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REVISION HISTORY

10/10—Revision 0: Initial Version

# SPECIFICATIONS

## 5 V DUAL SUPPLY

$V_{DD} = +5\text{ V} \pm 10\%$ ,  $V_{SS} = -5\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

Table 1.

| Parameter                                                | 25°C        | −40°C to +85°C     | Unit              | Test Conditions/Comments                                                                                                                                                                                       |
|----------------------------------------------------------|-------------|--------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                     |             |                    |                   |                                                                                                                                                                                                                |
| Analog Signal Range (Normal Mode)                        |             | −5.5 V to $V_{DD}$ | V                 | $V_{DD}$ to $V_{SS} = 16\text{ V}$ maximum                                                                                                                                                                     |
| On Resistance ( $R_{ON}$ )                               | 5.2         |                    | $\Omega$ typ      | $V_S = \pm 4.5\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 22                                                                                                                                               |
|                                                          | 6.1         | 7.6                | $\Omega$ max      | $V_{DD} = +4.5\text{ V}$ , $V_{SS} = -4.5\text{ V}$                                                                                                                                                            |
| On-Resistance Match Between Channels ( $\Delta R_{ON}$ ) | 0.05        |                    | $\Omega$ typ      | $V_S = \pm 4.5\text{ V}$ , $I_S = -10\text{ mA}$                                                                                                                                                               |
|                                                          | 0.15        | 0.18               | $\Omega$ max      |                                                                                                                                                                                                                |
| On-Resistance Flatness ( $R_{FLAT(ON)}$ )                | 1.4         |                    | $\Omega$ typ      | $V_S = \pm 4.5\text{ V}$ , $I_S = -10\text{ mA}$                                                                                                                                                               |
|                                                          | 1.75        | 2.2                | $\Omega$ max      |                                                                                                                                                                                                                |
| <b>LEAKAGE CURRENTS (NORMAL MODE)</b>                    |             |                    |                   |                                                                                                                                                                                                                |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 5$     |                    | nA typ            | $V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$<br>$V_S = \pm 4.5\text{ V}$ , $V_D = \mp 4.5\text{ V}$ ; see Figure 23                                                                                     |
|                                                          | $\pm 10$    | $\pm 300$          | nA max            |                                                                                                                                                                                                                |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 5$     |                    | nA typ            | $V_S = \pm 4.5\text{ V}$ , $V_D = \mp 4.5\text{ V}$ ; see Figure 23                                                                                                                                            |
|                                                          | $\pm 10$    | $\pm 300$          | nA max            |                                                                                                                                                                                                                |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)               | $\pm 10$    |                    | nA typ            | $V_S = V_D = \pm 4.5\text{ V}$ ; see Figure 24                                                                                                                                                                 |
|                                                          | $\pm 16$    | $\pm 700$          | nA max            |                                                                                                                                                                                                                |
| <b>LEAKAGE CURRENTS (ISOLATION MODE)</b>                 |             |                    |                   |                                                                                                                                                                                                                |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 0.03$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$<br>$V_S = -5.5\text{ V}$ , $V_D = +10.5\text{ V}$ ; or $V_S = +10.5\text{ V}$ , $V_D = -5.5\text{ V}$ ; see Figure 23 |
|                                                          | $\pm 0.1$   | $\pm 2.5$          | $\mu\text{A}$ max |                                                                                                                                                                                                                |
|                                                          | $\pm 8$     |                    | $\mu\text{A}$ typ | $V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$ or $0\text{ V}$                                                                                                                                            |
|                                                          | $\pm 22$    | $\pm 30$           | $\mu\text{A}$ max | $V_S = -5.5\text{ V}$ , $V_D = +10.5\text{ V}$ ; or $V_S = +10.5\text{ V}$ , $V_D = -5.5\text{ V}$ ; see Figure 23                                                                                             |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 0.03$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$<br>$V_S = -5.5\text{ V}$ , $V_D = +10.5\text{ V}$ ; or $V_S = +10.5\text{ V}$ , $V_D = -5.5\text{ V}$ ; see Figure 23 |
|                                                          | $\pm 0.1$   | $\pm 2.5$          | $\mu\text{A}$ max |                                                                                                                                                                                                                |
|                                                          | $\pm 8$     |                    | $\mu\text{A}$ typ | $V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$ or $0\text{ V}$                                                                                                                                            |
|                                                          | $\pm 22$    | $\pm 30$           | $\mu\text{A}$ max | $V_S = -5.5\text{ V}$ , $V_D = +10.5\text{ V}$ ; or $V_S = +10.5\text{ V}$ , $V_D = -5.5\text{ V}$ ; see Figure 23                                                                                             |
| <b>DIGITAL INPUTS</b>                                    |             |                    |                   |                                                                                                                                                                                                                |
| Input High Voltage, $V_{INH}$                            |             | 2.0                | V min             |                                                                                                                                                                                                                |
| Input Low Voltage, $V_{INL}$                             |             | 0.8                | V max             |                                                                                                                                                                                                                |
| Input Current, $I_{INL}$                                 | $\pm 0.015$ |                    | $\mu\text{A}$ typ | $V_{IN} = V_{GND}$                                                                                                                                                                                             |
|                                                          | $\pm 0.1$   | $\pm 0.15$         | $\mu\text{A}$ max |                                                                                                                                                                                                                |
| Input Current, $I_{INH}$                                 | $\pm 13$    |                    | $\mu\text{A}$ typ | $V_{IN} = V_{DD}$                                                                                                                                                                                              |
|                                                          | $\pm 16$    | $\pm 18$           | $\mu\text{A}$ max |                                                                                                                                                                                                                |
| Logic Pull-Down Resistance, $R_{PD}$                     | 400         |                    | k $\Omega$ typ    |                                                                                                                                                                                                                |
| Digital Input Capacitance, $C_{IN}$                      | 4           |                    | pF typ            |                                                                                                                                                                                                                |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>               |             |                    |                   |                                                                                                                                                                                                                |
| $t_{ON}$                                                 | 73          |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                                                                                                                                               |
|                                                          | 125         | 149                | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                                                                                                                                                             |
| $t_{OFF}$                                                | 100         |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                                                                                                                                               |
|                                                          | 125         | 149                | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                                                                                                                                                             |

# ADG4612/ADG4613

| Parameter                                             | 25°C | –40°C to +85°C | Unit              | Test Conditions/Comments                                                                         |
|-------------------------------------------------------|------|----------------|-------------------|--------------------------------------------------------------------------------------------------|
| Break-Before-Make Time Delay, $t_b$<br>(ADG4613 Only) | 20   | 3              | ns typ<br>ns min  | $R_L = 50\ \Omega$ , $C_L = 35\ \text{pF}$<br>$V_{S1} = V_{S2} = 3\ \text{V}$ ; see Figure 26    |
| Fault Response Time                                   | 295  |                | ns typ            | $V_S = 2\ \text{V}$ to $8\ \text{V}$ , $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$               |
| Fault Recovery Time                                   | 1.2  |                | $\mu\text{s}$ typ | $V_S = 2\ \text{V}$ to $8\ \text{V}$ , $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$               |
| Threshold Voltage, $V_T$                              | 1.8  |                | V typ             |                                                                                                  |
| Charge Injection                                      | 225  |                | pC typ            | $V_S = 0\ \text{V}$ , $R_S = 0\ \Omega$ , $C_L = 1\ \text{nF}$ ; see Figure 27                   |
| Off Isolation                                         | –54  |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ; see Figure 28                  |
| Channel-to-Channel Crosstalk                          | –71  |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ; see Figure 29                  |
| Total Harmonic Distortion + Noise, THD + N            | 0.13 |                | % typ             | $R_L = 110\ \Omega$ , $6\ \text{V}$ p-p, $f = 20\ \text{Hz}$ to $20\ \text{kHz}$ ; see Figure 31 |
| Insertion Loss                                        | –0.5 |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; $f = 1\ \text{MHz}$ ; see Figure 30                  |
| –3 dB Bandwidth                                       | 293  |                | MHz typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; see Figure 30                                        |
| $C_S$ (Off)                                           | 13   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| $C_D$ (Off)                                           | 13   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| $C_D$ (On), $C_S$ (On)                                | 50   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| POWER REQUIREMENTS                                    |      |                |                   |                                                                                                  |
| Normal Mode                                           |      |                |                   | Digital inputs = $0\ \text{V}$ or $V_{DD}$                                                       |
| $I_{DD}$                                              | 90   |                | $\mu\text{A}$ typ | $V_{DD} = +5.5\ \text{V}$ , $V_{SS} = -5.5\ \text{V}$                                            |
|                                                       | 140  | 165            | $\mu\text{A}$ max |                                                                                                  |
| $I_{SS}$                                              | 27   |                | $\mu\text{A}$ typ | $V_{DD} = +5.5\ \text{V}$ , $V_{SS} = -5.5\ \text{V}$                                            |
|                                                       | 50   | 58             | $\mu\text{A}$ max |                                                                                                  |
| Isolation Mode                                        |      |                |                   | $V_{DD} = +5.5\ \text{V}$ , $V_{SS} = -5.5\ \text{V}$ or floating                                |
| $I_{DD}$                                              | 90   |                | $\mu\text{A}$ typ | Digital inputs = $0\ \text{V}$ or $5.5\ \text{V}$                                                |
|                                                       | 140  | 165            | $\mu\text{A}$ max | $V_S = -5.5\ \text{V}$ or $+10.5\ \text{V}$                                                      |
|                                                       |      |                |                   | $V_{DD} = 0\ \text{V}$ or floating, $V_{SS} = -5.5\ \text{V}$                                    |
| $I_{SS}$                                              | 0.1  |                | $\mu\text{A}$ typ | Digital inputs = $0\ \text{V}$ or $5.5\ \text{V}$                                                |
|                                                       | 0.2  | 6              | $\mu\text{A}$ max | $V_S = -5.5\ \text{V}$ or $+10.5\ \text{V}$                                                      |

