



Low Capacitance, Triple/Quad SPDT ± 15 V/+12 V iCMOS™ Switches

ADG1233/ADG1234

FEATURES

1.5 pF off capacitance
 0.5 pC charge injection
 33 V supply range
 120 Ω on resistance
 Fully specified at ± 15 V/+12 V
 3 V logic-compatible inputs
 Rail-to-rail operation
 Break-before-make switching action
 16-lead TSSOP, 20-lead TSSOP, and 4 mm $\times$ 4 mm LFCSP
 Typical power consumption (<0.03 μ W)

APPLICATIONS

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

GENERAL DESCRIPTION

The ADG1233 and ADG1234 are monolithic iCMOS analog switches comprising three independently selectable single-pole, double throw SPDT switches and four independently selectable SPDT switches, respectively.

All channels exhibit break-before-make switching action preventing momentary shorting when switching channels. An $\overline{\text{EN}}$ input on the ADG1233 and ADG1234 is used to enable or disable the device. When disabled, all channels are switched off.

The iCMOS (industrial-CMOS) modular manufacturing process combines a high voltage complementary metal-oxide semiconductor (CMOS) and bipolar technologies. It enables the development of a wide range of high performance analog ICs capable of 33 V operation in a footprint that no other generation of high voltage parts has been able to achieve. Unlike analog ICs using conventional CMOS processes, iCMOS components can tolerate high supply voltages while providing increased performance, dramatically lowered power consumption, and reduced package size.

The ultralow capacitance and charge injection of these multiplexers make them ideal solutions for data acquisition and sample-and-hold applications, where low glitch and fast settling are required.

Rev. A

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FUNCTIONAL BLOCK DIAGRAMS

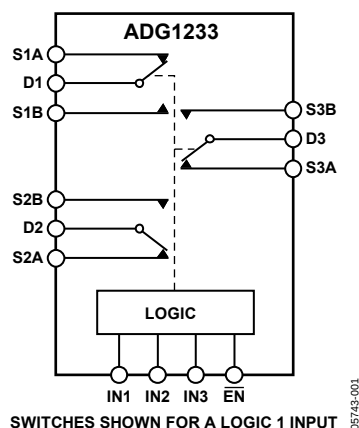


Figure 1.

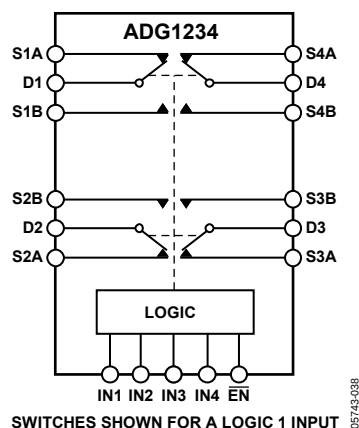


Figure 2.

Fast switching speed coupled with high signal bandwidth make the parts suitable for video signal switching. iCMOS construction ensures ultralow power dissipation, making the parts ideally suited for portable and battery-powered instruments.

PRODUCT HIGHLIGHTS

1. 1.5 pF off capacitance (± 15 V supply).
2. 0.5 pC charge injection.
3. 3 V logic-compatible digital input, $V_{IH} = 2.0$ V, $V_{IL} = 0.8$ V.
4. 16-lead TSSOP, 20-lead TSSOP, and 4 mm $\times$ 4 mm LFCSP.

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REVISION HISTORY

8/06—Rev. 0 to Rev. A

Updated Format.....	Universal
Changes to Table 1.....	3
Changes to Table 2.....	4
Changes to Figure 11.....	10
Changes to Figure 12.....	11

1/06—Revision 0: Initial Version

SPECIFICATIONS

DUAL SUPPLY

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

Table 1.

