

## FEATURES

**Latch-up proof**  
**8 kV HBM ESD rating**  
**Low on resistance (<10 Ω)**  
**±9 V to ±22 V dual-supply operation**  
**9 V to 40 V single-supply operation**  
**48 V supply maximum ratings**  
**Fully specified at ±15 V, ±20 V, +12 V, and +36 V**  
**V<sub>SS</sub> to V<sub>DD</sub> analog signal range**

## APPLICATIONS

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

## GENERAL DESCRIPTION

The ADG5404 is a complementary metal-oxide semiconductor (CMOS) analog multiplexer, comprising four single channels.

The on-resistance profile is very flat over the full analog input range, ensuring excellent linearity and low distortion when switching audio signals.

The ADG5404 is designed on a trench process, which guards against latch-up. A dielectric trench separates the P and N channel transistors, thereby preventing latch-up even under severe overvoltage conditions.

The ADG5404 switches one of four inputs to a common output, D, as determined by the 3-bit binary address lines, A0, A1, and EN. Logic 0 on the EN pin disables the device. Each switch conducts equally well in both directions when on and has an input signal range that extends to the supplies. In the off condition, signal levels up to the supplies are blocked. All switches exhibit break-before-make switching action.

## FUNCTIONAL BLOCK DIAGRAM

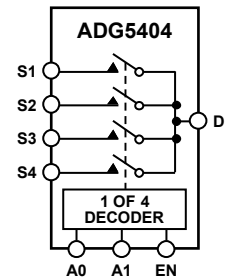


Figure 1.

## PRODUCT HIGHLIGHTS

1. Trench Isolation Guards Against Latch-Up. A dielectric trench separates the P and N channel transistors, thereby preventing latch-up even under severe overvoltage conditions.
2. Low R<sub>ON</sub>.
3. Dual-Supply Operation. For applications where the analog signal is bipolar, the ADG5404 can be operated from dual supplies of up to ±22 V.
4. Single-Supply Operation. For applications where the analog signal is unipolar, the ADG5404 can be operated from a single-rail power supply of up to 40 V.
5. 3 V logic-compatible digital inputs: V<sub>INH</sub> = 2.0 V, V<sub>INL</sub> = 0.8 V.
6. No V<sub>I</sub> logic power supply required.

Rev. B

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# ADG5404\* PRODUCT PAGE QUICK LINKS

Last Content Update: 11/18/2017

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## COMPARABLE PARTS

View a parametric search of comparable parts.

## EVALUATION KITS

- EVAL-14TSSOPEBZ Evaluation Board

## DOCUMENTATION

### Data Sheet

- ADG5404: High Voltage, Latch-up Proof, 4-Channel Multiplexer Data Sheet

### User Guides

- UG-1208: Evaluation Board for 14-Lead TSSOP Devices in the Switches and Multiplexers Portfolio

## REFERENCE MATERIALS

### Product Selection Guide

- Switches and Multiplexers Product Selection Guide

### Technical Articles

- Replacing Discrete Protection Components with Overvoltage Fault Protected Analog Switches

## DESIGN RESOURCES

- ADG5404 Material Declaration
- PCN-PDN Information
- Quality And Reliability
- Symbols and Footprints

## DISCUSSIONS

View all ADG5404 EngineerZone Discussions.

## SAMPLE AND BUY

Visit the product page to see pricing options.

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Submit a technical question or find your regional support number.

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## REVISION HISTORY

### 11/2017—Rev. A to Rev. B

Changes to Table 1.....	3
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Updated Outline Dimensions .....	20
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### 7/2011—Rev. 0 to Rev. A

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Change to $I_{SS}$ Parameter, Table 2.....	4
Updated Outline Dimensions .....	20

### 7/2010—Revision 0: Initial Version

# SPECIFICATIONS

## ±15 V DUAL SUPPLY

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

Table 1.

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			$V_{DD}$ to $V_{SS}$	V	
On Resistance, $R_{ON}$	9.8			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 23
	11	14	16	$\Omega$ max	$V_{DD} = +13.5\text{ V}$ , $V_{SS} = -13.5\text{ V}$
On-Resistance Match Between Channels, $\Delta R_{ON}$	0.35			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$
	0.7	0.9	1.1	$\Omega$ max	
On-Resistance Flatness, $R_{FLAT(ON)}$	1.2			$\Omega$ typ	$V_S = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$
	1.6	2	2.2	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.05$			nA typ	$V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$
	$\pm 0.25$	$\pm 0.75$	$\pm 6$	nA max	$V_S = V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 24
Drain Off Leakage, $I_D$ (Off)	$\pm 0.1$			nA typ	$V_S = V_S = \pm 10\text{ V}$ , $V_D = \mp 10\text{ V}$ ; see Figure 24
	$\pm 0.4$	$\pm 2$	$\pm 16$	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 25
	$\pm 0.4$	$\pm 2$	$\pm 16$	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, $I_{INL}$ or $I_{INH}$	0.002			$\mu\text{A}$ typ	$V_{IN} = V_{GND}$ or $V_{DD}$
			$\pm 0.1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	5			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>					
Transition Time, $t_{TRANSITION}$	187			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	242	285	330	ns max	$V_S = 10\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	160			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	204	247	278	ns max	$V_S = 10\text{ V}$ ; see Figure 32
$t_{OFF}$ (EN)	125			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	145	168	183	ns max	$V_S = 10\text{ V}$ ; see Figure 32
Break-Before-Make Time Delay, $t_D$	45			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
			12	ns min	$V_{S1} = V_{S2} = 10\text{ V}$ ; see Figure 31
Charge Injection, $Q_{INJ}$	220			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 33
Off Isolation	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; see Figure 26
Channel-to-Channel Crosstalk	-58			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28
Total Harmonic Distortion + Noise	0.009			% typ	$R_L = 1\text{ k}\Omega$ , $15\text{ V p-p}$ , $f = 20\text{ Hz to } 20\text{ kHz}$ ; see Figure 29
-3 dB Bandwidth	53			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 27
Insertion Loss	-0.7			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27
$C_S$ (Off)	19			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ (Off)	92			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	132			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	45			$\mu\text{A}$ typ	$V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$
	55		70	$\mu\text{A}$ max	Digital inputs = 0 V or $V_{DD}$
$I_{SS}$	0.001			$\mu\text{A}$ typ	Digital inputs = 0 V or $V_{DD}$
			1	$\mu\text{A}$ max	
$V_{DD}/V_{SS}$			$\pm 9/\pm 22$	V min/max	GND = 0 V