<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 2.**

| Parameter                                                | 25°C        | −40°C to +85°C     | Unit              | Test Conditions/Comments                                                                                                                                                   |
|----------------------------------------------------------|-------------|--------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                     |             |                    |                   |                                                                                                                                                                            |
| Analog Signal Range                                      |             | −5.5 V to $V_{DD}$ | V                 | $V_{DD}$ to $V_{SS} = 16\text{ V}$ maximum                                                                                                                                 |
| On-Resistance ( $R_{ON}$ )                               | 4.5         |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to $+10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 22                                                                                               |
|                                                          | 5.1         | 6.4                | $\Omega$ max      | $V_{DD} = 10.8\text{ V}$ , $V_{SS} = 0\text{ V}$                                                                                                                           |
| On-Resistance Match Between Channels ( $\Delta R_{ON}$ ) | 0.05        |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to $+10\text{ V}$ , $I_S = -10\text{ mA}$                                                                                                               |
|                                                          | 0.15        | 0.18               | $\Omega$ max      |                                                                                                                                                                            |
| On-Resistance Flatness ( $R_{FLAT(ON)}$ )                | 1           |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to $+10\text{ V}$ , $I_S = -10\text{ mA}$                                                                                                               |
|                                                          | 1.25        | 1.6                | $\Omega$ max      |                                                                                                                                                                            |
| <b>LEAKAGE CURRENTS</b>                                  |             |                    |                   |                                                                                                                                                                            |
| <b>Normal Mode</b>                                       |             |                    |                   |                                                                                                                                                                            |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 3$     |                    | nA typ            | $V_{DD} = 13.2\text{ V}$ , $V_{SS} = 0\text{ V}$                                                                                                                           |
|                                                          | $\pm 10$    | $\pm 200$          | nA max            | $V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 23                                                                                            |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 3$     |                    | nA typ            | $V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 23                                                                                            |
|                                                          | $\pm 10$    | $\pm 200$          | nA max            |                                                                                                                                                                            |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)               | $\pm 7$     |                    | nA typ            | $V_S = V_D = 1\text{ V}$ or $10\text{ V}$ ; Figure 24                                                                                                                      |
|                                                          | $\pm 11$    | $\pm 300$          | nA max            |                                                                                                                                                                            |
| <b>Isolation Mode</b>                                    |             |                    |                   |                                                                                                                                                                            |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 0.05$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$                                                                                   |
|                                                          | $\pm 0.3$   | $\pm 3$            | $\mu\text{A}$ max | $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; see Figure 23                                                                                            |
|                                                          | $\pm 10$    |                    | $\mu\text{A}$ typ | $V_{DD} = 13.2\text{ V}$ , $V_{SS} = 0\text{ V}$ , $V_S = 16\text{ V}/1\text{ V}$ , $V_D = 1\text{ V}/16\text{ V}$ ; see Figure 23                                         |
|                                                          | $\pm 28$    | $\pm 38$           | $\mu\text{A}$ max |                                                                                                                                                                            |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 0.05$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$ , $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; see Figure 23 |
|                                                          | $\pm 0.3$   | $\pm 3$            | $\mu\text{A}$ max |                                                                                                                                                                            |
|                                                          | $\pm 10$    |                    | $\mu\text{A}$ typ | $V_{DD} = 13.2\text{ V}$ , $V_{SS} = 0\text{ V}$                                                                                                                           |
|                                                          | $\pm 28$    | $\pm 38$           | $\mu\text{A}$ max | $V_S = 16\text{ V}/1\text{ V}$ , $V_D = 1\text{ V}/16\text{ V}$ ; see Figure 23                                                                                            |
| <b>DIGITAL INPUTS</b>                                    |             |                    |                   |                                                                                                                                                                            |
| Input High Voltage, $V_{INH}$                            |             | 2.0                | V min             |                                                                                                                                                                            |
| Input Low Voltage, $V_{INL}$                             |             | 0.8                | V max             |                                                                                                                                                                            |
| Input Current, $I_{INL}$                                 | $\pm 0.015$ |                    | $\mu\text{A}$ typ | $V_{IN} = V_{GND}$                                                                                                                                                         |
|                                                          | $\pm 0.1$   | $\pm 0.15$         | $\mu\text{A}$ max |                                                                                                                                                                            |
| Input Current, $I_{INH}$                                 | $\pm 13$    |                    | $\mu\text{A}$ typ | $V_{IN} = 5\text{ V}$                                                                                                                                                      |
|                                                          | $\pm 16$    | $\pm 18$           | $\mu\text{A}$ max |                                                                                                                                                                            |
| Input Current, $I_{INH}$                                 | $\pm 34$    |                    | $\mu\text{A}$ typ | $V_{IN} = V_{DD}$                                                                                                                                                          |
|                                                          | $\pm 40$    | $\pm 42$           | $\mu\text{A}$ max |                                                                                                                                                                            |
| Logic Pull-Down Resistance, $R_{PD}$                     | 400         |                    | k $\Omega$ typ    |                                                                                                                                                                            |
| Digital Input Capacitance, $C_{IN}$                      | 4           |                    | pF typ            |                                                                                                                                                                            |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>               |             |                    |                   |                                                                                                                                                                            |
| $t_{ON}$                                                 | 46          |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                                                                                                           |
|                                                          | 73          | 90                 | ns max            | $V_S = 8\text{ V}$ ; see Figure 25                                                                                                                                         |
| $t_{OFF}$                                                | 70          |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                                                                                                           |
|                                                          | 91          | 103                | ns max            | $V_S = 8\text{ V}$ ; see Figure 25                                                                                                                                         |

# ADG4612/ADG4613

| Parameter                                             | 25°C  | –40°C to +85°C | Unit              | Test Conditions/Comments                                                                         |
|-------------------------------------------------------|-------|----------------|-------------------|--------------------------------------------------------------------------------------------------|
| Break-Before-Make Time Delay, $t_D$<br>(ADG4613 Only) | 17    | 11             | ns typ<br>ns min  | $R_L = 50\ \Omega$ , $C_L = 35\ \text{pF}$<br>$V_{S1} = V_{S2} = 8\ \text{V}$ ; see Figure 26    |
| Fault Response Time                                   | 250   |                | ns typ            | $V_S = 9\ \text{V}$ to $15\ \text{V}$ , $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$              |
| Fault Recovery Time                                   | 1.4   |                | $\mu\text{s}$ typ | $V_S = 9\ \text{V}$ to $15\ \text{V}$ , $R_L = 300\ \Omega$ , $C_L = 35\ \text{pF}$              |
| Threshold Voltage, $V_T$                              | 1.8   |                | V typ             |                                                                                                  |
| Charge Injection                                      | 292   |                | pC typ            | $V_S = 6\ \text{V}$ , $R_S = 0\ \Omega$ , $C_L = 1\ \text{nF}$ ; see Figure 27                   |
| Off Isolation                                         | –56   |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ; see Figure 28                  |
| Channel-to-Channel Crosstalk                          | –74   |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 1\ \text{MHz}$ ; see Figure 29                  |
| Total Harmonic Distortion + Noise, THD + N            | 0.26  |                | % typ             | $R_L = 110\ \Omega$ , $6\ \text{V}$ p-p, $f = 20\ \text{Hz}$ to $20\ \text{kHz}$ ; see Figure 31 |
| Insertion Loss                                        | –0.27 |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; $f = 1\ \text{MHz}$ ; see Figure 30                  |
| –3 dB Bandwidth                                       | 250   |                | MHz typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; see Figure 30                                        |
| $C_S$ (Off)                                           | 11.5  |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| $C_D$ (Off)                                           | 11.5  |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| $C_D$ (On), $C_S$ (On)                                | 48    |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                        |
| <b>POWER REQUIREMENTS</b>                             |       |                |                   |                                                                                                  |
| Normal Mode                                           |       |                |                   | $V_{DD} = 13.2\ \text{V}$ , $V_{SS} = 0\ \text{V}$                                               |
| $I_{DD}$                                              | 90    |                | $\mu\text{A}$ typ | Digital inputs = $0\ \text{V}$ or $V_{DD}$                                                       |
|                                                       | 140   | 165            | $\mu\text{A}$ max |                                                                                                  |
| $I_{DD}$                                              | 600   |                | $\mu\text{A}$ typ | Digital inputs = $5\ \text{V}$                                                                   |
|                                                       | 660   | 900            | $\mu\text{A}$ max |                                                                                                  |
| Isolation Mode                                        |       |                |                   | $V_{DD} = 13.2\ \text{V}$ , $V_{SS} = 0\ \text{V}$ or floating                                   |
| $I_{DD}$                                              | 90    |                | $\mu\text{A}$ typ | $V_S = 16\ \text{V}$ or $1\ \text{V}$                                                            |
|                                                       | 140   | 165            | $\mu\text{A}$ max | Digital inputs = $0\ \text{V}$ or $V_{DD}$                                                       |

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

**5 V SINGLE SUPPLY**

$V_{DD} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ ,  $GND = 0\text{ V}$ , unless otherwise noted.

