

## ADG1408/ADG1409

### FEATURES

- 4.7  $\Omega$  maximum on resistance @ 25°C
- 0.5  $\Omega$  on resistance flatness
- Up to 190 mA continuous current
- Fully specified at  $\pm 15$  V/ $+12$  V/ $\pm 5$  V
- 3 V logic-compatible inputs
- Rail-to-rail operation
- Break-before-make switching action
- 16-lead TSSOP and 4 mm  $\times$  4 mm LFCSP packages

### APPLICATIONS

- Relay replacement
- Audio and video routing
- Automatic test equipment
- Data acquisition systems
- Temperature measurement systems
- Avionics
- Battery-powered systems
- Communication systems
- Medical equipment

### GENERAL DESCRIPTION

The ADG1408/ADG1409 are monolithic *i*CMOS<sup>®</sup> analog multiplexers comprising eight single channels and four differential channels, respectively. The ADG1408 switches one of eight inputs to a common output, as determined by the 3-bit binary address lines, A0, A1, and A2. The ADG1409 switches one of four differential inputs to a common differential output, as determined by the 2-bit binary address lines, A0 and A1. An EN input on both devices is used to enable or disable the device. When disabled, all channels are switched off.

The *i*CMOS (industrial CMOS) modular manufacturing process combines high voltage CMOS (complementary metal-oxide semiconductor) 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 other 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.

### FUNCTIONAL BLOCK DIAGRAM

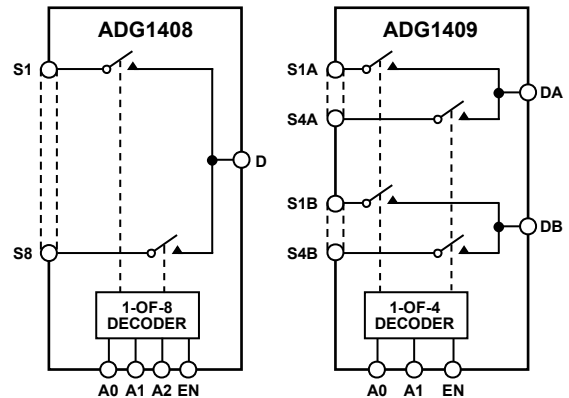


Figure 1.

The ultralow on resistance and on resistance flatness of these switches make them ideal solutions for data acquisition and gain switching applications where low distortion is critical. *i*CMOS construction ensures ultralow power dissipation, making the parts ideally suited for portable and battery-powered instruments.

### PRODUCT HIGHLIGHTS

1. 4  $\Omega$  on resistance.
2. 0.5  $\Omega$  on resistance flatness.
3. 3 V logic compatible digital input,  $V_{IH} = 2.0$  V,  $V_{IL} = 0.8$  V.
4. 16-lead TSSOP and 4 mm  $\times$  4 mm LFCSP packages.

Table 1. Related Devices

Part No.	Description
ADG1208/ADG1209	Low capacitance, low charge injection, and low leakage 4-/8-channel $\pm 15$ V multiplexers

### Rev. B

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## REVISION HISTORY

### 3/09—Rev. A to Rev. B

Change to I <sub>DD</sub> Parameter (Table 2) .....	4
Change to I <sub>DD</sub> Parameter (Table 3) .....	6

### 8/08—Rev. 0 to Rev. A

Changes to Features .....	1
Added Table 5; Renumbered Sequentially .....	8
Changes to Table 6 .....	9
Added Exposed Pad Notation to Figure 3 .....	10
Added Exposed Pad Notation to Figure 5 .....	11
Added Exposed Pad Notation to Outline Dimensions .....	19

### 8/06—Revision 0: Initial Version

# SPECIFICATIONS

## 15 V DUAL SUPPLY

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

Table 2.

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			$V_{SS}$ to $V_{DD}$	V	
On Resistance ( $R_{ON}$ )	4			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 26
	4.7	5.7	6.7	$\Omega$ max	$V_{DD} = +13.5\text{ V}$ , $V_{SS} = -13.5\text{ V}$
On Resistance Match Between Channels ( $\Delta R_{ON}$ )	0.2			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$
	0.78	0.85	1.1	$\Omega$ max	
On Resistance Flatness ( $R_{FLAT(ON)}$ )	0.5			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$
	0.72	0.77	0.92	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.04$			nA typ	$V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$
	$\pm 0.2$	$\pm 0.6$	$\pm 5$	nA max	$V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 27
Drain Off Leakage, $I_D$ (Off)	$\pm 0.04$			nA typ	$V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 27
	$\pm 0.45$	$\pm 2$	$\pm 30$	nA max	
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.1$			nA typ	$V_S = V_D = \pm 10\text{ V}$ ; see Figure 28
	$\pm 1.5$	$\pm 3$	$\pm 30$	nA max	
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current	$\pm 0.005$			$\mu\text{A}$ typ	$V_{IN} = V_{GND}$ or $V_{DD}$
			$\pm 0.1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	4			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>					
Transition Time, $t_{TRANSITION}$	140			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	170	210	240	ns max	$V_S = 10\text{ V}$ , see Figure 29
Break-Before-Make Time Delay, $t_{BBM}$	50			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
			30	ns min	$V_{S1} = V_{S2} = 10\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	100			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	120	150	165	ns max	$V_S = 10\text{ V}$ ; see Figure 31
$t_{OFF}$ (EN)	100			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	120	150	170	ns max	$V_S = 10\text{ V}$ ; see Figure 31
Charge Injection	-50			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 32
Off Isolation	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 33
Channel-to-Channel Crosstalk	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 34
Total Harmonic Distortion, THD + N	0.025			% typ	$R_L = 110\ \Omega$ , 15 V p-p, $f = 20\text{ Hz}$ to 20 kHz; see Figure 36
-3 dB Bandwidth					$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 35
ADG1408	60			MHz typ	
ADG1409	115			MHz typ	
Insertion Loss	0.24			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 35
$C_S$ (Off)	14			pF typ	$f = 1\text{ MHz}$
$C_D$ (Off)					
ADG1408	80			pF typ	$f = 1\text{ MHz}$
ADG1409	40			pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)					
ADG1408	135			pF typ	$f = 1\text{ MHz}$
ADG1409	90			pF typ	$f = 1\text{ MHz}$

# ADG1408/ADG1409

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
POWER REQUIREMENTS					$V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$
$I_{DD}$	0.002		1	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V or $V_{DD}$
	220		380	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 5 V
$I_{SS}$	0.002		1	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V, 5 V or $V_{DD}$
$V_{DD}/V_{SS}$			$\pm 4.5/\pm 16.5$	V min/max	

<sup>1</sup> Temperature range: Y version: -40°C to +125°C.