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

**±20 V DUAL SUPPLY**

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

**Table 2.**

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			$V_{DD}$ to $V_{SS}$	V	
On Resistance, $R_{ON}$	9	13	15	$\Omega$ typ $\Omega$ max	$V_S = \pm 15\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 23 $V_{DD} = +18\text{ V}$ , $V_{SS} = -18\text{ V}$
On-Resistance Match Between Channels, $\Delta R_{ON}$	0.35			$\Omega$ typ	$V_S = \pm 15\text{ V}$ , $I_S = -10\text{ mA}$
On-Resistance Flatness, $R_{FLAT(ON)}$	0.7	0.9	1.1	$\Omega$ max	
	1.5			$\Omega$ typ	$V_S = \pm 15\text{ V}$ , $I_S = -10\text{ mA}$
	1.8	2.2	2.5	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.05$			nA typ	$V_{DD} = +22\text{ V}$ , $V_{SS} = -22\text{ V}$ $V_S = \pm 15\text{ V}$ , $V_D = \mp 15\text{ V}$ ; see Figure 24
Drain Off Leakage, $I_D$ (Off)	$\pm 0.25$ $\pm 0.1$	$\pm 0.75$	$\pm 6$	nA max nA typ	$V_S = \pm 15\text{ V}$ , $V_D = \mp 15\text{ V}$ ; see Figure 24
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.4$ $\pm 0.1$ $\pm 0.4$	$\pm 2$	$\pm 16$	nA max nA typ nA max	$V_S = V_D = \pm 15\text{ V}$ ; see Figure 25
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current, $I_{INL}$ or $I_{INH}$	0.002			$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{IN} = V_{GND}$ or $V_{DD}$
Digital Input Capacitance, $C_{IN}$	5		$\pm 0.1$	pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>					
Transition Time, $t_{TRANSITION}$	175			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	224	262	301	ns max	$V_S = +10\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	148			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	185	222	250	ns max	$V_S = 10\text{ V}$ ; see Figure 32
$t_{OFF}$ (EN)	120			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	142	159	173	ns max	$V_S = 10\text{ V}$ ; see Figure 32
Break-Before-Make Time Delay, $t_D$	40		10	ns typ ns min	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_{S1} = V_{S2} = 10\text{ V}$ ; see Figure 31
Charge Injection, $Q_{INJ}$	290			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 33
Off Isolation	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; see Figure 26
Channel-to-Channel Crosstalk	-58			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28
Total Harmonic Distortion + Noise	0.008			% typ	$R_L = 1\text{ k}\Omega$ , 20 V p-p, $f = 20\text{ Hz}$ to 20 kHz; see Figure 29
-3 dB Bandwidth	54			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 27
Insertion Loss	-0.6			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27
$C_S$ (Off)	18			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ (Off)	88			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	129			pF typ	$V_S = 0\text{ V}$ , $f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	50			$\mu\text{A}$ typ	$V_{DD} = +22\text{ V}$ , $V_{SS} = -22\text{ V}$ Digital inputs = 0 V or $V_{DD}$
	70		110	$\mu\text{A}$ max	
$I_{SS}$	0.001			$\mu\text{A}$ typ	Digital inputs = 0 V or $V_{DD}$
			1	$\mu\text{A}$ max	
$V_{DD}/V_{SS}$			$\pm 9/\pm 22$	V min/max	$GND = 0\text{ V}$

<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 3.**

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			0 V to $V_{DD}$	V	
On Resistance, $R_{ON}$	19			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$ ; see Figure 23
	22	27	31	$\Omega$ max	$V_{DD} = 10.8\text{ V}$ , $V_{SS} = 0\text{ V}$
On-Resistance Match Between Channels, $\Delta R_{ON}$	0.4			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$
	0.8	1	1.2	$\Omega$ max	
On-Resistance Flatness, $R_{FLAT(ON)}$	4.4			$\Omega$ typ	$V_S = 0\text{ V to }10\text{ V}$ , $I_S = -10\text{ mA}$
	5.5	6.5	7.5	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.02$			nA typ	$V_{DD} = 13.2\text{ V}$ , $V_{SS} = 0\text{ V}$
	$\pm 0.25$	$\pm 0.75$	$\pm 6$	nA max	$V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 24
Drain Off Leakage, $I_D$ (Off)	$\pm 0.05$			nA typ	$V_S = 1\text{ V}/10\text{ V}$ , $V_D = 10\text{ V}/1\text{ V}$ ; see Figure 24
	$\pm 0.4$	$\pm 2$	$\pm 16$	nA max	
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.05$			nA typ	$V_S = V_D = 1\text{ V}/10\text{ V}$ ; see Figure 25
	$\pm 0.4$	$\pm 2$	$\pm 16$	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, $I_{INL}$ or $I_{INH}$	0.002			$\mu\text{A}$ typ	$V_{IN} = V_{GND}$ or $V_{DD}$
			$\pm 0.1$	$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	5			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>					
Transition Time, $t_{TRANSITION}$	266			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	358	446	515	ns max	$V_S = +8\text{ V}$ ; see Figure 30
$t_{ON}$ (EN)	260			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	339	423	485	ns max	$V_S = 8\text{ V}$ ; see Figure 32
$t_{OFF}$ (EN)	135			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
	162	189	210	ns max	$V_S = 8\text{ V}$ ; see Figure 32
Break-Before-Make Time Delay, $t_D$	125			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$
			45	ns min	$V_{S1} = V_{S2} = 8\text{ V}$ ; see Figure 31
Charge Injection, $Q_{INJ}$	92			pC typ	$V_S = 6\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 33
Off Isolation	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 26
Channel-to-Channel Crosstalk	-58			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28
Total Harmonic Distortion + Noise	0.075			% typ	$R_L = 1\text{ k}\ \Omega$ , 6 V p-p, $f = 20\text{ Hz to }20\text{ kHz}$ ; see Figure 29
-3 dB Bandwidth	43			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 27
Insertion Loss	-1.36			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27
$C_S$ (Off)	22			pF typ	$V_S = 6\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ (Off)	105			pF typ	$V_S = 6\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	140			pF typ	$V_S = 6\text{ V}$ , $f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	40			$\mu\text{A}$ typ	$V_{DD} = 13.2\text{ V}$
	50		65	$\mu\text{A}$ max	Digital inputs = 0 V or $V_{DD}$
$V_{DD}$			9/40	V min/max	$GND = 0\text{ V}$ , $V_{SS} = 0\text{ V}$