**Table 3.**

| Parameter                                                | 25°C        | –40°C to +85°C     | Unit              | Test Conditions/Comments                                                                 |
|----------------------------------------------------------|-------------|--------------------|-------------------|------------------------------------------------------------------------------------------|
| <b>ANALOG SWITCH</b>                                     |             |                    |                   |                                                                                          |
| Analog Signal Range                                      |             | –5.5 V to $V_{DD}$ | V                 | $V_{DD}$ to $V_{SS} = 16\text{ V}$ maximum                                               |
| On-Resistance ( $R_{ON}$ )                               | 12.5        |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to +4.5 V, $I_S = -10\text{ mA}$ ; see Figure 22                      |
|                                                          | 14.7        | 17                 | $\Omega$ max      | $V_{DD} = 4.5\text{ V}$ , $V_{SS} = 0\text{ V}$ ,                                        |
| On-Resistance Match Between Channels ( $\Delta R_{ON}$ ) | 0.15        |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to +4.5 V, $I_S = -10\text{ mA}$                                      |
|                                                          | 0.5         | 0.6                | $\Omega$ max      |                                                                                          |
| On-Resistance Flatness ( $R_{FLAT(ON)}$ )                | 6.2         |                    | $\Omega$ typ      | $V_S = 0\text{ V}$ to +4.5 V, $I_S = -10\text{ mA}$                                      |
|                                                          | 8           | 8.9                | $\Omega$ max      |                                                                                          |
| <b>LEAKAGE CURRENTS</b>                                  |             |                    |                   |                                                                                          |
| <b>Normal Mode</b>                                       |             |                    |                   |                                                                                          |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 0.8$   |                    | nA typ            | $V_{DD} = 5.5\text{ V}$ , $V_{SS} = 0\text{ V}$                                          |
|                                                          | $\pm 3$     | $\pm 80$           | nA max            | $V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$ ; see Figure 23        |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 0.8$   |                    | nA typ            | $V_S = 1\text{ V}/4.5\text{ V}$ , $V_D = 4.5\text{ V}/1\text{ V}$ ; see Figure 23        |
|                                                          | $\pm 3$     | $\pm 80$           | nA max            |                                                                                          |
| Channel On Leakage, $I_D$ (On), $I_S$ (On)               | $\pm 2$     |                    | nA typ            | $V_S = V_D = 1\text{ V}$ or 4.5 V; see Figure 24                                         |
|                                                          | $\pm 5$     | $\pm 120$          | nA max            |                                                                                          |
| <b>Isolation Mode</b>                                    |             |                    |                   |                                                                                          |
| Source Off Leakage, $I_S$ (Off)                          | $\pm 0.05$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$ |
|                                                          | $\pm 0.15$  | $\pm 3$            | $\mu\text{A}$ max | $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; see Figure 23          |
|                                                          | $\pm 10$    |                    | $\mu\text{A}$ typ | $V_{DD} = 5.5\text{ V}$ , $V_{SS} = 0\text{ V}$                                          |
|                                                          | $\pm 28$    | $\pm 38$           | $\mu\text{A}$ max | $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; Figure 23              |
| Drain Off Leakage, $I_D$ (Off)                           | $\pm 0.05$  |                    | $\mu\text{A}$ typ | $V_{DD} = 0\text{ V}$ or floating, $V_{SS} = 0\text{ V}$ or floating, $GND = 0\text{ V}$ |
|                                                          | $\pm 0.15$  | $\pm 3$            | $\mu\text{A}$ max | $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; see Figure 23          |
|                                                          | $\pm 10$    |                    | $\mu\text{A}$ typ | $V_{DD} = 5.5\text{ V}$ , $V_{SS} = 0\text{ V}$                                          |
|                                                          | $\pm 28$    | $\pm 38$           | $\mu\text{A}$ max | $V_S = 1\text{ V}/16\text{ V}$ , $V_D = 16\text{ V}/1\text{ V}$ ; see Figure 23          |
| <b>DIGITAL INPUTS</b>                                    |             |                    |                   |                                                                                          |
| Input High Voltage, $V_{INH}$                            |             | 2.0                | V min             |                                                                                          |
| Input Low Voltage, $V_{INL}$                             |             | 0.8                | V max             |                                                                                          |
| Input Current, $I_{INL}$                                 | $\pm 0.015$ |                    | $\mu\text{A}$ typ | $V_{IN} = V_{GND}$                                                                       |
|                                                          | $\pm 0.1$   | $\pm 0.15$         | $\mu\text{A}$ max |                                                                                          |
| Input Current, $I_{INH}$                                 | $\pm 13$    |                    | $\mu\text{A}$ typ | $V_{IN} = V_{DD}$                                                                        |
|                                                          | $\pm 16$    | $\pm 18$           | $\mu\text{A}$ max |                                                                                          |
| Logic Pull-Down Resistance, $R_{PD}$                     | 400         |                    | k $\Omega$ typ    |                                                                                          |
| Digital Input Capacitance, $C_{IN}$                      | 4           |                    | pF typ            |                                                                                          |
| <b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>               |             |                    |                   |                                                                                          |
| $t_{ON}$                                                 | 116         |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                         |
|                                                          | 190         | 226                | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                                       |
| $t_{OFF}$                                                | 87          |                    | ns typ            | $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$                                         |
|                                                          | 120         | 136                | ns max            | $V_S = 3\text{ V}$ ; see Figure 25                                                       |
| Break-Before-Make Time Delay, $t_D$<br>(ADG4613 Only)    | 70          |                    | ns typ            | $R_L = 50\text{ }\Omega$ , $C_L = 35\text{ pF}$                                          |
|                                                          |             | 32                 | ns min            | $V_{S1} = V_{S2} = 3\text{ V}$ ; see Figure 26                                           |
| Fault Response Time                                      | 240         |                    | ns typ            | $V_S = 2\text{ V}$ to 8 V, $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$              |
| Fault Recovery Time                                      | 1.2         |                    | $\mu\text{s}$ typ | $V_S = 2\text{ V}$ to 8 V, $R_L = 300\text{ }\Omega$ , $C_L = 35\text{ pF}$              |
| Threshold Voltage, $V_T$                                 | 1.8         |                    | V typ             |                                                                                          |
| Charge Injection                                         | 75          |                    | pC typ            | $V_S = 0\text{ V}$ , $R_S = 0\text{ }\Omega$ , $C_L = 1\text{ nF}$ ; see Figure 27       |
| Off Isolation                                            | –54         |                    | dB typ            | $R_L = 50\text{ }\Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; see Figure 28    |

# ADG4612/ADG4613

| Parameter                                  | 25°C | –40°C to +85°C | Unit              | Test Conditions/Comments                                                                                 |
|--------------------------------------------|------|----------------|-------------------|----------------------------------------------------------------------------------------------------------|
| Channel-to-Channel Crosstalk               | –71  |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ , $f = 100\ \text{kHz}$ ; see Figure 29                        |
| Total Harmonic Distortion + Noise, THD + N | 0.85 |                | % typ             | $R_L = 110\ \Omega$ , $f = 20\ \text{Hz to } 20\ \text{kHz}$ , $V_S = 3.5\ \text{V p-p}$ ; see Figure 31 |
| Insertion Loss                             | –0.5 |                | dB typ            | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; $f = 1\ \text{MHz}$ ; see Figure 30                          |
| –3 dB Bandwidth                            | 293  |                | MHz typ           | $R_L = 50\ \Omega$ , $C_L = 5\ \text{pF}$ ; see Figure 30                                                |
| $C_S$ (Off)                                | 14   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                |
| $C_D$ (Off)                                | 14   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                |
| $C_D$ (On), $C_S$ (On)                     | 50   |                | pF typ            | $V_S = 0\ \text{V}$ , $f = 1\ \text{MHz}$                                                                |
| <b>POWER REQUIREMENTS</b>                  |      |                |                   |                                                                                                          |
| Normal Mode                                |      |                |                   | $V_{DD} = 5.5\ \text{V}$ , $V_{SS} = 0\ \text{V}$                                                        |
| $I_{DD}$                                   | 90   |                | $\mu\text{A typ}$ | Digital inputs = 0 V or $V_{DD}$                                                                         |
|                                            | 140  | 165            | $\mu\text{A max}$ |                                                                                                          |
| Isolation Mode                             |      |                |                   | $V_{DD} = 5.5\ \text{V}$ , $V_{SS} = 0\ \text{V}$ or floating                                            |
| $I_{DD}$                                   | 90   |                | $\mu\text{A typ}$ | Digital inputs = 0 V or 5.5 V                                                                            |
|                                            | 140  | 165            | $\mu\text{A max}$ | $V_S = 1\ \text{V}/16\ \text{V}$ , $V_D = 16\ \text{V}/1\ \text{V}$                                      |

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

## CONTINUOUS CURRENT PER CHANNEL, SX OR DX

Table 4.

| Parameter                                         | 25°C | 85°C | Unit       |
|---------------------------------------------------|------|------|------------|
| <b>CONTINUOUS CURRENT, Sx OR Dx</b>               |      |      |            |
| $V_{DD} = +5\ \text{V}$ , $V_{SS} = -5\ \text{V}$ |      |      |            |
| TSSOP ( $\theta_{JA} = 112^\circ\text{C/W}$ )     | 109  | 52   | mA maximum |
| LFCSP ( $\theta_{JA} = 48.7^\circ\text{C/W}$ )    | 160  | 83   | mA maximum |
| $V_{DD} = 12\ \text{V}$ , $V_{SS} = 0\ \text{V}$  |      |      |            |
| TSSOP ( $\theta_{JA} = 112^\circ\text{C/W}$ )     | 113  | 56   | mA maximum |
| LFCSP ( $\theta_{JA} = 48.7^\circ\text{C/W}$ )    | 175  | 87   | mA maximum |
| $V_{DD} = 5\ \text{V}$ , $V_{SS} = 0\ \text{V}$   |      |      |            |
| TSSOP ( $\theta_{JA} = 112^\circ\text{C/W}$ )     | 78   | 39   | mA maximum |
| LFCSP ( $\theta_{JA} = 48.7^\circ\text{C/W}$ )    | 118  | 56   | mA maximum |

## POWER SUPPLY OPERATION

Temperature range is  $-40^\circ\text{C}$  to  $+105^\circ\text{C}$ , unless otherwise noted.