Parameter	Y Version ¹			Unit	Test Conditions/Comments
	+25°C	−40°C to +85°C	−40°C to +125°C		
ANALOG SWITCH					
Analog Signal Range			V _{SS} to V _{DD}	V	V _S = ±10 V, I _S = −1 mA; see Figure 24 V _{DD} = +13.5 V, V _{SS} = −13.5 V V _S = ±10 V, I _S = −1 mA
On Resistance (R _{ON})	120			Ω typ	
	190	230	260	Ω max	
On Resistance Match Between Channels (ΔR _{ON})	3.5			Ω typ	
	6	10	12	Ω max	V _S = −5 V, 0 V, +5 V; I _S = −1 mA
On Resistance Flatness (R _{FLAT (ON)})	20			Ω typ	
	60	72	79	Ω max	
LEAKAGE CURRENTS					
Source Off Leakage I _S (Off)	±0.02			nA typ	V _{DD} = +16.5 V, V _{SS} = −16.5 V V _D = ±10 V, V _S = −10 V; see Figure 25
	±0.1	±0.6	±1	nA max	
Drain Off Leakage I _D (Off)	±0.02			nA typ	V _S = 1 V/10 V, V _D = 10 V/1 V; see Figure 25
	±0.1	±0.6	±1	nA max	
Channel On Leakage I _D , I _S (On)	±0.02			nA typ	V _S = V _D = ±10 V; see Figure 26
	±0.2	±0.6	±1	nA max	
DIGITAL INPUTS					
Input High Voltage, V _{INH}			2.0	V min	V _{IN} = V _{INL} or V _{INH}
Input Low Voltage, V _{INL}			0.8	V max	
Input Current					
I _{INL} or I _{INH}	±0.005			μA typ	
			±0.1	μA max	
Digital Input Capacitance, C _{IN}	3			pF typ	
DYNAMIC CHARACTERISTICS ²					
t _{TRANSITION}	110			ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 10 V; see Figure 27
	130	150	170	ns max	
t _{BBM}	25			ns typ	R _L = 300 Ω, C _L = 35 pF V _{S1} = V _{S2} = +10 V; see Figure 28
			10	ns min	
t _{ON} ($\overline{\text{EN}}$)	120			ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 10 V; see Figure 29
	140	170	195	ns max	
t _{OFF} ($\overline{\text{EN}}$)	40			ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 10 V; see Figure 29
	45	55	60	ns max	
Charge Injection	0.5			pC typ	V _S = 0 V, R _S = 0 Ω, C _L = 1 nF; see Figure 30
Off Isolation	−80			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; see Figure 31
Channel-to-Channel Crosstalk	−85			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; see Figure 33
Total Harmonic Distortion, THD + N	0.14			% typ	R _L = 10 kΩ, 5 V rms, f = 20 Hz to 20 kHz; see Figure 34
−3 dB Bandwidth	900			MHz typ	R _L = 50 Ω, C _L = 5 pF; see Figure 32
C _S (Off)	1.5			pF typ	
	1.7			pF max	f = 1 MHz; V _S = 0 V
C _D (Off)	1.6			pF typ	f = 1 MHz; V _S = 0 V
	1.8			pF max	f = 1 MHz; V _S = 0 V
C _D , C _S (On)	3.5			pF typ	f = 1 MHz; V _S = 0 V
	4			pF max	f = 1 MHz; V _S = 0 V

ADG1233/ADG1234

Parameter	Y Version ¹			Unit	Test Conditions/Comments
	+25°C	–40°C to +85°C	–40°C to +125°C		
POWER REQUIREMENTS					$V_{DD} = +16.5\text{ V}$, $V_{SS} = -16.5\text{ V}$
I_{DD}	0.002		1.0	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V or V_{DD}
I_{DD}	260		420	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 5 V
I_{SS}	0.002		1.0	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 0 V or V_{DD}
I_{SS}	0.002		1.0	$\mu\text{A typ}$ $\mu\text{A max}$	Digital inputs = 5 V
V_{DD}/V_{SS}			$\pm 5/\pm 16.5$	V min/max	GND = 0 V

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

² Guaranteed by design, not subject to production test.

SINGLE SUPPLY

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

Table 2.

