

### FEATURES

**Latch-up proof**  
**3 pF off source capacitance**  
**26 pF off drain capacitance**  
**-0.6 pC charge injection**  
**Low leakage: 0.4 nA maximum at 85°C**  
**±9 V to ±22 V dual-supply operation**  
**9 V to 40 V single-supply operation**  
**48 V supply maximum ratings**  
**Fully specified at ±15 V, ±20 V, +12 V, and +36 V**  
 **$V_{SS}$  to  $V_{DD}$  analog signal range**

### APPLICATIONS

**Automatic test equipment**  
**Data acquisition**  
**Instrumentation**  
**Avionics**  
**Audio and video switching**  
**Communication systems**

### GENERAL DESCRIPTION

The ADG5204 is a complementary metal oxide semiconductor (CMOS) analog multiplexer, comprising four single channels.

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 together with high signal bandwidth make the ADG5204 suitable for video signal switching.

The ADG5204 is designed on a trench process, which guards against latch-up. A dielectric trench separates the P and N channel transistors, thereby preventing latch-up even under severe overvoltage conditions.

The ADG5204 switches one of four inputs to a common output, D, as determined by the 3-bit binary address lines, A0, A1, and EN. Logic 0 on the EN pin disables the device. Each switch conducts equally well in both directions when on, and each switch has an input signal range that extends to the supplies. In the off condition, signal levels up to the supplies are blocked. All switches exhibit break-before-make switching action.

### FUNCTIONAL BLOCK DIAGRAM

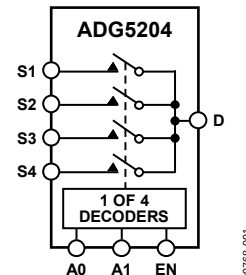


Figure 1.

### PRODUCT HIGHLIGHTS

1. Trench Isolation Guards Against Latch-Up.  
A dielectric trench separates the P and N channel transistors, thereby preventing latch-up even under severe overvoltage conditions.
2. Ultralow Capacitance and <1 pC Charge Injection.
3. Dual-Supply Operation.  
For applications where the analog signal is bipolar, the ADG5204 can be operated from dual supplies up to ±22 V.
4. Single-Supply Operation.  
For applications where the analog signal is unipolar, the ADG5204 can be operated from a single rail power supply up to 40 V.
5. 3 V Logic-Compatible Digital Inputs.  
 $V_{INH} = 2.0$  V,  $V_{INL} = 0.8$  V.
6. No  $V_L$  Logic Power Supply Required.

#### Rev. 0

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REVISION HISTORY

5/11—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 V, unless otherwise noted.

Table 1.

| Parameter                                                 | 25°C  | −40°C to +85°C | −40°C to +125°C                    | Unit      | Test Conditions/Comments                                                                                                                                                |
|-----------------------------------------------------------|-------|----------------|------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANALOG SWITCH                                             |       |                |                                    |           |                                                                                                                                                                         |
| Analog Signal Range                                       |       |                | V <sub>DD</sub> to V <sub>SS</sub> | V max     | V <sub>S</sub> = ±10 V, I <sub>S</sub> = −1 mA, see Figure 24<br>V <sub>DD</sub> = +13.5 V, V <sub>SS</sub> = −13.5 V<br>V <sub>S</sub> = ±10 V, I <sub>S</sub> = −1 mA |
| On Resistance, R <sub>ON</sub>                            | 160   | 250            | 280                                | Ω typ     |                                                                                                                                                                         |
| On-Resistance Match<br>Between Channels, ΔR <sub>ON</sub> | 200   |                |                                    | Ω max     |                                                                                                                                                                         |
|                                                           | 4.5   |                |                                    | Ω typ     |                                                                                                                                                                         |
| On-Resistance Flatness, R <sub>FLAT(ON)</sub>             | 8     | 9              | 10                                 | Ω max     | V <sub>S</sub> = ±10 V, I <sub>S</sub> = −1 mA                                                                                                                          |
|                                                           | 38    |                |                                    | Ω typ     |                                                                                                                                                                         |
|                                                           | 50    | 65             | 70                                 | Ω max     |                                                                                                                                                                         |
| LEAKAGE CURRENTS                                          |       |                |                                    |           |                                                                                                                                                                         |
| Source Off Leakage, I <sub>S</sub> (Off)                  | 0.01  | 0.2            | 0.4                                | nA typ    | V <sub>DD</sub> = +16.5 V, V <sub>SS</sub> = −16.5 V<br>V <sub>S</sub> = V <sub>S</sub> = ±10 V, V <sub>D</sub> = ∓10 V, see Figure 23                                  |
| Drain Off Leakage, I <sub>D</sub> (Off)                   | 0.1   |                |                                    | nA max    |                                                                                                                                                                         |
|                                                           | 0.01  | 0.4            | 1.2                                | nA typ    | V <sub>S</sub> = V <sub>S</sub> = ±10 V, V <sub>D</sub> = ∓10 V, see Figure 23                                                                                          |
| Channel On Leakage, I <sub>D</sub> , I <sub>S</sub> (On)  | 0.1   |                |                                    | nA max    |                                                                                                                                                                         |
|                                                           | 0.02  | 0.5            | 1.2                                | nA typ    | V <sub>S</sub> = V <sub>D</sub> = ±10 V, see Figure 26                                                                                                                  |
|                                                           | 0.2   |                |                                    | nA max    |                                                                                                                                                                         |
| DIGITAL INPUTS                                            |       |                |                                    |           |                                                                                                                                                                         |
| Input High Voltage, V <sub>INH</sub>                      | 0.002 |                | 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>       |       |                | ±0.1                               | μA typ    |                                                                                                                                                                         |
| Digital Input Capacitance, C <sub>IN</sub>                |       |                | 3                                  | μA max    |                                                                                                                                                                         |
|                                                           |       |                |                                    | pF typ    |                                                                                                                                                                         |
| DYNAMIC CHARACTERISTICS <sup>1</sup>                      |       |                |                                    |           |                                                                                                                                                                         |
| Transition Time, t <sub>TRANSITION</sub>                  | 175   | 285            | 320                                | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 29                                                                                  |
|                                                           | 230   |                |                                    | ns max    |                                                                                                                                                                         |
| t <sub>ON</sub> (EN)                                      | 155   | 255            | 285                                | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 31                                                                                  |
|                                                           | 205   |                |                                    | ns max    |                                                                                                                                                                         |
| t <sub>OFF</sub> (EN)                                     | 150   | 200            | 215                                | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 31                                                                                  |
|                                                           | 175   |                |                                    | ns max    |                                                                                                                                                                         |
| Break-Before-Make Time Delay, t <sub>D</sub>              | 80    |                | 30                                 | ns typ    | 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 30                                                               |
|                                                           |       |                |                                    | ns min    |                                                                                                                                                                         |
| Charge Injection, Q <sub>INJ</sub>                        | −0.6  |                |                                    | pC typ    | V <sub>S</sub> = 0 V, R <sub>S</sub> = 0 Ω, C <sub>L</sub> = 1 nF, see Figure 32                                                                                        |
| Off Isolation                                             | −80   |                |                                    | dB typ    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 100 kHz, see Figure 25                                                                                                |
| Channel-to-Channel Crosstalk                              | −80   |                |                                    | dB typ    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 28                                                                                                  |
| −3 dB Bandwidth                                           | 136   |                |                                    | MHz typ   | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, see Figure 27                                                                                                             |
| Insertion Loss                                            | −6.8  |                |                                    | dB typ    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 27                                                                                                  |
| C <sub>S</sub> (Off)                                      | 3     |                |                                    | pF typ    | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                                         |
| C <sub>D</sub> (Off)                                      | 26    |                |                                    | pF typ    | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                                         |
| C <sub>D</sub> , C <sub>S</sub> (On)                      | 30    |                |                                    | pF typ    | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                                         |
| POWER REQUIREMENTS                                        |       |                |                                    |           |                                                                                                                                                                         |
| I <sub>DD</sub>                                           | 45    |                | 70                                 | μA typ    | V <sub>DD</sub> = +16.5 V, V <sub>SS</sub> = −16.5 V<br>Digital inputs = 0 V or V <sub>DD</sub>                                                                         |
|                                                           | 55    |                |                                    | μA max    |                                                                                                                                                                         |
| I <sub>SS</sub>                                           | 0.001 |                |                                    | μA typ    |                                                                                                                                                                         |
|                                                           |       |                | 1                                  | μA max    |                                                                                                                                                                         |
| V <sub>DD</sub> /V <sub>SS</sub>                          |       |                | ±9/±22                             | V min/max | GND = 0 V                                                                                                                                                               |

