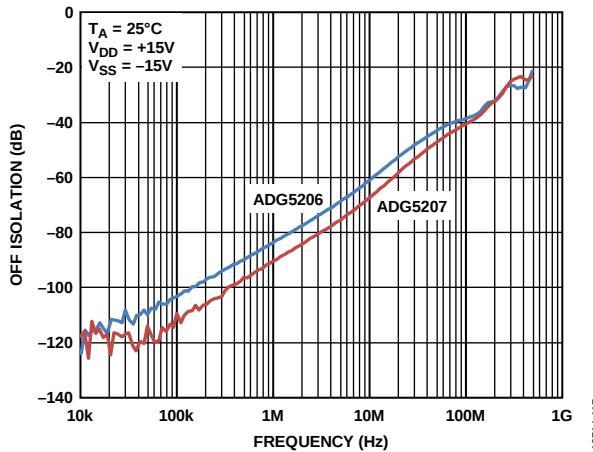


Figure 19. Off Isolation vs. Frequency,  $\pm 15$  V Dual Supply

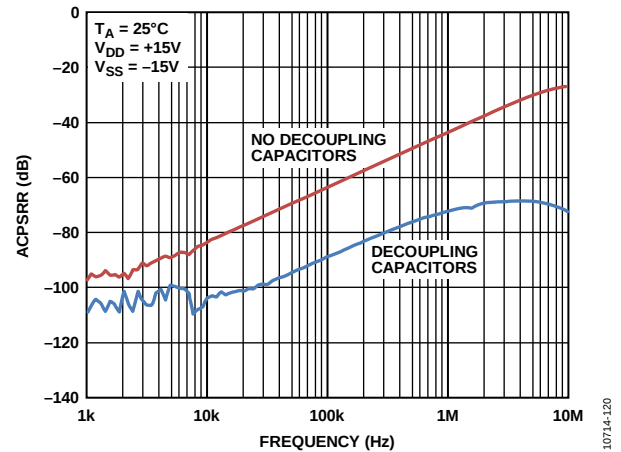


Figure 22. ACPSRR vs. Frequency,  $\pm 15$  V Dual Supply

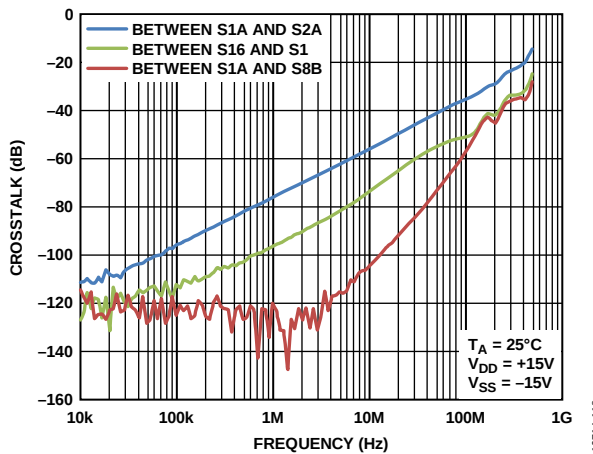


