

ADG1211/ADG1212/ADG1213

FEATURES

- 1 pF off capacitance
- 2.6 pF on capacitance
- <1 pC charge injection
- 33 V supply range
- 120 Ω on resistance
- Fully specified at ± 15 V, $+12$ V
- No V_L supply required
- 3 V logic-compatible inputs
- Rail-to-rail operation
- 16-lead TSSOP and 16-lead LFCSP
- Typical power consumption: <0.03 μ W

APPLICATIONS

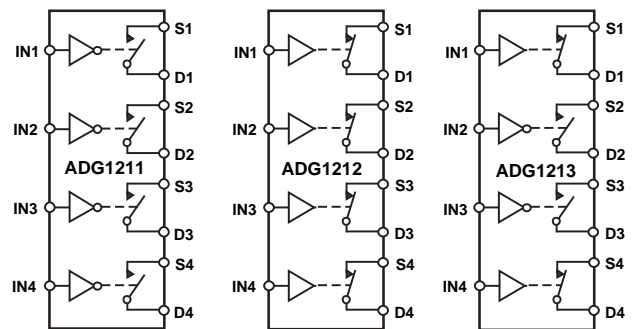
- Automatic test equipment
- Data acquisition systems
- Battery-powered systems
- Sample-and-hold systems
- Audio signal routing
- Video signal routing
- Communication systems

GENERAL DESCRIPTION

The ADG1211/ADG1212/ADG1213 are monolithic complementary metal-oxide semiconductor (CMOS) devices containing four independently selectable switches designed on an *i*CMOS (industrial CMOS) process. *i*CMOS is a modular manufacturing process combining high voltage CMOS and bipolar technologies. It enables the development of a wide range of high performance analog ICs capable of 33 V operation in a footprint that no previous generation of high voltage parts has been able to achieve. Unlike analog ICs using conventional CMOS processes, *i*CMOS components can tolerate high supply voltages while providing increased performance, dramatically lower power consumption, and reduced package size.

The ultralow capacitance and charge injection of these switches make them ideal solutions for data acquisition and sample-and-hold applications, where low glitch and fast settling are required. Fast switching speed coupled with high signal bandwidth make the parts suitable for video signal switching.

FUNCTIONAL BLOCK DIAGRAM



SWITCHES SHOWN FOR A LOGIC 1 INPUT

Figure 1.

*i*CMOS construction ensures ultralow power dissipation, making the parts ideally suited for portable and battery-powered instruments.

The ADG1211/ADG1212/ADG1213 contain four independent single-pole/single-throw (SPST) switches. The ADG1211 and ADG1212 differ only in that the digital control logic is inverted. The ADG1211 switches are turned on with Logic 0 on the appropriate control input, while Logic 1 is required for the ADG1212. The ADG1213 has two switches with digital control logic similar to that of the ADG1211; the logic is inverted on the other two switches. The ADG1213 exhibits break-before-make switching action for use in multiplexer applications.

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

PRODUCT HIGHLIGHTS

1. Ultralow capacitance.
2. <1 pC charge injection.
3. 3 V logic-compatible digital inputs: $V_{IH} = 2.0$ V, $V_{IL} = 0.8$ V.
4. No V_L logic power supply required.
5. Ultralow power dissipation: <0.03 μ W.
6. 16-lead TSSOP and 3 mm \times 3 mm LFCSP packages.

