

1.5 Ω R_{ON} , Quad SPST Switch with 1.2 V and 1.8 V JEDEC Logic Compliance

FEATURES

- ▶ 1.5 Ω on resistance for ± 15 V dual supply at 25°C
- ▶ 0.3 Ω on-resistance flatness for ± 15 V dual supply at 25°C
- ▶ 0.1 Ω on-resistance match between channels for ± 15 V dual supply at 25°C
- ▶ Fully specified at ± 15 V, +12 V, ± 5 V
 - ▶ ± 4.5 V to ± 16.5 V dual-supply operation
 - ▶ 5 V to 16.5 V single-supply operation
- ▶ V_L supply for low logic-level compatibility
 - ▶ 1.8 V JEDEC standard compliant (JESD8-7A)
 - ▶ 1.2 V JEDEC standard compliant (JESD8-12A.01)
- ▶ Rail-to-rail operation
- ▶ 24-lead, 4 mm $\times$ 4 mm LFCSP

APPLICATIONS

- ▶ Automated test equipment
- ▶ Data-acquisition systems
- ▶ Battery-powered systems
- ▶ Sample-and-hold systems
- ▶ FPGA and microcontroller systems
- ▶ Audio signal routing
- ▶ Video signal routing
- ▶ Communications systems
- ▶ Relay replacement

GENERAL DESCRIPTION

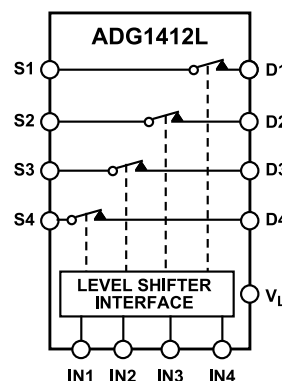
The ADG1412L is a monolithic complementary metal-oxide semiconductor (CMOS) device containing four independently selectable switches designed on an iCMOS[®] process. Industrial CMOS (iCMOS) is a modular manufacturing process combining high voltage CMOS and bipolar technologies.

The on-resistance profile is flat over the full analog input range, ensuring excellent linearity and low distortion (1.5 Ω typical) when switching signals.

The ADG1412L contains four independent SPST switches, and these switches are turned on with Logic 1. 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.

An external V_L supply provides flexibility for lower logic control. The ADG1412L is both 1.2 V and 1.8 V JEDEC standard compliant.

FUNCTIONAL BLOCK DIAGRAM



NOTES
1. SWITCHES SHOWN FOR A 1 INPUT LOGIC. 001

Figure 1. Functional Block Diagram

PRODUCT HIGHLIGHTS

1. 2.6 Ω maximum on resistance over temperature.
2. Minimum distortion.
3. V_L supply for low logic-level compatibility.
4. JEDEC standard compliant for both 1.2 V and 1.8 V logic levels.
5. Guaranteed switch off when digital inputs are floating.
6. 24-lead, 4 mm $\times$ 4 mm LFCSP.

TABLE OF CONTENTS

Features.....	1	Test Circuits.....	14
Applications.....	1	Terminology.....	16
General Description.....	1	Theory of Operation.....	17
Functional Block Diagram.....	1	Switch Architecture.....	17
Product Highlights.....	1	V _L Flexibility.....	17
Specifications.....	3	1.2 V and 1.8 V JEDEC Compliance.....	17
Operating Supply Voltages.....	3	Initialization Time.....	17
±15 V Dual Supply.....	3	Switches in a Known State.....	17
+12 V Single Supply.....	4	Applications Information.....	18
±5 V Dual Supply.....	5	Field Programmable Grid Array (FPGA) Low	
Continuous Current per Channel, Sx OR Dx.....	7	Logic Compliance.....	18
Absolute Maximum Ratings.....	8	V _{OH} and V _{OL} and V _{INH} and V _{INL} Relationship..	18
Thermal Resistance.....	8	Power-Supply Rails.....	18
Electrostatic Discharge (ESD) Ratings.....	8	Outline Dimensions.....	19
ESD Caution.....	8	Ordering Guide.....	19
Pin Configuration and Function Descriptions.....	9	Evaluation Boards.....	19
Typical Performance Characteristics.....	10		

REVISION HISTORY**8/2022—Revision 0: Initial Version**

SPECIFICATIONS

OPERATING SUPPLY VOLTAGES

Table 1. Operating Supply Voltages

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
SUPPLY VOLTAGE					
Dual	±4.5		±16.5	V	V_{DD} to V_{SS}
Single	5		16.5	V	V_{DD} to GND, $V_{SS} = \text{GND} = 0 \text{ V}$
DIGITAL VOLTAGE					
Single	1.1		1.3	V	V_L to GND, I_{NX} voltage (V_{INX}) = 1.2 V logic
	1.65		1.95	V	V_L to GND, $V_{INX} = 1.8 \text{ V}$ logic

±15 V DUAL SUPPLY

$V_{DD} = 15 \text{ V} \pm 10\%$, $V_{SS} = -15 \text{ V} \pm 10\%$, $\text{GND} = 0 \text{ V}$, and $V_L = 1.1 \text{ V}$ to 1.95 V , unless otherwise noted.

Table 2. ±15 V Dual Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			V_{DD} to V_{SS}	V	
On Resistance, R_{ON}	1.5			Ω typ	Source voltage (V_S) = $\pm 10 \text{ V}$, source current (I_S) = -10 mA, see Figure 26
	1.8	2.3	2.6	Ω max	$V_{DD} = +13.5 \text{ V}$, $V_{SS} = -13.5 \text{ V}$
On-Resistance Match Between Channels, ΔR_{ON}	0.1			Ω typ	$V_S = \pm 10 \text{ V}$, $I_S = -10 \text{ mA}$
	0.18	0.19	0.21	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	0.3			Ω typ	$V_S = \pm 10 \text{ V}$, $I_S = -10 \text{ mA}$
	0.36	0.4	0.45	Ω max	
LEAKAGE CURRENTS					$V_{DD} = +16.5 \text{ V}$, $V_{SS} = -16.5 \text{ V}$
Source Off Leakage, I_S (Off)	±0.03			nA typ	$V_S = \pm 10 \text{ V}$, drain voltage (V_D) = $\mp 10 \text{ V}$, see Figure 27
	±0.55	±2	±12.5	nA max	
Drain Off Leakage, I_D (Off)	±0.03			nA typ	$V_S = \pm 10 \text{ V}$, $V_D = \mp 10 \text{ V}$, see Figure 27
	±0.55	±2	±12.5	nA max	
Channel On Leakage, I_D , I_S (On)	±0.15			nA typ	$V_S = V_D = \pm 10 \text{ V}$, see Figure 28
	±2	±4	±30	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			$0.65 \times V_L$	V min	
Input Low Voltage, V_{INL}			$0.35 \times V_L$	V max	
Input High Current, I_{INH}	55			μA typ	$V_{INX} = V_L = 1.8 \text{ V}$, see the Theory of Operation section
			90	μA max	
	40			μA typ	$V_{INX} = V_L = 1.2 \text{ V}$, see the Theory of Operation section
			65	μA max	
Input Low Current, I_{INL}	0.2			μA typ	$V_{INX} = 0 \text{ V}$
			0.8	μA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t_{ON} ¹	110			ns typ	Load resistance (R_L) = 300 Ω , load capacitance (C_L) = 35 pF
	133	152	167	ns max	$V_S = 10 \text{ V}$, see Figure 33
Off Time, t_{OFF} ¹	161			ns typ	$R_L = 300 \Omega$, $C_L = 35 \text{ pF}$
	200	225	245	ns max	$V_S = 10 \text{ V}$, see Figure 33
Charge Injection, Q_{INJ}	-20			pC typ	$V_S = 0 \text{ V}$, $R_S = 0 \Omega$, $C_L = 1 \text{ nF}$, see Figure 34