Figure 20. Crosstalk vs. Frequency,  $\pm 15$  V Dual Supply

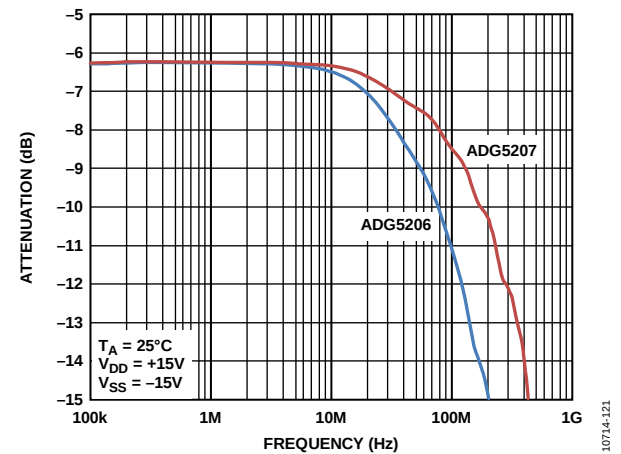


Figure 23. Bandwidth

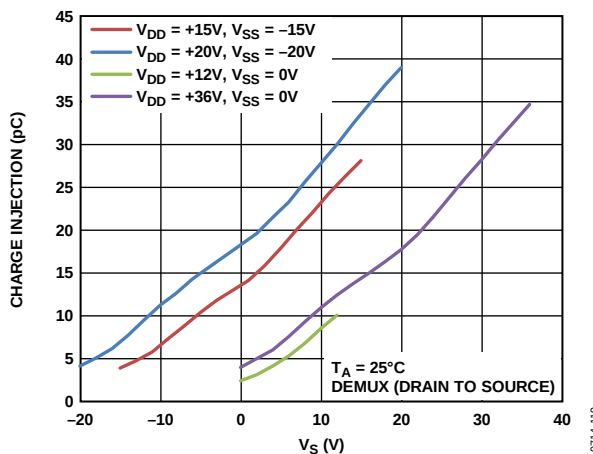


Figure 21. Charge Injection vs. Source Voltage, Drain to Source

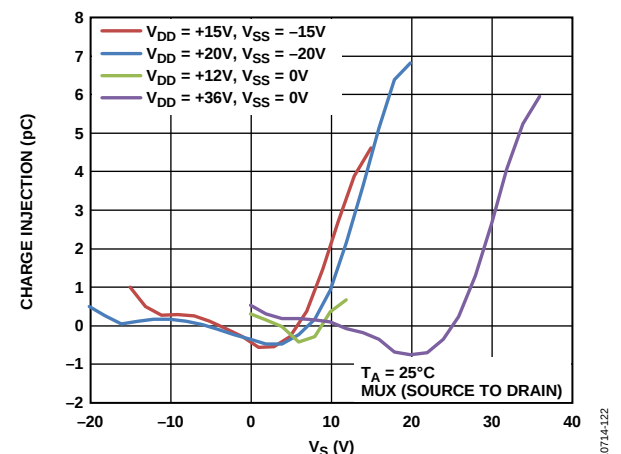