Rev. 0

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REVISION HISTORY

7/05—Revision 0: Initial Version

SPECIFICATIONS

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 | Y Version ¹ | | | Unit | Test Conditions/Comments |
|---|------------------------|----------------|------------------------------------|---------|--|
| | 25°C | –40°C to +85°C | –40°C to +125°C | | |
| ANALOG SWITCH | | | | | |
| Analog Signal Range | | | V _{DD} to V _{SS} | V | |
| On Resistance (R _{ON}) | 120 | | | Ω typ | V _S = ±10 V, I _S = –1 mA; Figure 20 |
| | 190 | 230 | 260 | Ω max | V _{DD} = +13.5 V, V _{SS} = –13.5 V |
| On Resistance Match Between Channels (ΔR _{ON}) | 2.5 | | | Ω typ | V _S = ±10 V, I _S = –1 mA |
| | 6 | 10 | 11 | Ω max | |
| On Resistance Flatness (R _{FLAT(ON)}) | 20 | | | Ω typ | V _S = –5 V/0 V/+5 V; I _S = –1 mA |
| | 57 | 72 | 79 | Ω max | |
| LEAKAGE CURRENTS | | | | | |
| Source Off Leakage, I _S (Off) | ±0.02 | | | nA typ | V _{DD} = +16.5 V, V _{SS} = –16.5 V |
| | ±0.1 | ±0.6 | ±1 | nA max | V _S = ±10 V, V _D = ∓10 V; Figure 21 |
| Drain Off Leakage, I _D (Off) | ±0.02 | | | nA typ | V _S = ±10 V, V _D = ∓10 V; Figure 21 |
| | ±0.1 | ±0.6 | ±1 | nA max | |
| Channel On Leakage, I _D , I _S (On) | ±0.02 | | | nA typ | V _S = V _D = ±10 V; Figure 22 |
| | ±0.1 | ±0.6 | ±1 | nA max | |
| DIGITAL INPUTS | | | | | |
| Input High Voltage, V _{INH} | | | 2.0 | V min | |
| Input Low Voltage, V _{INL} | | | 0.8 | V max | |
| Input Current, I _{INL} or I _{INH} | 0.005 | | | μA typ | V _{IN} = V _{INL} or V _{INH} |
| | | | ±0.1 | μA max | |
| Digital Input Capacitance, C _{IN} | 2.5 | | | pF typ | |
| DYNAMIC CHARACTERISTICS ² | | | | | |
| t _{ON} | 105 | | | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | 125 | 160 | 185 | ns max | V _S = 10 V; Figure 23 |
| t _{OFF} | 40 | | | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | 50 | 60 | 60 | ns max | V _S = 10 V; Figure 23 |
| Break-Before-Make Time Delay, t _D (ADG1213 Only) | 25 | | 10 | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | | | | ns min | V _{S1} = V _{S2} = 10 V; Figure 24 |
| Charge Injection | –0.3 | | | pC typ | V _S = 0 V, R _S = 0 Ω, C _L = 1 nF; Figure 25 |
| Off Isolation | 80 | | | dB typ | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Figure 26 |
| Channel-to-Channel Crosstalk | 90 | | | dB typ | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Figure 27 |
| Total Harmonic Distortion + Noise | 0.15 | | | % typ | R _L = 10 kΩ, 5 V rms, f = 20 Hz to 20 kHz |
| –3 dB Bandwidth | 1000 | | | MHz typ | R _L = 50 Ω, C _L = 5 pF; Figure 28 |
| C _S (Off) | 0.9 | | | pF typ | V _S = 0 V, f = 1 MHz |
| | 1.1 | | | pF max | V _S = 0 V, f = 1 MHz |
| C _D (Off) | 1 | | | pF typ | V _S = 0 V, f = 1 MHz |
| | 1.2 | | | pF max | V _S = 0 V, f = 1 MHz |
| C _D , C _S (On) | 2.6 | | | pF typ | V _S = 0 V, f = 1 MHz |
| | 3 | | | pF max | V _S = 0 V, f = 1 MHz |

ADG1211/ADG1212/ADG1213

| Parameter | Y Version ¹ | | | Unit | Test Conditions/Comments |
|--------------------|------------------------|----------------|-----------------|--|---|
| | 25°C | –40°C to +85°C | –40°C to +125°C | | |
| POWER REQUIREMENTS | | | | | $V_{DD} = +16.5\text{ V}$, $V_{SS} = -16.5\text{ V}$ |
| I_{DD} | 0.001 | | 1.0 | $\mu\text{A typ}$ $\mu\text{A max}$ | Digital inputs = 0 V or V_{DD} |
| I_{DD} | 220 | | 320 | $\mu\text{A typ}$ $\mu\text{A max}$ | Digital inputs = 5 V |
| I_{SS} | 0.001 | | 1.0 | $\mu\text{A typ}$ $\mu\text{A max}$ | Digital inputs = 0 V or V_{DD} |
| I_{SS} | 0.001 | | 1.0 | $\mu\text{A typ}$ $\mu\text{A max}$ | Digital inputs = 5 V |

¹ Temperature range for Y version is –40°C to +125°C.

² Guaranteed by design, not subject to production test.

SINGLE SUPPLY

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

Table 2.

| Parameter | Y Version ¹ | | | Unit | Test Conditions/Comments |
|---|------------------------|----------------|------------------------|---------|--|
| | 25°C | –40°C to +85°C | –40°C to +125°C | | |
| ANALOG SWITCH | | | | | |
| Analog Signal Range | | | 0 V to V _{DD} | V | |
| On Resistance (R _{ON}) | 300 | | | Ω typ | V _S = 0 V to 10 V, I _S = –1 mA; Figure 20 |
| | 475 | 567 | 625 | Ω max | V _{DD} = 10.8 V, V _{SS} = 0 V |
| On Resistance Match Between Channels (ΔR _{ON}) | 4.5 | | | Ω typ | V _S = 0 V to 10 V, I _S = –1 mA |
| | 12 | 26 | 27 | Ω max | |
| On Resistance Flatness (R _{FLAT(ON)}) | 60 | | | Ω typ | V _S = 3 V/6 V/9 V, I _S = –1 mA |
| LEAKAGE CURRENTS | | | | | |
| Source Off Leakage, I _S (Off) | ±0.02 | | | nA typ | V _{DD} = 13.2 V, V _{SS} = 0 V |
| | ±0.1 | ±0.6 | ±1 | nA max | V _S = 1 V/10 V, V _D = 10 V/1 V; Figure 21 |
| Drain Off Leakage, I _D (Off) | ±0.02 | | | nA typ | V _S = 1 V/10 V, V _D = 10 V/1 V; Figure 21 |
| | ±0.1 | ±0.6 | ±1 | nA max | |
| Channel On Leakage, I _D , I _S (On) | ±0.02 | | | nA typ | V _S = V _D = 1 V or 10 V; Figure 22 |
| | ±0.1 | ±0.6 | ±1 | nA max | |
| DIGITAL INPUTS | | | | | |
| Input High Voltage, V _{INH} | | | 2.0 | V min | |
| Input Low Voltage, V _{INL} | | | 0.8 | V max | |
| Input Current, I _{INL} or I _{INH} | 0.001 | | | μA typ | V _{IN} = V _{INL} or V _{INH} |
| | | | ±0.1 | μA max | |
| Digital Input Capacitance, C _{IN} | 3 | | | pF typ | |
| DYNAMIC CHARACTERISTICS ² | | | | | |
| t _{ON} | 120 | | | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | 155 | 190 | 225 | ns max | V _S = 8 V; Figure 23 |
| t _{OFF} | 45 | | | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | 65 | 75 | 85 | ns max | V _S = 8 V; Figure 23 |
| Break-Before-Make Time Delay, t _D (ADG1213 Only) | 50 | | 10 | ns typ | R _L = 300 Ω, C _L = 35 pF |
| | | | | ns min | V _{S1} = V _{S2} = 8 V; Figure 24 |
| Charge Injection | 0 | | | pC typ | V _S = 6 V, R _S = 0 Ω, C _L = 1 nF; Figure 25 |
| Off Isolation | 80 | | | dB typ | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Figure 26 |
| Channel-to-Channel Crosstalk | 90 | | | dB typ | R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Figure 27 |
| –3 dB Bandwidth | 900 | | | MHz typ | R _L = 50 Ω, C _L = 5 pF; Figure 28 |
| C _S (Off) | 1.2 | | | pF typ | V _S = 6 V, f = 1 MHz |
| | 1.4 | | | pF max | V _S = 6 V, f = 1 MHz |
| C _D (Off) | 1.3 | | | pF typ | V _S = 6 V, f = 1 MHz |
| | 1.5 | | | pF max | V _S = 6 V, f = 1 MHz |
| C _D , C _S (On) | 3.2 | | | pF typ | V _S = 6 V, f = 1 MHz |
| | 3.9 | | | pF max | V _S = 6 V, f = 1 MHz |
| POWER REQUIREMENTS | | | | | |
| I _{DD} | 0.001 | | | μA typ | V _{DD} = 13.2 V |
| | | | 1.0 | μA max | Digital inputs = 0 V or V _{DD} |
| I _{DD} | 220 | | | μA typ | Digital inputs = 5 V |
| | | | 320 | μA max | |