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

# ADG5204

## ±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 +85°C | −40°C to +125°C                    | Unit                | Test Conditions/Comments                                                                                                                                            |                                                                                        |
|-----------------------------------------------------------|-------------|----------------|------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| ANALOG SWITCH                                             |             |                |                                    |                     |                                                                                                                                                                     |                                                                                        |
| Analog Signal Range                                       |             |                | V <sub>DD</sub> to V <sub>SS</sub> | V max               | V <sub>S</sub> = ±15 V, I <sub>S</sub> = −1 mA, see Figure 24<br>V <sub>DD</sub> = +18 V, V <sub>SS</sub> = −18 V<br>V <sub>S</sub> = ±15 V, I <sub>S</sub> = −1 mA |                                                                                        |
| On Resistance, R <sub>ON</sub>                            | 140<br>160  | 200            | 230                                | Ω typ<br>Ω max      |                                                                                                                                                                     |                                                                                        |
| On-Resistance Match<br>Between Channels, ΔR <sub>ON</sub> | 4.5         |                |                                    | Ω typ               |                                                                                                                                                                     |                                                                                        |
| On-Resistance Flatness, R <sub>FLAT(ON)</sub>             | 8           | 9              | 10                                 | Ω max               | V <sub>S</sub> = ±15 V, I <sub>S</sub> = −1 mA                                                                                                                      |                                                                                        |
|                                                           | 33          |                |                                    | Ω typ               |                                                                                                                                                                     |                                                                                        |
|                                                           | 45          |                |                                    | Ω max               |                                                                                                                                                                     |                                                                                        |
| LEAKAGE CURRENTS                                          |             |                |                                    |                     |                                                                                                                                                                     |                                                                                        |
| Source Off Leakage, I <sub>S</sub> (Off)                  | 0.01        | 0.2            | 0.4                                | nA typ              | V <sub>DD</sub> = +22 V, V <sub>SS</sub> = −22 V<br>V <sub>S</sub> = ±15 V, V <sub>O</sub> = ∓15 V, see Figure 23                                                   |                                                                                        |
| Drain Off Leakage, I <sub>D</sub> (Off)                   | 0.1<br>0.01 |                |                                    | nA max<br>nA typ    |                                                                                                                                                                     |                                                                                        |
| Channel On Leakage, I <sub>D</sub> , I <sub>S</sub> (On)  | 0.1         | 0.4            | 1.2                                | nA max              | V <sub>S</sub> = ±15 V, V <sub>O</sub> = ∓15 V, see Figure 23                                                                                                       |                                                                                        |
|                                                           | 0.02        |                |                                    | nA typ              |                                                                                                                                                                     | V <sub>S</sub> = V <sub>O</sub> = ±15 V, see Figure 26                                 |
|                                                           | 0.2         |                |                                    | nA max              |                                                                                                                                                                     |                                                                                        |
| DIGITAL INPUTS                                            |             |                |                                    |                     |                                                                                                                                                                     |                                                                                        |
| Input High Voltage, V <sub>INH</sub>                      | 0.002       |                | 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>       |             |                | ±0.1                               | μA typ              |                                                                                                                                                                     |                                                                                        |
| Digital Input Capacitance, C <sub>IN</sub>                |             |                |                                    | 3                   |                                                                                                                                                                     | μA max<br>pF typ                                                                       |
| DYNAMIC CHARACTERISTICS <sup>1</sup>                      |             |                |                                    |                     |                                                                                                                                                                     |                                                                                        |
| Transition Time, t <sub>TRANSITION</sub>                  | 160<br>215  | 260            | 290                                | ns typ<br>ns max    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 29                                                                              |                                                                                        |
| t <sub>ON</sub> (EN)                                      | 150         |                |                                    | ns typ              |                                                                                                                                                                     | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 31 |
| t <sub>OFF</sub> (EN)                                     | 185<br>150  | 225            | 255                                | ns max<br>ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 10 V, see Figure 31                                                                              |                                                                                        |
| Break-Before-Make Time Delay, t <sub>D</sub>              | 175<br>75   |                |                                    | 195                 |                                                                                                                                                                     | 210                                                                                    |
| Charge Injection, Q <sub>INJ</sub>                        | −0.6        |                | 30                                 |                     | ns min<br>pC typ                                                                                                                                                    |                                                                                        |
| Off Isolation                                             | −80         |                |                                    | dB typ              | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 100 kHz,<br>see Figure 25                                                                                         |                                                                                        |
| Channel-to-Channel Crosstalk                              | −80         |                |                                    | dB typ              |                                                                                                                                                                     | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 28                 |
| −3 dB Bandwidth                                           | 150         |                |                                    | MHz typ             | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, see Figure 27                                                                                                         |                                                                                        |
| Insertion Loss                                            | −6          |                |                                    | dB typ              |                                                                                                                                                                     | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 27                 |
| C <sub>S</sub> (Off)                                      | 3           |                |                                    | pF typ              | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                                     |                                                                                        |
| C <sub>D</sub> (Off)                                      | 26          |                |                                    | pF typ              |                                                                                                                                                                     | V <sub>S</sub> = 0 V, f = 1 MHz                                                        |
| C <sub>D</sub> , C <sub>S</sub> (On)                      | 30          |                |                                    | pF typ              | V <sub>S</sub> = 0 V, f = 1 MHz                                                                                                                                     |                                                                                        |
| POWER REQUIREMENTS                                        |             |                |                                    |                     |                                                                                                                                                                     |                                                                                        |
| I <sub>DD</sub>                                           | 50<br>70    |                | 110                                | μA typ<br>μA max    | V <sub>DD</sub> = +22 V, V <sub>SS</sub> = −22 V<br>Digital inputs = 0 V or V <sub>DD</sub>                                                                         |                                                                                        |
| I <sub>SS</sub>                                           | 0.001       |                |                                    | μA typ<br>μA max    |                                                                                                                                                                     | Digital inputs = 0 V or V <sub>DD</sub>                                                |
| V <sub>DD</sub> /V <sub>SS</sub>                          |             |                | 1<br>±9/±22                        | μA max<br>V min/max | GND = 0 V                                                                                                                                                           |                                                                                        |