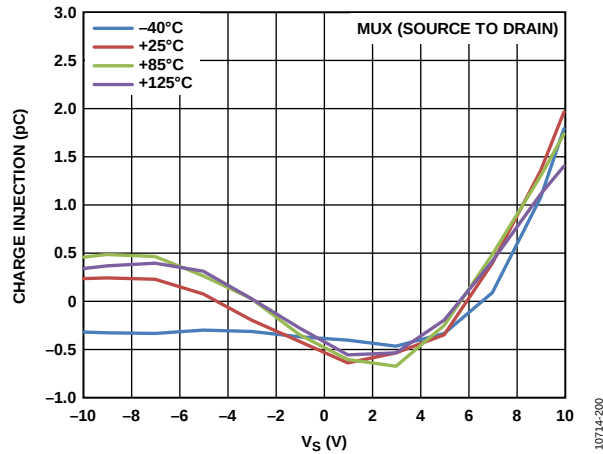
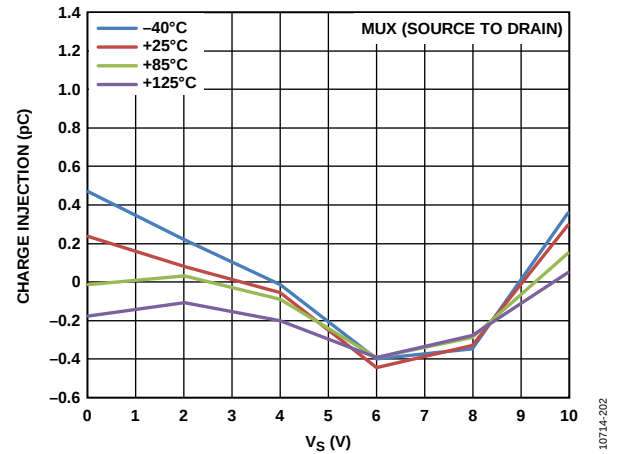
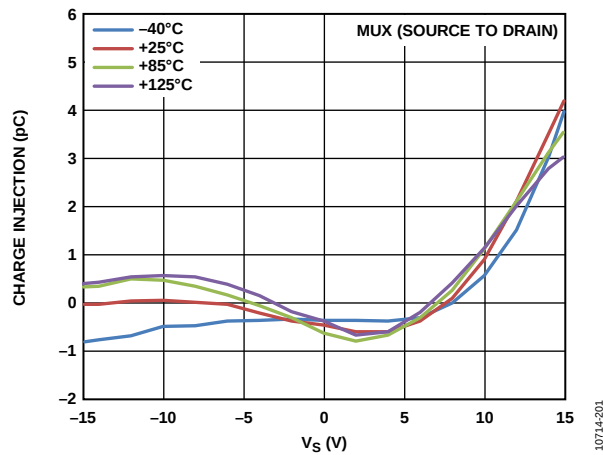
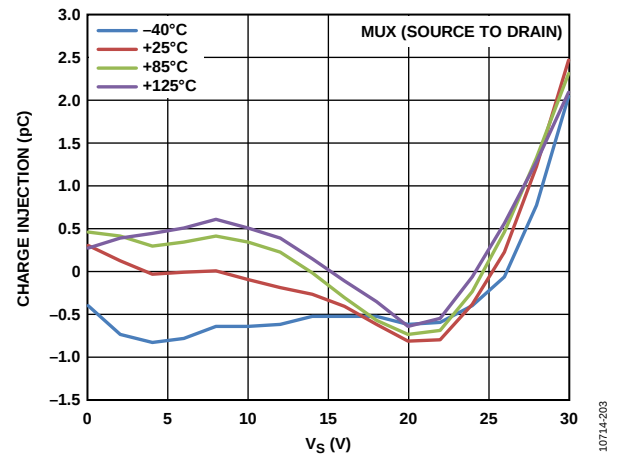
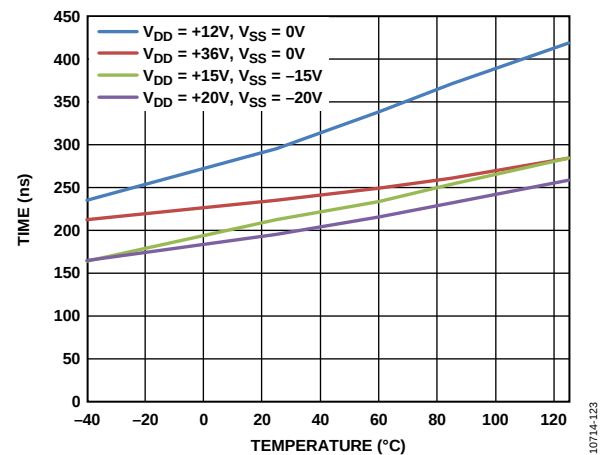
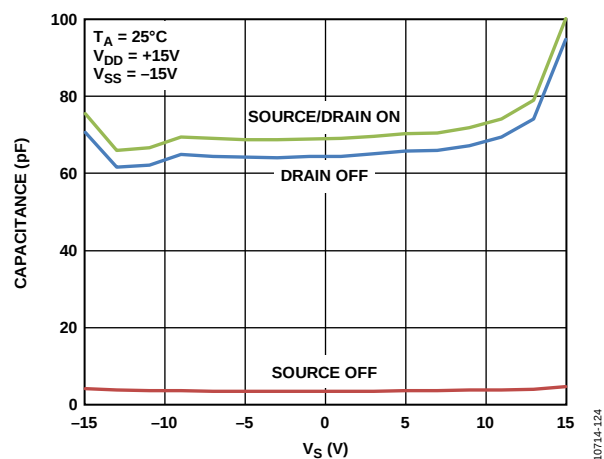
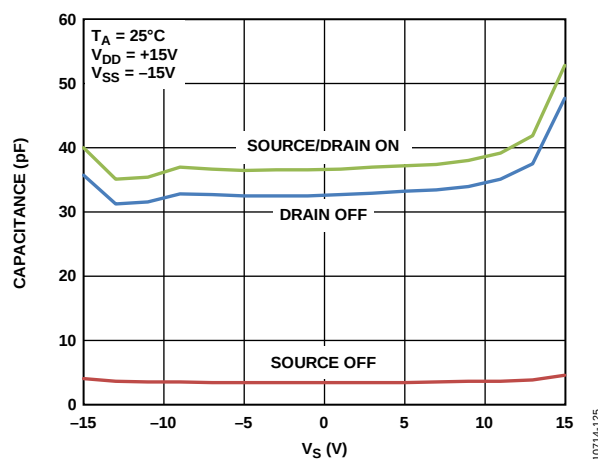