SPECIFICATIONS

Table 2. ± 15 V Dual Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
Off Isolation	-76			dB typ	$R_L = 50\ \Omega$, $C_L = 5\ \text{pF}$, frequency = 100 kHz, see Figure 29
Channel-to-Channel Crosstalk	-100			dB typ	$R_L = 50\ \Omega$, $C_L = 5\ \text{pF}$, frequency = 1 MHz, see Figure 30
Total Harmonic Distortion, THD	-101			dB typ	$R_L = 10\ \text{k}\Omega$, 20 V p-p, frequency = 20 kHz, see Figure 32
	-89			dB typ	$R_L = 10\ \text{k}\Omega$, 20 V p-p, frequency = 100 kHz, see Figure 32
Total Harmonic Distortion + Noise, THD + N	0.004			% typ	$R_L = 10\ \text{k}\Omega$, 20 V p-p, frequency = 100 kHz, see Figure 32
-3 dB Bandwidth	170			MHz typ	$R_L = 50\ \Omega$, $C_L = 5\ \text{pF}$, see Figure 31
Insertion Loss	-0.2			dB typ	$R_L = 50\ \Omega$, $C_L = 5\ \text{pF}$, frequency = 1 MHz, see Figure 31
Source Off Capacitance, C_S (Off)	22			pF typ	$V_S = 0\ \text{V}$, frequency = 1 MHz
Drain Off Capacitance, C_D (Off)	23			pF typ	$V_S = 0\ \text{V}$, frequency = 1 MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	113			pF typ	$V_S = 0\ \text{V}$, frequency = 1 MHz
POWER REQUIREMENTS					
Positive Supply Current, I_{DD}	55		95	μA typ μA max	$V_{DD} = +16.5\ \text{V}$, $V_{SS} = -16.5\ \text{V}$ Digital inputs = 0 V or V_{VL}
Negative Supply Current, I_{SS}	0.01		1	μA typ μA max	Digital inputs = 0 V or V_{VL}
Digital Supply Current, I_{VL}	45		70	μA typ μA max	$V_{INx} = V_L = 1.8\ \text{V}$
	30		55	μA typ μA max	$V_{INx} = V_L = 1.2\ \text{V}$

¹ A minimum 50 μs initialization time is required before applying an INx input. See the Theory of Operation section.

+12 V SINGLE SUPPLY

$V_{DD} = 12\ \text{V} \pm 10\%$, $V_{SS} = 0\ \text{V}$, $\text{GND} = 0\ \text{V}$, and $V_L = 1.1\ \text{V}$ to $1.95\ \text{V}$, unless otherwise noted.

Table 3. +12 V Single Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V_{DD}	V	
On Resistance, R_{ON}	2.8			Ω typ	$V_S = 0\ \text{V}$ to 10 V, $I_S = -10\ \text{mA}$, see Figure 26
	3.5	4.3	4.8	Ω max	$V_{DD} = 10.8\ \text{V}$, $V_{SS} = 0\ \text{V}$
On-Resistance Match	0.13			Ω typ	$V_S = 0\ \text{V}$ to 10 V, $I_S = -10\ \text{mA}$
Between Channels, ΔR_{ON}					
	0.21	0.23	0.25	Ω max	
On-Resistance Flatness, $R_{\text{FLAT(ON)}}$	0.6			Ω typ	$V_S = 0\ \text{V}$ to 10 V, $I_S = -10\ \text{mA}$
	1.1	1.2	1.3	Ω max	
LEAKAGE CURRENTS					
Source Off Leakage, I_S (Off)	± 0.02			nA typ	$V_{DD} = 10.8\ \text{V}$, $V_{SS} = 0\ \text{V}$
	± 0.55	± 2	± 12.5	nA max	$V_S = 1\ \text{V}/10\ \text{V}$, $V_D = 10\ \text{V}/0\ \text{V}$, see Figure 27
Drain Off Leakage, I_D (Off)	± 0.02			nA typ	$V_S = 1\ \text{V}/10\ \text{V}$, $V_D = 10\ \text{V}/0\ \text{V}$, see Figure 27
	± 0.55	± 2	± 12.5	nA max	
Channel On Leakage, I_D , I_S (On)	± 0.15			nA typ	$V_S = V_D = 1\ \text{V}/10\ \text{V}$, see Figure 28
	± 1.5	± 4	± 30	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			$0.65 \times V_L$	V min	
Input Low Voltage, V_{INL}			$0.35 \times V_L$	V max	
Input High Current, I_{INH}	55			μA typ	$V_{INx} = V_L = 1.8\ \text{V}$, see the Theory of Operation section

SPECIFICATIONS

Table 3. +12 V Single Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
Input Low Current, I_{INL}			90	μA max	$V_{INx} = V_L = 1.2\text{ V}$, see the Theory of Operation section
	40			μA typ	
			65	μA max	
	0.2			μA typ	
			0.8	μA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	$V_{INx} = 0\text{ V}$
DYNAMIC CHARACTERISTICS					
On Time, t_{ON} ¹	182	269	300	ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$
	225			ns max	$V_S = 8\text{ V}$, see Figure 33
Off Time, t_{OFF} ¹	175	262	295	ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$
	230			ns max	$V_S = 8\text{ V}$, see Figure 33
Charge Injection, Q_{INJ}	10			pC typ	$V_S = 6\text{ V}$, $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$, see Figure 34
Off Isolation	-76			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, frequency = 100 kHz, see Figure 29
Channel-to-Channel Crosstalk	-100			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, frequency = 1 MHz, see Figure 30
Total Harmonic Distortion, THD	-87			dB typ	$R_L = 10\text{ k}\Omega$, 9 V p-p, frequency = 20 kHz, see Figure 32
	-83			dB typ	$R_L = 10\text{ k}\Omega$, 9 V p-p, frequency = 100 kHz, see Figure 32
Total Harmonic Distortion + Noise, THD + N	0.007			% typ	$R_L = 10\text{ k}\Omega$, 9 V p-p, frequency = 100 kHz, see Figure 32
-3 dB Bandwidth	130			MHz typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, see Figure 31
Insertion Loss	-0.3			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, frequency = 1 MHz, see Figure 31
Source Off Capacitance, C_S (Off)	29			pF typ	$V_S = 6\text{ V}$, frequency = 1 MHz
Drain Off Capacitance, C_D (Off)	30			pF typ	$V_S = 6\text{ V}$, frequency = 1 MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	116			pF typ	$V_S = 6\text{ V}$, frequency = 1 MHz
POWER REQUIREMENTS					
Positive Supply Current, I_{DD}	55			μA typ	$V_{DD} = 13.2\text{ V}$
			95	μA max	Digital inputs = 0 V or V_{VL}
Digital Supply Current, I_{VL}	45			μA typ	$V_{INx} = V_L = 1.8\text{ V}$
			70	μA max	
	30			μA typ	$V_{INx} = V_L = 1.2\text{ V}$
			55	μA max	

¹ A minimum 50 μs initialization time is required before applying an INx input. See the [Theory of Operation](#) section.

 $\pm 5\text{ V}$ DUAL SUPPLY

$V_{DD} = 5\text{ V} \pm 10\%$, $V_{SS} = -5\text{ V} \pm 10\%$, GND = 0 V, and $V_L = 1.1\text{ V}$ to 1.95 V, unless otherwise noted.