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

**12 V SINGLE SUPPLY**

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

**Table 3.**

| Parameter                                                 | 25°C  | −40°C to +85°C | −40°C to +125°C        | Unit      | Test Conditions/Comments                                                                                                                                                       |
|-----------------------------------------------------------|-------|----------------|------------------------|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANALOG SWITCH                                             |       |                |                        |           |                                                                                                                                                                                |
| Analog Signal Range                                       |       |                | 0 V to V <sub>DD</sub> | V max     | V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA, see Figure 24<br>V <sub>DD</sub> = 10.8 V, V <sub>SS</sub> = 0 V<br>V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA |
| On Resistance, R <sub>ON</sub>                            | 340   | 610            | 700                    | Ω typ     |                                                                                                                                                                                |
|                                                           | 500   |                |                        | Ω max     |                                                                                                                                                                                |
| On-Resistance Match<br>Between Channels, ΔR <sub>ON</sub> | 5     |                |                        | Ω typ     |                                                                                                                                                                                |
|                                                           | 20    | 21             | 22                     | Ω max     |                                                                                                                                                                                |
| On-Resistance Flatness, R <sub>FLAT(ON)</sub>             | 145   |                |                        | Ω typ     | V <sub>S</sub> = 0 V to 10 V, I <sub>S</sub> = −1 mA                                                                                                                           |
|                                                           | 280   | 335            | 370                    | Ω max     |                                                                                                                                                                                |
| LEAKAGE CURRENTS                                          |       |                |                        |           |                                                                                                                                                                                |
| Source Off Leakage, I <sub>S</sub> (Off)                  | 0.01  | 0.2            | 0.4                    | nA typ    | V <sub>DD</sub> = 13.2 V, V <sub>SS</sub> = 0 V<br>V <sub>S</sub> = 1 V/10 V, V <sub>D</sub> = 10 V/1 V, see Figure 23                                                         |
|                                                           | 0.1   |                |                        | nA max    |                                                                                                                                                                                |
| Drain Off Leakage, I <sub>D</sub> (Off)                   | 0.01  | 0.4            | 1.2                    | nA typ    | V <sub>S</sub> = 1 V/10 V, V <sub>D</sub> = 10 V/1 V, see Figure 23                                                                                                            |
|                                                           | 0.1   |                |                        | nA max    |                                                                                                                                                                                |
| Channel On Leakage, I <sub>D</sub> , I <sub>S</sub> (On)  | 0.02  | 0.5            | 1.2                    | nA typ    | V <sub>S</sub> = V <sub>D</sub> = 1 V/10 V, see Figure 26                                                                                                                      |
|                                                           | 0.2   |                |                        | nA max    |                                                                                                                                                                                |
| DIGITAL INPUTS                                            |       |                |                        |           |                                                                                                                                                                                |
| Input High Voltage, V <sub>INH</sub>                      | 0.002 |                | 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>       |       |                | ±0.1                   | μA typ    |                                                                                                                                                                                |
|                                                           |       |                |                        | μA max    |                                                                                                                                                                                |
| Digital Input Capacitance, C <sub>IN</sub>                | 3     |                |                        | pF typ    |                                                                                                                                                                                |
| DYNAMIC CHARACTERISTICS <sup>1</sup>                      |       |                |                        |           |                                                                                                                                                                                |
| Transition Time, t <sub>TRANSITION</sub>                  | 240   | 445            | 515                    | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 8 V, see Figure 29                                                                                          |
|                                                           | 350   |                |                        | ns max    |                                                                                                                                                                                |
| t <sub>ON</sub> (EN)                                      | 250   | 420            | 485                    | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 8 V, see Figure 31                                                                                          |
|                                                           | 335   |                |                        | ns max    |                                                                                                                                                                                |
| t <sub>OFF</sub> (EN)                                     | 160   | 220            | 240                    | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S</sub> = 8 V, see Figure 31                                                                                          |
|                                                           | 195   |                |                        | ns max    |                                                                                                                                                                                |
| Break-Before-Make Time Delay, t <sub>D</sub>              | 140   |                | 60                     | ns typ    | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>V <sub>S1</sub> = V <sub>S2</sub> = 8 V, see Figure 30                                                                       |
|                                                           |       |                |                        | ns min    |                                                                                                                                                                                |
| Charge Injection, Q <sub>INJ</sub>                        | −1.2  |                |                        | pC typ    | V <sub>S</sub> = 6 V, R <sub>S</sub> = 0 Ω, C <sub>L</sub> = 1 nF, see Figure 32                                                                                               |
| Off Isolation                                             | −80   |                |                        | dB typ    |                                                                                                                                                                                |
| Channel-to-Channel Crosstalk                              | −80   |                |                        | dB typ    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 25<br>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 28                               |
| −3 dB Bandwidth                                           | 106   |                |                        | MHz typ   |                                                                                                                                                                                |
| Insertion Loss                                            | −11   |                |                        | dB typ    | R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, see Figure 27<br>R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz, see Figure 27                                          |
| C <sub>S</sub> (Off)                                      | 3.5   |                |                        | pF typ    |                                                                                                                                                                                |
| C <sub>D</sub> (Off)                                      | 29    |                |                        | pF typ    | V <sub>S</sub> = 6 V, f = 1 MHz<br>V <sub>S</sub> = 6 V, f = 1 MHz                                                                                                             |
| C <sub>D</sub> , C <sub>S</sub> (On)                      | 33    |                |                        | pF typ    |                                                                                                                                                                                |
| POWER REQUIREMENTS                                        |       |                |                        |           |                                                                                                                                                                                |
| I <sub>DD</sub>                                           | 40    |                | 65                     | μA typ    | V <sub>DD</sub> = 13.2 V<br>Digital inputs = 0 V or V <sub>DD</sub>                                                                                                            |
|                                                           |       |                |                        | μA max    |                                                                                                                                                                                |
| V <sub>DD</sub>                                           |       |                | 9/40                   | V min/max | GND = 0 V, V <sub>SS</sub> = 0 V                                                                                                                                               |

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

# ADG5204

## 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 +85°C | −40°C to +125°C | Unit                                         | Test Conditions/Comments                                                                                                                                                                           |
|----------------------------------------------------------|---------------|----------------|-----------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ANALOG SWITCH                                            |               |                |                 |                                              |                                                                                                                                                                                                    |
| Analog Signal Range                                      |               |                | 0 V to $V_{DD}$ | V max                                        | $V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -1 \text{ mA}$ , see Figure 24<br>$V_{DD} = 32.4 \text{ V}$ , $V_{SS} = 0 \text{ V}$<br>$V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -1 \text{ mA}$ |
| On Resistance, $R_{ON}$                                  | 150<br>170    | 215            | 245             | $\Omega$ typ<br>$\Omega$ max                 |                                                                                                                                                                                                    |
| On-Resistance Match<br>Between Channels, $\Delta R_{ON}$ | 4.5           |                |                 | $\Omega$ typ                                 |                                                                                                                                                                                                    |
| On-Resistance Flatness, $R_{FLAT(ON)}$                   | 8<br>35<br>50 | 9<br>60        | 10<br>65        | $\Omega$ max<br>$\Omega$ typ<br>$\Omega$ max | $V_S = 0 \text{ V to } 30 \text{ V}$ , $I_S = -1 \text{ mA}$                                                                                                                                       |
| LEAKAGE CURRENTS                                         |               |                |                 |                                              | $V_{DD} = 39.6 \text{ V}$ , $V_{SS} = 0 \text{ V}$                                                                                                                                                 |
| Source Off Leakage, $I_S$ (Off)                          | 0.01<br>0.1   | 0.2            | 0.4             | nA typ<br>nA max                             | $V_S = 1 \text{ V/30 V}$ , $V_D = 30 \text{ V/1 V}$ , see Figure 23                                                                                                                                |
| Drain Off Leakage, $I_D$ (Off)                           | 0.01<br>0.1   |                |                 | nA typ<br>nA max                             |                                                                                                                                                                                                    |
| Channel On Leakage, $I_D$ , $I_S$ (On)                   | 0.02<br>0.2   | 0.4<br>0.5     | 1.2<br>1.2      | nA typ<br>nA max                             | $V_S = V_D = 1 \text{ V/30 V}$ , see Figure 26                                                                                                                                                     |
| DIGITAL INPUTS                                           |               |                |                 |                                              |                                                                                                                                                                                                    |
| Input High Voltage, $V_{INH}$                            | 0.002         |                | 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 $I_{INH}$                    |               |                | $\pm 0.1$       | $\mu\text{A}$ typ                            |                                                                                                                                                                                                    |
| Digital Input Capacitance, $C_{IN}$                      |               |                |                 | $\mu\text{A}$ max<br>pF typ                  |                                                                                                                                                                                                    |
| DYNAMIC CHARACTERISTICS <sup>1</sup>                     |               |                |                 |                                              |                                                                                                                                                                                                    |
| Transition Time, $t_{TRANSITION}$                        | 180<br>250    | 275            | 305             | ns typ<br>ns max                             | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$<br>$V_S = 18 \text{ V}$ , see Figure 29                                                                                                                 |
| $t_{ON}$ (EN)                                            | 170<br>220    |                |                 | ns typ<br>ns max                             |                                                                                                                                                                                                    |
| $t_{OFF}$ (EN)                                           | 170<br>210    | 215            | 220             | ns typ<br>ns max                             | $R_L = 300 \Omega$ , $C_L = 35 \text{ pF}$<br>$V_S = 18 \text{ V}$ , see Figure 31                                                                                                                 |
| Break-Before-Make Time Delay, $t_D$                      | 80            |                |                 | ns typ<br>ns min                             |                                                                                                                                                                                                    |
| Charge Injection, $Q_{INJ}$                              | −0.6          |                | 30              | pC typ                                       | $V_{S1} = V_{S2} = 18 \text{ V}$ , see Figure 30                                                                                                                                                   |
| Off Isolation                                            | −80           |                |                 | dB typ                                       | $V_S = 18 \text{ V}$ , $R_S = 0 \Omega$ , $C_L = 1 \text{ nF}$ , see Figure 32                                                                                                                     |
| Channel-to-Channel Crosstalk                             | −80           |                |                 | dB typ                                       | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ , see Figure 25                                                                                                                     |
| −3 dB Bandwidth                                          | 136           |                |                 | MHz typ                                      | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ , see Figure 28                                                                                                                     |
| Insertion Loss                                           | −6.7          |                |                 | dB typ                                       | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , see Figure 27                                                                                                                                           |
| $C_S$ (Off)                                              | 3             |                |                 | pF typ                                       | $R_L = 50 \Omega$ , $C_L = 5 \text{ pF}$ , $f = 1 \text{ MHz}$ , see Figure 27                                                                                                                     |
| $C_D$ (Off)                                              | 26            |                |                 | pF typ                                       | $V_S = 18 \text{ V}$ , $f = 1 \text{ MHz}$                                                                                                                                                         |
| $C_D$ , $C_S$ (On)                                       | 30            |                |                 | pF typ                                       | $V_S = 18 \text{ V}$ , $f = 1 \text{ MHz}$                                                                                                                                                         |
| POWER REQUIREMENTS                                       |               |                |                 |                                              | $V_{DD} = 39.6 \text{ V}$                                                                                                                                                                          |
| $I_{DD}$                                                 | 85<br>100     |                | 130             | $\mu\text{A}$ typ<br>$\mu\text{A}$ max       | Digital inputs = 0 V or $V_{DD}$                                                                                                                                                                   |
| $V_{DD}$                                                 |               |                | 9/40            | V min/max                                    | $GND = 0 \text{ V}$ , $V_{SS} = 0 \text{ V}$                                                                                                                                                       |