¹ Temperature range for Y version is –40°C to +125°C.

² Guaranteed by design, not subject to production test.

ADG1211/ADG1212/ADG1213

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 3.

| Parameter | Rating |
|---|--|
| V _{DD} to V _{SS} | 35 V |
| V _{DD} to GND | −0.3 V to +25 V |
| V _{SS} to GND | +0.3 V to −25 V |
| Analog Inputs ¹ | V _{SS} − 0.3 V to V _{DD} + 0.3 V or 30 mA, whichever occurs first |
| Digital Inputs ¹ | GND − 0.3 V to V _{DD} + 0.3 V or 30 mA, whichever occurs first |
| Peak Current, S or D | 100 mA (pulsed at 1 ms, 10% duty cycle max) |
| Continuous Current per Channel, S or D | 25 mA |
| Operating Temperature Range Automotive (Y Version) | −40°C to +125°C |
| Storage Temperature Range | −65°C to +150°C |
| Junction Temperature | 150°C |
| 16-Lead TSSOP, θ _{JA} Thermal Impedance (4-Layer Board) | 112°C/W |
| 16-Lead LFCSP, θ _{JA} Thermal Impedance | 72.7°C/W |
| Reflow Soldering Peak Temperature, Pb free | 260°C |

¹ Overvoltages at IN, S, or D are clamped by internal diodes. Current should be limited to the maximum ratings given.

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 may be applied at any one time.

Table 4. ADG1211/ADG1212 Truth Table

| ADG1211 INx | ADG1212 INx | Switch Condition |
|-------------|-------------|------------------|
| 0 | 1 | On |
| 1 | 0 | Off |

Table 5. ADG1213 Truth Table

| ADG1213 INx | Switch 1, 4 | Switch 2, 3 |
|-------------|-------------|-------------|
| 0 | Off | On |
| 1 | On | Off |

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

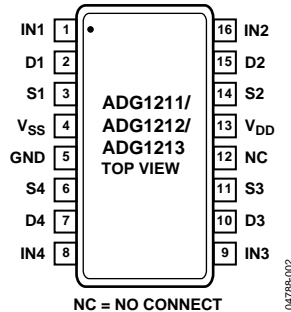
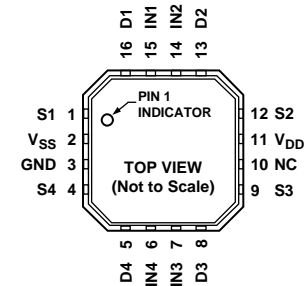


Figure 2. TSSOP Pin Configuration

ADG1211/ADG1212/ADG1213



NOTES

1. EXPOSED PAD TIED TO SUBSTRATE, V_{SS} .

Figure 3. LFCSP Pin Configuration

Table 6. Pin Function Descriptions

| Pin No. | | Mnemonic | Description |
|---------|-------|----------|---|
| TSSOP | LFCSP | | |
| 1 | 15 | IN1 | Logic Control Input. |
| 2 | 16 | D1 | Drain Terminal. Can be an input or output. |
| 3 | 1 | S1 | Source Terminal. Can be an input or output. |
| 4 | 2 | V_{SS} | Most Negative Power Supply Potential. |
| 5 | 3 | GND | Ground (0 V) Reference. |
| 6 | 4 | S4 | Source Terminal. Can be an input or output. |
| 7 | 5 | D4 | Drain Terminal. Can be an input or output. |
| 8 | 6 | IN4 | Logic Control Input. |
| 9 | 7 | IN3 | Logic Control Input. |
| 10 | 8 | D3 | Drain Terminal. Can be an input or output. |
| 11 | 9 | S3 | Source Terminal. Can be an input or output. |
| 12 | 10 | NC | No Connection. |
| 13 | 11 | V_{DD} | Most Positive Power Supply Potential. |
| 14 | 12 | S2 | Source Terminal. Can be an input or output. |
| 15 | 13 | D2 | Drain Terminal. Can be an input or output. |
| 16 | 14 | IN2 | Logic Control Input. |

TERMINOLOGY

I_{DD}

The positive supply current.