Figure 24. Charge Injection vs. Source Voltage, Source to Drain

Figure 25.  $Q_{INJ}$  as a Function of  $V_S$  for Different Temperatures,  $\pm 15$  V Dual SupplyFigure 28.  $Q_{INJ}$  as a Function of  $V_S$  for Different Temperatures, 12 V Single SupplyFigure 26.  $Q_{INJ}$  as a Function of  $V_S$  for Different Temperatures,  $\pm 20$  V Dual SupplyFigure 29.  $Q_{INJ}$  as a Function of  $V_S$  for Different Temperatures, 36 V Single SupplyFigure 27.  $t_{TRANSITION}$  Time vs. Temperature

Figure 30. ADG5206 Capacitance vs. Source Voltage,  $\pm 15\text{ V}$  Dual SupplyFigure 31. ADG5207 Capacitance vs. Source Voltage,  $\pm 15\text{ V}$  Dual Supply

## TEST CIRCUITS

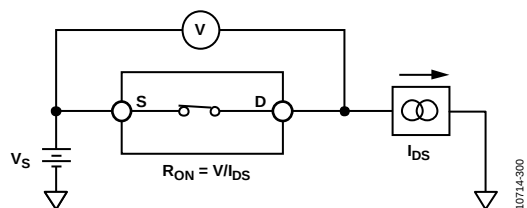


Figure 32. On Resistance

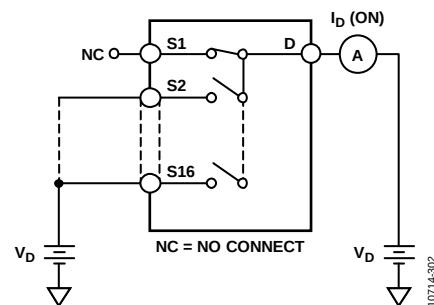


Figure 34. On Leakage

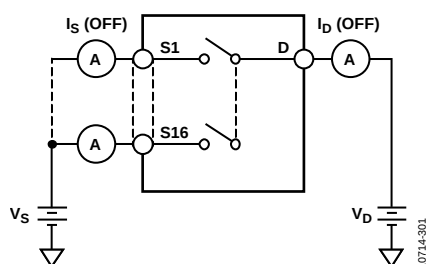
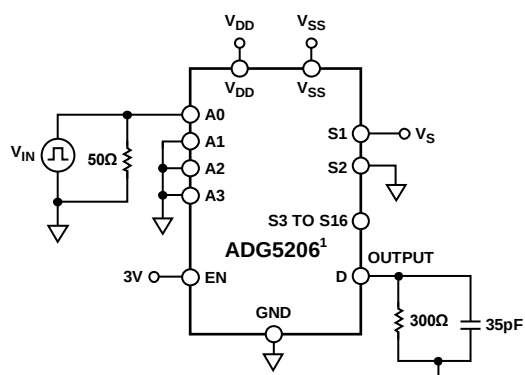
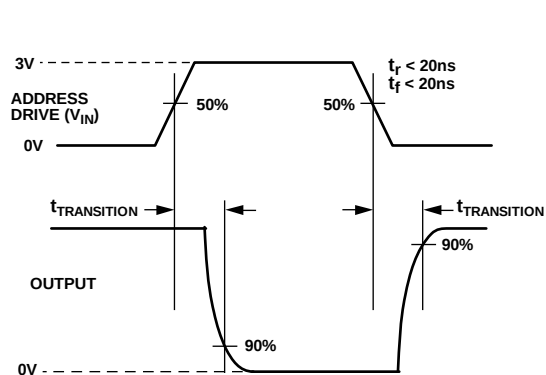
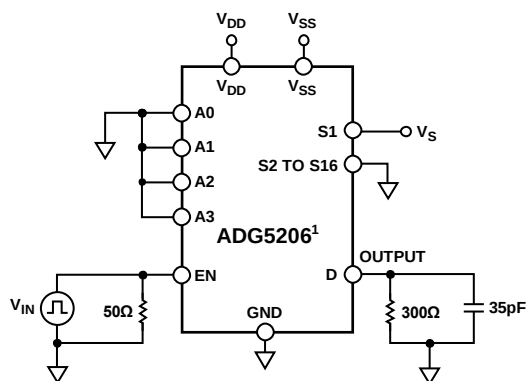
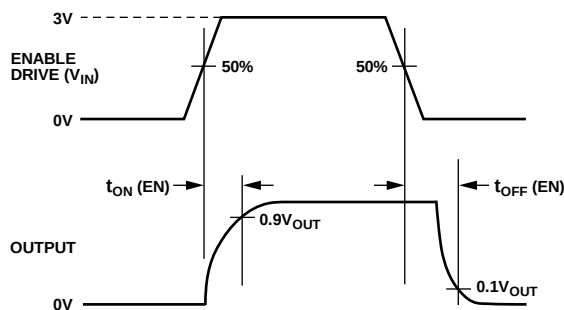
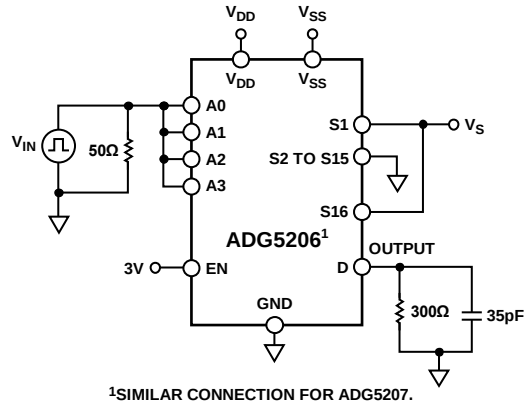
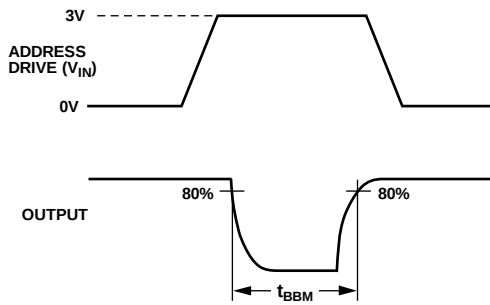