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

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

Table 5.

| Parameter                                         | 25°C | 85°C | 125°C | Unit   |
|---------------------------------------------------|------|------|-------|--------|
| CONTINUOUS CURRENT, Sx OR D PINS                  |      |      |       |        |
| $V_{DD} = +15\text{ V}$ , $V_{SS} = -15\text{ V}$ |      |      |       |        |
| TSSOP ( $\theta_{JA} = 112.6^{\circ}\text{C/W}$ ) | 24.5 | 7.5  | 2.8   | mA max |
| LFCSP ( $\theta_{JA} = 30.4^{\circ}\text{C/W}$ )  | 35.7 | 7.7  | 2.8   | mA max |
| $V_{DD} = +20\text{ V}$ , $V_{SS} = -20\text{ V}$ |      |      |       |        |
| TSSOP ( $\theta_{JA} = 112.6^{\circ}\text{C/W}$ ) | 26   | 7.5  | 2.8   | mA max |
| LFCSP ( $\theta_{JA} = 30.4^{\circ}\text{C/W}$ )  | 37   | 7.7  | 2.8   | mA max |
| $V_{DD} = 12\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |       |        |
| TSSOP ( $\theta_{JA} = 112.6^{\circ}\text{C/W}$ ) | 18   | 7    | 2.8   | mA max |
| LFCSP ( $\theta_{JA} = 30.4^{\circ}\text{C/W}$ )  | 28   | 7.7  | 2.8   | mA max |
| $V_{DD} = 36\text{ V}$ , $V_{SS} = 0\text{ V}$    |      |      |       |        |
| TSSOP ( $\theta_{JA} = 112.6^{\circ}\text{C/W}$ ) | 30   | 7.7  | 2.8   | mA max |
| LFCSP ( $\theta_{JA} = 30.4^{\circ}\text{C/W}$ )  | 41   | 7.7  | 2.8   | mA max |

## ABSOLUTE MAXIMUM RATINGS

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

**Table 6.**

| 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 30 mA, whichever occurs first |
| Digital Inputs <sup>1</sup>                                    | $V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or 30 mA, whichever occurs first |
| Peak Current, Sx or D Pins                                     | 81 mA (pulsed at 1 ms, 10% duty cycle maximum)                                      |
| Continuous Current, Sx or D <sup>2</sup>                       | Data + 15%                                                                          |
| Operating Temperature Range                                    | –40°C to +125°C                                                                     |
| Storage Temperature Range                                      | –65°C to +150°C                                                                     |
| Junction Temperature                                           | 150°C                                                                               |
| Thermal Impedance, $\theta_{JA}$                               |                                                                                     |
| 16-Lead TSSOP, $\theta_{JA}$ Thermal Impedance (4-Layer Board) | 112.6°C/W                                                                           |
| 16-Lead LFCSP, $\theta_{JA}$ Thermal Impedance (4-Layer Board) | 30.4°C/W                                                                            |
| Reflow Soldering Peak Temperature, Pb Free                     | 260(+0/–5)°C                                                                        |

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

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

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

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

### ESD CAUTION



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

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

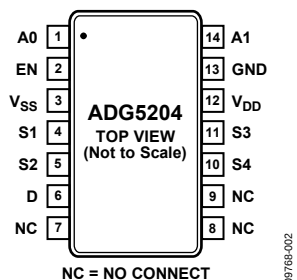


Figure 2. TSSOP Pin Configuration

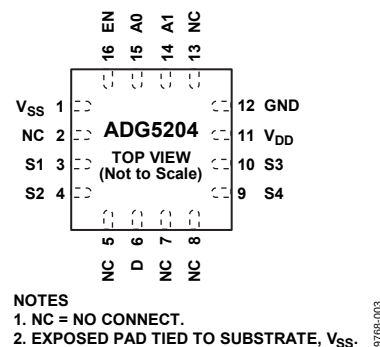


Figure 3. LFCSP Pin Configuration

Table 7. Pin Function Descriptions

| Pin No.          |                | Mnemonic        | Description                                                                                                                                                                                                         |
|------------------|----------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSSOP            | LFCSP          |                 |                                                                                                                                                                                                                     |
| 1                | 15             | A0              | Logic Control Input.                                                                                                                                                                                                |
| 2                | 16             | EN              | Active High Digital Input. When this pin is low, the device is disabled and all switches are off. When this pin is high, the Ax logic inputs determine the on switches.                                             |
| 3                | 1              | V <sub>SS</sub> | Most Negative Power Supply Potential.                                                                                                                                                                               |
| 4                | 3              | S1              | Source Terminal. Can be an input or an output.                                                                                                                                                                      |
| 5                | 4              | S2              | Source Terminal. Can be an input or an output.                                                                                                                                                                      |
| 6                | 6              | D               | Drain Terminal. Can be an input or an output.                                                                                                                                                                       |
| 7 to 9           | 2, 5, 7, 8, 13 | NC              | No Connect. These pins are open.                                                                                                                                                                                    |
| 10               | 9              | S4              | Source Terminal. Can be an input or an output.                                                                                                                                                                      |
| 11               | 10             | S3              | Source Terminal. Can be an input or an output.                                                                                                                                                                      |
| 12               | 11             | V <sub>DD</sub> | Most Positive Power Supply Potential.                                                                                                                                                                               |
| 13               | 12             | GND             | Ground (0 V) Reference.                                                                                                                                                                                             |
| 14               | 14             | A1              | Logic Control Input.                                                                                                                                                                                                |
| N/A <sup>1</sup> | EP             | Exposed Pad     | 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> . |

<sup>1</sup> N/A means not applicable.