I_{SS}

The negative supply current.

V_D (V_S)

The analog voltage on Terminals D and S.

R_{ON}

The ohmic resistance between D and S.

R_{FLAT(ON)}

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

I_S (Off)

The source leakage current with the switch off.

I_D (Off)

The drain leakage current with the switch off.

I_D, I_S (On)

The channel leakage current with the switch on.

V_{INL}

The maximum input voltage for Logic 0.

V_{INH}

The minimum input voltage for Logic 1.

I_{INL} (I_{INH})

The input current of the digital input.

C_S (Off)

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

C_D (Off)

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

C_D, C_S (On)

The on switch capacitance, measured with reference to ground.

C_{IN}

The digital input capacitance.

t_{ON}

The delay between applying the digital control input and the output switching on. See Figure 23.

t_{OFF}

The delay between applying the digital control input and the output switching off. See Figure 23.

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.

THD + N

The ratio of the harmonic amplitude plus noise of the signal to the fundamental.

TYPICAL PERFORMANCE CHARACTERISTICS

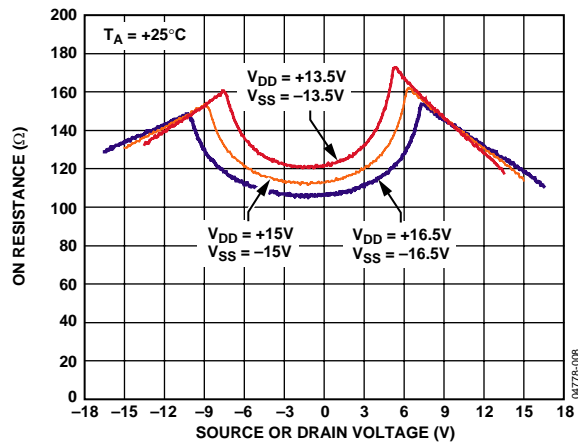


Figure 4. On Resistance as a Function of V_D (V_S) for Dual Supply

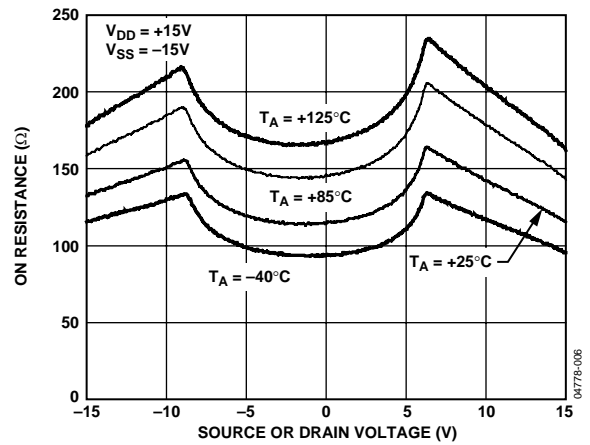


Figure 7. On Resistance as a Function of V_D (V_S) for Different Temperatures, Dual Supply