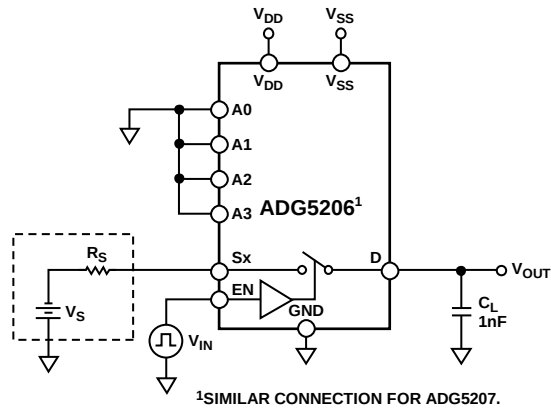
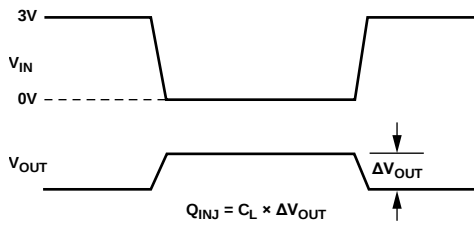
Figure 33. Off Leakage

<sup>1</sup>SIMILAR CONNECTION FOR ADG5207.Figure 35. Address to Output Switching Times,  $t_{\text{TRANSITION}}$ <sup>1</sup>SIMILAR CONNECTION FOR ADG5207.Figure 36. Enable Delay,  $t_{\text{ON}}(\text{EN})$ ,  $t_{\text{OFF}}(\text{EN})$



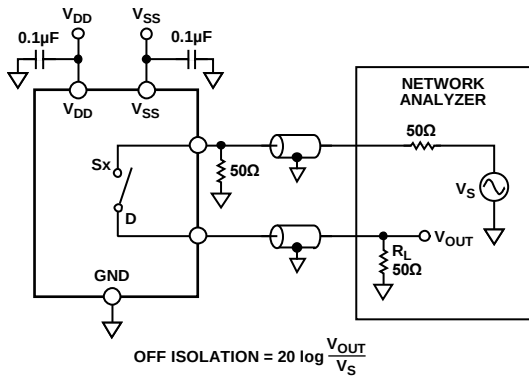
10714-035

Figure 37. Break-Before-Make Time Delay,  $t_D$



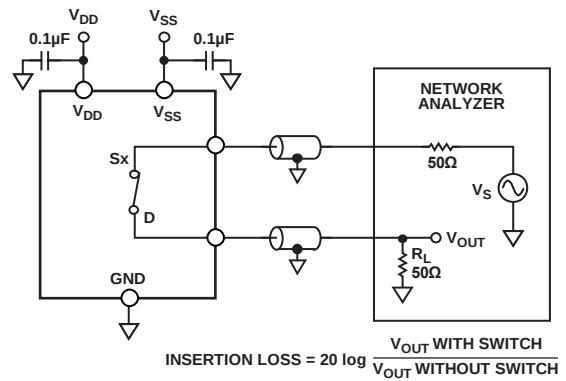
10714-037

Figure 38. Charge Injection



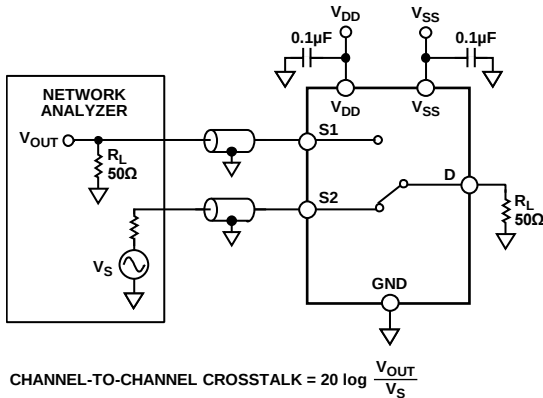
10714-032

Figure 39. Off Isolation



10714-033

Figure 41. Bandwidth



10714-030

Figure 40. Channel-to-Channel Crosstalk

## TERMINOLOGY

### **I<sub>DD</sub>**

I<sub>DD</sub> represents the positive supply current.

### **I<sub>SS</sub>**

I<sub>SS</sub> represents the negative supply current.

### **V<sub>D</sub>, V<sub>S</sub>**

V<sub>D</sub> and V<sub>S</sub> represent the analog voltage on Terminal D and Terminal S, respectively.