Parameter	Y Version ¹			Unit	Test Conditions/Comments
	+25°C	–40°C to +85°C	–40°C to +125°C		
ANALOG SWITCH					
Analog Signal Range			0 to V _{DD}	V	
On Resistance (R _{ON})	300			Ω typ	V _S = 0 V to 10 V, I _S = –1 mA; see Figure 24
On Resistance Match Between Channels (ΔR _{ON})	475 5	567	625	Ω max Ω typ	V _{DD} = 10.8 V, V _{SS} = 0 V V _S = 0 V to 10 V, I _S = –1 mA
On Resistance Flatness (R _{FLAT (ON)})	16 60	26	27	Ω max Ω typ	V _S = 3 V, 6 V, 9 V, I _S = –1 mA
LEAKAGE CURRENTS					
Source Off Leakage I _S (Off)	±0.02			nA typ	V _{DD} = 13.2 V V _S = 1 V/10 V, V _D = 10 V/1 V; see Figure 25
Drain Off Leakage I _D (Off)	±0.1 ±0.02	±0.6	±1	nA max nA typ	V _S = 1 V/10 V, V _D = 10 V/1 V; see Figure 25
Channel On Leakage I _D , I _S (On)	±0.1 ±0.02 ±0.2	±0.6	±1	nA max nA typ nA max	V _S = V _D = 1 V or 10 V, see Figure 26
DIGITAL INPUTS					
Input High Voltage, V _{INH}			2.0	V min	
Input Low Voltage, V _{INL}			0.8	V max	
Input Current, I _{INL} or I _{INH}	±0.001		±0.1	μA typ μA max	V _{IN} = V _{INL} or V _{INH}
Digital Input Capacitance, C _{IN}	2			pF typ	
DYNAMIC CHARACTERISTICS ²					
t _{TRANSITION}	135 170	200	230	ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 8 V; see Figure 27
t _{BBM}	45		10	ns typ ns min	R _L = 300 Ω, C _L = 35 pF V _{S1} = V _{S2} = 8 V; see Figure 28
t _{ON} ($\overline{\text{EN}}$)	150			ns typ	R _L = 300 Ω, C _L = 35 pF
t _{OFF} ($\overline{\text{EN}}$)	195 45	230	265	ns typ	V _S = 8 V; see Figure 29 R _L = 300 Ω, C _L = 35 pF
Charge Injection	60 –0.3	70	75	ns typ pC typ	V _S = 8 V; see Figure 29 V _S = 6 V, R _S = 0 Ω, C _L = 1 nF; see Figure 30
Off Isolation	–80			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; see Figure 31
Channel-to-Channel Crosstalk	–85			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; see Figure 33
–3 dB Bandwidth	600			MHz typ	R _L = 50 Ω, C _L = 5 pF; see Figure 32
C _S (Off)	1.5 1.7			pF typ pF max	f = 1 MHz; V _S = 6 V
C _D (Off)	2 2.2			pF typ pF max	f = 1 MHz; V _S = 6 V
C _D , C _S (On)	4 4.5			pF typ pF max	f = 1 MHz; V _S = 6 V

ADG1233/ADG1234

Parameter	Y Version ¹			Unit	Test Conditions/Comments
	+25°C	–40°C to +85°C	–40°C to +125°C		
POWER REQUIREMENTS					
I _{DD}	0.002		1.0	μA typ μA max	V _{DD} = 13.2 V Digital inputs = 0 V or V _{DD}
I _{DD}	260		440	μA typ μA max	Digital inputs = 5 V
V _{DD}			5/16.5	V min/max	V _{SS} = 0 V, GND = 0 V

¹ Temperature range for the Y version: –40°C to +125°C

² Guaranteed by design, not subject to production test.

ABSOLUTE MAXIMUM RATINGS

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

Table 3.

Parameter	Rating
V_{DD} to V_{SS}	35 V
V_{DD} to GND	–0.3 V to +25 V
V_{SS} to GND	+0.3 V to –25 V
Analog, Digital Inputs ¹	$V_{SS} - 0.3\text{ V}$ to $V_{DD} + 0.3\text{ V}$ or 30 mA, whichever occurs first
Continuous Current, S or D	24 mA
Peak Current, S or D (Pulsed at 1 ms, 10% Duty Cycle Mximum)	100 mA
Operating Temperature Range	
Automotive Temperature Range (Y Version)	–40°C to +125°C
Storage Temperature Range	–65°C to +150°C
Junction Temperature	150°C
TSSOP, θ_{JA} , Thermal Impedance	112°C/W
LFCSP, θ_{JA} , Thermal Impedance	30.4°C/W
Reflow Soldering Peak Temperature, Pb-Free	260°C

¹ Overvoltages at A, $\overline{EN}$, 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 is applied at any one time.

ESD CAUTION

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



ADG1233/ADG1234

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

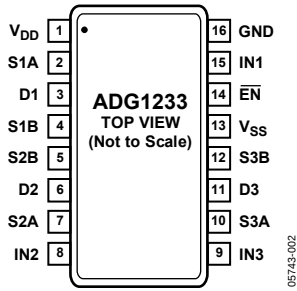


Figure 3. 16-Lead TSSOP Pin Configuration

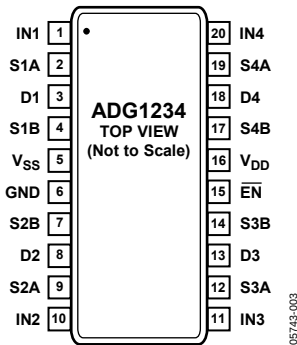


Figure 4. 20-Lead TSSOP Pin Configuration

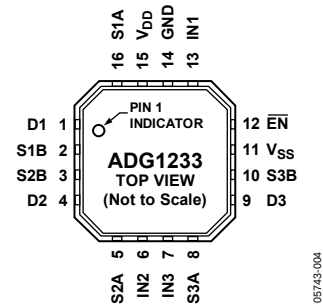


Figure 5. 16-Lead, 4 mm x 4 mm LFCSP Pin Configuration, Exposed Pad Tied to Substrate, V_{SS}