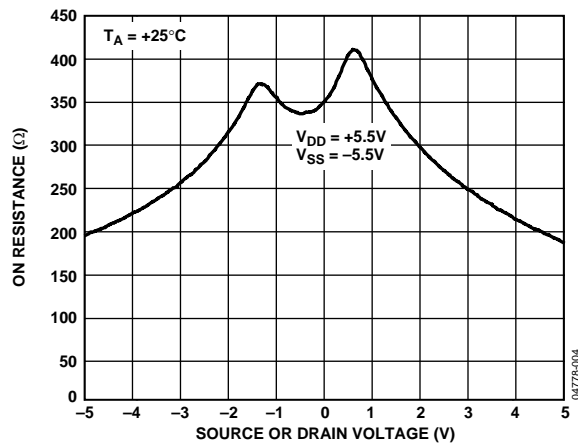


Figure 5. On Resistance as a Function of V_D (V_S) for Dual Supply

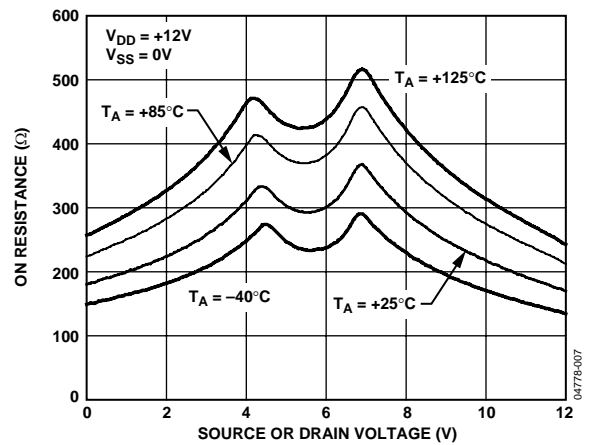


Figure 8. On Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply

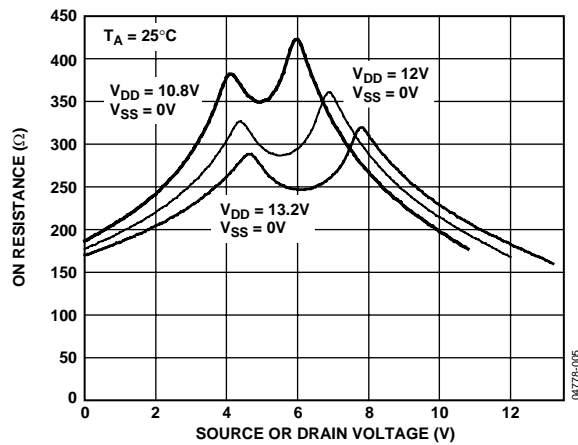


Figure 6. On Resistance as a Function of V_D (V_S) for Single Supply

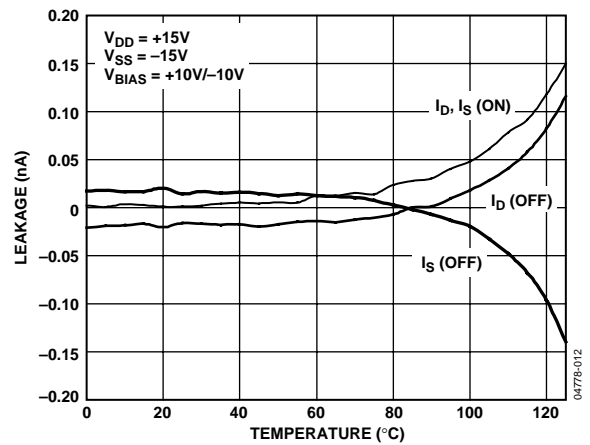


Figure 9. Leakage Currents as a Function of Temperature, Dual Supply

ADG1211/ADG1212/ADG1213

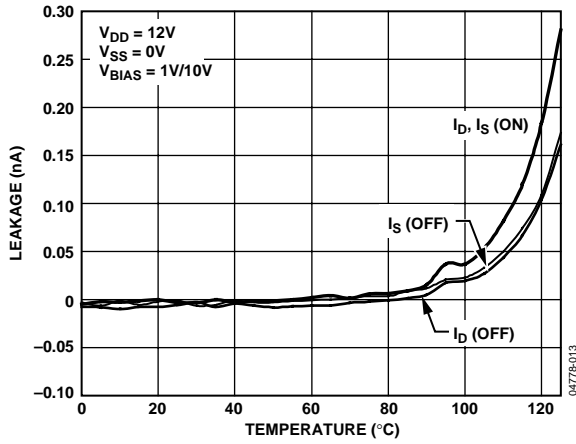


Figure 10. Leakage Currents as a Function of Temperature, Single Supply