### **R<sub>ON</sub>**

R<sub>ON</sub> is the ohmic resistance between Terminal D and Terminal S.

### **ΔR<sub>ON</sub>**

ΔR<sub>ON</sub> represents the difference between the R<sub>ON</sub> of any two channels.

### **R<sub>FLAT (ON)</sub>**

R<sub>FLAT (ON)</sub> is the flatness defined as the difference between the maximum and the minimum value of on resistance measured over the specified analog signal range.

### **I<sub>S</sub> (Off)**

I<sub>S</sub> (Off) is the source leakage current with the switch off.

### **I<sub>D</sub> (Off)**

I<sub>D</sub> (Off) is the drain leakage current with the switch off.

### **I<sub>D</sub> (On), I<sub>S</sub> (On)**

I<sub>D</sub> (On) and I<sub>S</sub> (On) represent the channel leakage currents with the switch on.

### **V<sub>INL</sub>**

V<sub>INL</sub> is the maximum input voltage for Logic 0.

### **V<sub>INH</sub>**

V<sub>INH</sub> is the minimum input voltage for Logic 1.

### **I<sub>INL</sub>, I<sub>INH</sub>**

I<sub>INL</sub> and I<sub>INH</sub> represent the low and high input currents of the digital inputs.

### **C<sub>D</sub> (Off)**

C<sub>D</sub> (Off) represents the off switch drain capacitance, which is measured with reference to ground.

### **C<sub>S</sub> (Off)**

C<sub>S</sub> (Off) represents the off switch source capacitance, which is measured with reference to ground.

### **C<sub>D</sub> (On), C<sub>S</sub> (On)**

C<sub>D</sub> (On) and C<sub>S</sub> (On) represent on switch capacitances, which are measured with reference to ground.

### **C<sub>IN</sub>**

C<sub>IN</sub> represents digital input capacitance.

### **t<sub>ON</sub> (EN)**

t<sub>ON</sub> (EN) represents the delay time between the 50% and 90% points of the digital input and switch on condition.

### **t<sub>OFF</sub> (EN)**

t<sub>OFF</sub> (EN) represents the delay time between the 50% and 90% points of the digital input and switch off condition.

### **t<sub>TRANSITION</sub>**

t<sub>TRANSITION</sub> represents the 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.

### **Break-Before-Make Time Delay (t<sub>D</sub>)**

t<sub>D</sub> 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.

### **AC Power Supply Rejection Ratio (ACPSRR)**

ACPSRR is a measure of the ability of a device 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.

## APPLICATIONS INFORMATION

The ADG52xx family of switches and multiplexers provides a robust solution for instrumentation, industrial, automotive, 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 [ADG5206/ADG5207](#) 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.

### TRENCH ISOLATION

In the [ADG5206/ADG5207](#), 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.