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

**+36 V SINGLE SUPPLY**

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

**Table 4.**

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			0 V to $V_{DD}$	V	
On Resistance, $R_{ON}$	10.6 12	15	17	$\Omega$ typ $\Omega$ max	$V_S = 0\text{ V}$ to 30 V, $I_S = -10\text{ mA}$ ; see Figure 23 $V_{DD} = 32.4\text{ V}$ , $V_{SS} = 0\text{ V}$
On-Resistance Match Between Channels, $\Delta R_{ON}$	0.35			$\Omega$ typ	$V_S = 0\text{ V}$ to 30 V, $I_S = -10\text{ mA}$
On-Resistance Flatness, $R_{FLAT(ON)}$	0.7	0.9	1.1	$\Omega$ max	$V_S = 0\text{ V}$ to 30 V, $I_S = -10\text{ mA}$
	2.7			$\Omega$ typ	
	3.2	3.8	4.5	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.05$ $\pm 0.25$	$\pm 0.75$	$\pm 6$	nA typ nA max	$V_{DD} = 39.6\text{ V}$ , $V_{SS} = 0\text{ V}$ $V_S = 1\text{ V}/30\text{ V}$ , $V_D = 30\text{ V}/1\text{ V}$ ; see Figure 24
Drain Off Leakage, $I_D$ (Off)	$\pm 0.1$ $\pm 0.4$	$\pm 2$	$\pm 16$	nA typ nA max	$V_S = 1\text{ V}/30\text{ V}$ , $V_D = 30\text{ V}/1\text{ V}$ ; see Figure 24
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.1$ $\pm 0.4$	$\pm 2$	$\pm 16$	nA typ nA max	
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	$V_{IN} = V_{GND}$ or $V_{DD}$
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current, $I_{INL}$ or $I_{INH}$	0.002			$\mu\text{A}$ typ $\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	5		$\pm 0.1$	pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>1</sup></b>					
Transition Time, $t_{TRANSITION}$	196			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = 18\text{ V}$ ; see Figure 30
	256	276	314	ns max	
$t_{ON}$ (EN)	170			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = 18\text{ V}$ ; see Figure 32
	214	247	273	ns max	
$t_{OFF}$ (EN)	130			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = 18\text{ V}$ ; see Figure 32
	172	167	176	ns max	
Break-Before-Make Time Delay, $t_D$	52			ns typ	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_{S1} = V_{S2} = 18\text{ V}$ ; see Figure 31
			13	ns min	
Charge Injection, $Q_{INJ}$	280			pC typ	$V_S = 18\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; see Figure 33
Off Isolation	−78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 26
Channel-to-Channel Crosstalk	−58			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 28
Total Harmonic Distortion + Noise	0.03			% typ	$R_L = 1\text{ k}\ \Omega$ , 18 V p-p, $f = 20\text{ Hz}$ to 20 kHz; see Figure 29
−3 dB Bandwidth	47			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; see Figure 27
Insertion Loss	−0.85			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; see Figure 27
$C_S$ (Off)	18			pF typ	$V_S = 18\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ (Off)	89			pF typ	$V_S = 18\text{ V}$ , $f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	128			pF typ	$V_S = 18\text{ V}$ , $f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	80			$\mu\text{A}$ typ	$V_{DD} = 39.6\text{ V}$ Digital inputs = 0 V or $V_{DD}$
	100		130	$\mu\text{A}$ max	
$V_{DD}$			9/40	V min/max	$GND = 0\text{ V}$ , $V_{SS} = 0\text{ V}$

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

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

Table 5.

Parameter	25°C	85°C	125°C	Unit
CONTINUOUS CURRENT, S OR D				
$V_{DD} = +15\text{ V}, V_{SS} = -15\text{ V}$				
TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ )	165	96	49	mA max
LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )	290	141	57	mA max
$V_{DD} = +20\text{ V}, V_{SS} = -20\text{ V}$				
TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ )	176	101	51	mA max
LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )	282	146	58	mA max
$V_{DD} = 12\text{ V}, V_{SS} = 0\text{ V}$				
TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ )	114	72	42	mA max
LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )	203	112	53	mA max
$V_{DD} = 36\text{ V}, V_{SS} = 0\text{ V}$				
TSSOP ( $\theta_{JA} = 112.6^\circ\text{C/W}$ )	149	89	48	mA max
LFCSP ( $\theta_{JA} = 30.4^\circ\text{C/W}$ )	263	133	56	mA max



## ABSOLUTE MAXIMUM RATINGS

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

Table 6.

Parameter	Rating
$V_{DD}$ to $V_{SS}$	48 V
$V_{DD}$ to GND	-0.3 V to +48 V
$V_{SS}$ to GND	+0.3 V to -48 V
Analog Inputs <sup>1</sup>	$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or 30 mA, whichever occurs first
Digital Inputs <sup>1</sup>	$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or 30 mA, whichever occurs first
Peak Current, Sx or D Pins	515 mA (pulsed at 1 ms, 10% duty cycle maximum)
Continuous Current, S or D <sup>2</sup>	Data + 15%
Operating Temperature Range	-40°C to +125°C
Storage Temperature Range	-65°C to +150°C
Junction Temperature	150°C
Thermal Impedance, $\theta_{JA}$	
16-Lead TSSOP, $\theta_{JA}$ Thermal Impedance (4-Layer Board)	112.6°C/W
16-Lead LFCSP, $\theta_{JA}$ Thermal Impedance (4-Layer Board)	30.4°C/W
Reflow Soldering Peak Temperature, Pb Free	260(+0/-5)°C

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

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

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

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

### ESD CAUTION



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

# PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

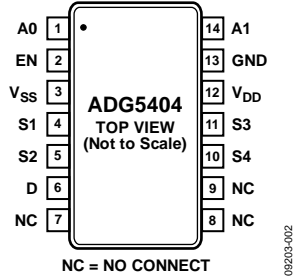
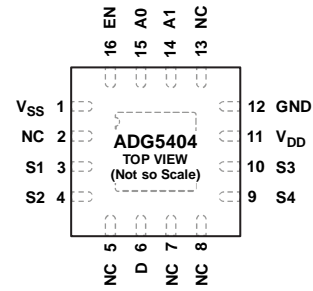


Figure 2. TSSOP Pin Configuration



- NOTES  
 1. NC = NO CONNECT.  
 2. EXPOSED PAD TIED TO SUBSTRATE, V<sub>SS</sub>.

Figure 3. LFCSP Pin Configuration

Table 7. Pin Function Descriptions

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

## TRUTH TABLE

Table 8.