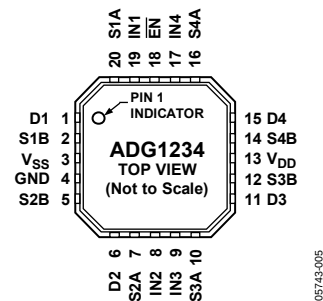


Figure 6. 20-Lead, 4 mm x 4 mm LFCSP Pin Configuration, Exposed Pad Tied to Substrate, V_{SS}

Table 4. 16-Lead TSSOP/20-Lead TSSOP Pin Configurations

Pin No. ADG1233 16-Lead TSSOP	Pin No. ADG1234 20-Lead TSSOP	Mnemonic
1	16	V _{DD}
2	2	S1A
3	3	D1
4	4	S1B
5	7	S2B
6	8	D2
7	9	S2A
8	10	IN2
9	11	IN3
10	12	S3A
11	13	D3
12	14	S3B
13	5	V _{SS}
14	15	EN
15	1	IN1
16	6	GND
N/A	17	S4B
N/A	18	D4
N/A	19	S4A
N/A	20	IN4

Table 5. 16-Lead LFCSP/20-Lead LFCSP Pin Configurations

Pin No. ADG1233 16-Lead LFCSP	Pin No. ADG1234 20-Lead LFCSP	Mnemonic
1	1	D1
2	2	S1B
3	5	S2B
4	6	D2
5	7	S2A
6	8	IN2
7	9	IN3
8	10	S3A
9	11	D3
10	12	S3B
11	3	V _{SS}
12	18	EN
13	19	IN1
14	4	GND
15	13	V _{DD}
16	20	S1A
N/A	14	S4B
N/A	15	D4
N/A	16	S4A
N/A	17	IN4

Table 6. ADG1233/ADG1234 Truth Table

EN	IN _x	Switch xA	Switch xB
1	X	Off	Off
0	0	Off	On
0	1	On	Off

TERMINOLOGY

V_{DD}

Most positive supply potential.

V_{SS}

Most negative power supply potential in dual supplies. In single-supply applications, it can be connected to ground.

GND

Ground (0 V) reference.

R_{ON}

Ohmic resistance between D and S.

ΔR_{ON}

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

I_S (Off)

Source leakage current when switch is off.

I_D (Off)

Drain leakage current when switch is off.

I_D, I_S (On)

Channel leakage current when switch is on.

V_D, V_S

Analog voltage on Terminal D, 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.

$t_{ON}(\overline{EN})$

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

$t_{OFF}(\overline{EN})$

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 an 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.

THD + N

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

TYPICAL PERFORMANCE CHARACTERISTICS

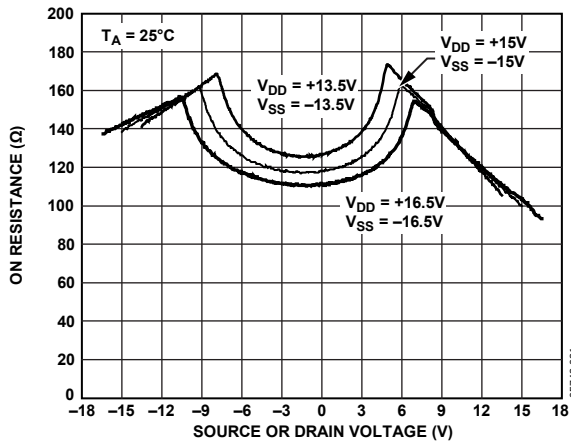


Figure 7. On Resistance as a Function of V_D (V_S) for Dual Supply

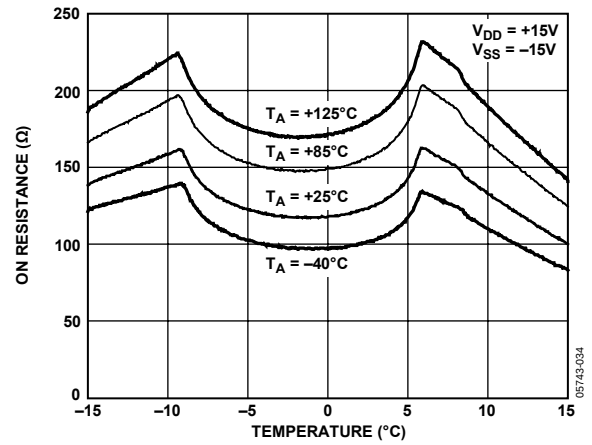


Figure 10. On Resistance as a Function of V_D (V_S) for Different Temperatures, Dual Supply