<sup>2</sup> Guaranteed by design, not subject to production test.

## 12 V SINGLE SUPPLY

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

**Table 3.**

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			0 to $V_{DD}$	V	
On Resistance ( $R_{ON}$ )	6			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 26
	8	9.5	11.2	$\Omega$ max	$V_{DD} = 10.8\text{ V}$ , $V_{SS} = 0\text{ V}$
On Resistance Match	0.2			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$
Between Channels ( $\Delta R_{ON}$ )	0.82	0.85	1.1	$\Omega$ max	
On Resistance Flatness ( $R_{FLAT(ON)}$ )	1.5			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$
	2.5	2.5	2.8	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.04$			nA typ	$V_{DD} = 13.2\text{ V}$ $V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 27
	$\pm 0.2$	$\pm 0.6$	$\pm 5$	nA max	
Drain Off Leakage, $I_D$ (Off)	$\pm 0.04$			nA typ	$V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 27
	$\pm 0.45$	$\pm 1$	$\pm 37$	nA max	
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.06$			nA typ	$V_S = V_D = 1\text{ V or }10\text{ V}$ ; see Figure 28
	$\pm 0.44$	$\pm 1.3$	$\pm 32$	nA max	
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current	$\pm 0.005$			$\mu\text{A}$ typ	$V_{IN} = V_{GND}$ or $V_{DD}$
			$\pm 0.1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	5			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>					
Transition Time, $t_{TRANSITION}$	200			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	260	330	380	ns max	$V_S = 8\text{ V}$ ; see Figure 29
Break-Before-Make Time Delay, $t_{BBM}$	90			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
			40	ns min	$V_{S1} = V_{S2} = 8\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	160			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	210	250	285	ns max	$V_S = 8\text{ V}$ ; see Figure 31
$t_{OFF}$ (EN)	115			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	145	180	200	ns max	$V_S = 8\text{ V}$ ; see Figure 31
Charge Injection	-12			pC typ	$V_S = 6\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 32
Off Isolation	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 33
Channel-to-Channel Crosstalk	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 34
-3 dB Bandwidth					$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 35
ADG1408	36			MHz typ	
ADG1409	72			MHz typ	
Insertion Loss	0.5			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 35
$C_S$ (Off)	25			pF typ	$f = 1\text{ MHz}$
$C_D$ (Off)					
ADG1408	165			pF typ	$f = 1\text{ MHz}$
ADG1409	80			pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)					
ADG1408	200			pF typ	$f = 1\text{ MHz}$
ADG1409	120			pF typ	$f = 1\text{ MHz}$

# ADG1408/ADG1409

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
POWER REQUIREMENTS					$V_{DD} = 13.2\text{ V}$
$I_{DD}$	0.002		1	$\mu\text{A typ}$	Digital inputs = 0 V or $V_{DD}$
	220		380	$\mu\text{A max}$	Digital inputs = 5 V
$V_{DD}$			5/16.5	V min/max	$V_{SS} = 0\text{ V}, \text{GND} = 0\text{ V}$

<sup>1</sup> Temperature range for Y version: -40°C to +125°C.

<sup>2</sup> Guaranteed by design, not subject to production test.

**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 4.**

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			$V_{SS}$ to $V_{DD}$	V	
On Resistance ( $R_{ON}$ )	7			$\Omega$ typ	$V_S = \pm 4.5\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 26
	9	10.5	12	$\Omega$ max	$V_{DD} = +4.5\text{ V}$ , $V_{SS} = -4.5\text{ V}$
On Resistance Match Between Channels ( $\Delta R_{ON}$ )	0.3			$\Omega$ typ	$V_S = \pm 4.5\text{ V}$ , $I_S = -10\text{ mA}$
	0.78	0.91	1.1	$\Omega$ max	
On Resistance Flatness ( $R_{FLAT(ON)}$ )	1.5			$\Omega$ typ	$V_S = \pm 4.5\text{ V}$ ; $I_S = -10\text{ mA}$
	2.5	2.5	3	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.02$			nA typ	$V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$
	$\pm 0.2$	$\pm 0.6$	$\pm 5$	nA max	$V_S = \pm 4.5\text{ V}$ , $V_D = \mp 4.5\text{ V}$ ; see Figure 27
Drain Off Leakage, $I_D$ (Off)	$\pm 0.02$			nA typ	$V_S = \pm 4.5\text{ V}$ , $V_D = \mp 4.5\text{ V}$ ; see Figure 27
	$\pm 0.45$	$\pm 0.8$	$\pm 20$	nA max	
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.04$			nA typ	$V_S = V_D = \pm 4.5\text{ V}$ ; see Figure 28
	$\pm 0.3$	$\pm 1.1$	$\pm 22$	nA max	
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current	$\pm 0.005$			$\mu\text{A}$ typ	$V_{IN} = V_{GND}$ or $V_{DD}$
			$\pm 0.1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	5			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>					
Transition Time, $t_{TRANSITION}$	330			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	440	530	550	ns max	$V_S = 5\text{ V}$ ; see Figure 29
Break-Before-Make Time Delay, $t_{BBM}$	100			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
			50	ns min	$V_{S1} = V_{S2} = 5\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	245			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	330	400	440	ns max	$V_S = 5\text{ V}$ ; see Figure 31
$t_{OFF}$ (EN)	215			ns typ	$R_L = 100\ \Omega$ , $C_L = 35\text{ pF}$
	285	335	370	ns max	$V_S = 5\text{ V}$ ; see Figure 31
Charge Injection	-10			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 32
Off Isolation	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 33
Channel-to-Channel Crosstalk	-70			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 34
Total Harmonic Distortion, THD + N	0.06			% typ	$R_L = 110\ \Omega$ , $5\text{ V p-p}$ , $f = 20\text{ Hz to } 20\text{ kHz}$ ; see Figure 36
-3 dB Bandwidth					$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 35
ADG1408	40			MHz typ	
ADG1409	80			MHz typ	
Insertion Loss	0.5			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 35
$C_S$ (Off)	20			pF typ	$f = 1\text{ MHz}$
$C_D$ (Off)					
ADG1408	130			pF typ	$f = 1\text{ MHz}$
ADG1409	65			pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)					
ADG1408	180			pF typ	$f = 1\text{ MHz}$
ADG1409	120			pF typ	$f = 1\text{ MHz}$

# ADG1408/ADG1409

Parameter	+25°C	-40°C to +85°C	-40°C to +125°C <sup>1</sup>	Unit	Test Conditions/Comments
POWER REQUIREMENTS					$V_{DD} = +5.5\text{ V}$ , $V_{SS} = -5.5\text{ V}$
$I_{DD}$	0.001		1	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V or $V_{DD}$
$I_{SS}$	0.001		1	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V, 5 V or $V_{DD}$
$V_{DD}/V_{SS}$			$\pm 4.5/\pm 16.5$	V min/max	

<sup>1</sup> Temperature range for Y version: -40°C to +125°C.