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

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

TYPICAL PERFORMANCE CHARACTERISTICS

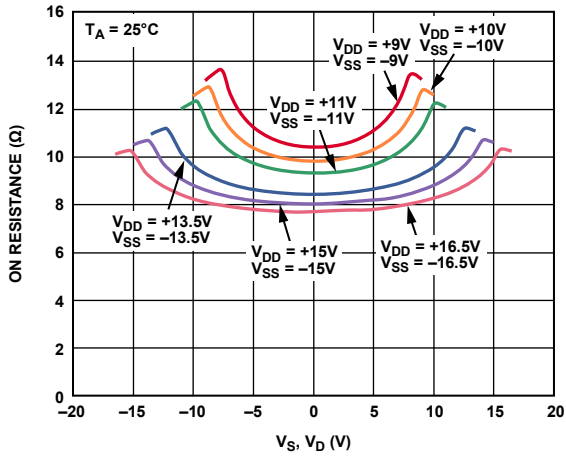


Figure 4.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Dual Supply

09203-029

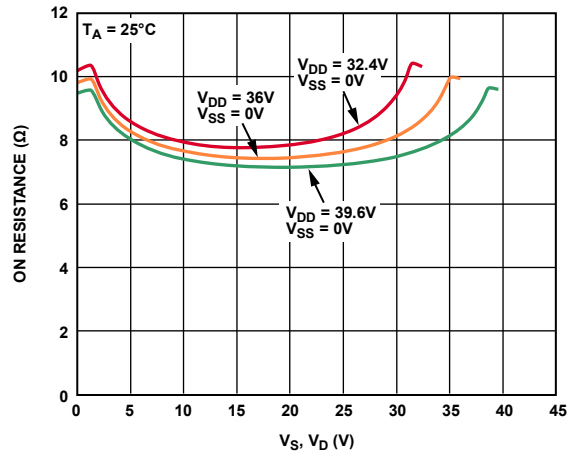


Figure 7.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Single Supply

09203-028

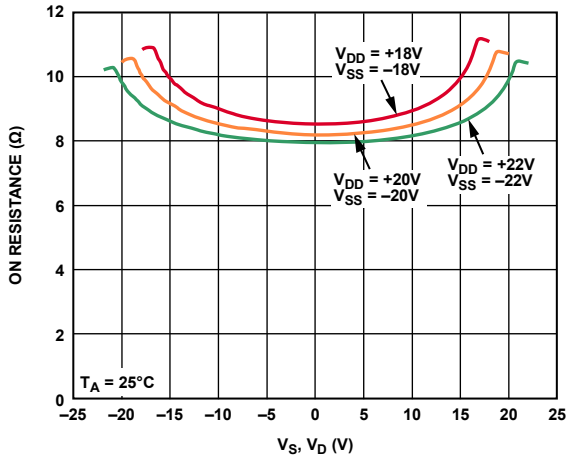


Figure 5.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Dual Supply

09203-030

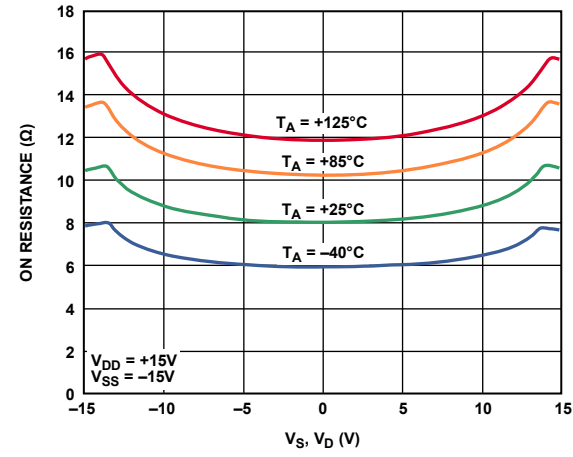


Figure 8.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures,  $\pm 15$  V Dual Supply

09203-023

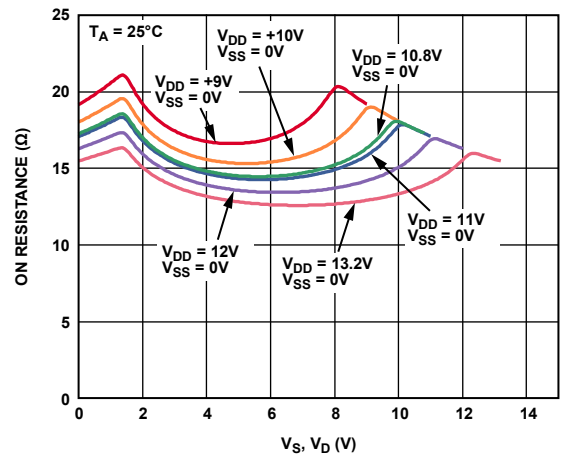


Figure 6.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Single Supply

09203-027

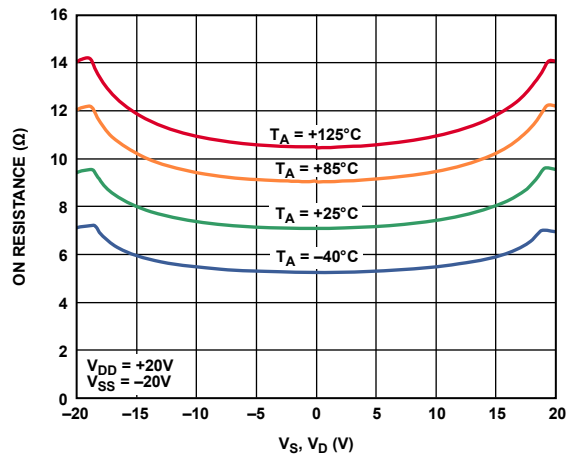


Figure 9.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures,  $\pm 20$  V Dual Supply

09203-024

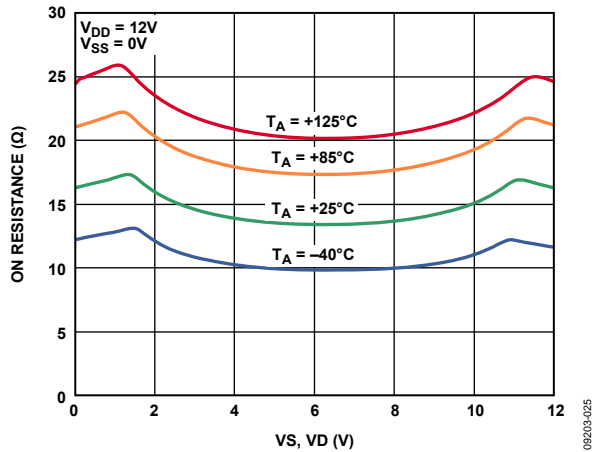


Figure 10.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures, 12 V Single Supply