Table 4. $\pm 5\text{ V}$ Dual Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			V _{DD} to V _{SS}	V	
On Resistance, R _{ON}	3.3	4.9	5.4	Ω typ	V _S = ±4.5 V, I _S = -10 mA, see Figure 26
	4			Ω max	V _{DD} = +4.5 V, V _{SS} = -4.5 V
On-Resistance Match Between Channels, ΔR _{ON}	0.13			Ω typ	V _S = ±4.5 V, I _S = -10 mA
On-Resistance Flatness, R _{FLAT(ON)}	0.22	0.23	0.25	Ω max	V _S = ±4.5 V, I _S = -10 mA
	0.9			Ω typ	
		1.1	1.24	1.31	
LEAKAGE CURRENTS					
Source Off Leakage, I _S (Off)	±0.03			nA typ	V _{DD} = +5.5 V, V _{SS} = -5.5 V
					V _S = ±4.5 V, V _D = ∓4.5 V, see Figure 27

SPECIFICATIONS

Table 4. ± 5 V Dual Supply

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
Drain Off Leakage, I _D (Off)	±0.55 ±0.03	±2	±12.5	nA max nA typ	V _S = ±4.5 V, V _D = ∓4.5 V, see Figure 27
Channel On Leakage, I _D , I _S (On)	±0.55 ±0.05 ±1.0	±2 ±4	±12.5 ±30	nA max nA typ nA max	V _S = V _D = ±4.5 V, see Figure 28
DIGITAL INPUTS					
Input High Voltage, V _{INH}			0.65 × V _L	V min	V _{INX} = V _L = 1.8 V, see the Theory of Operation section
Input Low Voltage, V _{INL}			0.35 × V _L	V max	
Input High Current, I _{INH}	55		90	μA typ μA max	V _{INX} = V _L = 1.2 V, see the Theory of Operation section
	40		65	μA typ μA max	V _{INX} = 0 V
Input Low Current, I _{INL}	0.2		0.8	μA typ μA max	
Digital-Input Capacitance, C _{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t _{ON} ¹	252 333	388	432	ns typ ns max	R _L = 300 Ω, C _L = 35 pF V _S = 3 V, see Figure 33
Off Time, t _{OFF} ¹	256 345			ns typ ns max	R _L = 300 Ω, C _L = 35 pF V _S = 3 V, see Figure 33
Charge Injection, Q _{INJ}	10	391	422	ns max pC typ	V _S = 0 V, R _S = 0 Ω, C _L = 1 nF, see Figure 34
Off Isolation	-76			dB typ	R _L = 50 Ω, C _L = 5 pF, frequency = 100 kHz, see Figure 29
Channel-to-Channel Crosstalk	-100			dB typ	R _L = 50 Ω, C _L = 5 pF, frequency = 1 MHz, see Figure 30
Total Harmonic Distortion, THD	-90			dB typ	R _L = 10 kΩ, 10 V p-p, frequency = 20 kHz, see Figure 32
	-78			dB typ	R _L = 10 kΩ, 10 V p-p, frequency = 100 kHz, see Figure 32
Total Harmonic Distortion + Noise, THD + N	0.02			% typ	R _L = 10 kΩ, 10 V p-p, frequency = 100 kHz, see Figure 32
-3 dB Bandwidth	130			MHz typ	R _L = 50 Ω, C _L = 5 pF, see Figure 31
Insertion Loss	-0.3			dB typ	R _L = 50 Ω, C _L = 5 pF, frequency = 1 MHz, see Figure 31
Source Off Capacitance, C _S (Off)	32			pF typ	V _S = 0 V, frequency = 1 MHz
Source Off Capacitance, C _D (Off)	33			pF typ	V _S = 0 V, frequency = 1 MHz
Drain On Capacitance, C _D (On), Source On Capacitance, C _S (On)	116			pF typ	V _S = 0 V, frequency = 1 MHz
POWER REQUIREMENTS					
Positive Supply Current, I _{DD}	50		90	μA typ μA max	V _{DD} = +5.5 V, V _{SS} = -5.5 V Digital inputs = 0 V or V _{VL}
Negative Supply Current, I _{SS}	0.01		1.0	μA typ μA max	Digital inputs = 0 V or V _{VL}
Digital Supply Current, I _{VL}	45		70	μA typ μA max	V _{INX} = V _L = 1.8 V
	30		55	μA typ μA max	V _{INX} = V _L = 1.2 V

¹ A minimum 50 μ s initialization time is required before applying an INx input. See the [Theory of Operation](#) section.

SPECIFICATIONS

CONTINUOUS CURRENT PER CHANNEL, SX OR DX

Table 5. Four Channels On

Parameter	25°C	85°C	125°C	Unit
CONTINUOUS CURRENT, Sx OR Dx ¹ ($\theta_{JA} = 45^{\circ}\text{C/W.}$)				
$V_{DD} = +15\text{ V}, V_{SS} = -15\text{ V}$	321	174	80	mA maximum
$V_{DD} = +5\text{ V}, V_{SS} = -5\text{ V}$	242	143	74	mA maximum
$V_{DD} = 12\text{ V}, V_{SS} = 0\text{ V}$	260	150	76	mA maximum

¹ Sx refer to S1 to S4 pins, and Dx refers to the D1 to D4 pins.

Table 6. One Channel On

Parameter	25°C	85°C	125°C	Unit
CONTINUOUS CURRENT, Sx OR Dx ¹ ($\theta_{JA} = 45^{\circ}\text{C/W.}$)				
$V_{DD} = +15\text{ V}, V_{SS} = -15\text{ V}$	572	244	88	mA maximum
$V_{DD} = +5\text{ V}, V_{SS} = -5\text{ V}$	436	211	85	mA maximum
$V_{DD} = 12\text{ V}, V_{SS} = 0\text{ V}$	467	220	86	mA maximum

¹ Sx refer to S1 to S4 pins, and Dx refers to the D1 to D4 pins.

ABSOLUTE MAXIMUM RATINGS

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

Table 7. Absolute Maximum Ratings

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
V_I to GND	−0.3 V to +2.25 V
Analog Inputs ¹	$V_{SS} - 0.3$ V to $V_{DD} + 0.3$ V or 30 mA, whichever occurs first
Digital Inputs ²	GND − 0.3 V to 2.25 V or 30 mA, whichever occurs first
Peak Current, Sx or Dx Pins ³	650 mA (pulsed at 1 ms, 10% duty-cycle maximum)
Continuous Current, Sx or Dx Pins ³	Data + 15% ⁴
Temperature	
Operating Range	−40°C to +125°C
Storage Range	−65°C to +150°C
Junction	150°C
Reflow Soldering Peak, Pb-Free	As per JEDEC J-STD-020

¹ Overvoltages at the INx, Sx, and Dx pins are clamped by internal diodes. Current must be limited to the maximum ratings given.

² Overvoltages at the INx digital-input pins are clamped by internal diodes.

³ Sx refers to the S1 to S4 pins, and Dx refers to the D1 to D4 pins.

⁴ See Table 5 and Table 6.

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.

THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

θ_{JA} is the natural convection junction-to-ambient thermal resistance measured in a one cubic foot sealed enclosure, and θ_{JC} is the junction-to-case thermal resistance.

Table 8. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
CP-24-17 ¹	45	4.62	°C/W

¹ Thermal impedance simulated values are based on JEDEC 2S2P thermal test board without thermal vias. See JEDEC JESD-51.

ELECTROSTATIC DISCHARGE (ESD) RATINGS

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

Human body model (HBM) per ANSI/ESDA/JEDEC JS-001.

Field induced charged-device model (FICDM) per ANSI/ESDA/JEDEC JS-002.

ESD Ratings for ADG1412L

Table 9. ADG1412L, 24-Lead LFCSP

ESD Model	Withstand Threshold (V)	Class
HBM ¹	±2000	2
FICDM	±1250	C3

¹ For the input and output port to the supplies, the input and output port to the input and output port, and all other inputs.