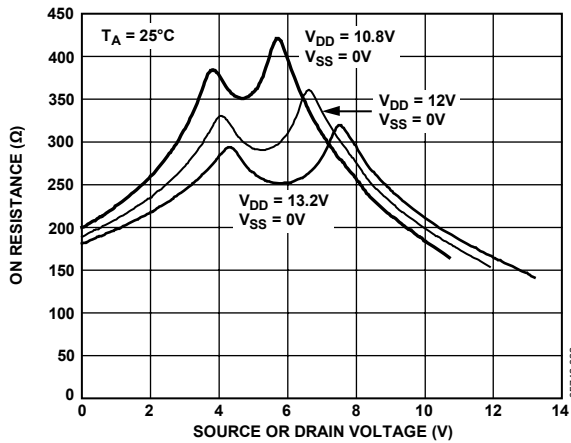


Figure 8. On Resistance as a Function of V_D (V_S) for Dual Supply

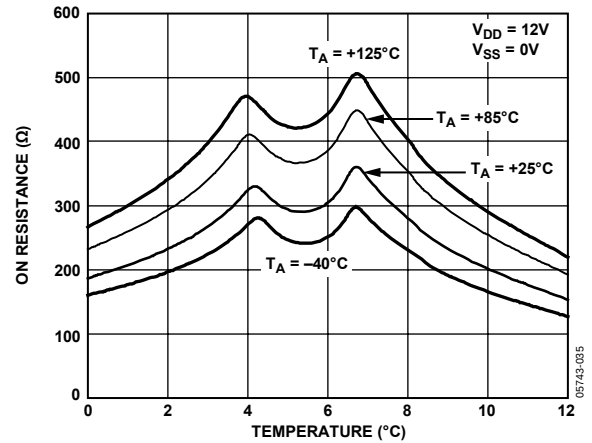


Figure 11. On Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply

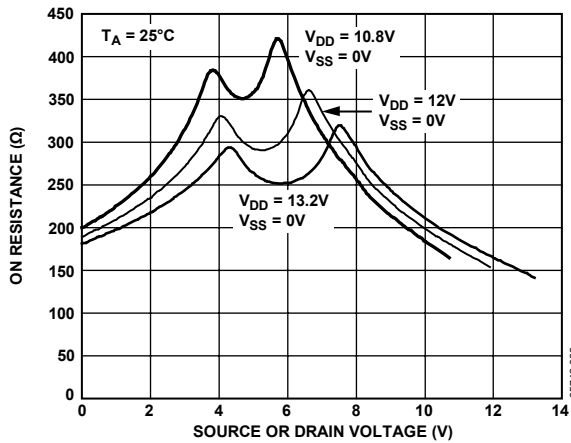


Figure 9. On Resistance as a Function of V_D (V_S) for Single Supply

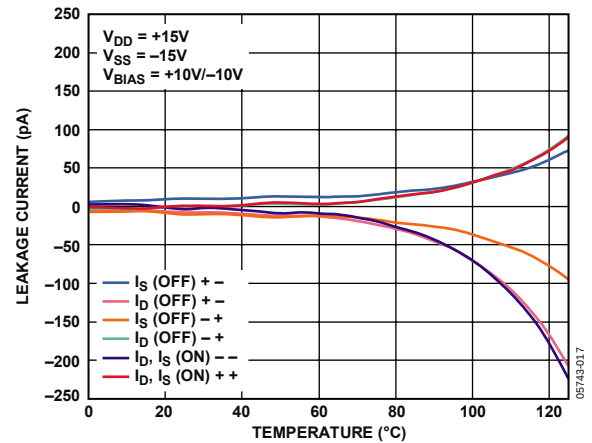


Figure 12. Leakage Currents as a Function of Temperature, Dual Supply

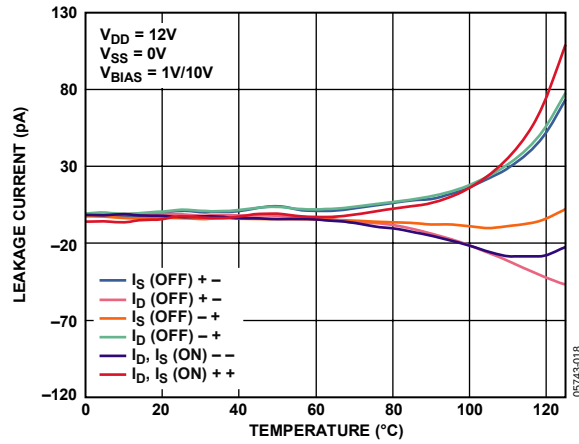