<sup>2</sup> Guaranteed by design, not subject to production test.

## CONTINUOUS CURRENT PER CHANNEL, S OR D

Table 5.

Parameter	25°C	85°C	125°C	Unit	Test Conditions/Comments
CONTINUOUS CURRENT, S or D <sup>1</sup>					
15 V Dual Supply					$V_{DD} = +13.5\text{ V}$ , $V_{SS} = -13.5\text{ V}$
ADG1408	190	105	50	mA max	
ADG1409	140	85	45	mA max	
12 V Single Supply					$V_{DD} = 10.8\text{ V}$ , $V_{SS} = 0\text{ V}$
ADG1408	160	95	50	mA max	
ADG1409	120	75	40	mA max	
5 V Dual Supply					$V_{DD} = +4.5\text{ V}$ , $V_{SS} = -4.5\text{ V}$
ADG1408	155	90	45	mA max	
ADG1409	115	70	40	mA max	

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



## ABSOLUTE MAXIMUM RATINGS

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

**Table 6.**

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, Digital Inputs <sup>1</sup>	$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or 30 mA, whichever occurs first
Continuous Current, S or D	Table 5 data + 10%
Peak Current, S or D (Pulsed at 1 ms, 10% Duty Cycle Maximum)	350 mA
Operating Temperature Range Industrial (Y Version)	-40°C to +125°C
Storage Temperature Range	-65°C to +150°C
Junction Temperature	150°C
Reflow Soldering Peak Temperature (Pb-Free)	260(+0/-5)°C

<sup>1</sup> Overvoltages at A, EN, 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 can be applied at any one time.

### THERMAL RESISTANCE

$\theta_{JA}$  is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

**Table 7. Thermal Resistance**

Package Type	$\theta_{JA}$	$\theta_{JC}$	Unit
16-Lead TSSOP	150.4	50	°C/W
16-Lead LFCSP	30.4		°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.

# ADG1408/ADG1409

## PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

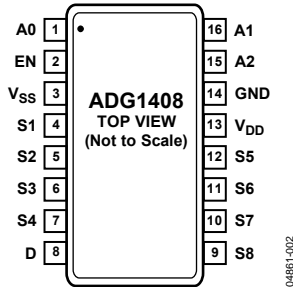
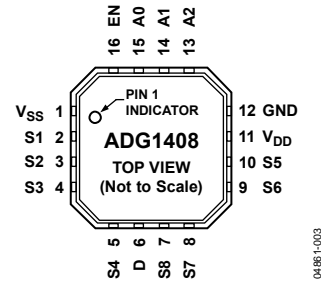


Figure 2. ADG1408 Pin Configuration (TSSOP)



NOTES  
 1. THE EXPOSED PAD IS CONNECTED INTERNALLY. FOR INCREASED RELIABILITY OF THE SOLDER JOINTS AND MAXIMUM THERMAL CAPABILITY, IT IS RECOMMENDED THAT THE PAD BE SOLDERED TO THE SUBSTRATE,  $V_{SS}$ .

Figure 3. ADG1408 Pin Configuration (LFCSP)

Table 8. ADG1408 Pin Function Descriptions

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

Table 9. ADG1408 Truth Table

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

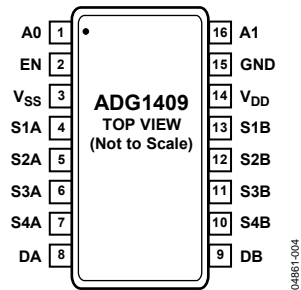
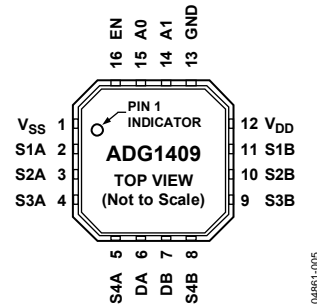


Figure 4. ADG1409 Pin Configuration (TSSOP)



**NOTES**  
 1. THE EXPOSED PAD IS CONNECTED INTERNALLY. FOR INCREASED RELIABILITY OF THE SOLDER JOINTS AND MAXIMUM THERMAL CAPABILITY, IT IS RECOMMENDED THAT THE PAD BE SOLDERED TO THE SUBSTRATE,  $V_{SS}$ .

Figure 5. ADG1409 Pin Configuration (LFCSP)

**Table 10. ADG1409 Pin Function Descriptions**

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

**Table 11. ADG1409 Truth Table**

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

## TYPICAL PERFORMANCE CHARACTERISTICS

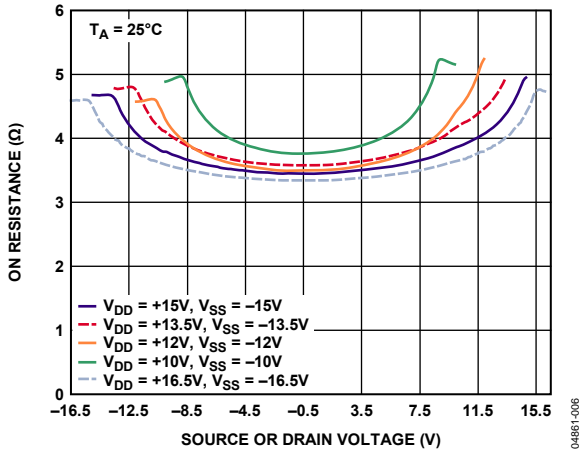


Figure 6. On Resistance vs.  $V_D$ ,  $V_S$ ; Dual Supply

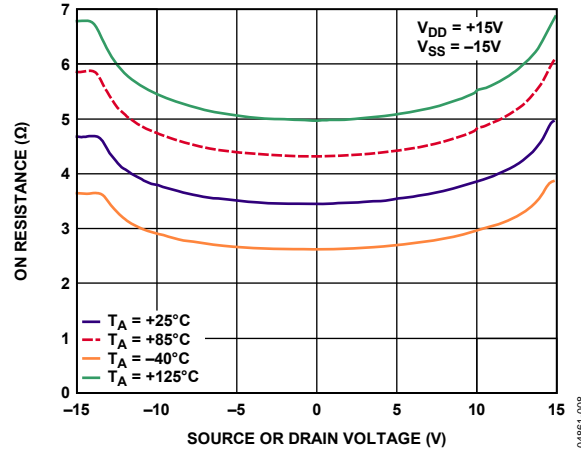


Figure 9. On Resistance vs.  $V_D$ ,  $V_S$  for Different Temperatures; 15 V Dual Supply