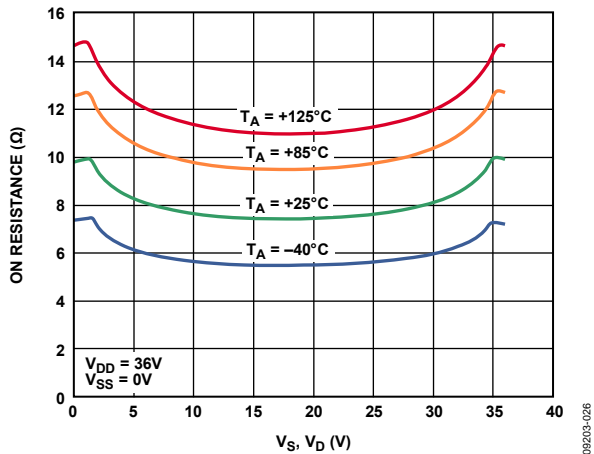


Figure 11.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures, 36 V Single Supply

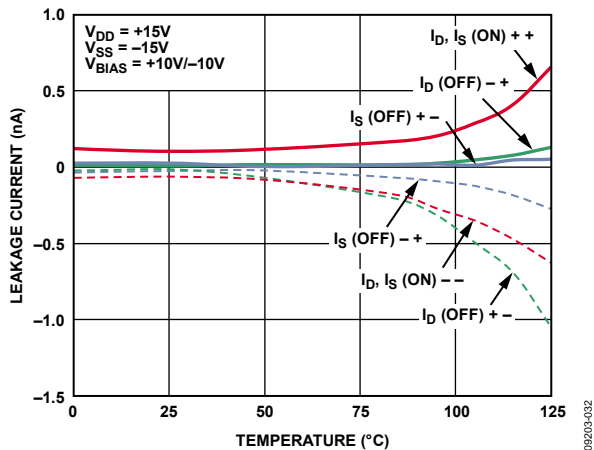


Figure 12. Leakage Currents vs. Temperature,  $\pm 15$  V Dual Supply

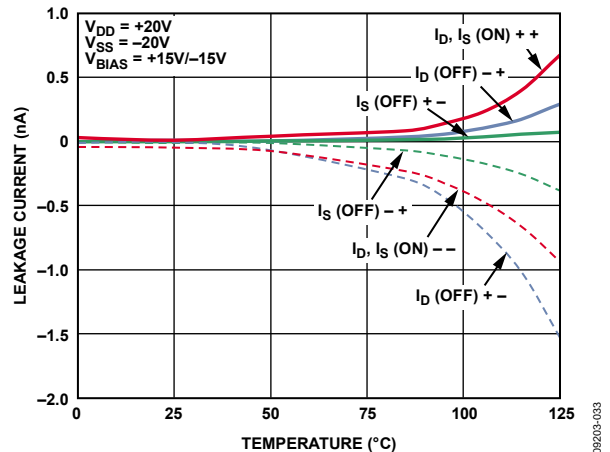


Figure 13. Leakage Currents vs. Temperature,  $\pm 20$  V Dual Supply

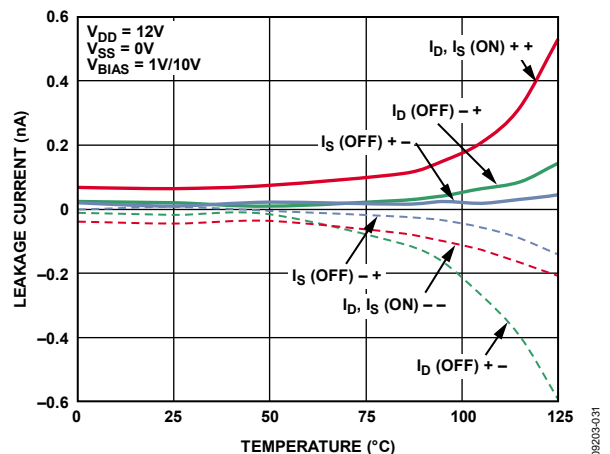


Figure 14. Leakage Currents vs. Temperature, 12 V Single Supply

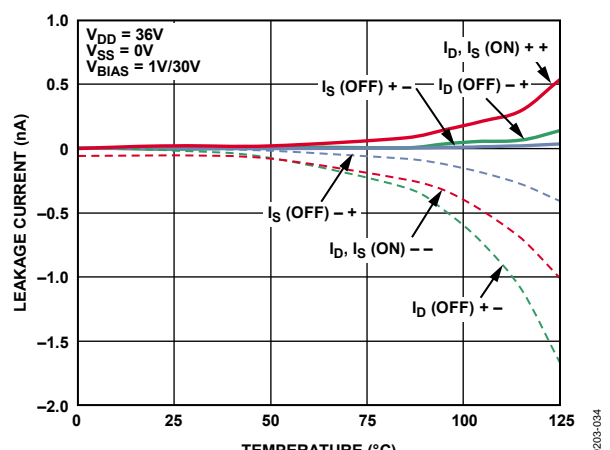


Figure 15. Leakage Currents vs. Temperature, 36 V Single Supply

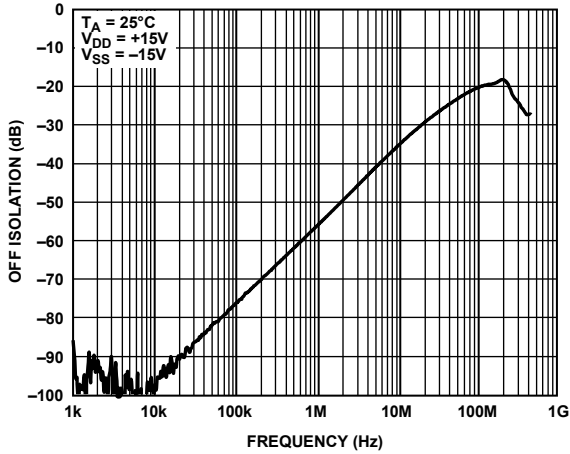


Figure 16. Off Isolation vs. Frequency,  $\pm 15\text{ V}$  Dual Supply

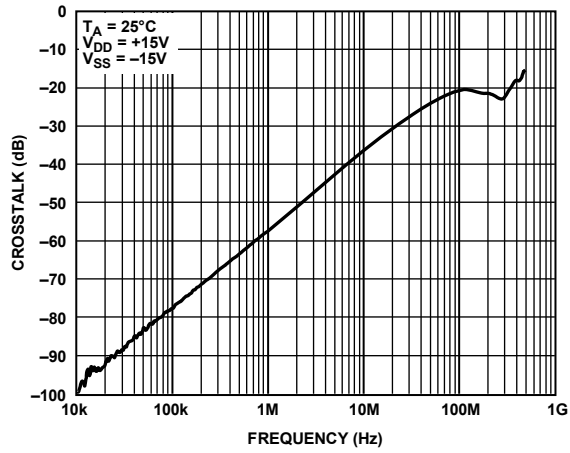


Figure 17. Crosstalk vs. Frequency,  $\pm 15\text{ V}$  Dual Supply