Figure 13. Leakage Currents as a Function of Temperature, Single Supply

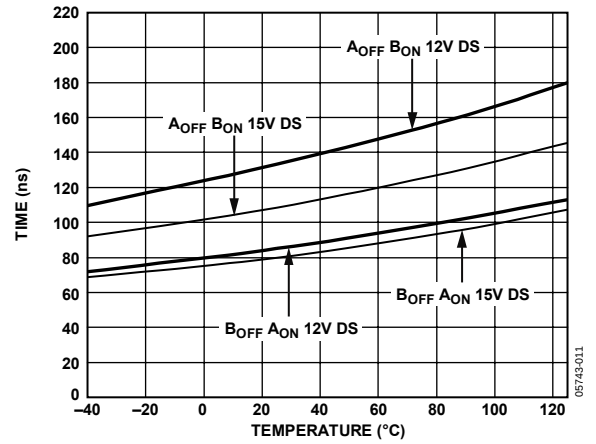


Figure 16. $t_{\text{TRANSITION}}$ vs. Temperature

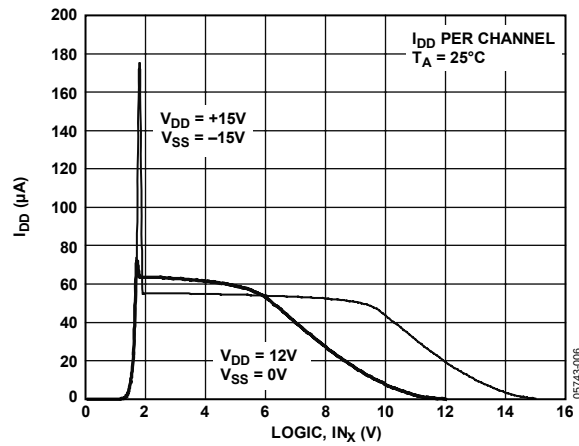


Figure 14. I_{DD} vs. Logic Level

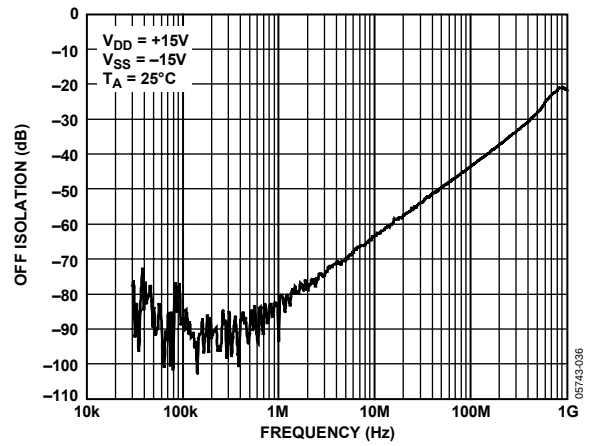


Figure 17. Off Isolation vs. Frequency

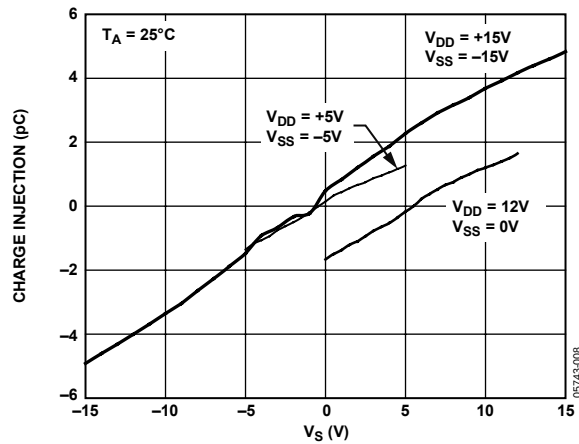


Figure 15. Charge Injection vs. Source Voltage

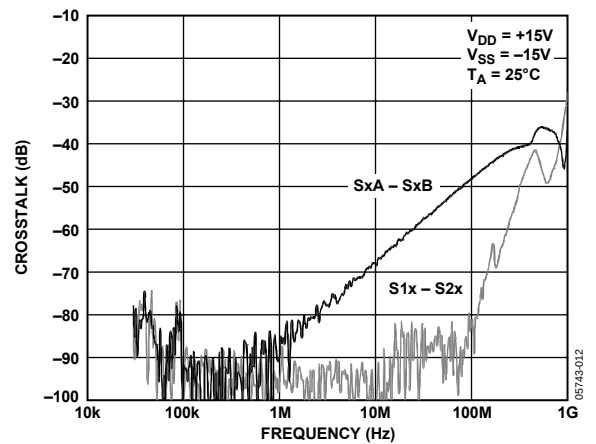