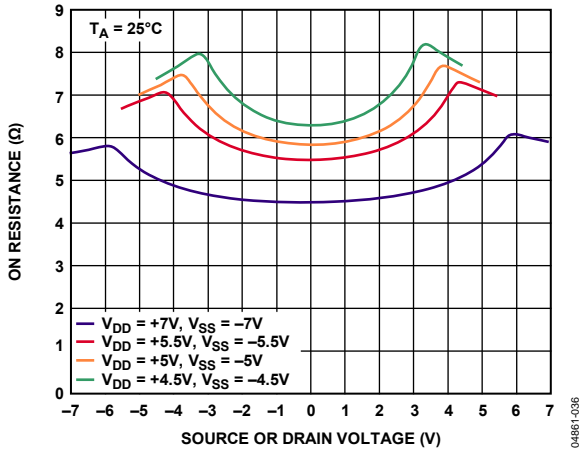


Figure 7. On Resistance vs.  $V_D$ ,  $V_S$ ; Dual Supply

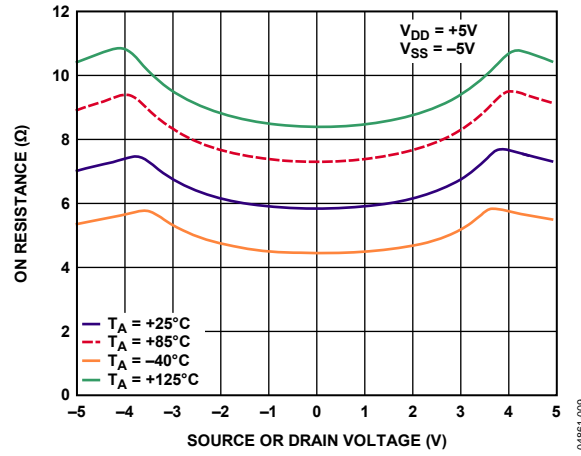


Figure 10. On Resistance vs.  $V_D$ ,  $V_S$  for Different Temperatures; 5 V Dual Supply

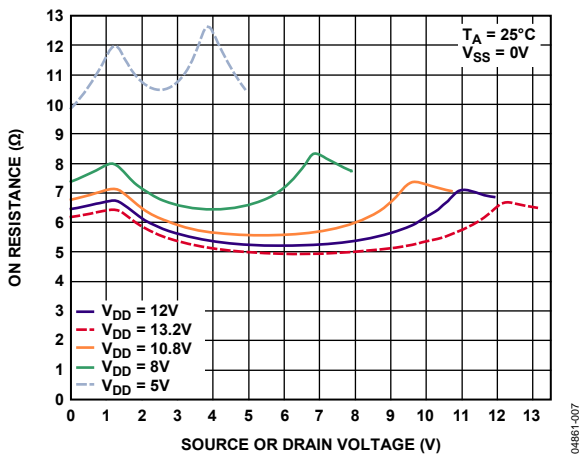


Figure 8. On Resistance vs.  $V_D$ ,  $V_S$ ; Single Supply

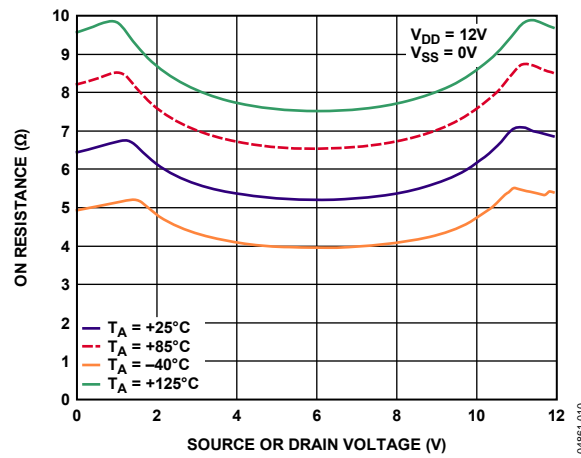


Figure 11. On Resistance vs.  $V_D$ ,  $V_S$  for Different Temperatures; 12 V Single Supply