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 CONFIGURATION AND FUNCTION DESCRIPTIONS

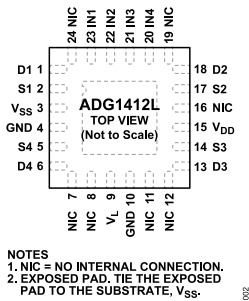


Figure 2. Pin Configuration

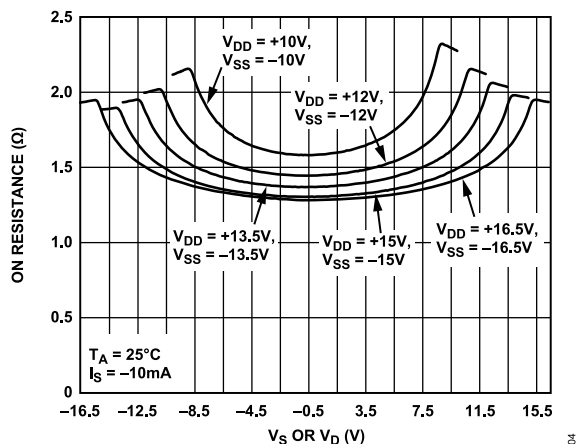
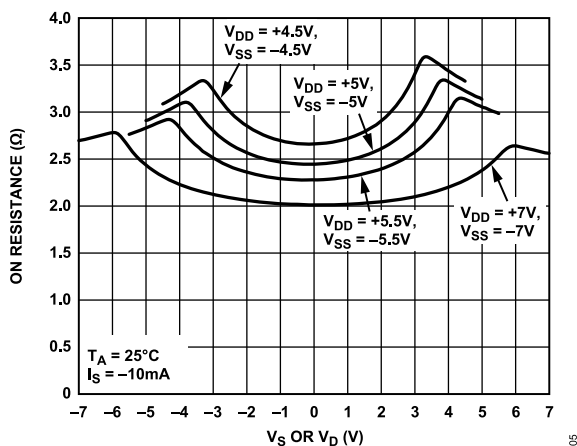
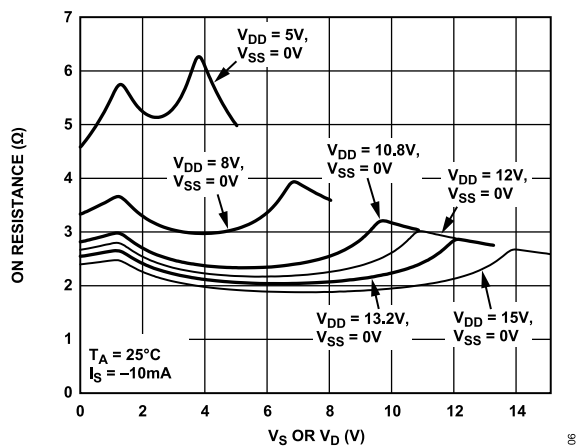
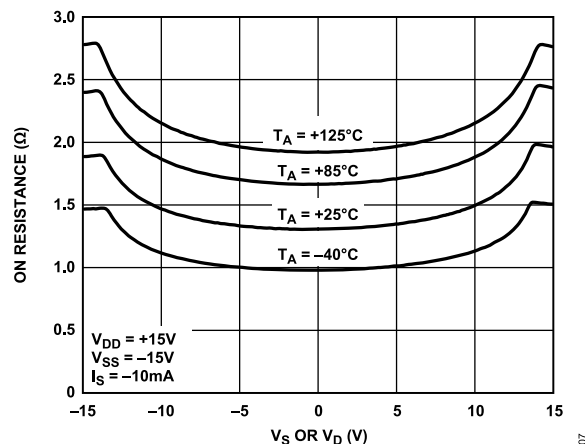
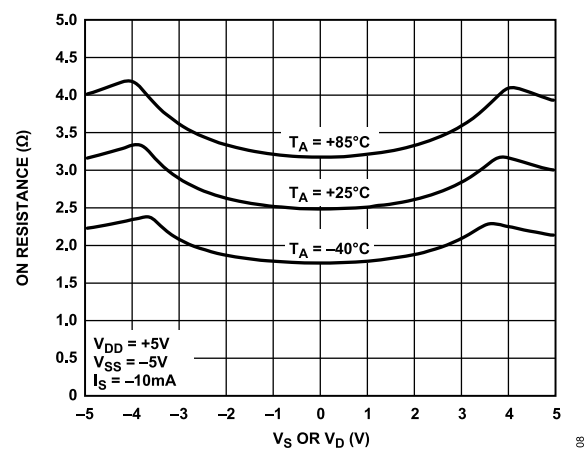
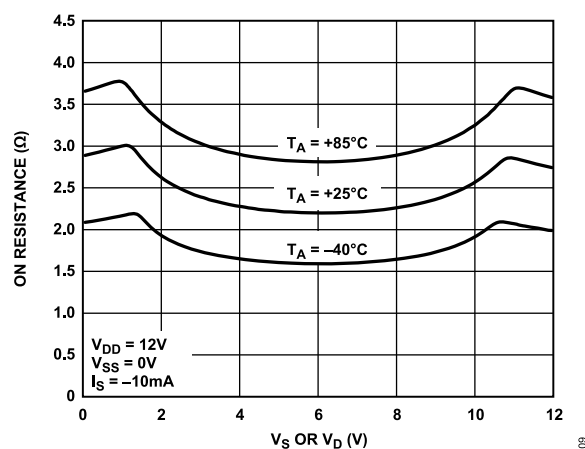
Table 10. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	D1	Drain Terminal. The D1 pin can be an input or output.
2	S1	Source Terminal. The S1 pin can be an input or output.
3	V_{SS}	Most Negative Power-Supply Potential.
4, 10	GND	Ground (0 V) Reference. The GND pins must be tied together.
5	S4	Source Terminal. The S4 pin can be an input or output.
6	D4	Drain Terminal. The D4 pin can be an input or output.
7, 8, 11, 12, 16, 19, 24	NIC	No Internal Connection. This pin is not connected internally.
9	V_L	Logic Power-Supply Potential.
13	D3	Drain Terminal. The D3 pin can be an input or output.
14	S3	Source Terminal. The S3 pin can be an input or output.
15	V_{DD}	Most Positive Power-Supply Potential.
17	S2	Source Terminal. The S2 pin can be an input or output.
18	D2	Drain Terminal. The D2 pin can be an input or output.
20	IN4	Logic Control Input.
21	IN3	Logic Control Input.
22	IN2	Logic Control Input.
23	IN1	Logic Control Input.
	EPAD	Exposed Pad. Tie the exposed pad to the substrate, V_{SS} .

Table 11. ADG1412L Truth Table

INx	Switch Condition
0	Off
1	On

TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3. On Resistance vs. V_D or V_S , Dual SupplyFigure 4. On Resistance vs. V_D or V_S , Dual SupplyFigure 5. On Resistance vs. V_D or V_S , Single SupplyFigure 6. On Resistance vs. V_D or V_S for Different Temperatures, ± 15 V Dual SupplyFigure 7. On Resistance vs. V_D or V_S for Different Temperatures, ± 5 V Dual SupplyFigure 8. On Resistance vs. V_D or V_S for Different Temperatures, +12 V Single Supply