Figure 18. Crosstalk vs. Frequency

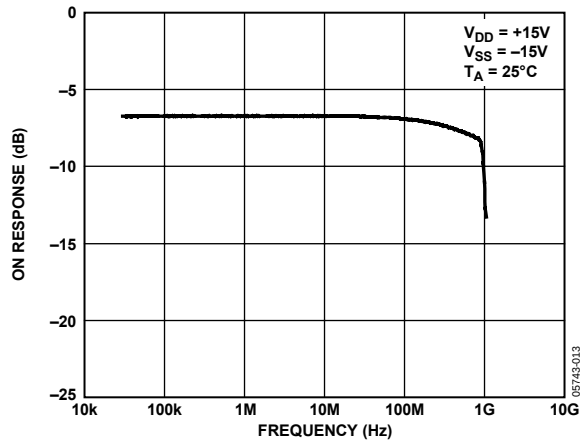


Figure 19. On Response vs. Frequency

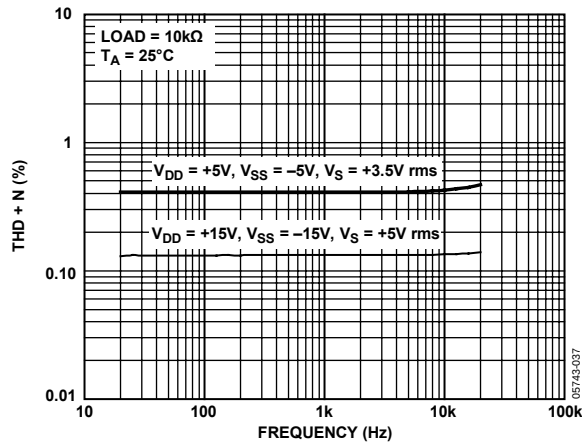


Figure 20. THD + N vs. Frequency

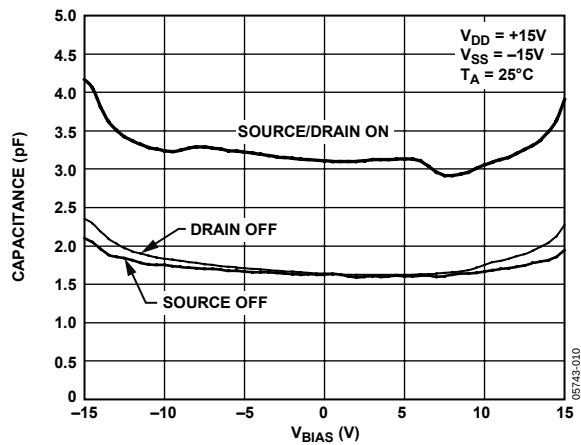


Figure 21. Capacitance vs. Source Voltage for Dual Supply

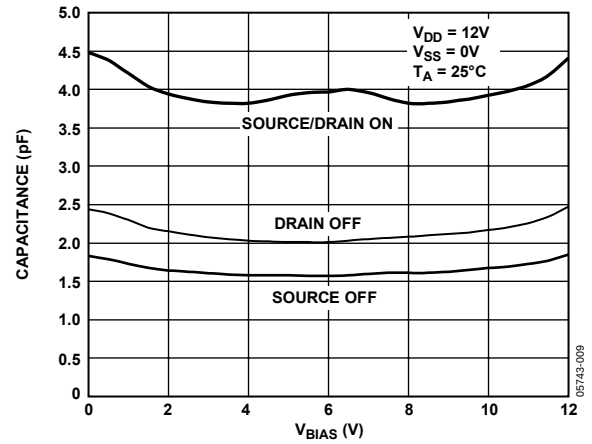


Figure 22. Capacitance vs. Source Voltage for Single Supply

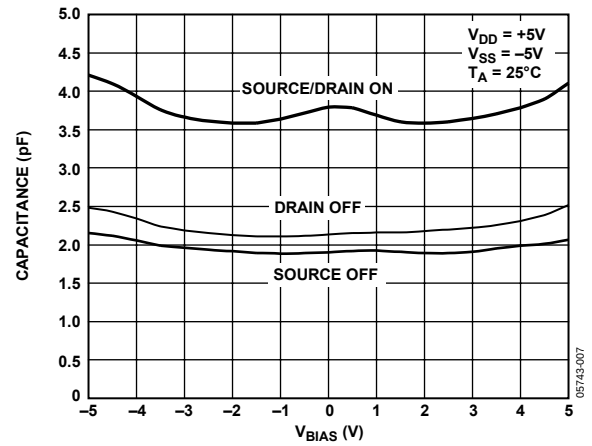


Figure 23. Capacitance vs. Source Voltage for Dual Supply