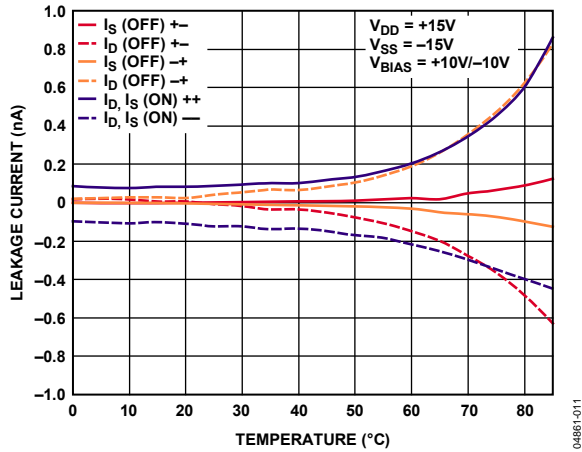


Figure 12. Leakage Current vs. Temperature; 15 V Dual Supply

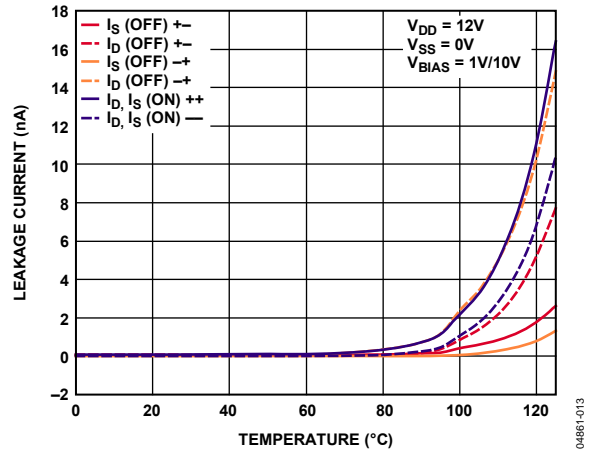


Figure 15. Leakage Current vs. Temperature; 12 V Single Supply

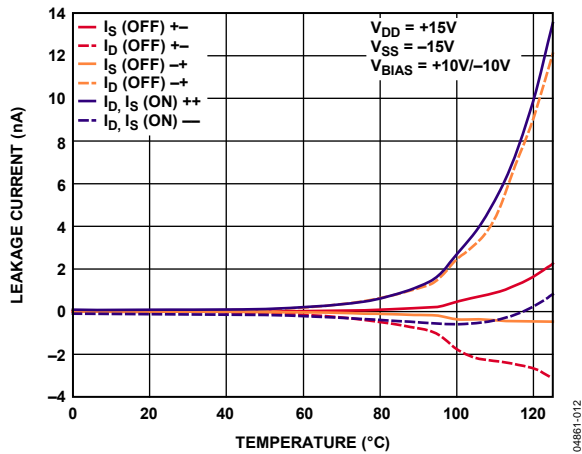


Figure 13. Leakage Current vs. Temperature; 15 V Dual Supply

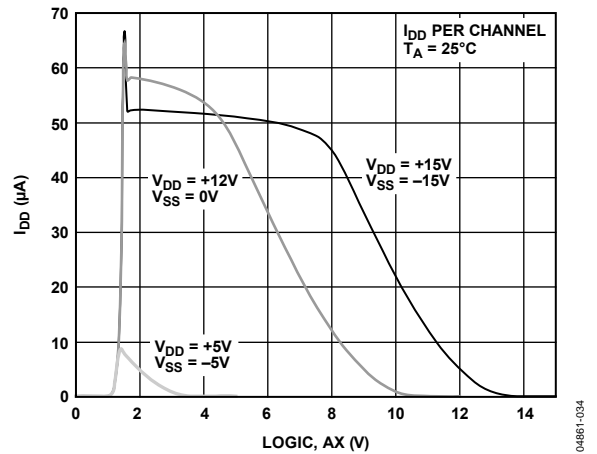


Figure 16. Positive Supply Current vs. Logic Level

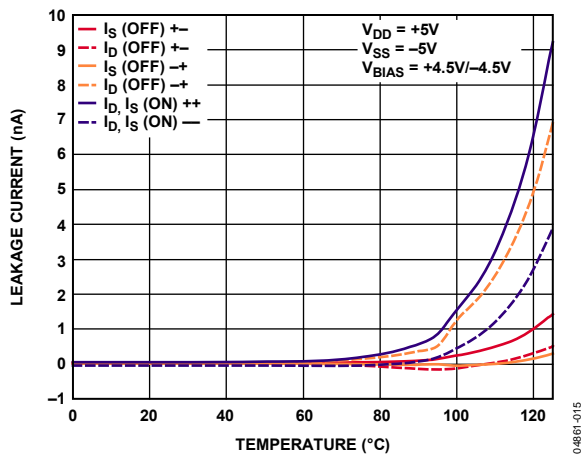


Figure 14. Leakage Current vs. Temperature; 5 V Dual Supply

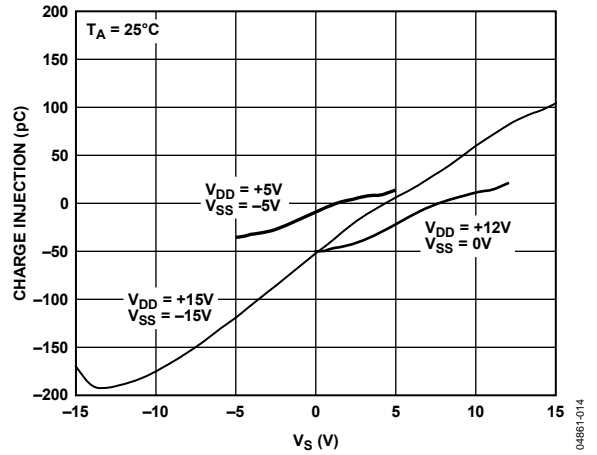


Figure 17. Charge Injection vs. Source Voltage

# ADG1408/ADG1409

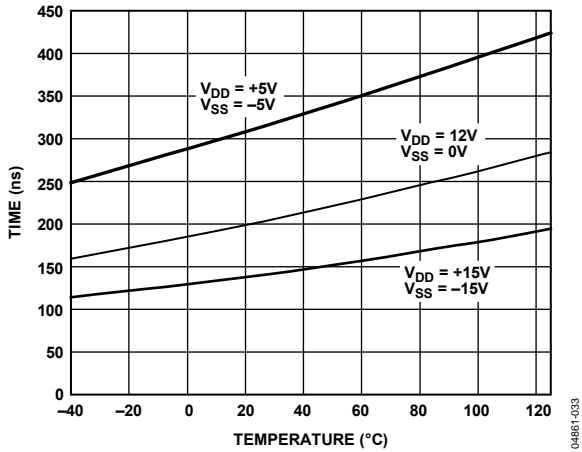


Figure 18. Transition Time vs. Temperature

04861-023

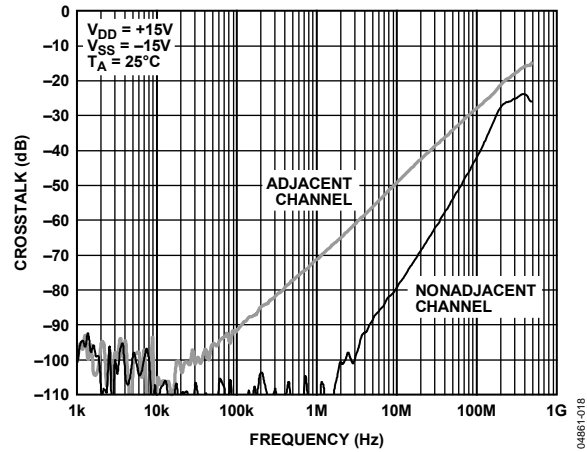


Figure 21. ADG1409 Crosstalk vs. Frequency

04861-018

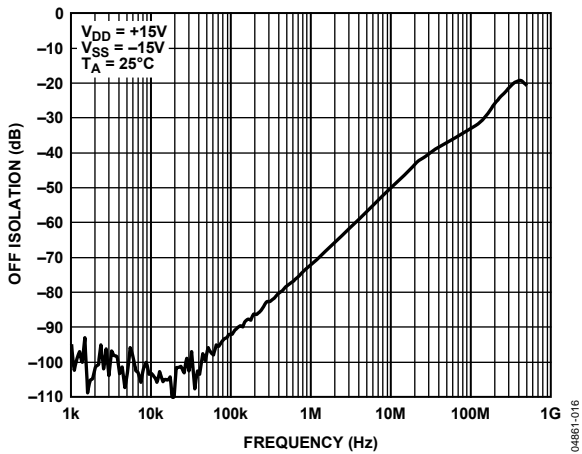


Figure 19. Off Isolation vs. Frequency

04861-016

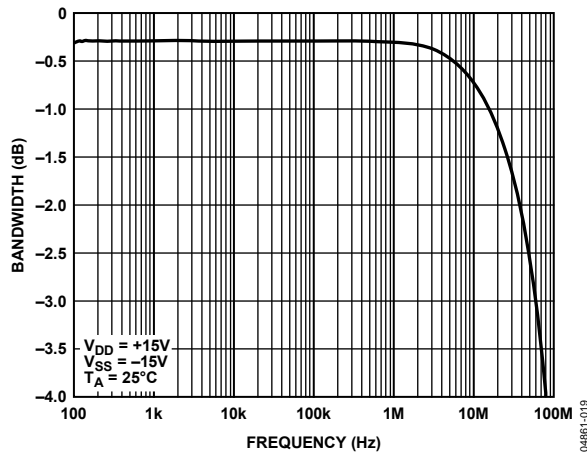


Figure 22. ADG1408 On Response vs. Frequency

04861-019

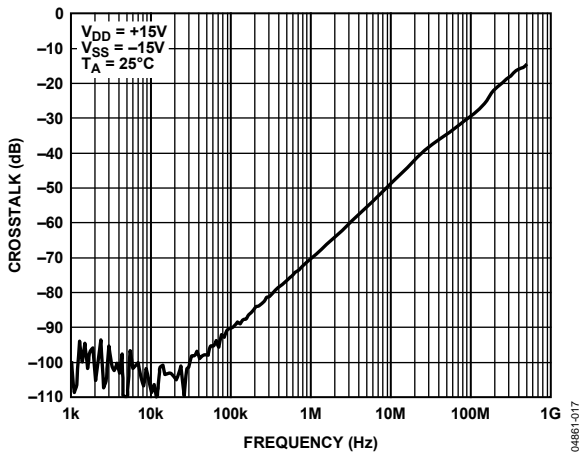


Figure 20. ADG1408 Crosstalk vs. Frequency

04861-017

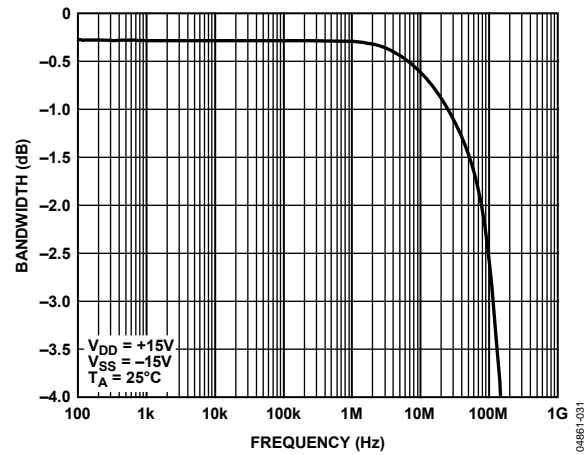


Figure 23. ADG1409 On Response vs. Frequency

04861-031

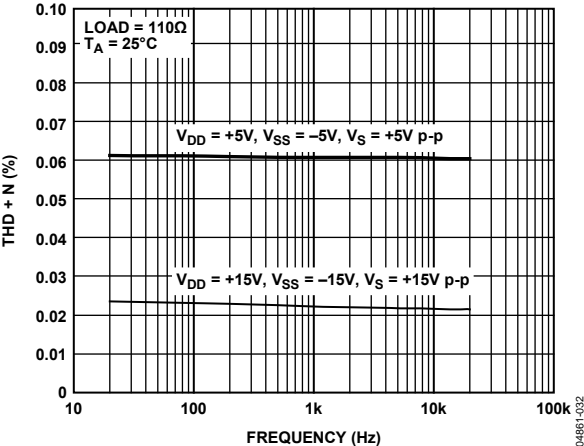


Figure 24. Total Harmonic Distortion Plus Noise vs. Frequency

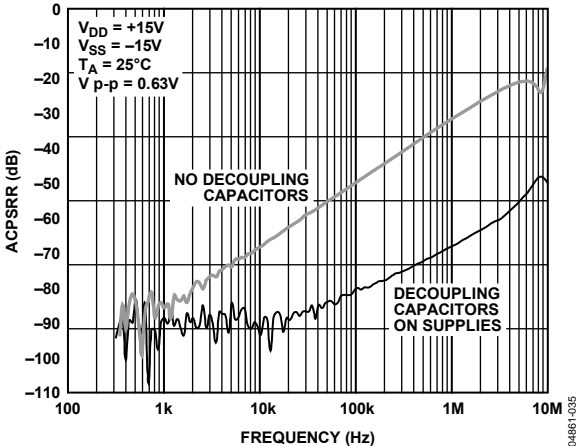


Figure 25. AC Power Supply Rejection Ratio vs. Frequency

## TERMINOLOGY

### $R_{ON}$

Ohmic resistance between D and S.

### $\Delta R_{ON}$

Difference between the  $R_{ON}$  of any two channels.

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

Flatness is defined as the difference between the maximum and minimum value of on resistance as measured.

### $I_S$ (Off)

Source leakage current when the switch is off.

### $I_D$ (Off)

Drain leakage current when the switch is off.

### $I_D, I_S$ (On)

Channel leakage current when the switch is on.

### $V_D$ ( $V_S$ )

Analog voltage on Terminal D and Terminal S.

### $C_S$ (Off)

Channel input capacitance for off condition.

### $C_D$ (Off)

Channel output capacitance for off condition.

### $C_D, C_S$ (On)

On switch capacitance.

### $C_{IN}$

Digital input capacitance.

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

Delay time between the 50% and 90% points of the digital input and switch on condition.

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

Delay time between the 50% and 90% points of the digital input and switch off condition.

### $t_{TRANSITION}$

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

### $t_{BBM}$

Off time measured between the 80% point of both switches when switching from one address state to another.

### $V_{INL}$

Maximum input voltage for Logic 0.

### $V_{INH}$

Minimum input voltage for Logic 1.

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

Input current of the digital input.

### $I_{DD}$

Positive supply current.

### $I_{SS}$

Negative supply current.