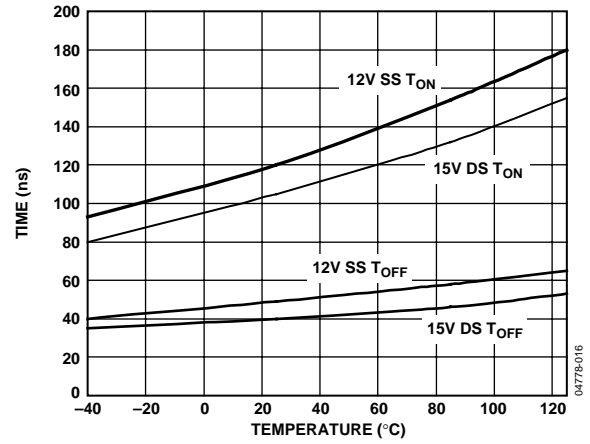


Figure 13. T_{ON}/T_{OFF} Times vs. Temperature

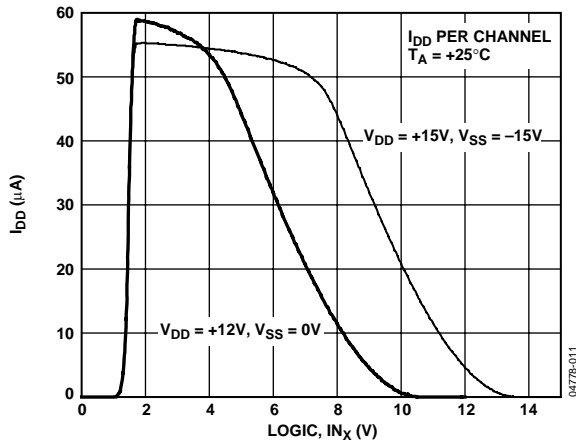


Figure 11. I_{DD} vs. Logic Level

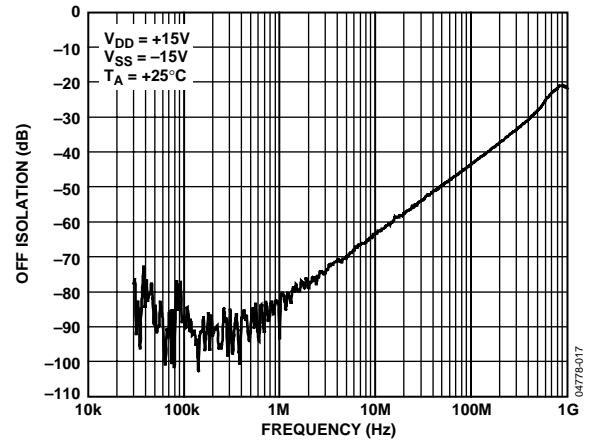


Figure 14. Off Isolation vs. Frequency

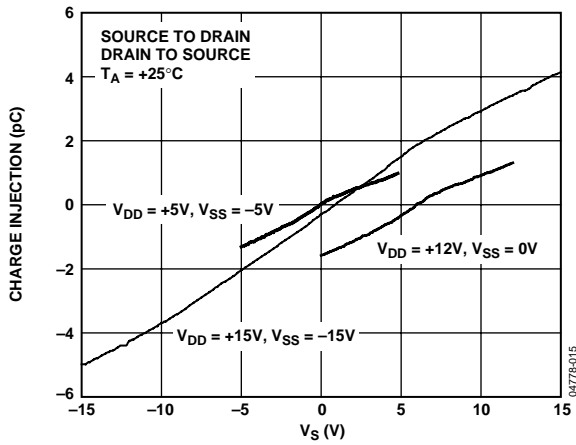


Figure 12. Charge Injection vs. Source Voltage

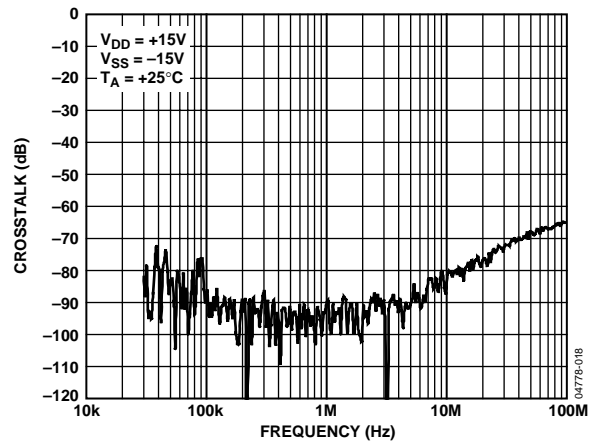


Figure 15. Crosstalk vs. Frequency

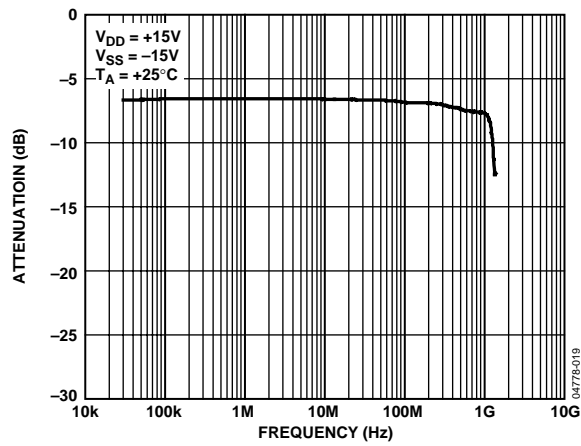


Figure 16. On Response vs. Frequency

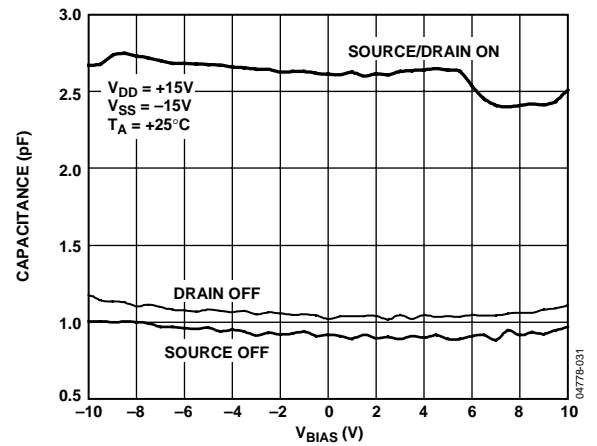