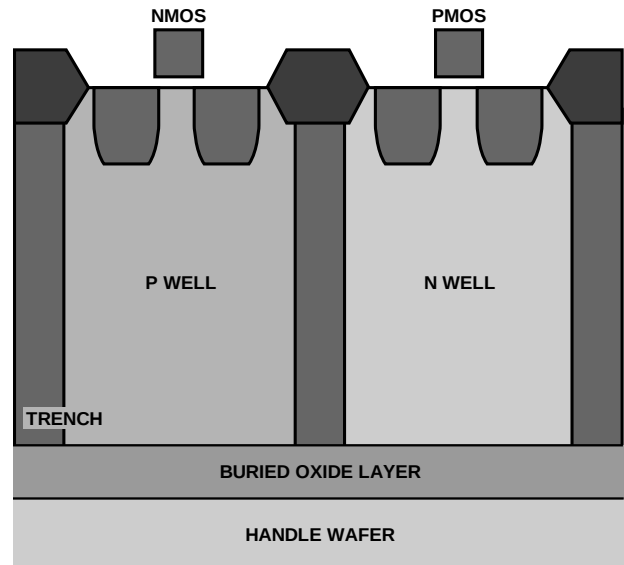


Figure 42. Trench Isolation

10714-038

## OUTLINE DIMENSIONS

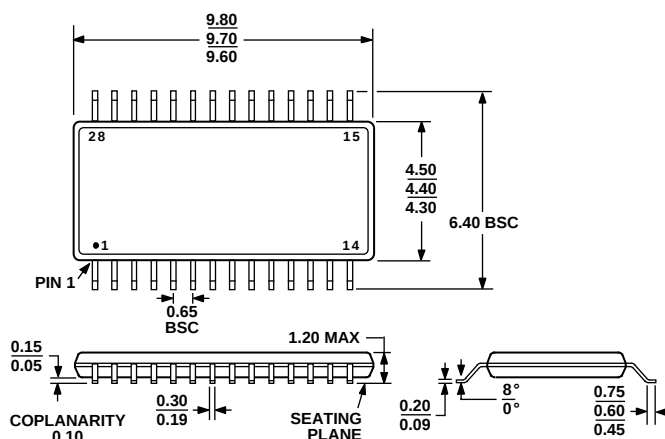
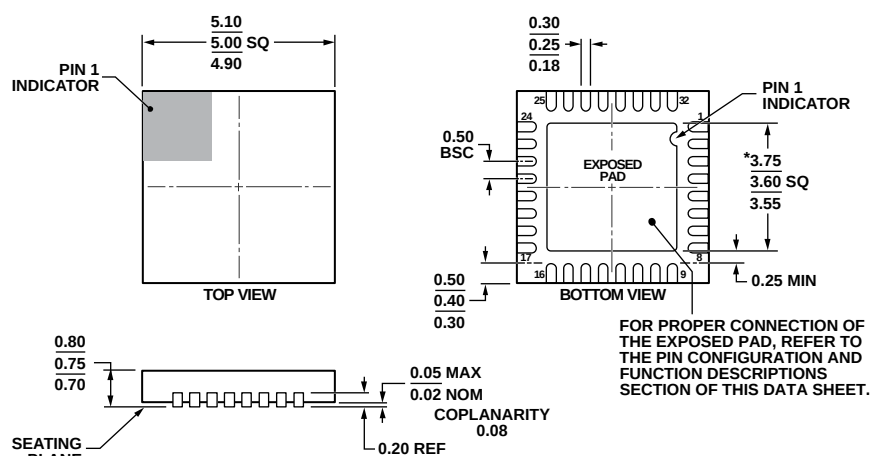


Figure 43. 28-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-28)

Dimensions shown in millimeters



\*COMPLIANT TO JEDEC STANDARDS MO-220-WHHD-5  
WITH EXCEPTION TO EXPOSED PAD DIMENSION.

Figure 44. 32-Lead Lead Frame Chip Scale Package [LFCSP\_WQ]

5 × 5 mm Body, Very Very Thin Quad (CP-32-12)

Dimensions shown in millimeters

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                               | Package Option |
|--------------------|-------------------|---------------------------------------------------|----------------|
| ADG5206BRUZ        | −40°C to +125°C   | 28-Lead Thin Shrink Small Outline Package [TSSOP] | RU-28          |
| ADG5206BRUZ-RL7    | −40°C to +125°C   | 28-Lead Thin Shrink Small Outline Package [TSSOP] | RU-28          |
| ADG5206BCPZ-RL7    | −40°C to +125°C   | 32-Lead Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-32-12       |
| ADG5207BRUZ        | −40°C to +125°C   | 28-Lead Thin Shrink Small Outline Package [TSSOP] | RU-28          |
| ADG5207BRUZ-RL7    | −40°C to +125°C   | 28-Lead Thin Shrink Small Outline Package [TSSOP] | RU-28          |
| ADG5207BCPZ-RL7    | −40°C to +125°C   | 32-Lead Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-32-12       |

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

**NOTES**

## NOTES

**NOTES**