### Off Isolation

A measure of unwanted signal coupling through an off channel.

### Charge Injection

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

### Bandwidth

Frequency at which the output is attenuated by 3 dB.

### On Response

Frequency response of the on switch.

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

Ratio of the harmonic amplitude plus noise of the signal to the fundamental.

### AC Power Supply Rejection Ratio (ACPSRR)

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



## TEST CIRCUITS

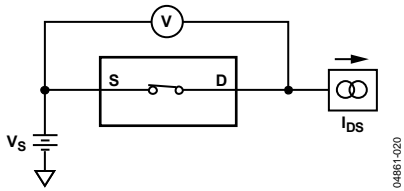


Figure 26. On Resistance

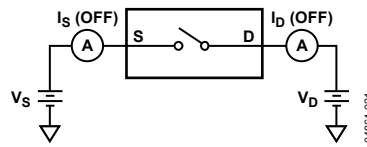


Figure 27. Off Leakage

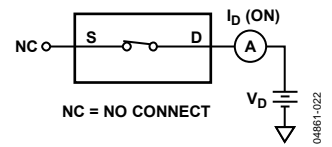


Figure 28. On Leakage

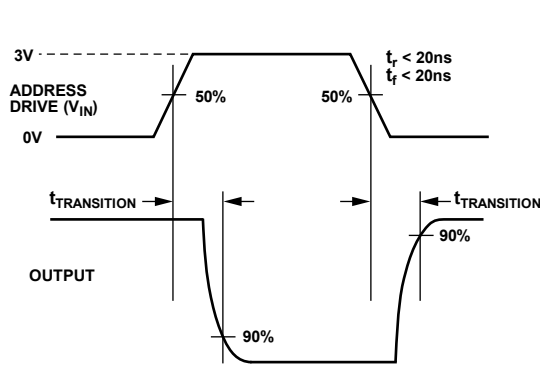
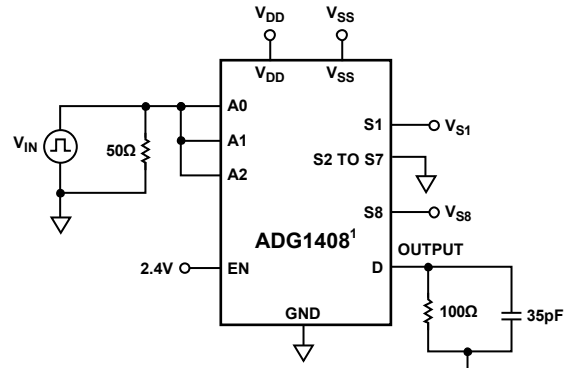


Figure 29. Address to Output Switching Times,  $t_{\text{TRANSITION}}$



<sup>1</sup>SIMILAR CONNECTION FOR ADG1409.

04861-023

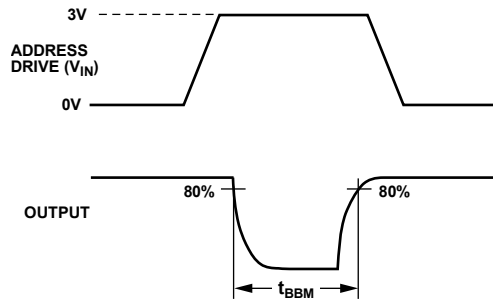
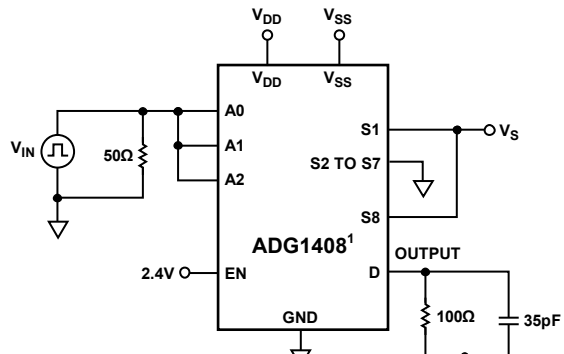


Figure 30. Break-Before-Make Delay,  $t_{\text{BBM}}$



<sup>1</sup>SIMILAR CONNECTION FOR ADG1409.

04861-024

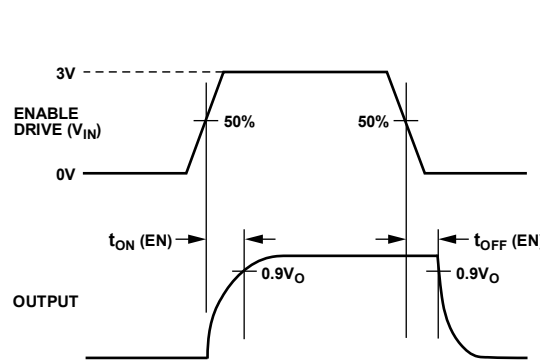
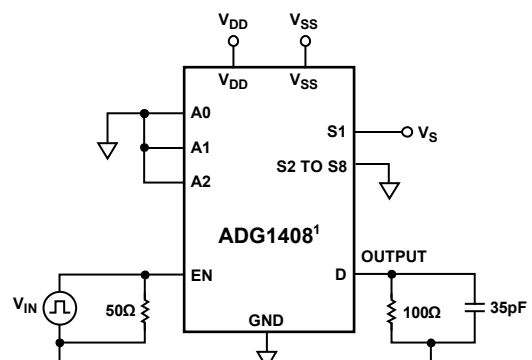


Figure 31. Enable Delay,  $t_{\text{ON}}(\text{EN})$ ,  $t_{\text{OFF}}(\text{EN})$



<sup>1</sup>SIMILAR CONNECTION FOR ADG1409.