TYPICAL PERFORMANCE CHARACTERISTICS

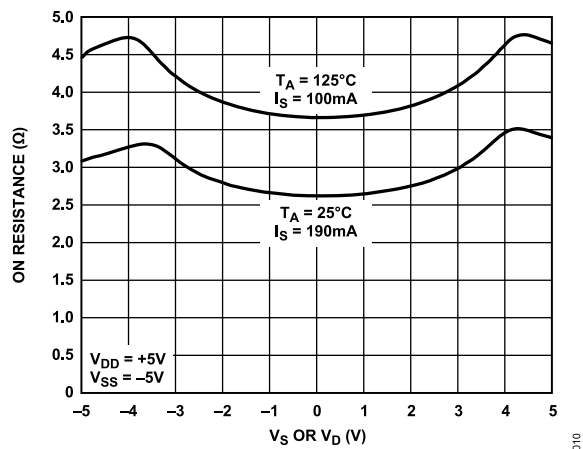
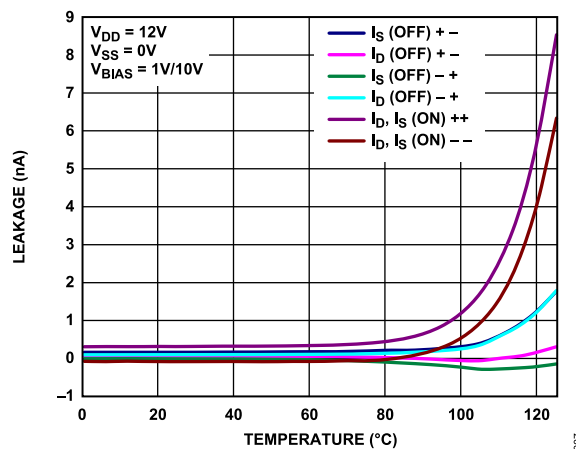
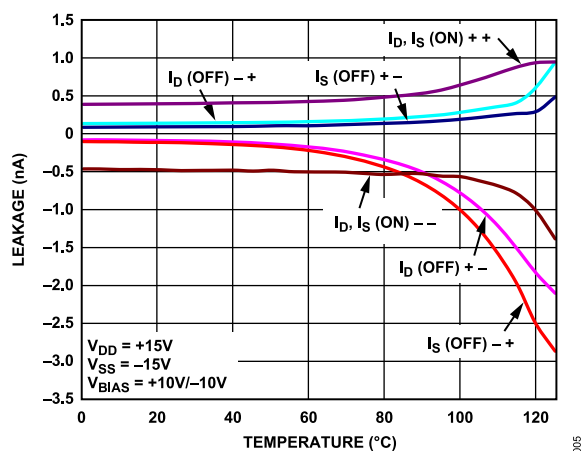
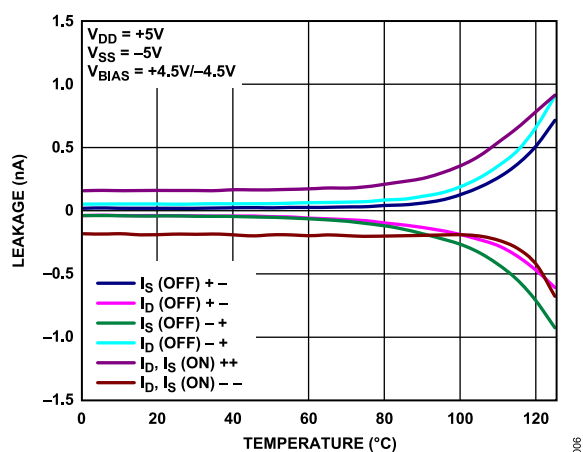
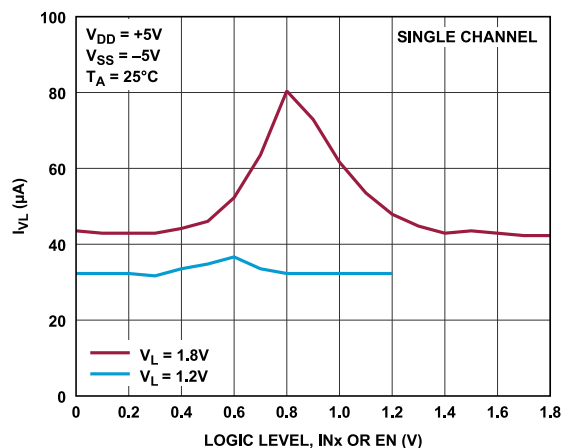
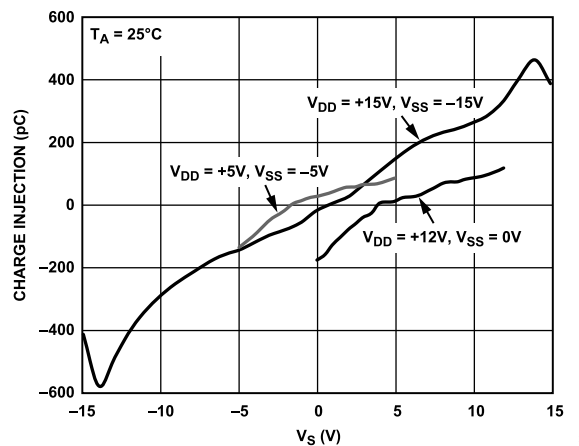
Figure 9. On Resistance vs. V_D or V_S for Different Current Levels, ± 5 V Dual Supply

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

Figure 10. Leakage Currents vs. Temperature, ± 15 V Dual SupplyFigure 11. Leakage Currents vs. Temperature, ± 5 V Dual SupplyFigure 13. I_{VL} vs. Logic LevelFigure 14. Charge Injection vs. V_S

TYPICAL PERFORMANCE CHARACTERISTICS

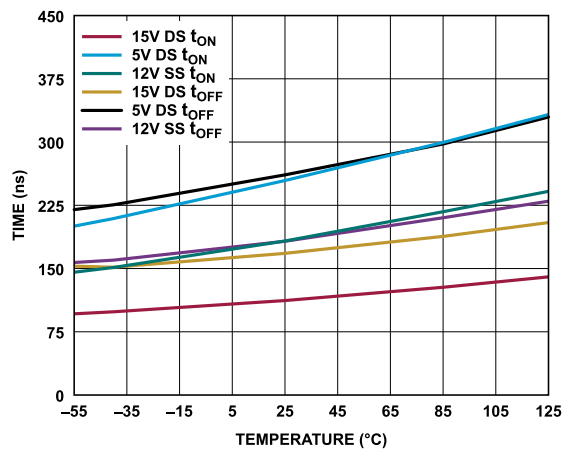


Figure 15. t_{ON}/t_{OFF} Time vs. Temperature for Single Supply (SS) and Dual Supply (DS)