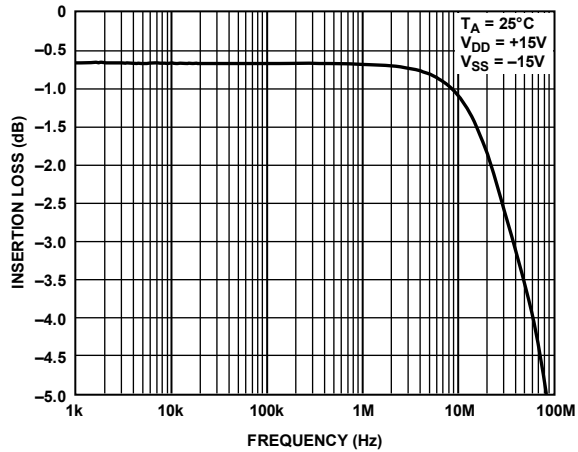


Figure 18. On Response vs. Frequency,  $\pm 15\text{ V}$  Dual Supply

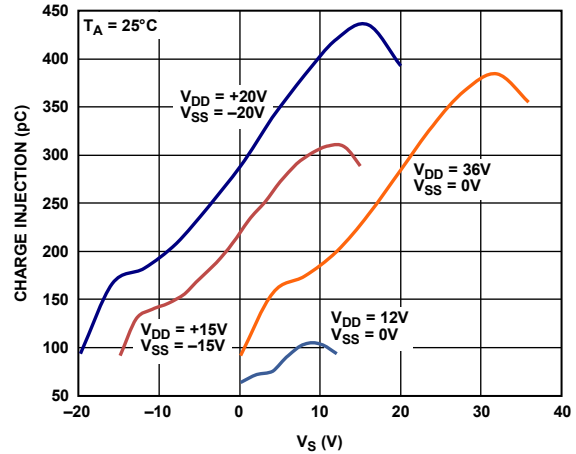


Figure 19. Charge Injection vs. Source Voltage

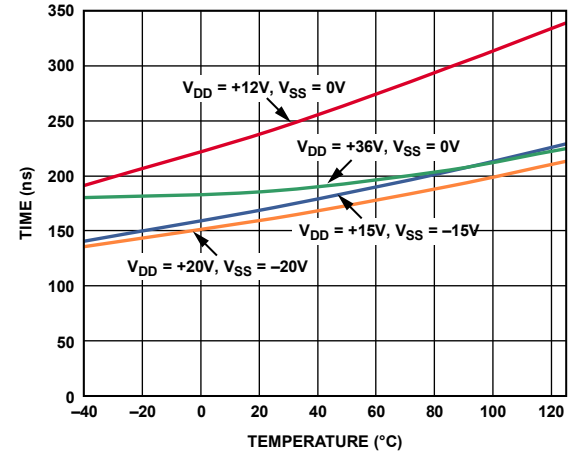


Figure 20. Transition Time vs. Temperature

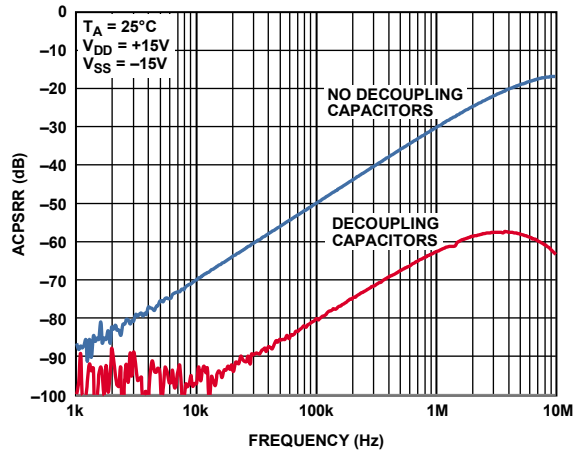


Figure 21. ACPSRR vs. Frequency,  $\pm 15\text{ V}$  Dual Supply

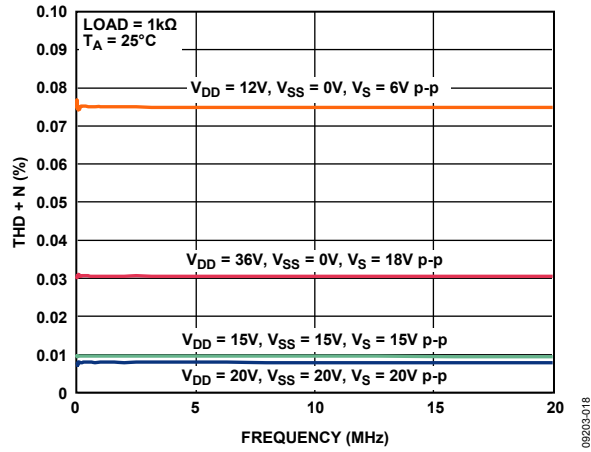


Figure 22. THD + N vs. Frequency, ±15 V Dual Supply

TEST CIRCUITS

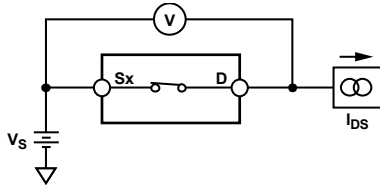
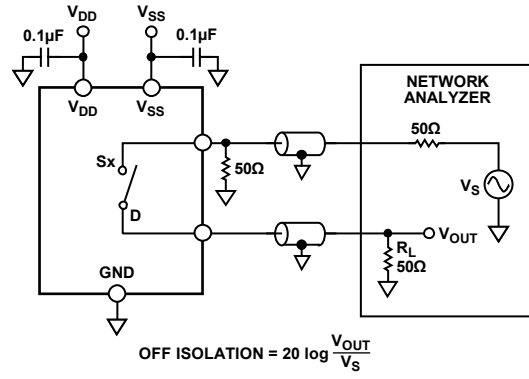


Figure 23. On Resistance

09203-005



$$\text{OFF ISOLATION} = 20 \log \frac{V_{\text{OUT}}}{V_s}$$

Figure 26. Off Isolation

09203-008

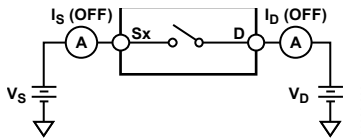
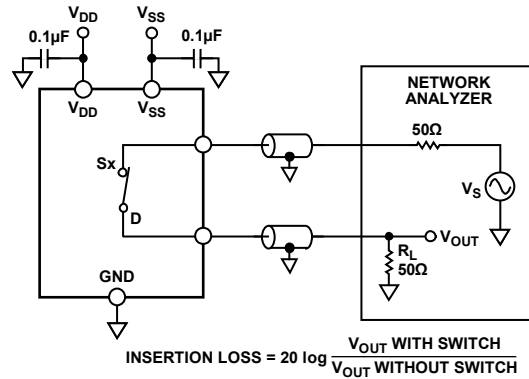