Table 5.

| Parameter                          | Min  | Max      | Unit | Comments                                                                                                                 |
|------------------------------------|------|----------|------|--------------------------------------------------------------------------------------------------------------------------|
| <b>POWER SUPPLY</b>                |      |          |      |                                                                                                                          |
| $V_{DD}$ to $V_{SS}$               |      | 16       | V    | GND = 0 V                                                                                                                |
| $V_{DD}$                           | 2.7  | 16       | V    | GND = 0 V                                                                                                                |
| $V_{SS}$                           | –5.5 | 0        | V    | GND = 0 V                                                                                                                |
| <b>DUAL SUPPLY</b>                 |      |          |      |                                                                                                                          |
| $V_{SS}/V_{DD}$                    | –5.5 | +10.5    | V    | $V_{DD}$ to $V_{SS} = 16\ \text{V}$ , GND = 0 V                                                                          |
| <b>SINGLE SUPPLY</b>               |      |          |      |                                                                                                                          |
| $V_{DD}$                           | 0    | 16       | V    | $V_{DD}$ to $V_{SS} = 16\ \text{V}$ , GND = 0 V, $V_{SS} = 0\ \text{V}$                                                  |
| Analog Signal Range, $V_D$ , $V_S$ |      |          |      |                                                                                                                          |
| Normal Mode                        | –5.5 | $V_{DD}$ | V    | $V_{DD}$ to $V_{SS} = 16\ \text{V}$ maximum                                                                              |
| Isolation Mode                     | –5.5 | +16      | V    | Most negative ( $V_S$ , $V_D$ , or $V_{SS}$ ) to most positive ( $V_S$ , $V_D$ , $I_{nx}$ , or $V_{DD}$ ) = 16 V maximum |

## ABSOLUTE MAXIMUM RATINGS

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

**Table 6.**

| Parameter                                                                                                  | Rating                                         |
|------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| $V_{DD}$ to $V_{SS}$                                                                                       | 18 V                                           |
| $V_{DD}$ to GND                                                                                            | −0.3 V to +18 V                                |
| $V_{SS}$ to GND                                                                                            | +0.3 V to −7 V                                 |
| Analog Inputs; $V_S$ to $V_D$                                                                              | 18 V                                           |
| Analog Inputs; $V_D$ , $V_S$                                                                               | −7 V to +18 V                                  |
| Most Negative ( $V_S$ , $V_D$ or $V_{SS}$ ) to<br>Most Positive ( $V_S$ , $V_D$ , $I_{NX}$ , or $V_{DD}$ ) | 18 V                                           |
| Digital Inputs, $I_{NX}$                                                                                   | GND − 0.3 V to +18 V                           |
| Peak Current, $S_x$ or $D_x$                                                                               | 350 mA (pulsed at 1 ms,<br>10% duty cycle max) |
| Continuous Current, $S_x$ or $D_x$ <sup>1</sup>                                                            | Data + 15%                                     |
| Operating Temperature Range                                                                                | −40°C to +105°C                                |
| Storage Temperature Range                                                                                  | −65°C to +150°C                                |
| Junction Temperature                                                                                       | 150°C                                          |
| Reflow Soldering Peak<br>Temperature, Pb-free                                                              | 260 (0/−5)°C                                   |

<sup>1</sup> See Table 4.

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 listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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

### THERMAL RESISTANCE

$\theta_{JA}$  is specified for a 4-layer board and, where applicable, with the exposed pad soldered to the board.

**Table 7. Thermal Resistance**

| Package Type  | $\theta_{JA}$ | Unit |
|---------------|---------------|------|
| 16-Lead TSSOP | 112           | °C/W |
| 16-Lead LFCSP | 48.7          | °C/W |

### 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.

# ADG4612/ADG4613

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

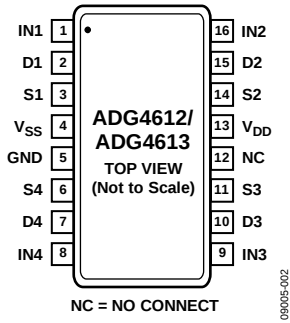
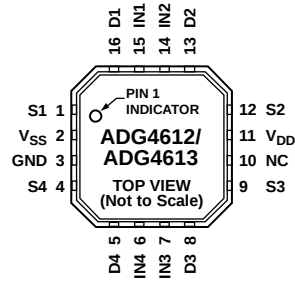


Figure 2. TSSOP Pin Configuration



- NOTES
1. EXPOSED PAD TIED TO SUBSTRATE, GND.
  2. NC = NO CONNECT.

Figure 3. LFCSP Pin Configuration

Table 8. Pin Function Descriptions

| Pin No. |       | Mnemonic        | Description                                                                                                                                                                                                                                                                                                                                                  |
|---------|-------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSSOP   | LFCSP |                 |                                                                                                                                                                                                                                                                                                                                                              |
| 1       | 15    | IN1             | Logic Control Input 1. This pin has an internal 400 k $\Omega$ pull-down resistor to GND.                                                                                                                                                                                                                                                                    |
| 2       | 16    | D1              | Drain Terminal 1. Can be an input or output.                                                                                                                                                                                                                                                                                                                 |
| 3       | 1     | S1              | Source Terminal 1. Can be an input or output.                                                                                                                                                                                                                                                                                                                |
| 4       | 2     | V <sub>SS</sub> | Most Negative Power Supply Potential.                                                                                                                                                                                                                                                                                                                        |
| 5       | 3     | GND             | Ground (0 V) Reference.                                                                                                                                                                                                                                                                                                                                      |
| 6       | 4     | S4              | Source Terminal 4. Can be an input or output.                                                                                                                                                                                                                                                                                                                |
| 7       | 5     | D4              | Drain Terminal 4. Can be an input or output.                                                                                                                                                                                                                                                                                                                 |
| 8       | 6     | IN4             | Logic Control Input 4. This pin has an internal 400 k $\Omega$ pull-down resistor to GND.                                                                                                                                                                                                                                                                    |
| 9       | 7     | IN3             | Logic Control Input 3. This pin has an internal 400 k $\Omega$ pull-down resistor to GND.                                                                                                                                                                                                                                                                    |
| 10      | 8     | D3              | Drain Terminal 3. Can be an input or output.                                                                                                                                                                                                                                                                                                                 |
| 11      | 9     | S3              | Source Terminal 3. Can be an input or output.                                                                                                                                                                                                                                                                                                                |
| 12      | 10    | NC              | No Connection.                                                                                                                                                                                                                                                                                                                                               |
| 13      | 11    | V <sub>DD</sub> | Most Positive Power Supply Potential.                                                                                                                                                                                                                                                                                                                        |
| 14      | 12    | S2              | Source Terminal 2. Can be an input or output.                                                                                                                                                                                                                                                                                                                |
| 15      | 13    | D2              | Drain Terminal 2. Can be an input or output.                                                                                                                                                                                                                                                                                                                 |
| 16      | 14    | IN2             | Logic Control Input 2. This pin has an internal 400 k $\Omega$ pull-down resistor to GND.                                                                                                                                                                                                                                                                    |
| N/A     | 0     | EPAD            | The exposed pad is connected to the substrate GND. For best heat dissipation, it is recommended that this pad be connected to GND. If heat dissipation is not a concern, it is possible to leave the pad floating. Connecting the exposed pad to V <sub>SS</sub> (if V <sub>SS</sub> is not equal to GND) can cause current to flow and can damage the part. |