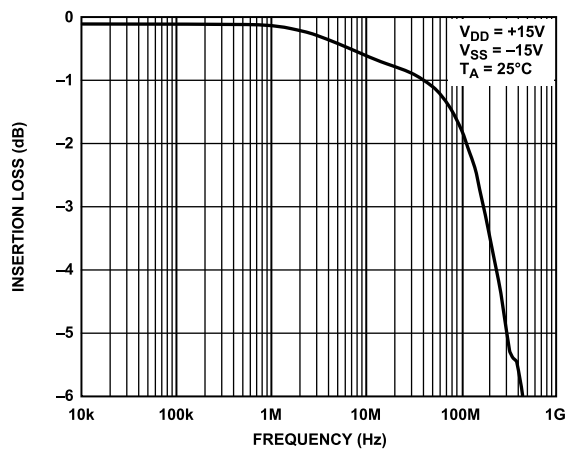


Figure 18. Insertion Loss vs. Frequency, ± 15 V Dual Supply

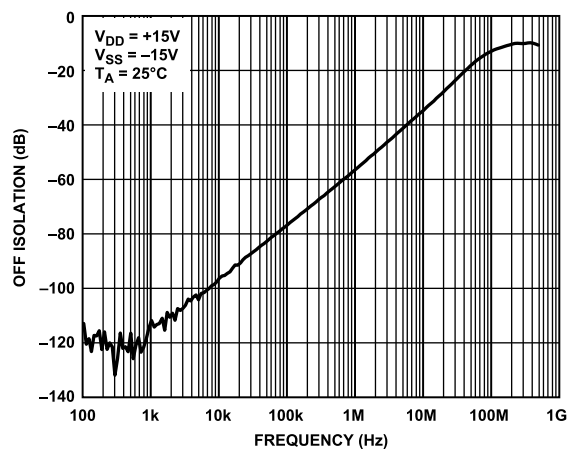


Figure 16. Off Isolation vs. Frequency, ± 15 V Dual Supply

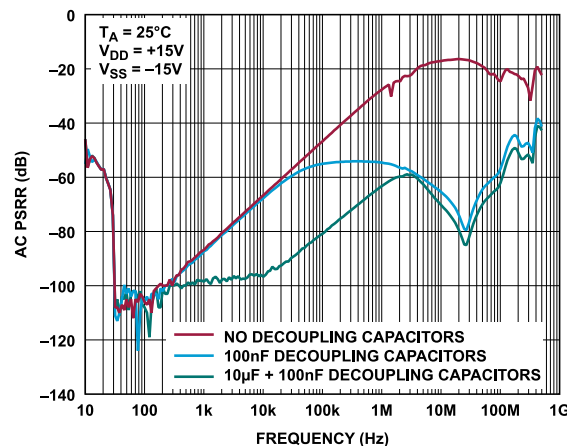


Figure 19. AC PSRR vs. Frequency, ± 15 V Dual Supply

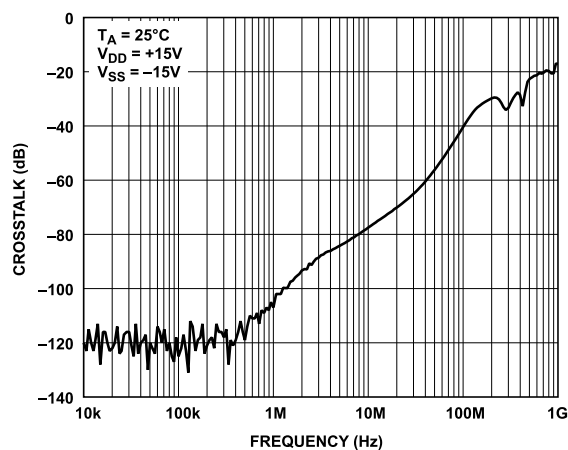


Figure 17. Crosstalk vs. Frequency, ± 15 V Dual Supply

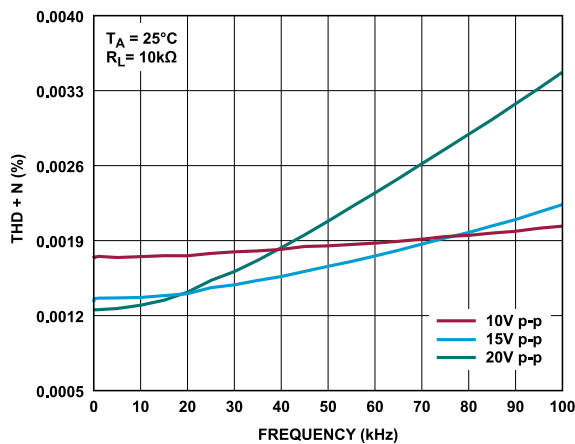


Figure 20. THD + N vs. Frequency, ± 15 V Dual Supply

TYPICAL PERFORMANCE CHARACTERISTICS

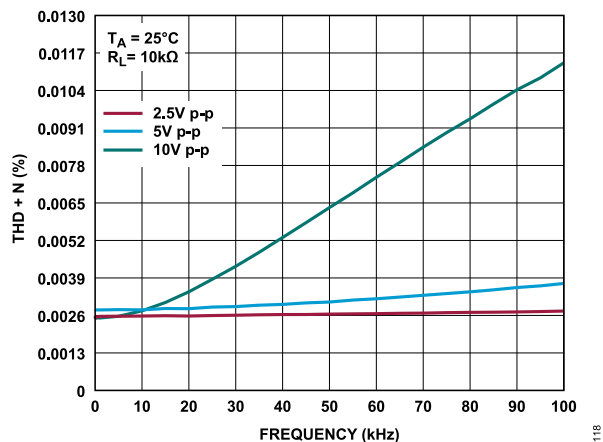
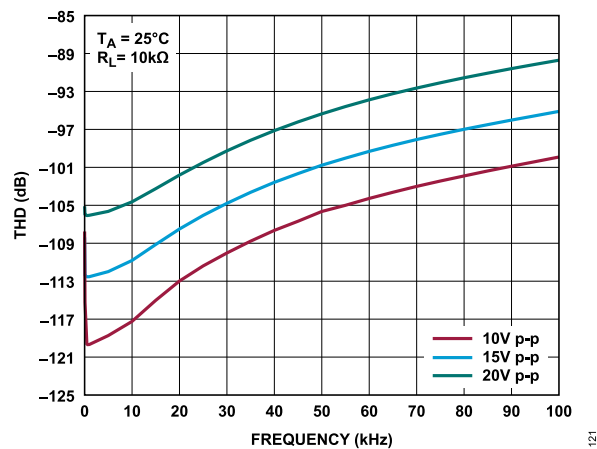
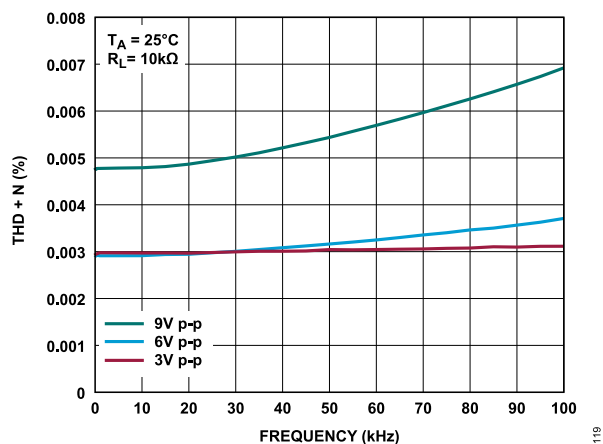
Figure 21. THD + N vs. Frequency, ± 5 V Dual SupplyFigure 24. THD vs. Frequency, ± 15 V Dual Supply

Figure 22. THD + N vs. Frequency, +12 V Single Supply

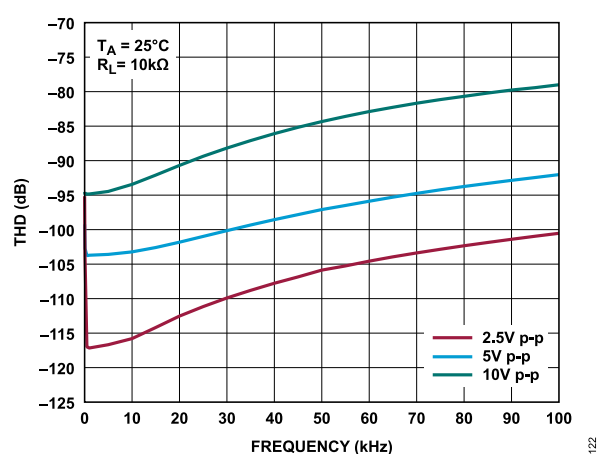
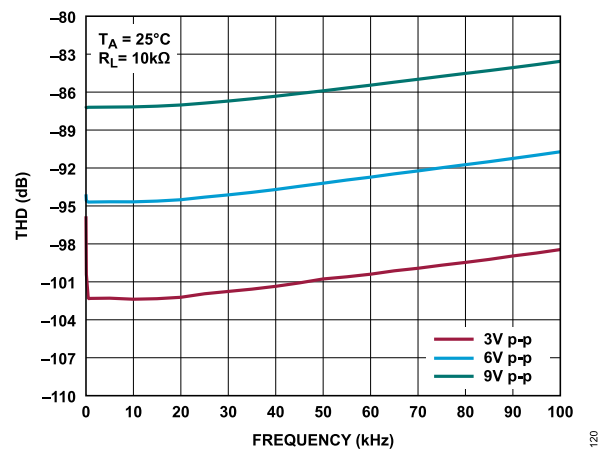
Figure 25. THD vs. Frequency, ± 5 V Dual Supply