Figure 24. Off Leakage

09203-006



$$\text{INSERTION LOSS} = 20 \log \frac{V_{\text{OUT WITH SWITCH}}}{V_{\text{OUT WITHOUT SWITCH}}}$$

Figure 27. Bandwidth

09203-009

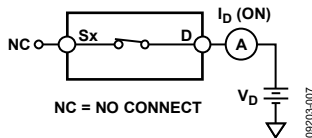
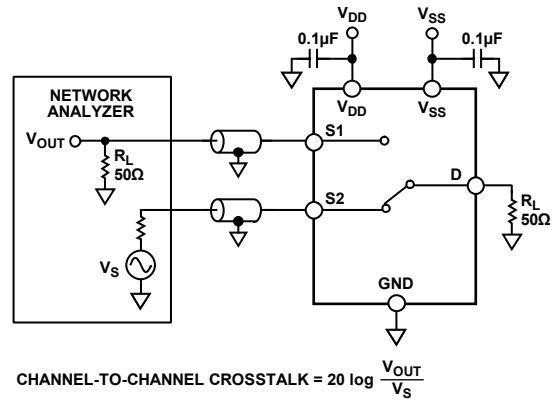


Figure 25. On Leakage

09203-007



$$\text{CHANNEL-TO-CHANNEL CROSSTALK} = 20 \log \frac{V_{\text{OUT}}}{V_s}$$

Figure 28. Channel-to-Channel Crosstalk

09203-010

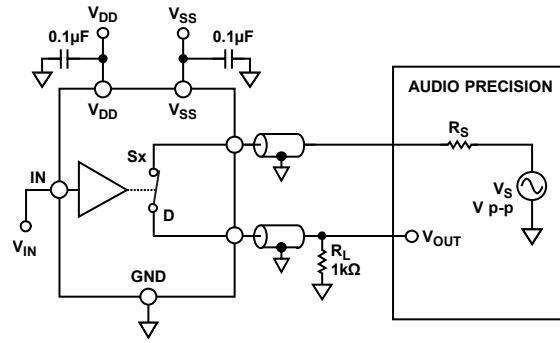


Figure 29. THD + Noise

09203-011

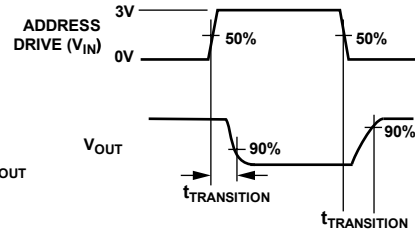
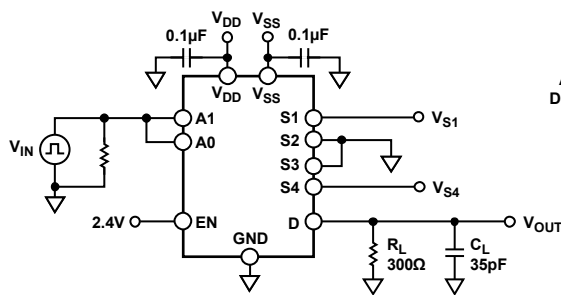


Figure 30. Address to Output Switching Times

09203-012

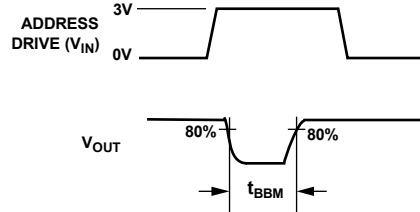
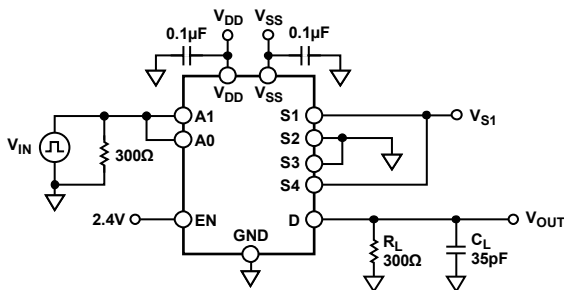


Figure 31. Break-Before-Make Time Delay

09203-013



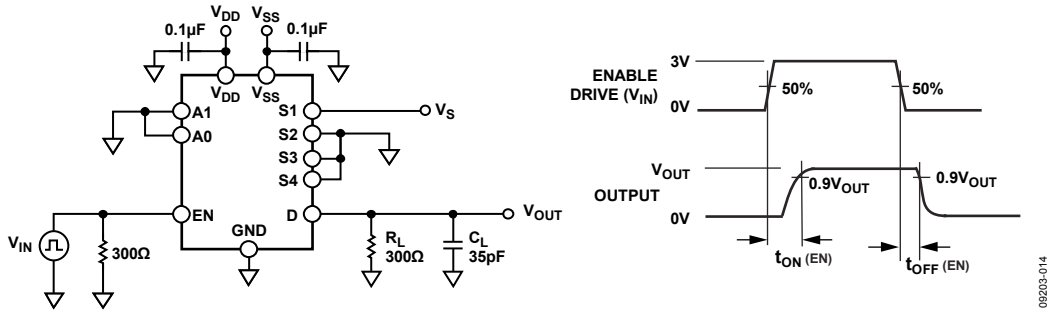


Figure 32. Enable-to-Output Switching Delay

092203-014

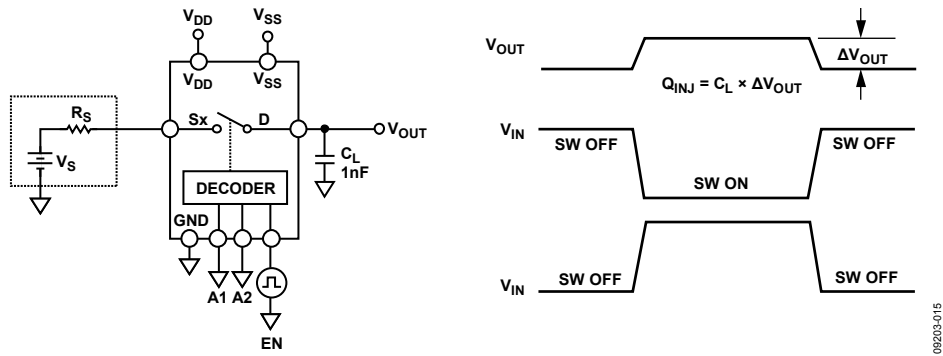


Figure 33. Charge Injection

092203-015

## TERMINOLOGY

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

The positive supply current.