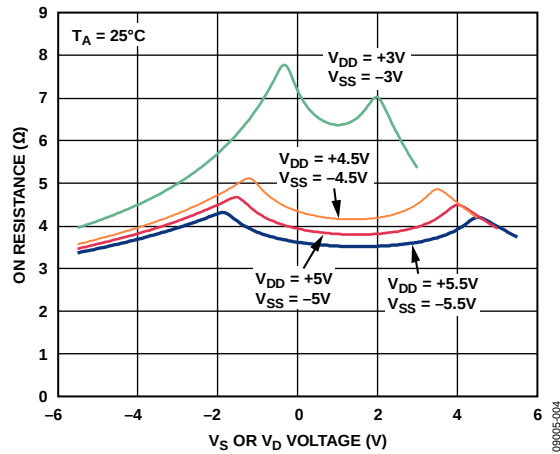
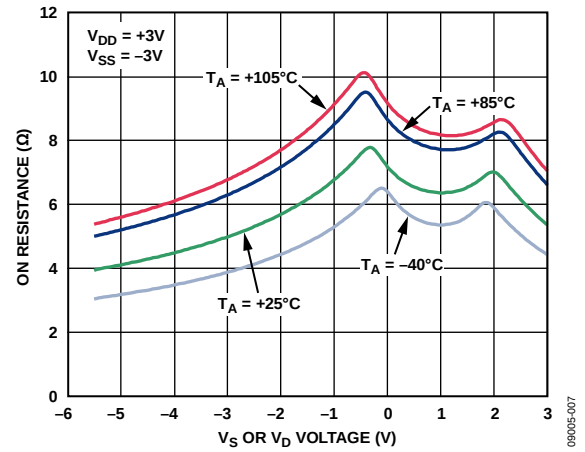
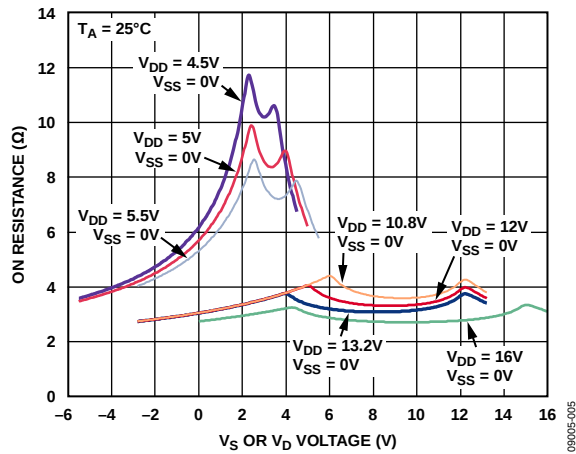
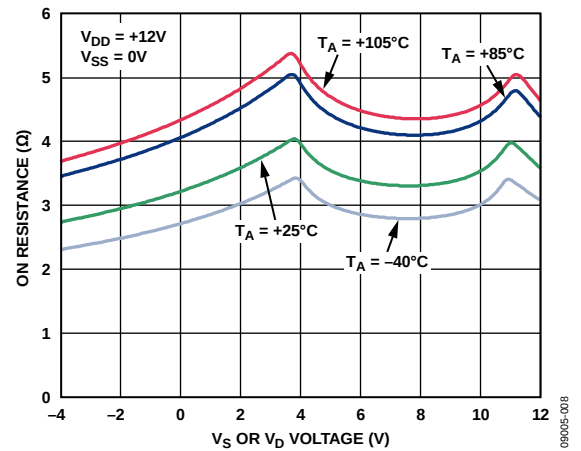
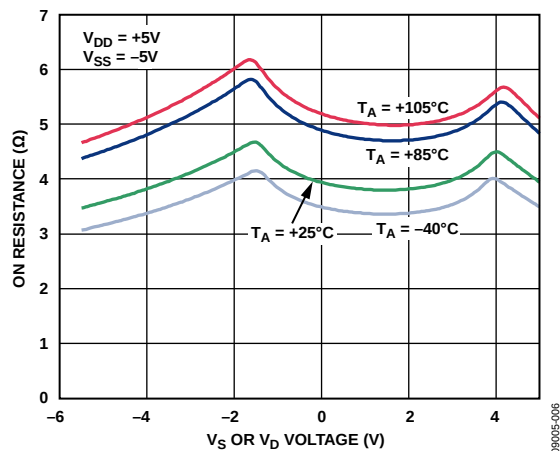
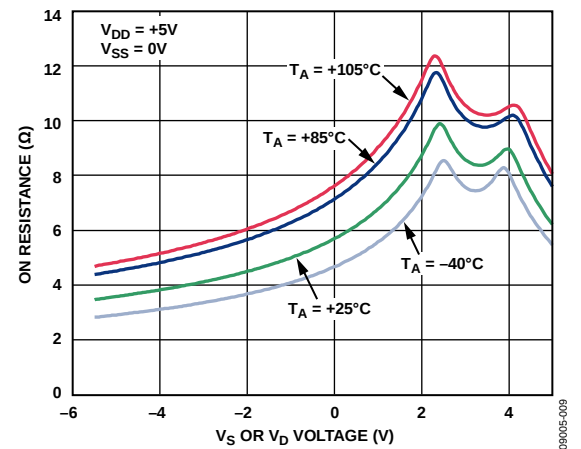
Table 9. ADG4612 Truth Table

| ADG4612 INx | Switch Condition |
|-------------|------------------|
| 1           | On               |
| 0           | Off              |

Table 10. ADG4613 Truth Table

| ADG4613 INx | S1, S4 | S2, S3 |
|-------------|--------|--------|
| 0           | Off    | On     |
| 1           | On     | Off    |

## TYPICAL PERFORMANCE CHARACTERISTICS

Figure 4. On Resistance as a Function of  $V_S$ ,  $V_D$  (Dual Supply)Figure 7. On Resistance as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 3 V Dual SupplyFigure 5. On Resistance as a Function of  $V_S$ ,  $V_D$  (Single Supply)Figure 8. On Resistance as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 12 V Single SupplyFigure 6. On Resistance as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 5 V Dual SupplyFigure 9. On Resistance as a Function of  $V_S$ ,  $V_D$  for Different Temperatures, 5 V Single Supply