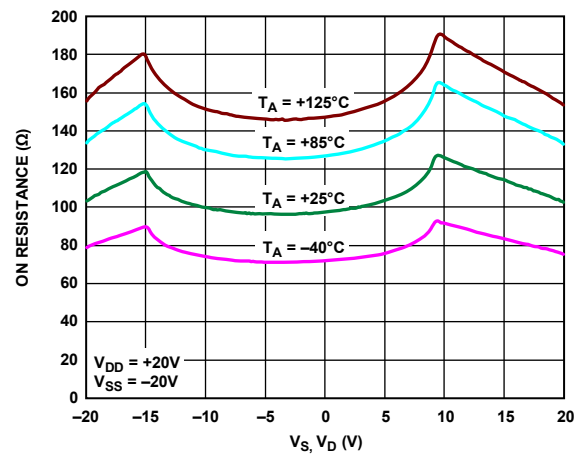
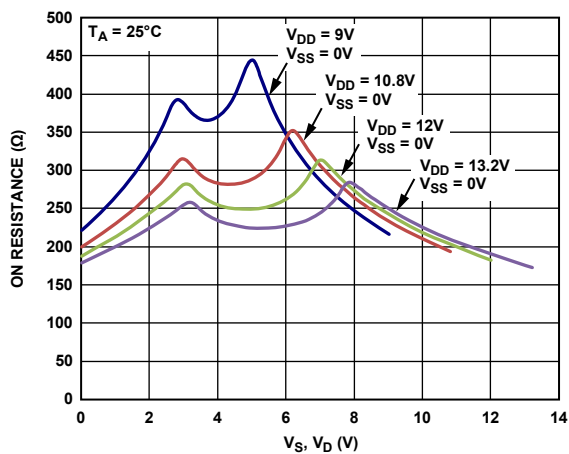
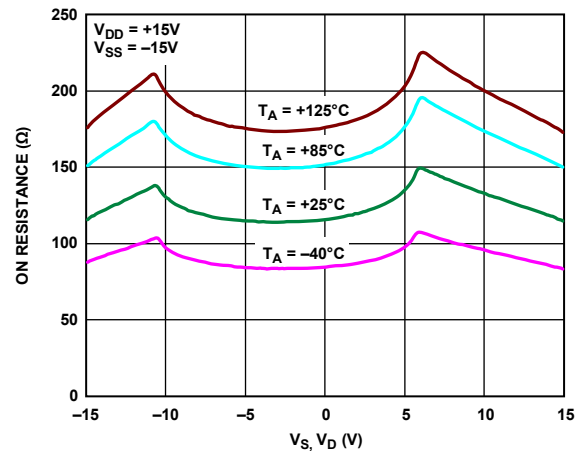
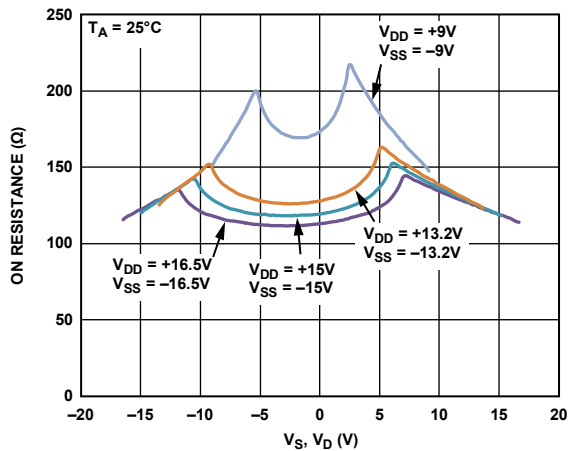
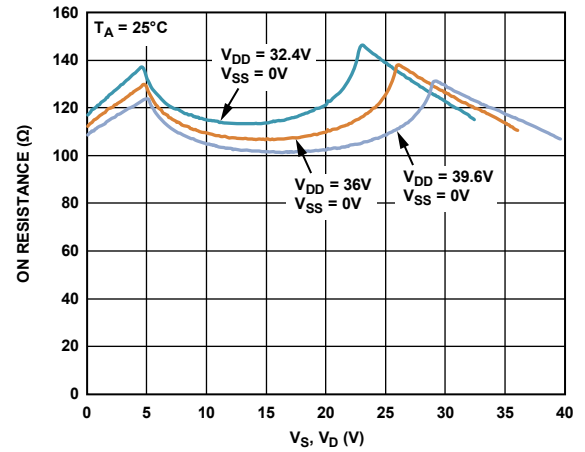
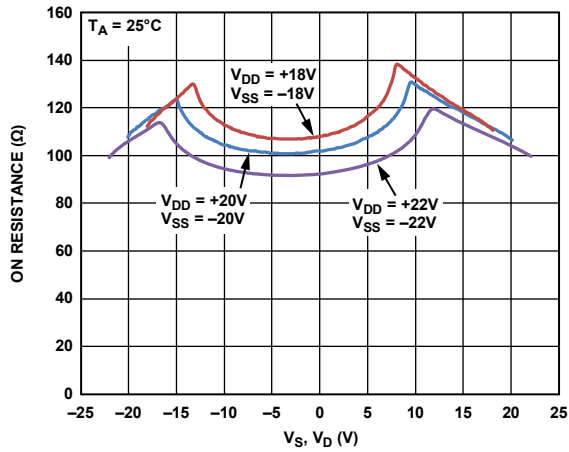
## TRUTH TABLE

Table 8.

| EN | A1             | A0             | S1  | S2  | S3  | S4  |
|----|----------------|----------------|-----|-----|-----|-----|
| 0  | X <sup>1</sup> | X <sup>1</sup> | Off | Off | Off | Off |
| 1  | 0              | 0              | On  | Off | Off | Off |
| 1  | 0              | 1              | Off | On  | Off | Off |
| 1  | 1              | 0              | Off | Off | On  | Off |
| 1  | 1              | 1              | Off | Off | Off | On  |

<sup>1</sup> X is don't care.

## TYPICAL PERFORMANCE CHARACTERISTICS



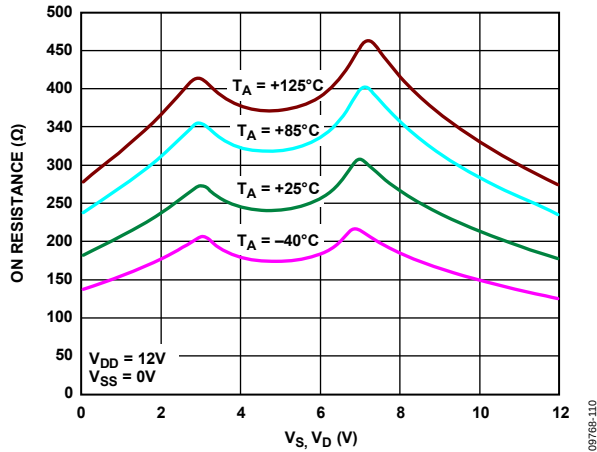


Figure 10.  $R_{ON}$  as a Function of  $V_D$  or  $V_S$  for Different Temperatures, 12 V Single Supply

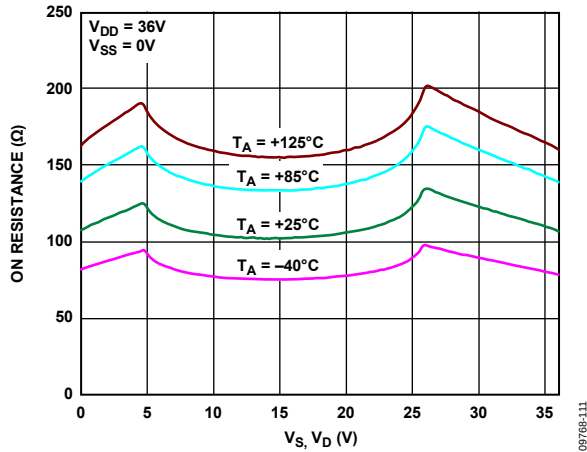


Figure 11.  $R_{ON}$  as a Function of  $V_D$  or  $V_S$  for Different Temperatures, 36 V Single Supply