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

The negative supply current.

**V<sub>D</sub> (V<sub>S</sub>)**

The analog voltage on Terminal D and Terminal S.

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

The ohmic resistance between Terminal D and Terminal S.

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

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

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

The source leakage current with the switch off.

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

The drain leakage current with the switch off.

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

The channel leakage current with the switch on.

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

The maximum input voltage for Logic 0.

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

The minimum input voltage for Logic 1.

**I<sub>INL</sub> (I<sub>INH</sub>)**

The input current of the digital input.

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

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

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

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

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

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

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

The digital input capacitance.

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

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

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

The delay between applying the digital control input and the output switching on. See Figure 32.

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

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

### 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.

### ACPSRR (AC Power Supply Rejection Ratio)

The ratio of the amplitude of signal on the output to the amplitude of the modulation. This is a measure of the part's ability 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.

## TRENCH ISOLATION

In the ADG5404, an insulating oxide layer (trench) is placed between the NMOS and the PMOS transistors of each CMOS switch. Parasitic junctions, which occur between the transistors in junction-isolated switches, are eliminated, and the result is a completely latch-up proof switch.

In junction isolation, the N and P wells of the PMOS and NMOS transistors form a diode that is reverse-biased under normal operation. However, during overvoltage conditions, this diode can become forward-biased. A silicon-controlled rectifier (SCR) type circuit is formed by the two transistors, causing a significant amplification of the current that, in turn, leads to latch-up. With trench isolation, this diode is removed, and the result is a latch-up proof switch.

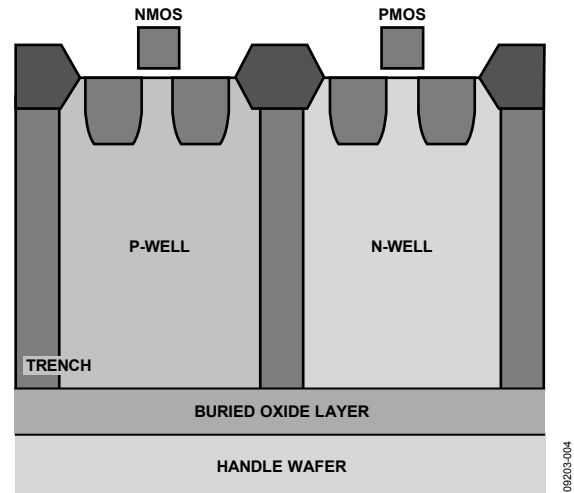


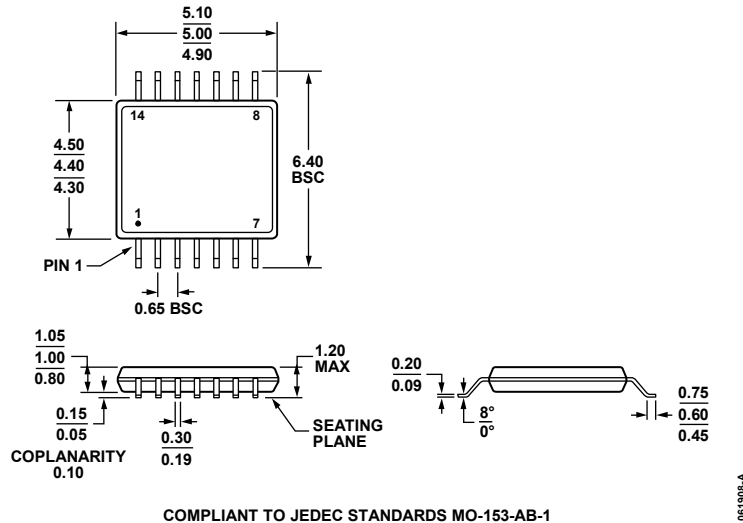
Figure 34. Trench Isolation

## APPLICATIONS INFORMATION

The ADG54xx family of switches and multiplexers provide a robust solution for instrumentation, industrial, automotive, aerospace, and other harsh environments that are prone to latch-up, which is an undesirable high current state that can lead to device failure and persists until the power supply is turned off. The ADG5404 high voltage multiplexer allows

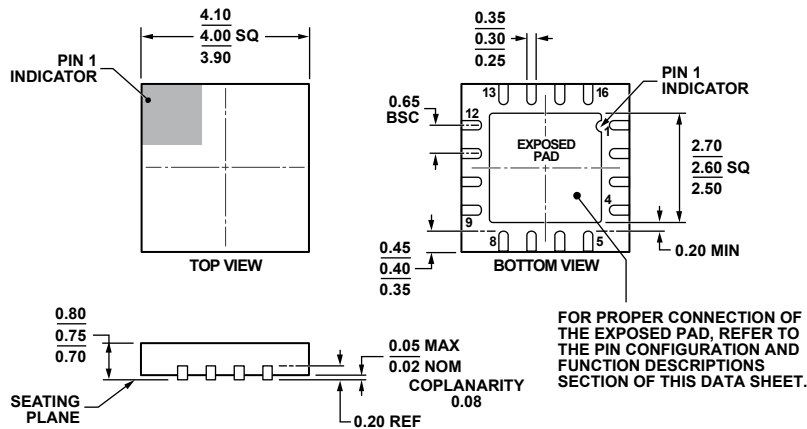
single-supply operation from 9 V to 40 V and dual-supply operation from  $\pm 9$  V to  $\pm 22$  V. The ADG5404, as well as three other ADG54xx family members, [ADG5412/ADG5413](#) and [ADG5436](#), achieve an 8 kV human body model ESD rating that provides a robust solution and eliminates the need for separate protection circuitry designs in some applications.

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB-1

Figure 35. 14-Lead Thin Shrink Small Outline Package [TSSOP] (RU-14)  
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-WGGC.

Figure 36. 16-Lead Lead Frame Chip Scale Package [LFCSP] 4 mm x 4 mm Body and 0.75 mm Package Height (CP-16-17)  
Dimensions shown in millimeters

ORDERING GUIDE

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
ADG5404BRUZ	-40°C to +125°C	14-Lead Thin Shrink Small Outline Package [TSSOP]	RU-14
ADG5404BRUZ-REEL7	-40°C to +125°C	14-Lead Thin Shrink Small Outline Package [TSSOP]	RU-14
ADG5404BCPZ-REEL7	-40°C to +125°C	16-Lead Lead Frame Chip Scale Package [LFCSP]	CP-16-17

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