# ADG4612/ADG4613

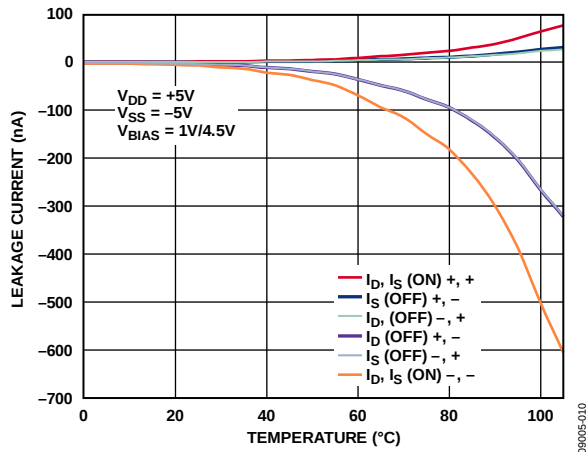


Figure 10. Leakage Currents as a Function of Temperature, 5 V Dual Supply

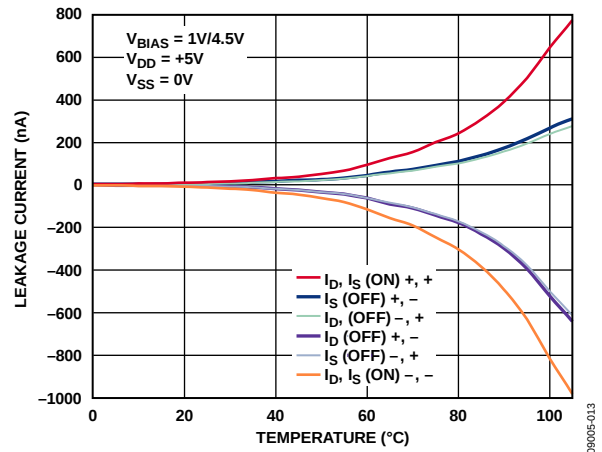


Figure 13. Leakage Currents as a Function of Temperature, 5 V Single Supply

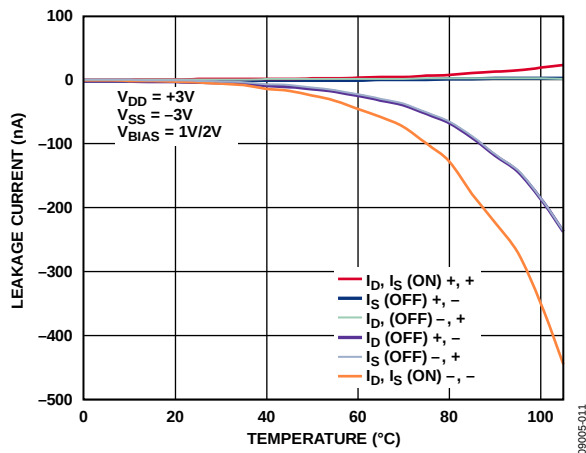


Figure 11. Leakage Currents as a Function of Temperature, 3 V Dual Supply

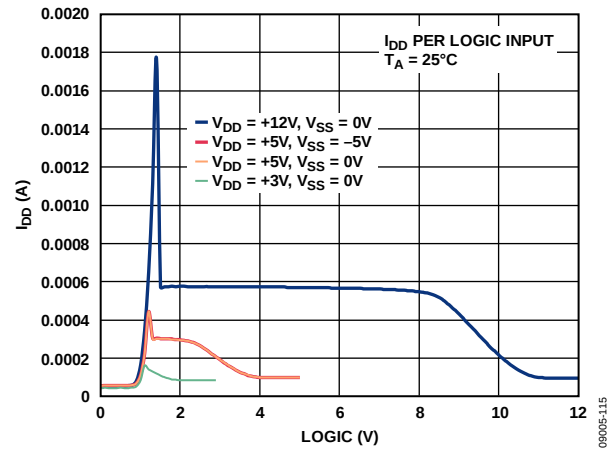


Figure 14.  $I_{DD}$  vs. Logic Level

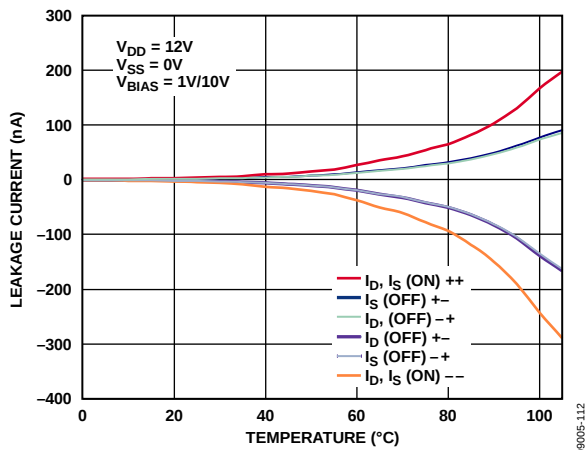


Figure 12. Leakage Currents as a Function of Temperature, 12 V Single Supply

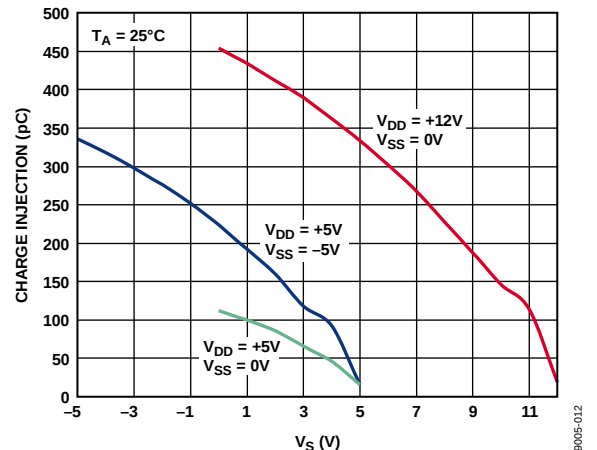


Figure 15. Charge Injection vs. Source Voltage

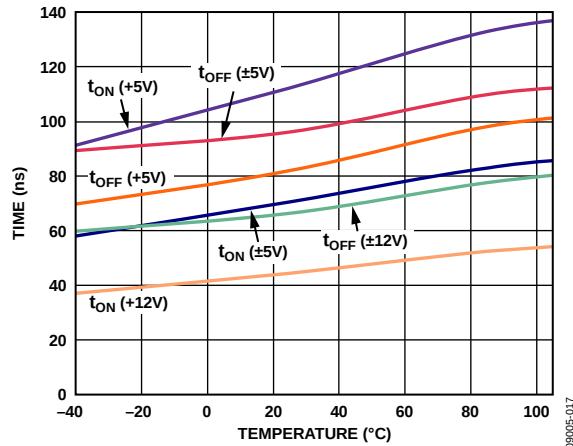


Figure 16.  $t_{ON}/t_{OFF}$  Times vs. Temperature

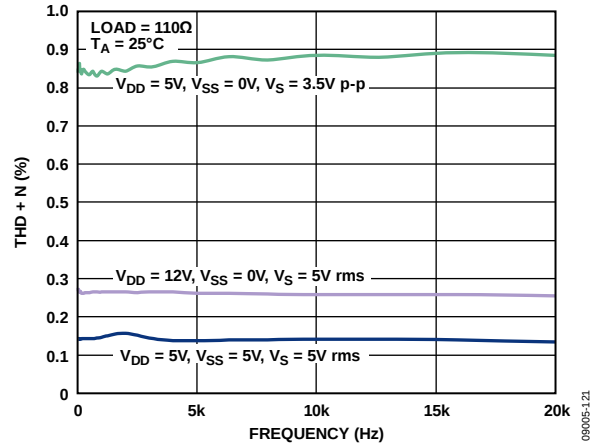


Figure 19. THD + N vs. Frequency

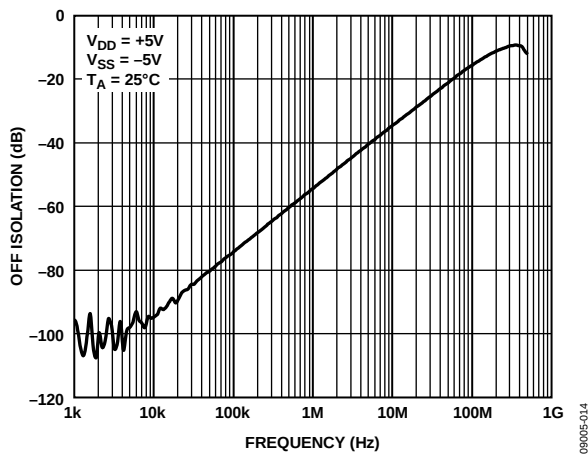


Figure 17. Off Isolation vs. Frequency

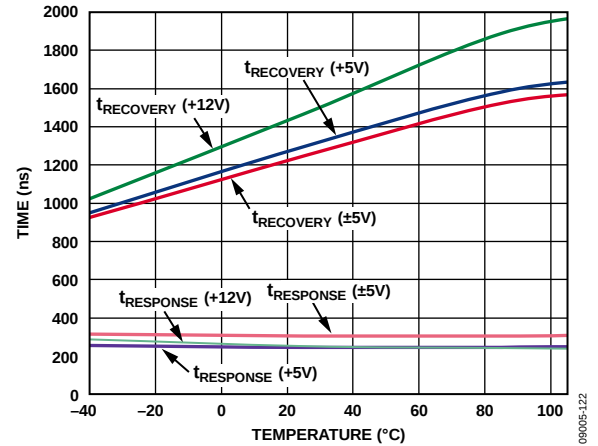


Figure 20. Fault Response Time/Fault Recovery Time

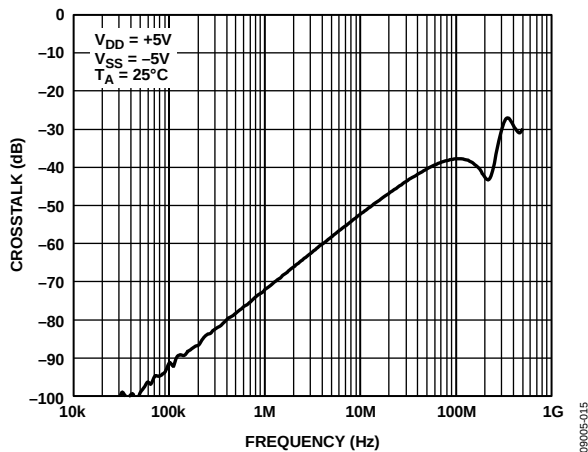


Figure 18. Crosstalk vs. Frequency

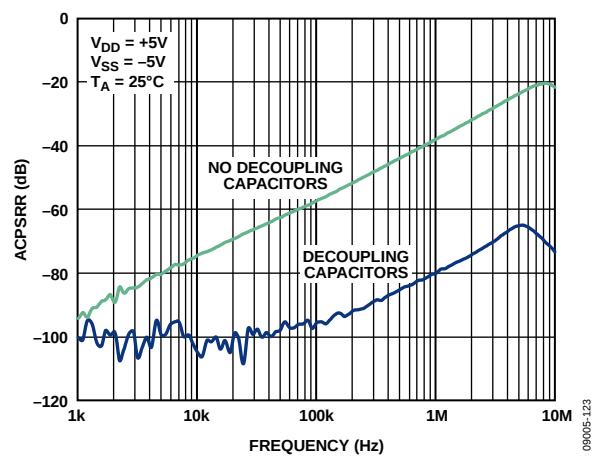


Figure 21. ACPSRR vs. Frequency

## TEST CIRCUITS

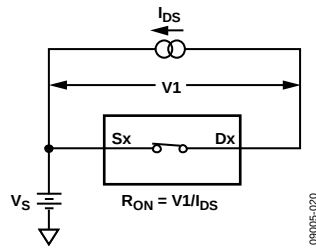


Figure 22. On Resistance

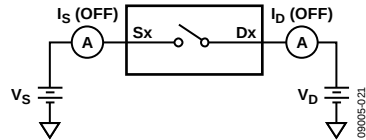


Figure 23. Off Leakage

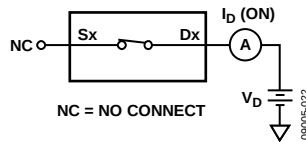


Figure 24. On Leakage

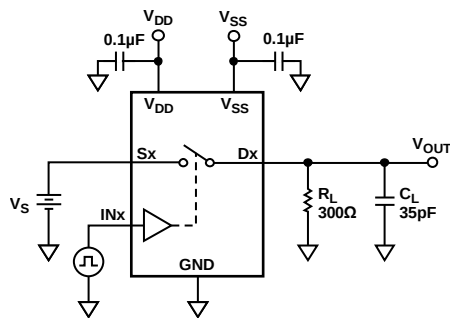


Figure 25. Switching Times

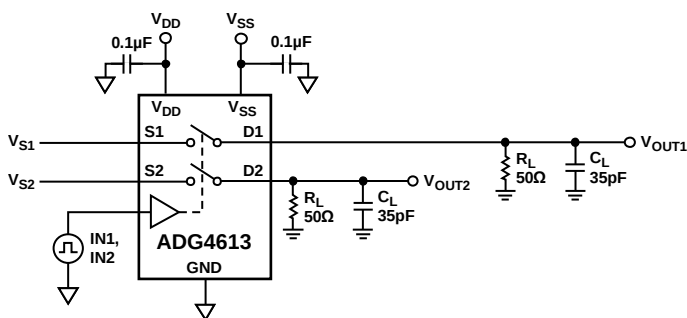


Figure 26. Break-Before-Make Time Delay,  $t_D$

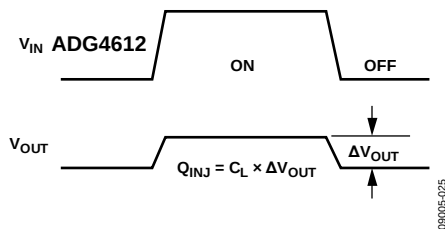
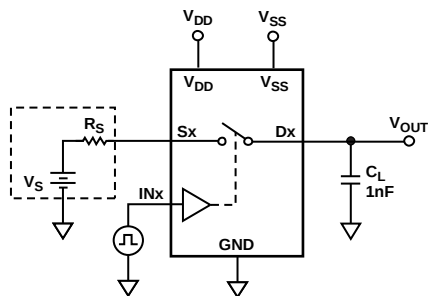