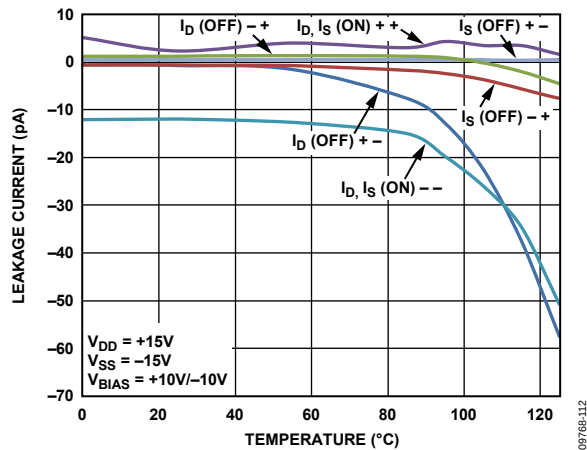


Figure 12. Leakage Current vs. Temperature,  $\pm 15$  V Dual Supply

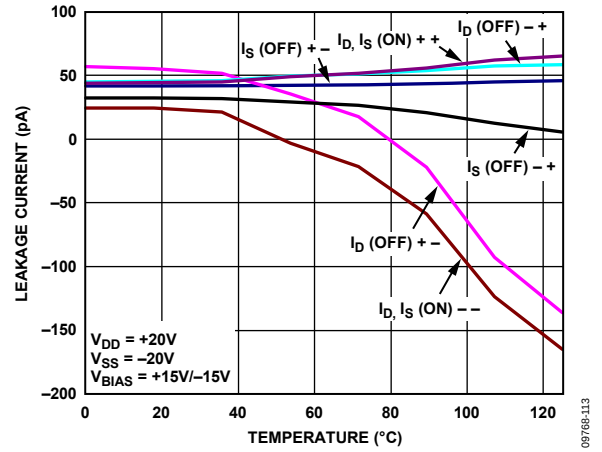


Figure 13. Leakage Current vs. Temperature,  $\pm 20$  V Dual Supply

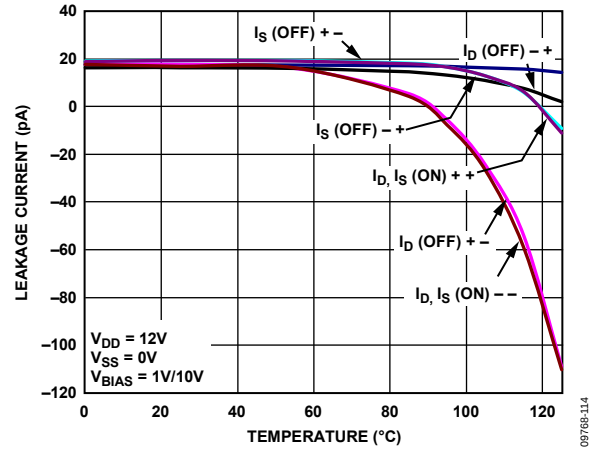


Figure 14. Leakage Current vs. Temperature, 12 V Single Supply

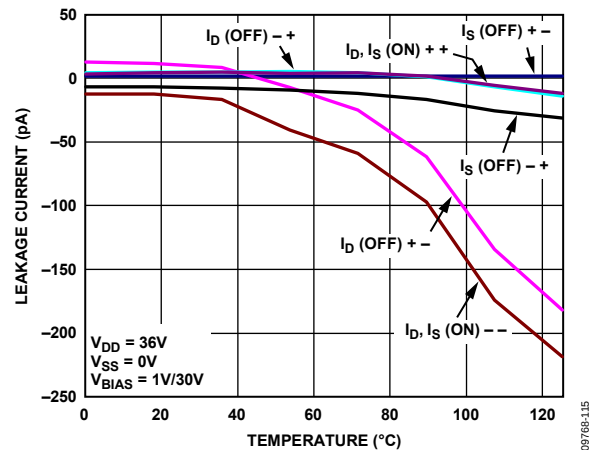


Figure 15. Leakage Current vs. Temperature, 36 V Single Supply

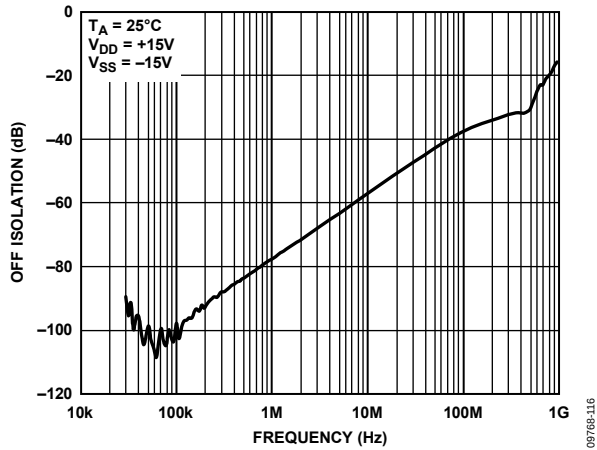


Figure 16. Off Isolation vs. Frequency,  $\pm 15$  V Dual Supply

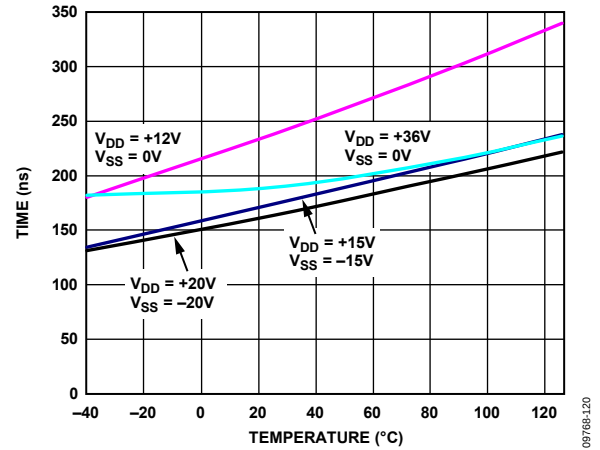


Figure 19. Transition Time vs. Temperature

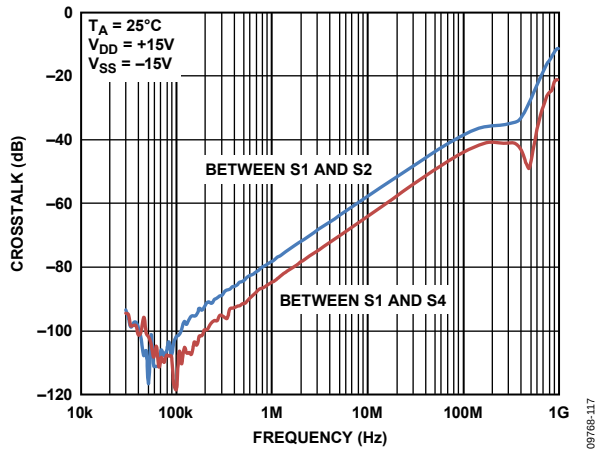


Figure 17. Crosstalk vs. Frequency,  $\pm 15$  V Dual Supply

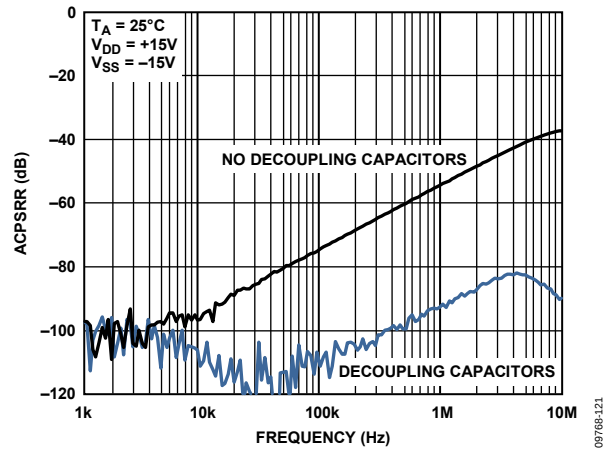


Figure 20. ACPSRR vs. Frequency,  $\pm 15$  V Dual Supply

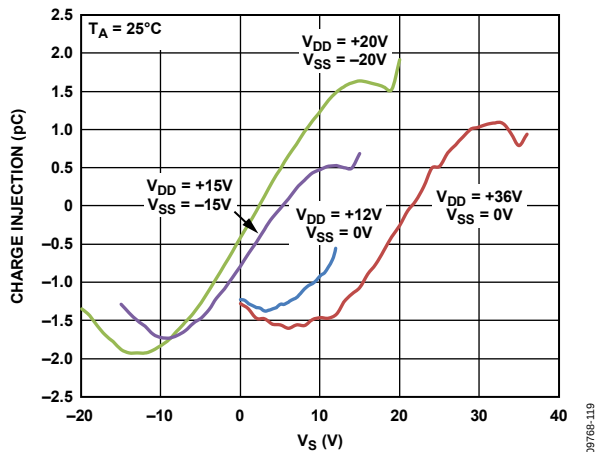


Figure 18. Charge Injection vs. Source Voltage

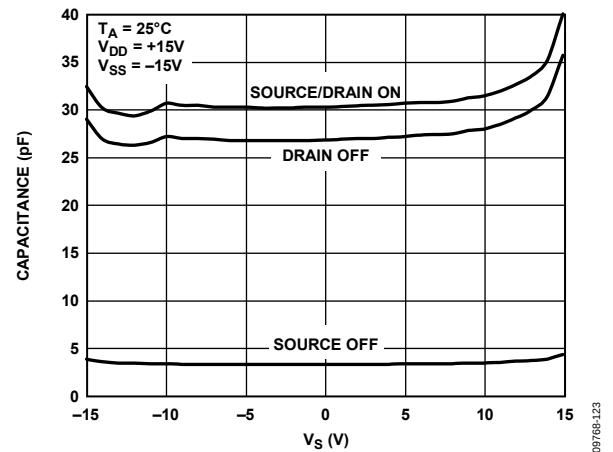


Figure 21. Capacitance vs. Source Voltage, Dual Supply

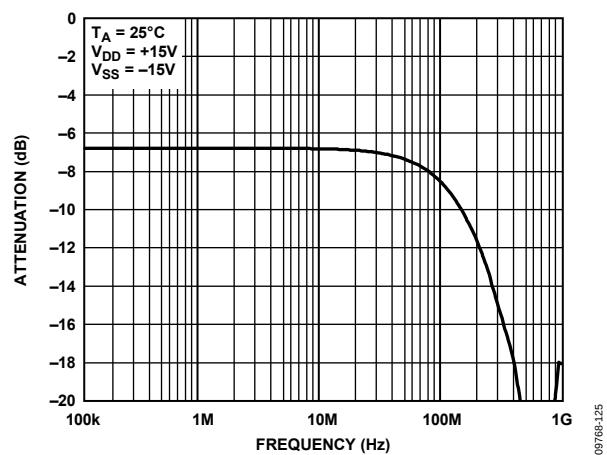


Figure 22. Bandwidth

## TEST CIRCUITS

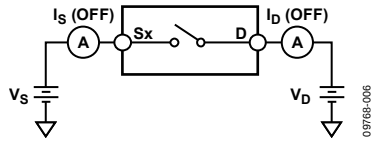


Figure 23. Off Leakage

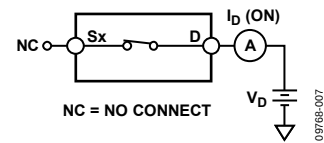


Figure 26. On Leakage

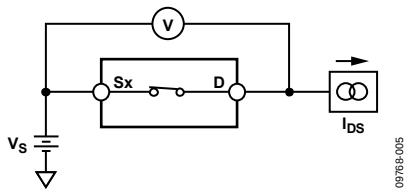


Figure 24. On Resistance

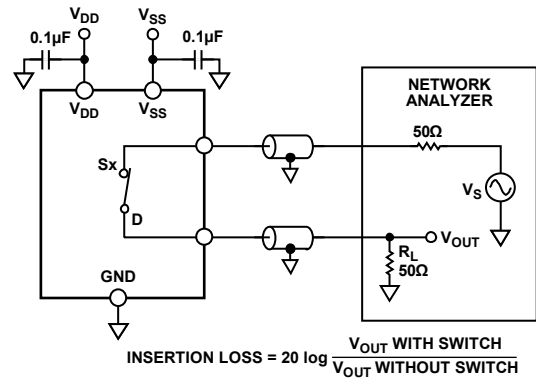


Figure 27. Bandwidth

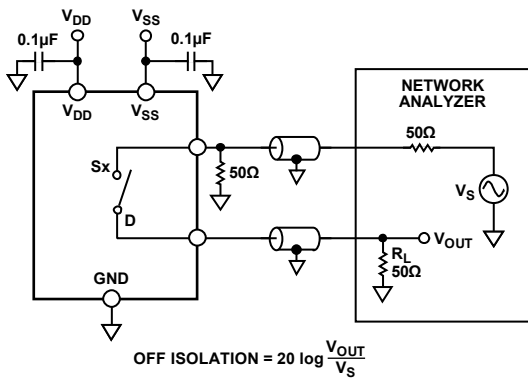


Figure 25. Off Isolation

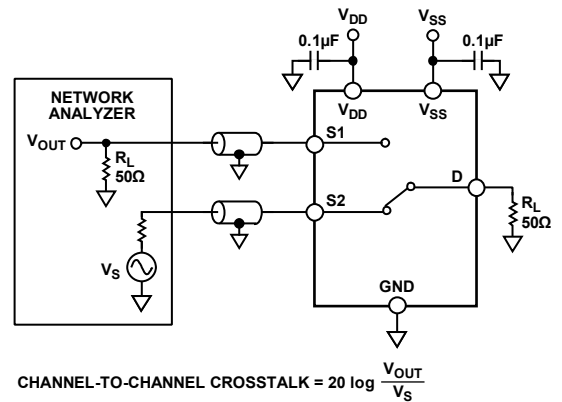


Figure 28. Channel-to-Channel Crosstalk

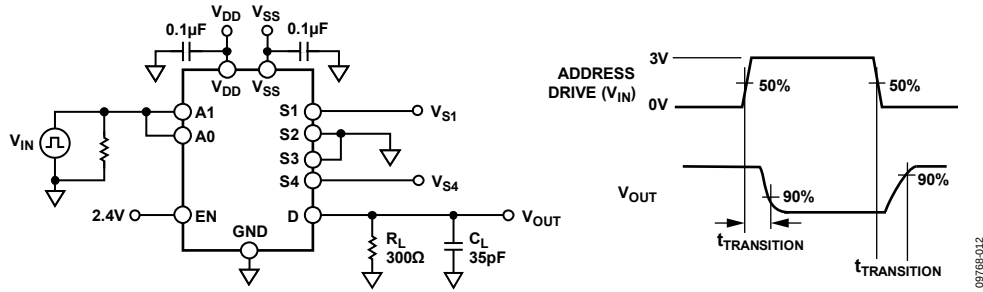


Figure 29. Address to Output Switching Times

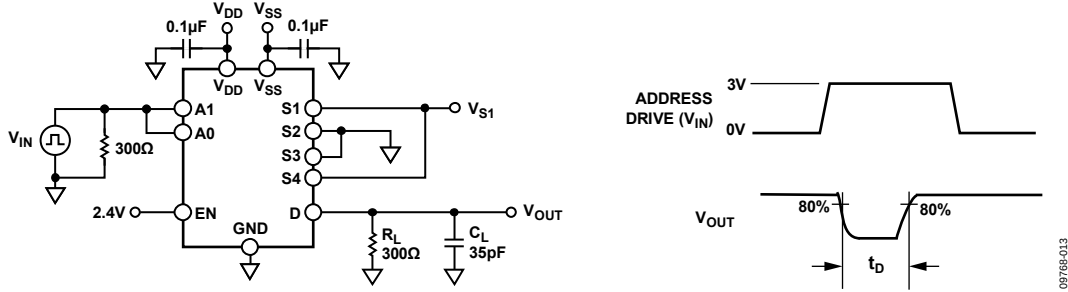


Figure 30. Break-Before-Make Time Delay,  $t_D$

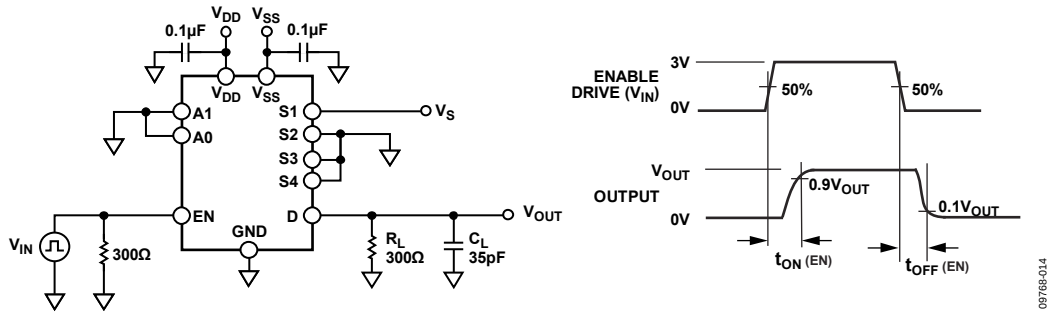


Figure 31. Enable-to-Output Switching Delay

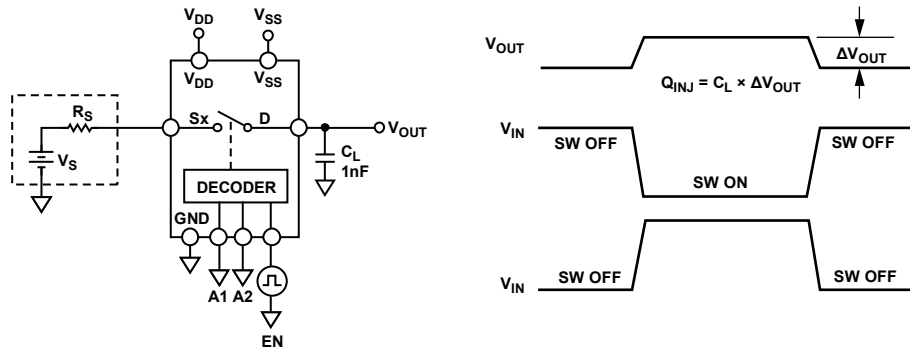


Figure 32. Charge Injection

## TERMINOLOGY

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

The positive supply current.

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

The negative supply current.

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