Figure 23. THD vs. Frequency, +12 V Single Supply

TEST CIRCUITS

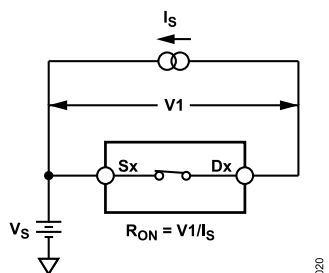


Figure 26. On Resistance

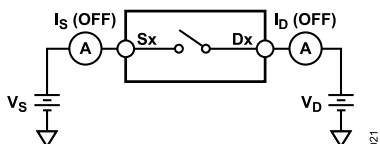
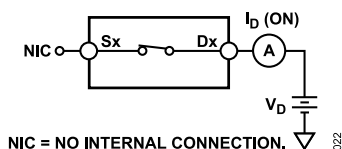


Figure 27. Off Leakage



NIC = NO INTERNAL CONNECTION.

Figure 28. On Leakage

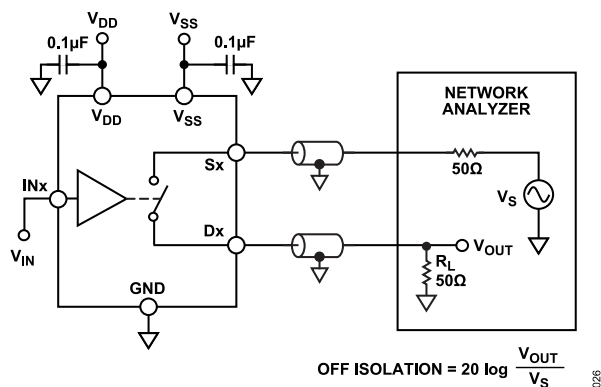


Figure 29. Off Isolation

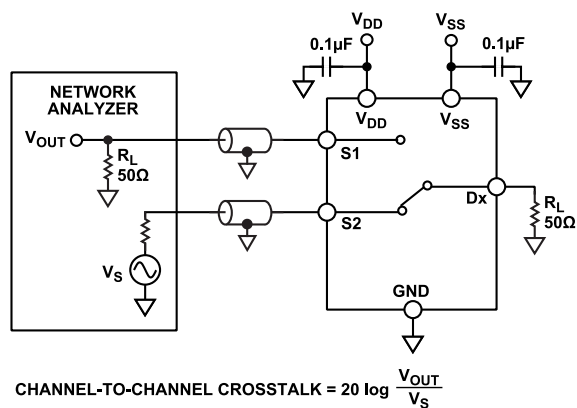


Figure 30. Channel-to-Channel Crosstalk

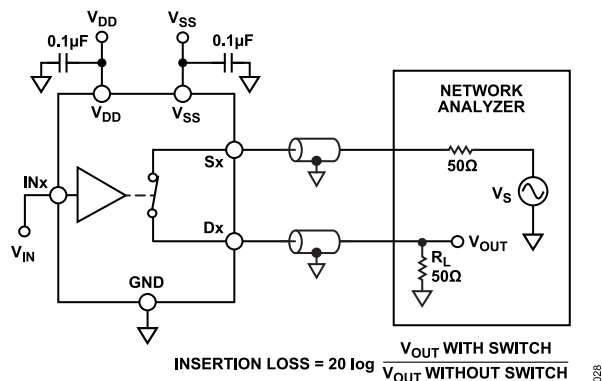


Figure 31. Bandwidth

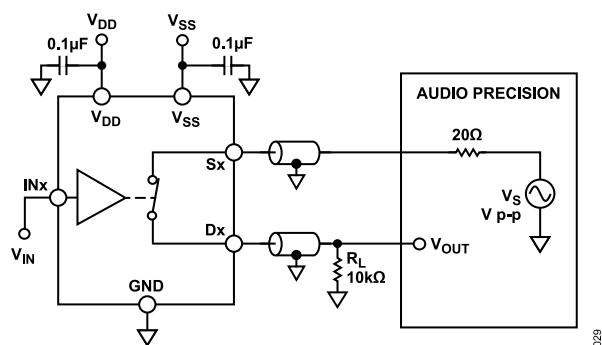


Figure 32. THD + Noise

TEST CIRCUITS

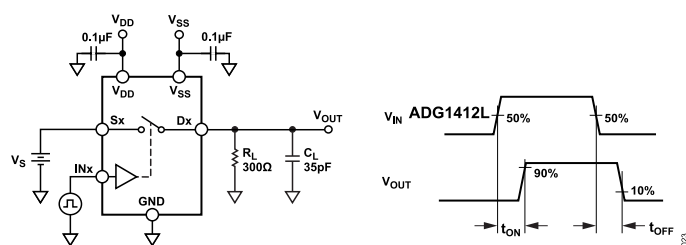


Figure 33. Switching Times

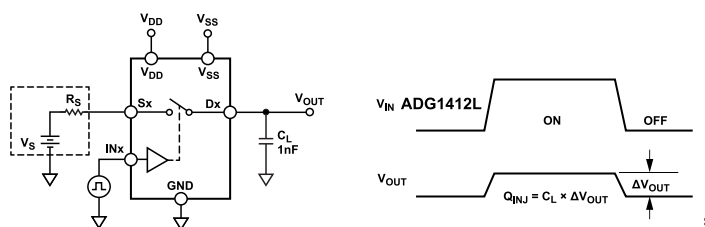


Figure 34. Charge Injection

TERMINOLOGY

I_{DD}

The positive supply current.

I_{SS}

The negative supply current.

I_{VL}

The digital supply current.

V_D and V_S

The analog voltage on Terminal D and Terminal S.

R_{ON}

The ohmic resistance between Terminal D and Terminal S.

R_{FLAT(ON)}

The difference between the maximum and minimum value of on resistance measured over the specified analog signal range.

ΔR_{ON}

The difference between the R_{ON} of any two channels.

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_D AND V_S

Analog voltages on Terminal D and Terminal S.

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 when high or when low.

C_S (Off) and C_D (Off)

The off switch source and drain capacitance for the off condition, which is measured with reference to ground.

C_D (On) and C_S (On)

The on switch drain and source capacitance for the on condition, which is measured with reference to ground.

C_{IN}

The digital input capacitance.

t_{ON}

The delay between the 50% and 90% points of the digital control input and the output switching on.

t_{OFF}

The delay between the 50% and 10% points of 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.

Channel-to-Channel 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.

Insertion Loss

The loss due to the on resistance of the switch.

TOTAL HARMONIC DISTORTION (THD)

THD is the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.

Total Harmonic Distortion + Noise (THD + N)

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

AC Power Supply Rejection Ratio (AC PSRR)

A measure of the ability of the device 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 0.115 V p-p. The ratio of the amplitude of the signal on the output to the amplitude of the modulation is the AC PSRR.

THEORY OF OPERATION

SWITCH ARCHITECTURE

The ADG1412L is a set of low logic controlled, quad SPST switches that are compatible with 1.2 V or 1.8 V logic depending on the V_L input.

V_L FLEXIBILITY

An external V_L supply provides flexibility for lower logic levels. The following V_L conditions must be satisfied for the switch to operate in either 1.2 V or 1.8 V logic operation:

- ▶ $V_L = 1.1 \text{ V to } 1.3 \text{ V}$ for 1.2 V logic
- ▶ $V_L = 1.65 \text{ V to } 1.95 \text{ V}$ for 1.8 V logic

1.2 V AND 1.8 V JEDEC COMPLIANCE

The ADG1412L is both 1.2 V and 1.8 V JEDEC standard compliant (normal range) to the digital-input threshold. This compliance with the digital-input threshold ensures low voltage CMOS logic compatibility when operating with a valid logic power-supply range.