Figure 27. Charge Injection

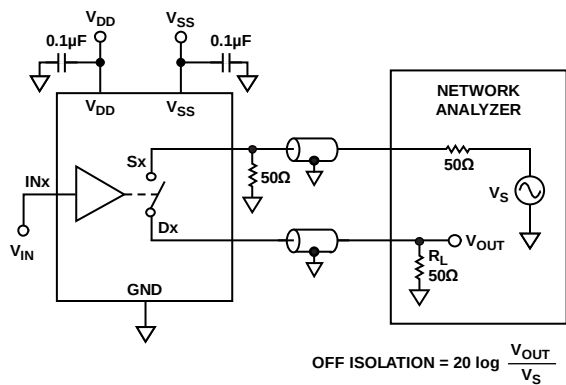


Figure 28. Off Isolation

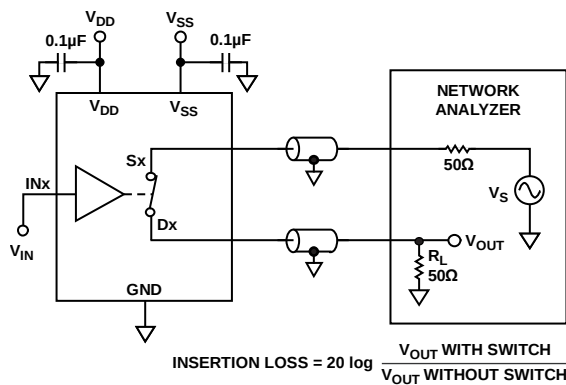


Figure 30. Bandwidth

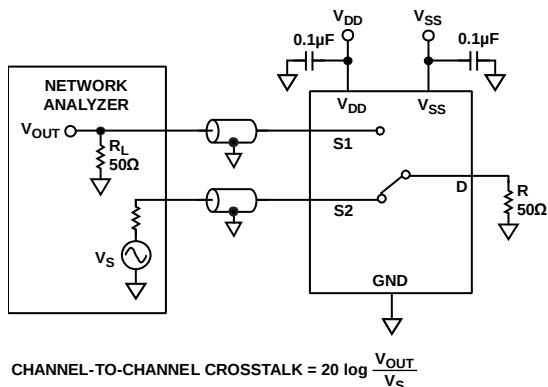


Figure 29. Channel-to-Channel Crosstalk

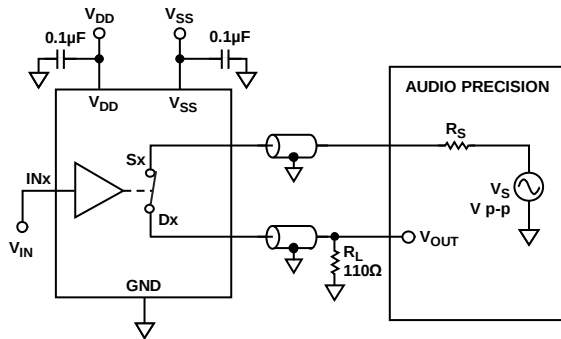


Figure 31. THD + Noise

## 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> represents 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>**

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

**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> is the digital input capacitance.

**t<sub>ON</sub>**

t<sub>ON</sub> represents the delay between applying the digital control input and the output switching on.

**t<sub>OFF</sub>**

t<sub>OFF</sub> represents the delay between applying the digital control input and the output switching off.

**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.

**Fault Response Time**

Fault response time is the delay between a fault condition (V<sub>S</sub> > V<sub>DD</sub>) on an analog input and the corresponding output below V<sub>DD</sub>.

**Fault Recovery Time**

Fault recovery time is, in recovering from a fault condition, the delay between 50% of the input signal to 90% of the output signal.

**Charge Injection**

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

**Off Isolation**

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

**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.

**Insertion Loss**

Insertion loss is the loss due to the on resistance of the switch.

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

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

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

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

## THEORY OF OPERATION

The ADG4612/ADG4613 contain four independent single-pole/single-throw (SPST) switches. Each switch is rail-to-rail and conducts equally well in both directions when on.

The ADG4612/ADG4613 has two modes of operation: normal mode and isolation mode.

The operation modes are made possible by a special detection circuitry that monitors the voltage levels at the source or drain terminals and  $V_{DD}$  relative to ground. Depending on these voltage levels, the device operates in normal mode or isolation mode accordingly.

Isolation mode is a useful feature that isolates the inputs from the outputs where input signals may be present before supplies or during positive fault conditions that can occur in applications.

### Normal Mode

In normal mode, the switch functions as a normal  $4 \times$  SPST switch, whereby the switch is controlled by the logic input pins, IN1 to IN4.

The following three conditions need to be satisfied for the switch to be in the on condition;

- $V_{DD} \geq 2.7$  V; and
- Input signal,  $V_S, V_D < V_{DD} + V_T$ ; and
- Logic input, INx set to on level

When the switch is in the on condition, if the signal range is from  $V_{DD}$  to  $-5.5$  V, the signals present on the switch inputs are passed through to the switch output. If the analog input exceeds

$V_{DD}$  by a threshold voltage,  $V_T$ , the switch turns off and is in isolation mode.

If the analog input signal exceeds the negative supply,  $V_{SS}$ , when the switch is off, the switch blocks a signal up to  $-5.5$  V. If the switch is on, the switch remains on, and this signal is passed to the output. See the Negative Fault Condition; Negative Signal Handling section for more details.

### Isolation Mode

In isolation mode, all switches are in the off condition. The switch inputs are isolated from the switch outputs. The switch inputs are high impedance inputs with greater than  $475$  k $\Omega$  impedance to  $V_{DD}$  ground and across the switch. This prevents any current from flowing that can damage the switch. This is very useful in applications where analog signals may be present at the switch inputs before power is present or where the user has no control over the power supply sequence.

The switch is in isolation mode when

- No power supplies are present, that is, when  $V_{DD}$  is floating or  $V_{DD} \leq 1$  V; or
- Input signal,  $V_S, V_D > V_{DD} + V_T$

The negative supply rail,  $V_{SS}$ , can be floating or  $0$  V to  $-5.5$  V. The ground pin must be connected to the ground potential.

**Table 11. Switch Operation Mode**

| $V_{DD}$                      | $V_{SS}$ <sup>1</sup> | GND | $V_S, V_D$<br>(Input Voltage, Sx or Dx)  | Switch Condition                                 | Switch Mode |
|-------------------------------|-----------------------|-----|------------------------------------------|--------------------------------------------------|-------------|
| Floating                      | X                     | 0 V | $-5.5$ V to $+10.5$ V<br>$0$ V to $16$ V | All switches off<br>Inputs isolated from outputs | Isolation   |
| $0$ V to $0.8$ V              | X                     | 0 V | $-5.5$ V to $+10.5$ V<br>$0$ V to $16$ V | All switches off<br>Inputs isolated from outputs | Isolation   |
| $V_{DD} \geq 2.7$ V           | X                     | 0 V | $V_S, V_D > V_{DD} + V_T$                | All switches off<br>Inputs isolated from outputs | Isolation   |
| $V_{DD} \geq 2.7$ V to $16$ V | $0$ V to $-5.5$ V     | 0 V | $V_{DD}$ to $V_{DD} - 16$ V              | Switch state is determined by logic levels, INx  | Normal      |

<sup>1</sup> X = don't care; for example, floating,  $0$  V to  $-5.5$  V.

## BIPOLAR OPERATION AND SINGLE-SUPPLY OPERATION

The ADG4612/ADG4613 have a maximum operational range from  $V_{DD}$  to  $V_{SS}$  of 16 V. The maximum signal range from source to drain,  $V_S$  to  $V_D$ , is also 16 V. During operation of the device, the signal range can exceed the power supply rails, but the voltage between the most negative voltage on the device ( $V_S$ ,  $V_D$  or  $V_{SS}$ ) should be within 16 V of the most positive voltage ( $V_S$ ,  $V_D$ ,  $IN_X$ , or  $V_{DD}$ ). These voltage ratings should be adhered to at all times for guaranteed functionality. See Table 5 for guaranteed supply ranges. Signal ranges and power supply ranges exceeding 16 V may affect the long-term reliability of the device.

The ground pin must always be connected to the GND potential to ensure proper functionality in isolation and normal operation mode.

The minimum  $V_{DD}$  voltage that the part is guaranteed operational is 2.7 V. The maximum recommended  $V_{DD}$  voltage is 16 V.

The minimum supply voltage recommended on  $V_{SS}$  is  $-5.5$  V, and the maximum voltage allowable on  $V_{SS}$  is 0 V. Therefore, given that the  $V_{DD}$  to  $V_{SS}$  range is 16 V maximum when,  $V_{SS} = -5.5$  V, the  $V_{DD} = +10.5$  V maximum.

### Positive Fault Condition

If the analog input exceeds  $V_{DD}$  by a threshold voltage,  $V_T$ , then the switch turns off and is in isolation mode. The part can handle a fault of up to 16 V, referenced to the most negative signal. For example, if  $V_{DD} = 5$  V,  $V_{SS} = 0$  V, then the switch protects against an overvoltage of up to 16 V. If  $V_{SS} = -5$  V and  $V_{DD} = +5$  V, then the switch protects against an overvoltage of up to  $+11$  V.

### Negative Fault Condition; Negative Signal Handling

The ADG4612/ADG4613 are not damaged if the analog inputs exceed the negative supply,  $V_{SS}$ . If the switch is in the off condition, the switch blocks a signal up to  $-5.5$  V. If the switch is in the on condition, the switch remains on, and the negative signal is passed to the output; therefore, the ADG4612/ADG4613 can pass a negative signal up to  $-5.5$  V with  $V_{SS} = 0$  V. The user must ensure that the downstream circuitry can handle this signal level. Also, the user should ensure the voltage between the most negative voltage on the device ( $V_S$ ,  $V_D$  or  $V_{SS}$ ) is within 16 V of the most positive voltage ( $V_S$ ,  $V_D$ ,  $IN_X$ , or  $V_{DD}$ ).