The analog voltage on Terminal D and Terminal S.

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

The ohmic resistance between Terminal D and Terminal S.

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

Flatness that is defined as the difference between the maximum and minimum value of on resistance measured over the specified analog signal range.

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

The source leakage current with the switch off.

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

The drain leakage current with the switch off.

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

The channel leakage current with the switch on.

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

The maximum input voltage for Logic 0.

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

The minimum input voltage for Logic 1.

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

The input current of the digital input.

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

The off switch source capacitance, which is measured with reference to ground.

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

The off switch drain capacitance, which is measured with reference to ground.

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

The on switch capacitance, which is measured with reference to ground.

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

The digital input capacitance.

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

The delay time between the 50% and 90% points of the digital input and switch-on condition when switching from one address state to another.

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

The delay between applying the digital control input and the output switching on. See Figure 31.

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

The delay between applying the digital control input and the output switching off. See Figure 31.

### **Charge Injection**

A measure of the glitch impulse transferred from the digital input to the analog output during switching.

### **Off Isolation**

A measure of unwanted signal coupling through an off switch.

### **Crosstalk**

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

### **Bandwidth**

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

### **On Response**

The frequency response of the on switch.

### **Insertion Loss**

The loss due to the on resistance of the switch.

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

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

## TRENCH ISOLATION

In the ADG5204, 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. By using trench isolation, this diode is removed, and the result is a latch-up proof switch.

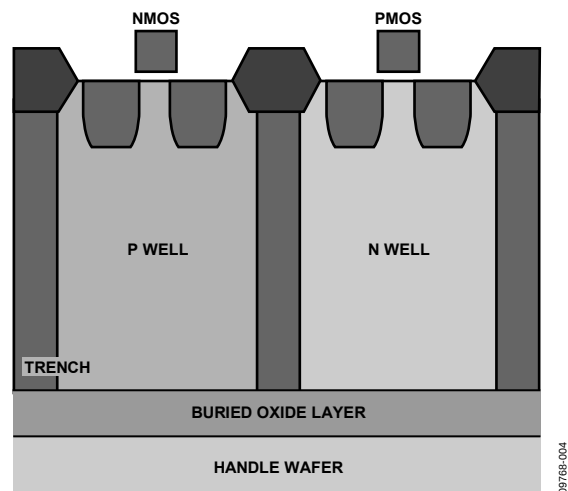


Figure 33. Trench Isolation

### APPLICATIONS INFORMATION

The ADG52xx family of switches and multiplexers provide 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 persists until the power supply is turned off. The ADG5204 high voltage multiplexer allows single-supply operation from 9 V to 40 V and dual-supply operation from  $\pm 9$  V to  $\pm 22$  V.

## OUTLINE DIMENSIONS

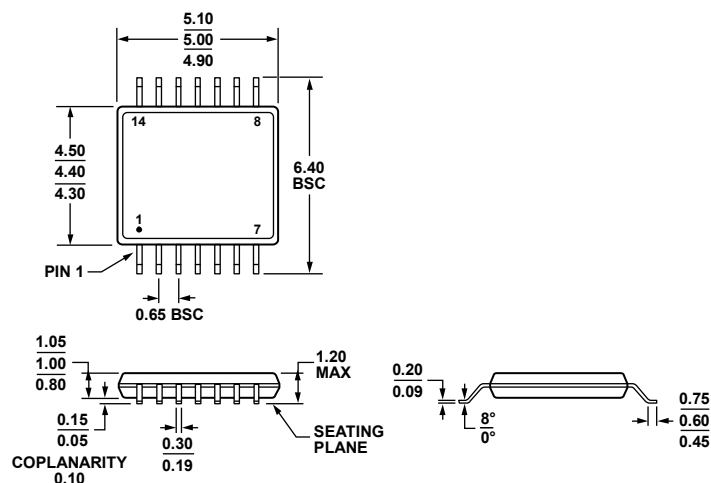
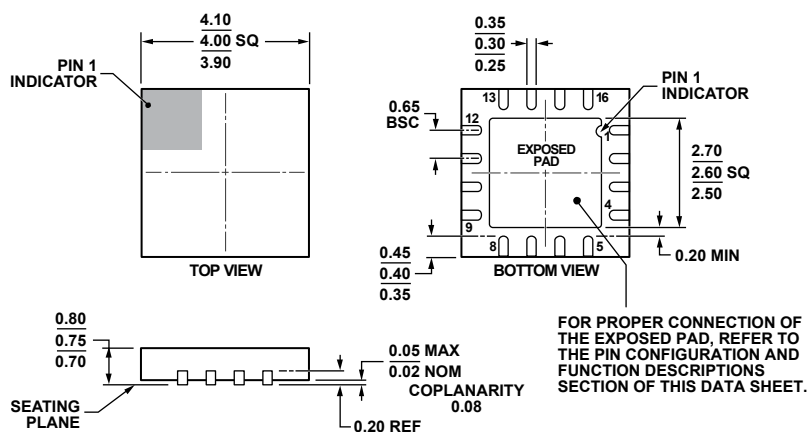


Figure 34. 14-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-14)  
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-WGGC.  
Figure 35. 16-Lead Lead Frame Chip Scale Package [LFCSP\_WQ]  
4 mm × 4 mm Body, Very Very Thin Quad  
(CP-16-17)  
Dimensions shown in millimeters

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                               | Package Option |
|--------------------|-------------------|---------------------------------------------------|----------------|
| ADG5204BRUZ        | −40°C to +125°C   | 14-Lead Thin Shrink Small Outline Package [TSSOP] | RU-14          |
| ADG5204BRUZ-RL7    | −40°C to +125°C   | 14-Lead Thin Shrink Small Outline Package [TSSOP] | RU-14          |
| ADG5204BCPZ-RL7    | −40°C to +125°C   | 16-Lead Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-16-17       |

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

**ADG5204**

## NOTES