Note that the switch digital-input requirement for both the 1.2 V and 1.8 V logic levels are the following:

- ▶ $V_{INH} = 0.65 \times V_L$
- ▶ $V_{INL} = 0.35 \times V_L$

INITIALIZATION TIME

The digital section of the ADG1412L goes through an initialization phase during V_{DD} , V_{SS} , and V_L power up. After V_{DD} , V_{SS} , and V_L power up, ensure that a minimum of 50 μs has passed and that V_{DD} , V_{SS} , and V_L do not drop before issuing an INx input.

SWITCHES IN A KNOWN STATE

The switches within the ADG1412L are off when the INx pins are floating, which prevents unwanted signals from passing through these switches. This built-in feature of the ADG1412L eliminates the need to install an external pull-down resistor. The ADG1412L can pull down the floating INx inputs against the leakage currents up to half of the I_{INH} .

APPLICATIONS INFORMATION

FIELD PROGRAMMABLE GRID ARRAY (FPGA)
LOW LOGIC COMPLIANCE

Figure 35 shows a typical application where the ADG1412L is used together with an FPGA or microcontroller. The flexible V_L pin can be tied to the digital-supply voltage (V_{CCO}), and the INx input can be tied directly to the digital IO port for ease of use.

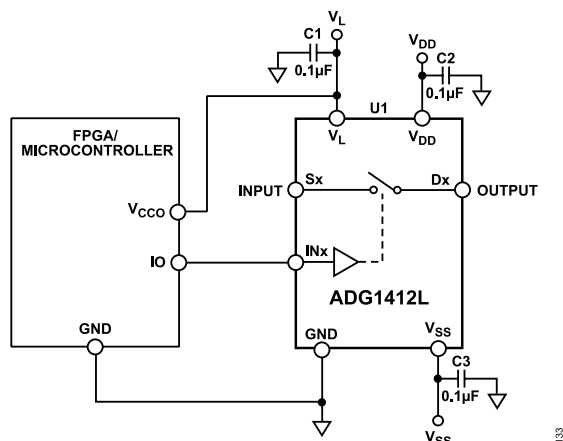


Figure 35. Typical Application

The ADG1412L is 1.2 V and 1.8 V JEDEC standard compliant, which ensures that the logic-input specifications, V_{INH} and V_{INL} , meet the digital-output specifications, minimum V_{OH} and maximum V_{OL} , of the FPGA or microcontroller. Common implementations do not guarantee logic-level compatibility, which can introduce implementation risks. The ADG1412L eliminates these risks by complying with the widely accepted 1.2 V and 1.8 V logic-level standard.

 V_{OH} AND V_{OL} AND V_{INH} AND V_{INL} RELATIONSHIP

It is recommended to confirm that the logic output high, V_{OH} , of the FPGA or microcontroller is higher than the input logic high, V_{INH} . In addition, the logic output low, V_{OL} , of the FPGA or microcontroller must be lower than the input low, V_{INL} .

Figure 36 shows the 1.2 V logic compatibility relationship between V_{OH} and V_{OL} of the FPGA or the microcontroller with the INx inputs of the ADG1412L, V_{INH} and V_{INL} .

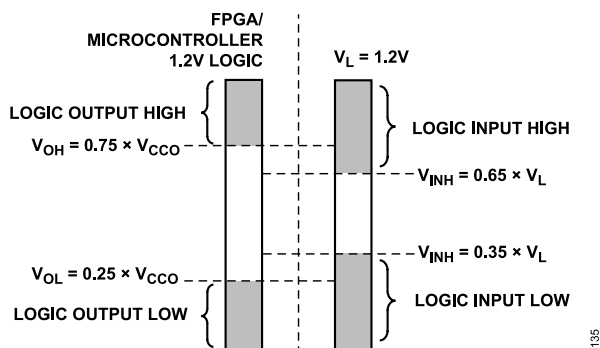


Figure 36. 1.2 V Logic Compatibility Between V_{OH} and V_{OL} and V_{INH} and V_{INL}

Figure 37 shows the 1.8 V logic compatibility relationship between V_{OH} and V_{OL} of the FPGA or the microcontroller with the INx inputs of the ADG1412L, V_{INH} and V_{INL} .

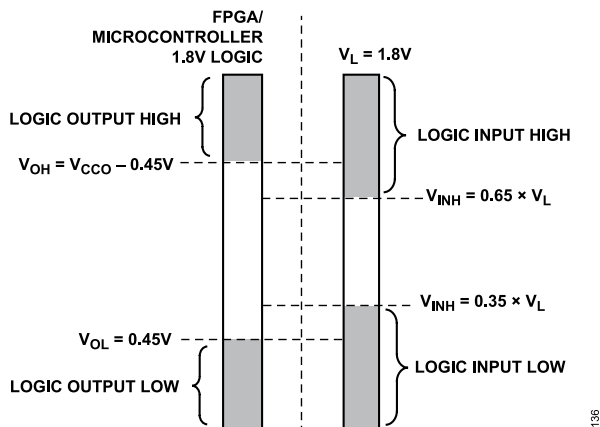


Figure 37. 1.8 V Logic Compatibility Between V_{OH} and V_{OL} and V_{INH} and V_{INL}

POWER-SUPPLY RAILS

To guarantee correct operation of the ADG1412L, a minimum of 0.1 μ F decoupling capacitors are required on the V_{DD} , V_{SS} , and V_L supply pins.

The ADG1412L can operate with V_{DD} and V_{SS} dual supplies between ± 4.5 V to ± 16.5 V. This device can also operate with a V_{DD} single supply between 5 V to 16.5 V and a V_L of between 1.1 V to 1.95 V. However, the V_{DD} to V_{SS} range must not exceed 35 V, and the V_L range must not exceed 2.25 V, as stated in the [Absolute Maximum Ratings](#) section.

OUTLINE DIMENSIONS

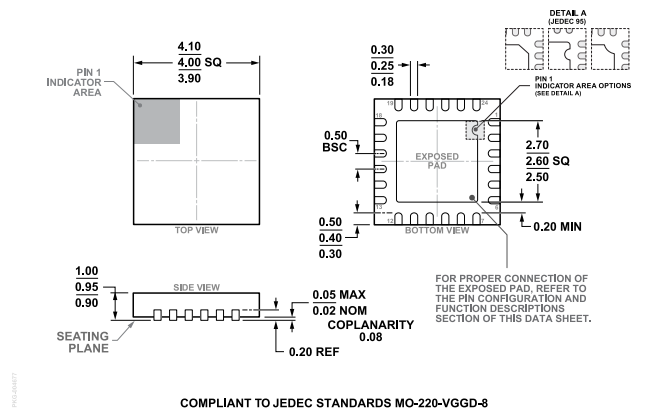


Figure 38. 24-Lead Lead Frame Chip Scale Package [LFCSP]
4 mm x 4 mm Body and 0.95 mm Package Height
(CP-24-17)
Dimensions shown in millimeters

ORDERING GUIDE

Table 12. Ordering Guide

Model ¹	Temperature	Package Description	Package Option	Package Quantity
ADG1412LYCPZ-REEL7	-40°C to +125°C	24-Lead Lead Frame Chip Scale Package [LFCSP]	CP-24-17	Reel, 1500

¹ Z = RoHS Compliant Part.

EVALUATION BOARDS

Table 13. Evaluation Boards

Model ¹	Description
EVAL-ADG1412LEBZ	Evaluation Board

¹ Z = RoHS Compliant Part.