## APPLICATIONS INFORMATION

There are many application scenarios that benefit from the functionality offered on the ADG4612/ADG4613 switches.

The ADG4612/ADG4613 offer power-off protection, ensuring the switch is guaranteed off and inputs are high impedance with no power supplies present. This isolation mode is a useful feature that isolates the inputs from the outputs where input signals may be present before supplies. The isolation mode also protects the system against positive fault conditions that can occur in applications, ensuring that the switch turns off and protects downstream circuitry. For example, a module can be connected to a live backplane, supplying signals to the board before supplies are present. This is common in hot swap applications where a card could be hot plugged in a shelf where there are others cards already working and powered on.

The ADG4612/ADG4613 allow negative signals, down to  $-5.5\text{ V}$  to be passed without a negative supply. This can be very useful in applications that need to pass negative signals but do not have a negative supply available. This cannot be done with conventional CMOS switches because ESD protection diodes turn on and clamp the signals.

Theses features ensure the system is very robust to power supply sequencing issues that can be present in conventional CMOS devices.

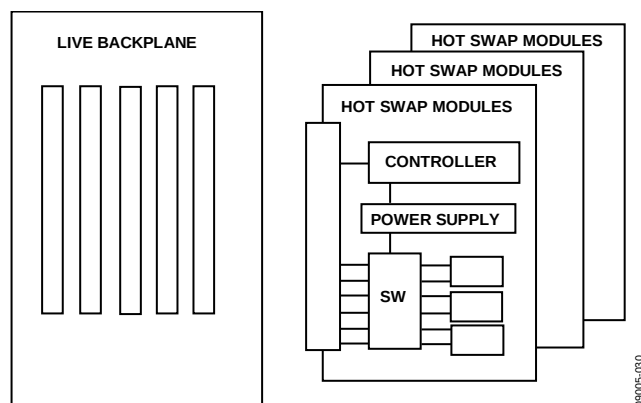


Figure 32. Typical Application

### Signals on Inputs with No Power Present

In conventional CMOS switches, ESD protection diodes can be found on the analog and digital inputs to  $V_{DD}$  and GND or  $V_{SS}$  (see Figure 33, for example). If an input voltage is present on the switch inputs with no power supplies applied, current can flow through the ESD protection diodes. If this current is not limited to a safe level, it is possible to damage the ESD protection diodes and, hence, the switch. Input signals may pass through the switch to the output affecting downstream circuitry. The user may also be exceeding the absolute maximum ratings of the devices, and, therefore, affecting the long-term reliability of the device.

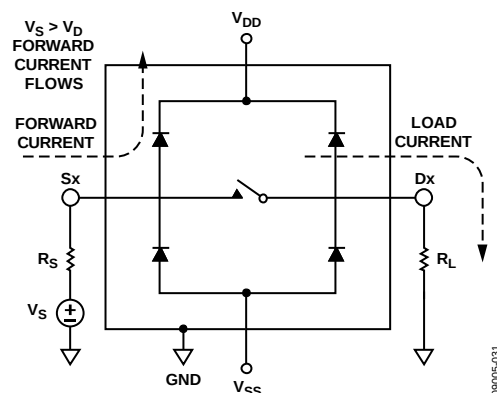


Figure 33. ESD Protection Diodes on Conventional CMOS Switch

Some users add external diodes or add current-limiting resistors to protect the device against the conditions shown in Figure 33. However, these solutions all have disadvantages in that they add extra board area, extra component count, and cost. The system level performance can also be affected by the higher on resistance from the current-limiting resistors or the higher leakage from external Schottky diodes. Using external diodes for protection still creates the problem where a floating  $V_{DD}$  line can be pulled up to a diode drop from the input signal.

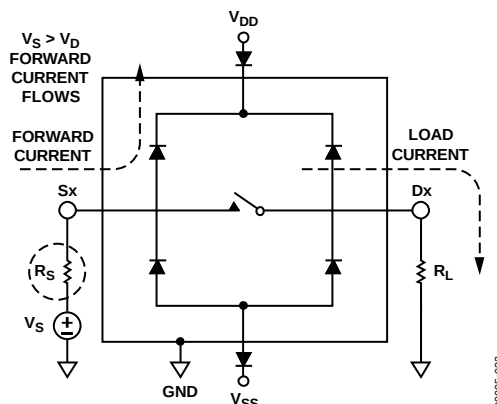


Figure 34. External Protection Added to Protect Switch Against Damage If Signals Present on Inputs Without Power Supplies

The ADG4612/ADG4613 eliminate the concerns shown in Figure 34. There are no internal ESD diodes from the analog or digital inputs to  $V_{DD}$  or  $V_{SS}$ . If signals are present on the ADG4612/ADG4613 inputs before power is present, the switch is in isolation mode, which means that the inputs have high impedance to  $V_{DD}$ , GND, and the output. This prevents current flow and protects the device from damage.

## ADG4612/ADG4613

### **Power Supply Sequencing**

Another benefit of the ADG4612/ADG4613 is it eliminates concerns about the power supply sequence. The part can be powered up in any sequence without damage. For devices with conventional CMOS switches, it is recommend that power supplies are powered up before analog or digital inputs are present. The ADG4612/ADG4613 do not have any power supply sequencing requirements, thereby making them a very robust design. However, a ground must first be present for the device to function in isolation mode and normal mode.

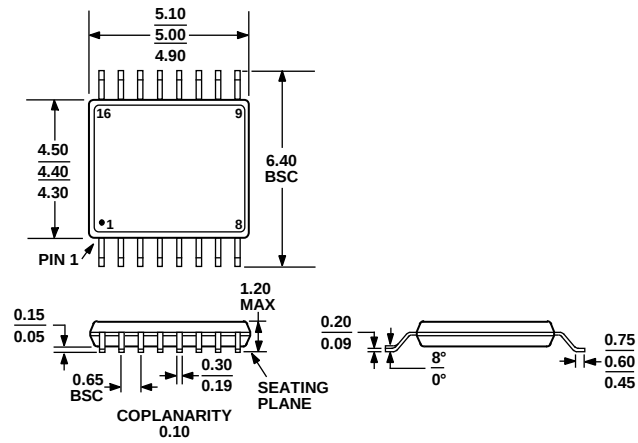
### **V<sub>DD</sub> Supply**

Another area of concern with conventional CMOS switches that have analog signals present before the part is powered up is that the V<sub>DD</sub> supply can be pulled up through the internal ESD

protection diodes. The V<sub>DD</sub> supply normally gets pulled up to the input voltage level minus a diode drop,  $V_{DD} \sim V_S, V_D - V_{DIODE}$ . This voltage can be high enough to power up other chips that are connected to this supply rail in a system, potentially damaging other components in that system.

The ADG4612/ADG4613 architecture ensures that the V<sub>DD</sub> supply is isolated from the analog inputs, thereby preventing the supplies from being pulled to a higher potential when a signal is present on the inputs without any power having been applied.

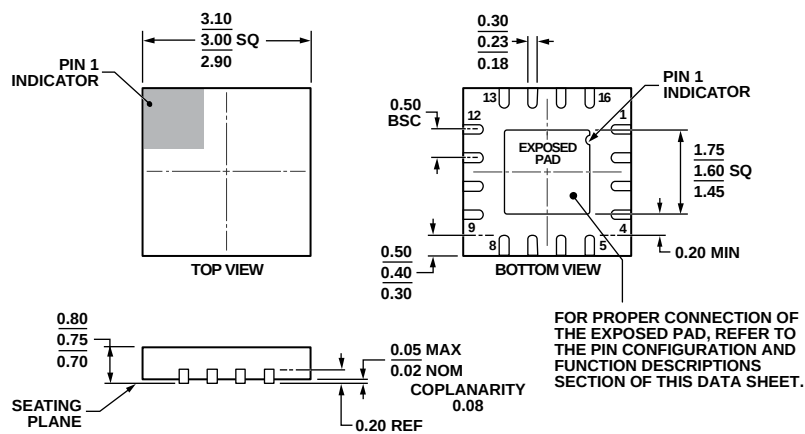
## OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

Figure 35. 16-Lead Thin Shrink Small Outline Package [TSSOP]  
(RU-16)

Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-WEED-6.

Figure 36. 16-Lead Lead Frame Chip Scale Package [LFCSP\_WQ]  
3 mm x 3 mm Body, Very Thin Quad  
(CP-16-22)

Dimensions shown in millimeters

01-13-2010-D

# ADG4612/ADG4613

## ORDERING GUIDE

| Model <sup>1</sup> | Temperature Range | Package Description                       | Package Option | Branding |
|--------------------|-------------------|-------------------------------------------|----------------|----------|
| ADG4612BRUZ        | –40°C to +105°C   | Thin Shrink Small Outline Package [TSSOP] | RU-16          | LG5      |
| ADG4612BRUZ-REEL7  | –40°C to +105°C   | Thin Shrink Small Outline Package [TSSOP] | RU-16          |          |
| ADG4612BCPZ-REEL7  | –40°C to +105°C   | Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-16-22       |          |
| EVAL-ADG4612EBZ    |                   | Evaluation Board                          |                |          |
| ADG4613BRUZ        | –40°C to +105°C   | Thin Shrink Small Outline Package [TSSOP] | RU-16          | S3Y      |
| ADG4613BRUZ-REEL7  | –40°C to +105°C   | Thin Shrink Small Outline Package [TSSOP] | RU-16          |          |
| ADG4613BCPZ-REEL7  | –40°C to +105°C   | Lead Frame Chip Scale Package [LFCSP_WQ]  | CP-16-22       |          |

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

NOTES

## NOTES