04861-025

# ADG1408/ADG1409

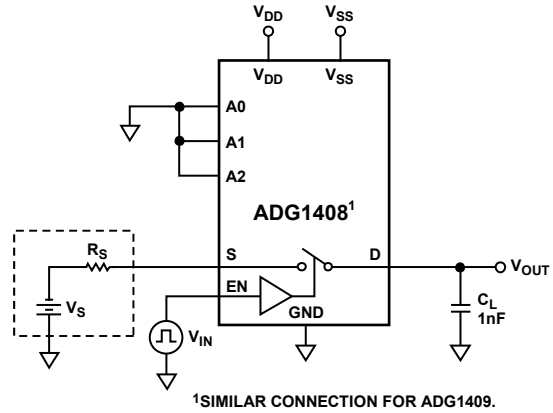
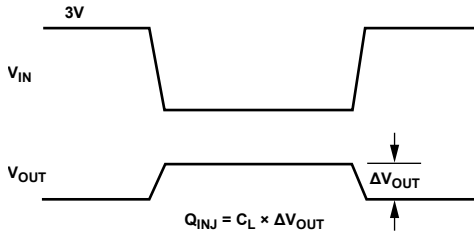


Figure 32. Charge Injection

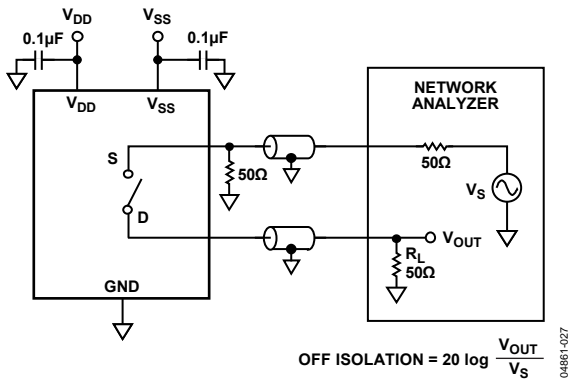


Figure 33. Off Isolation

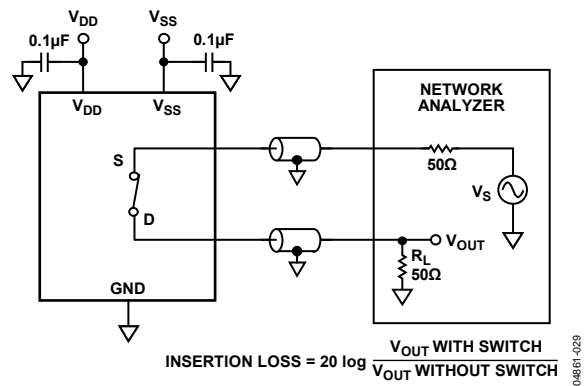


Figure 35. Insertion Loss

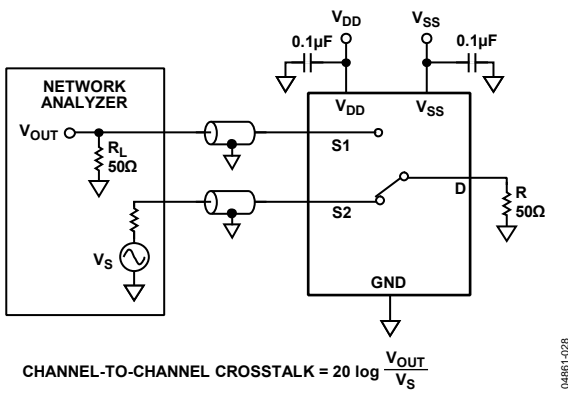


Figure 34. Channel-to-Channel Crosstalk

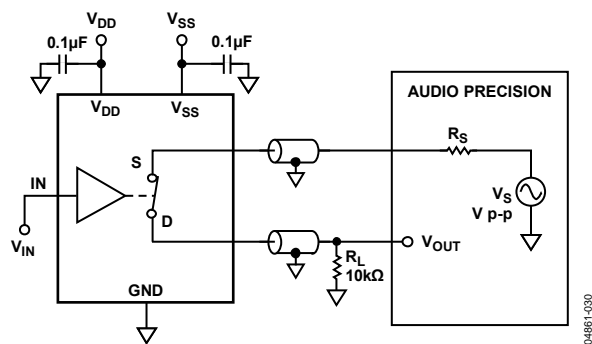
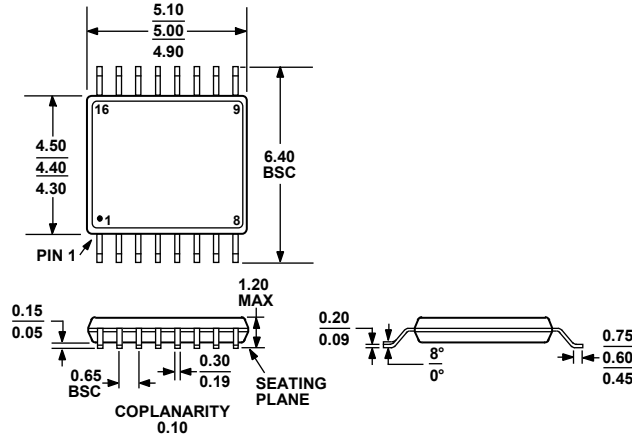


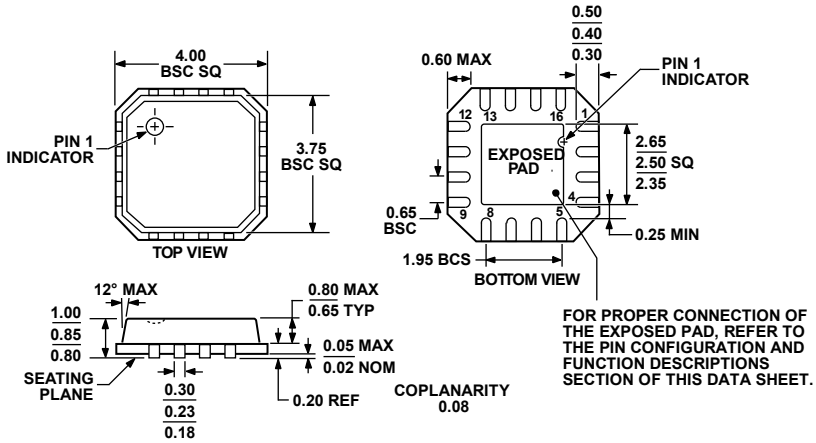
Figure 36. THD + Noise

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

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



COMPLIANT TO JEDEC STANDARDS MO-220-VGGC.

Figure 38. 16-Lead Lead Frame Chip Scale Package [LF CSP\_VQ]  
4 mm × 4 mm, Very Thin Quad (CP-16-13)  
Dimensions shown in millimeters

031006-A

# ADG1408/ADG1409

## ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADG1408YRUZ <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1408YRUZ-REEL <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1408YRUZ-REEL7 <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1408YCPZ-REEL7 <sup>1</sup>	-40°C to +125°C	16-Lead Lead Frame Chip Scale Package [LFCSP_VQ]	CP-16-13
ADG1409YRUZ <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1409YRUZ-REEL <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1409YRUZ-REEL7 <sup>1</sup>	-40°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG1409YCPZ-REEL7 <sup>1</sup>	-40°C to +125°C	16-Lead Lead Frame Chip Scale Package [LFCSP_VQ]	CP-16-13

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