Figure 18. Capacitance vs. Source Voltage, Dual Supply

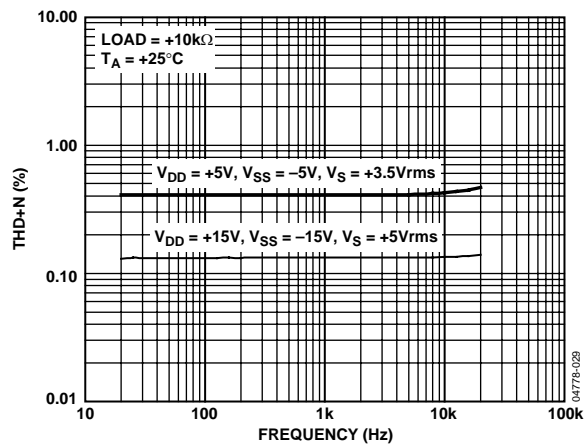


Figure 17. THD + N vs. Frequency

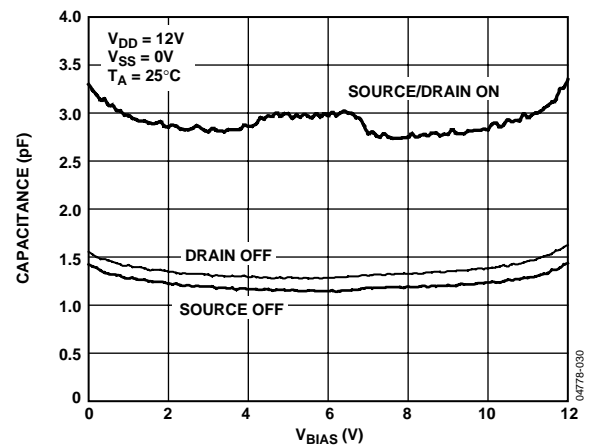
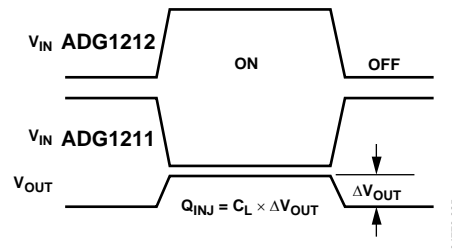
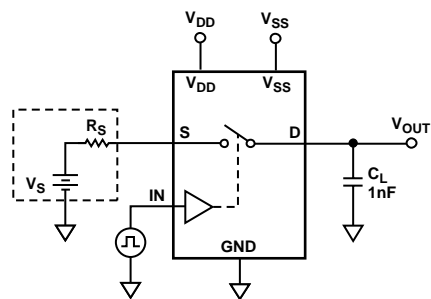
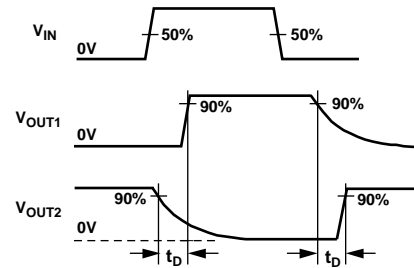
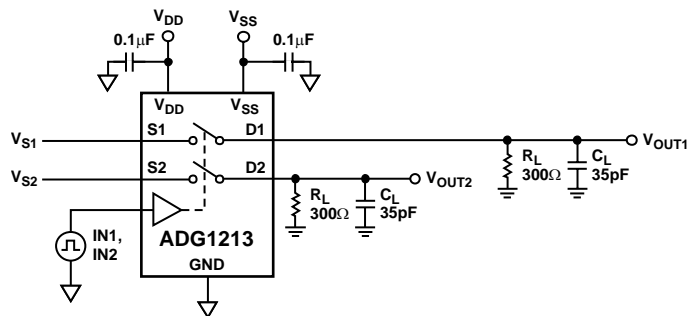
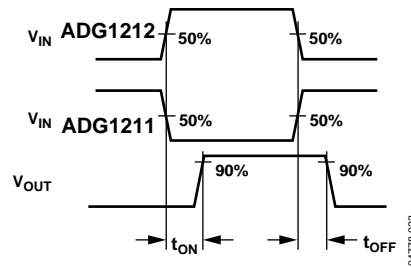
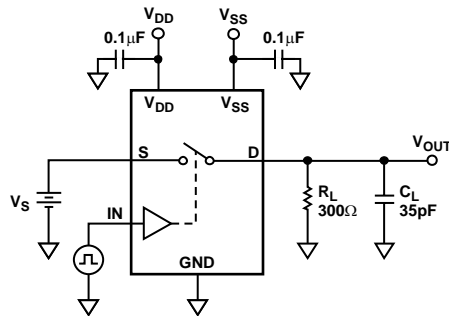
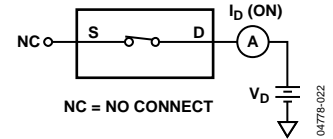
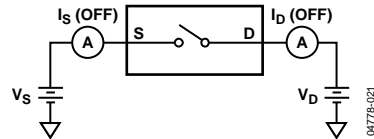
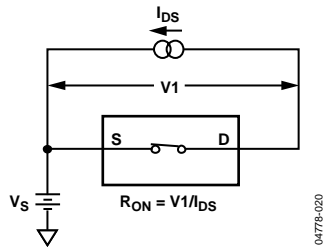


Figure 19. Capacitance vs. Source Voltage, Single Supply

TEST CIRCUITS



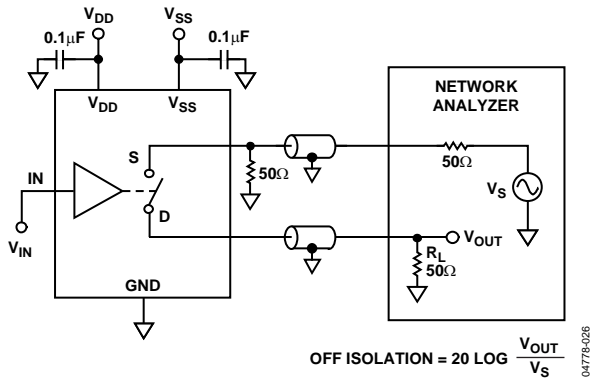


Figure 26. Test Circuit 7—Off Isolation

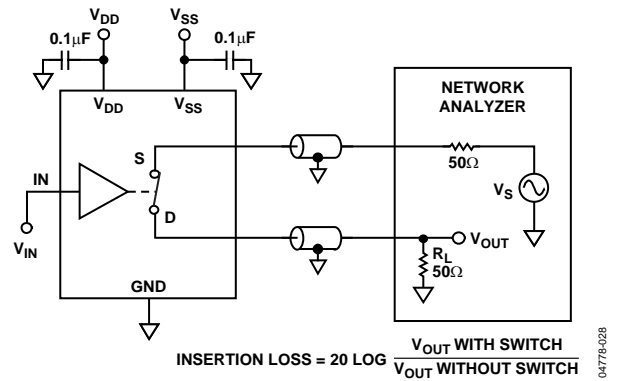


Figure 28. Test Circuit 9—Bandwidth

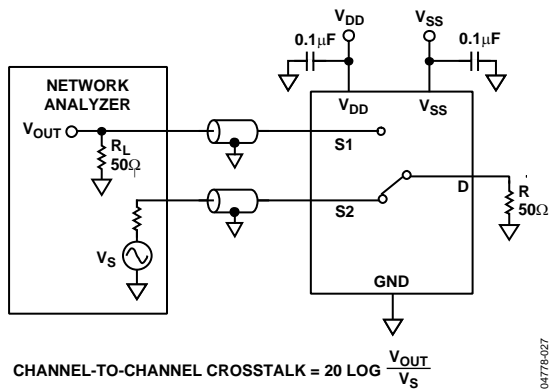


Figure 27. Test Circuit 8—Channel-to-Channel Crosstalk

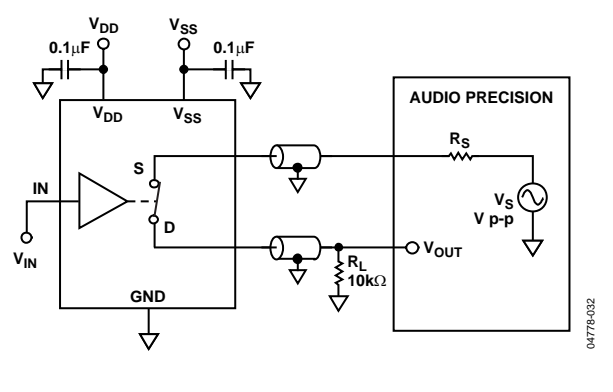


Figure 29. Test Circuit 10—THD + Noise

OUTLINE DIMENSIONS

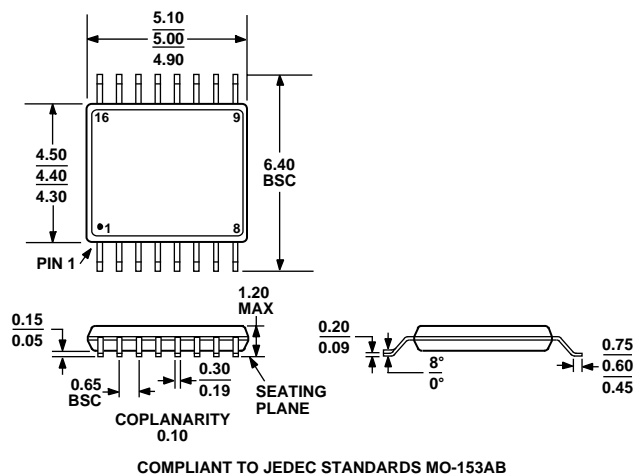


Figure 30. 16-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-16)

Dimensions shown in millimeters

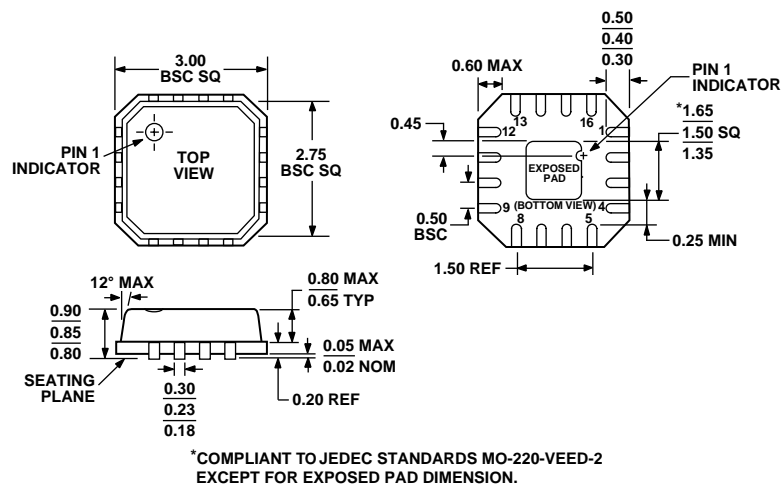


Figure 31. 16-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
3 mm x 3 mm Body, Very Thin Quad
(CP-16-3)

Dimensions shown in millimeters

ORDERING GUIDE

| Model | Temperature Range | Package Description | Package Option |
|--------------------------------|-------------------|---|----------------|
| ADG1211YRUZ ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1211YRUZ-REEL ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1211YRUZ-REEL7 ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1211YCPZ-500RL ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |
| ADG1211YCPZ-REEL7 ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |
| ADG1212YRUZ ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1212YRUZ-REEL ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1212YRUZ-REEL7 ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1212YCPZ-500RL ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |
| ADG1212YCPZ-REEL7 ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |
| ADG1213YRUZ ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1213YRUZ-REEL ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1213YRUZ-REEL7 ¹ | –40°C to +125°C | Thin Shrink Small Outline Package (TSSOP) | RU-16 |
| ADG1213YCPZ-500RL ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |
| ADG1213YCPZ-REEL7 ¹ | –40°C to +125°C | Lead Frame Chip Scale Package (LFCSP_VQ) | CP-16-3 |

¹ Z = Pb-free part.

NOTES