TEST CIRCUITS

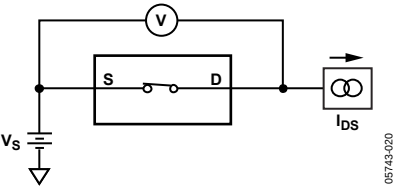


Figure 24. On Resistance

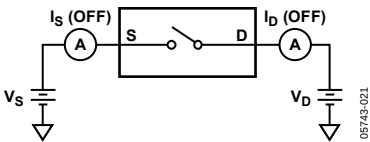


Figure 25. Off Leakage

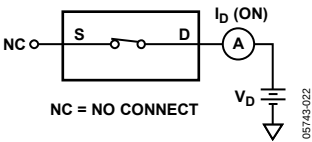


Figure 26. On Leakage

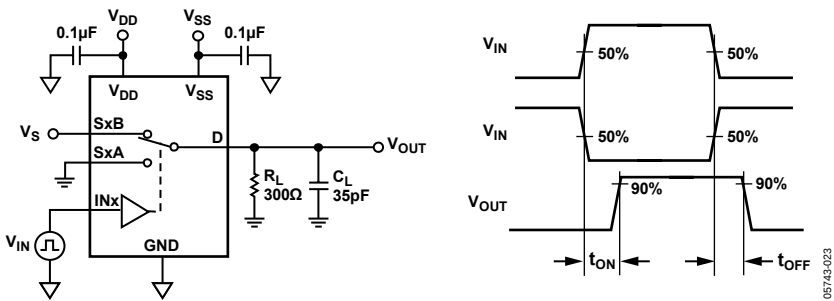


Figure 27. Switching Timing

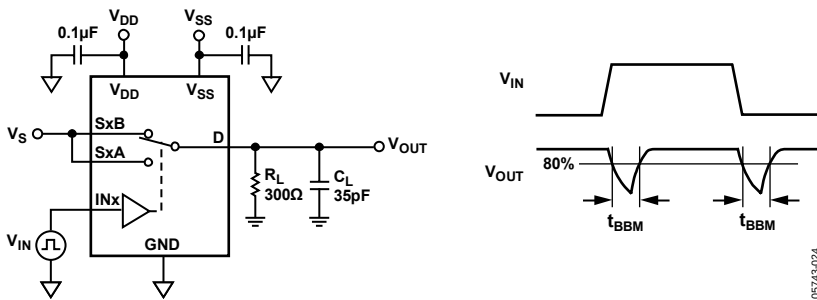
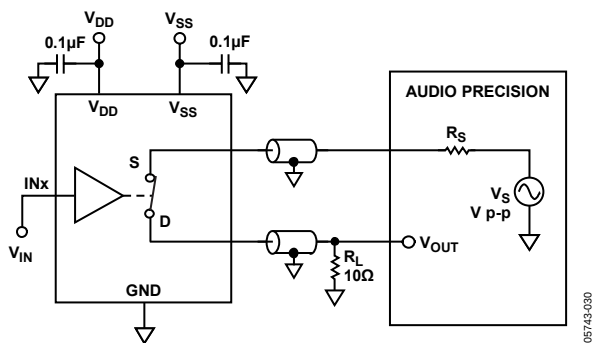
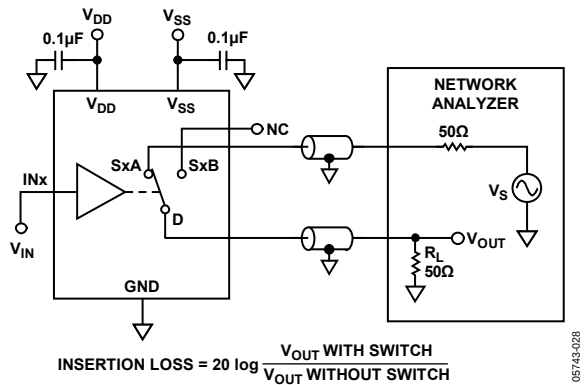
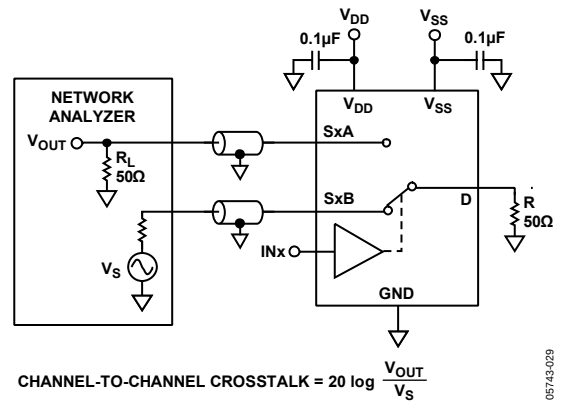
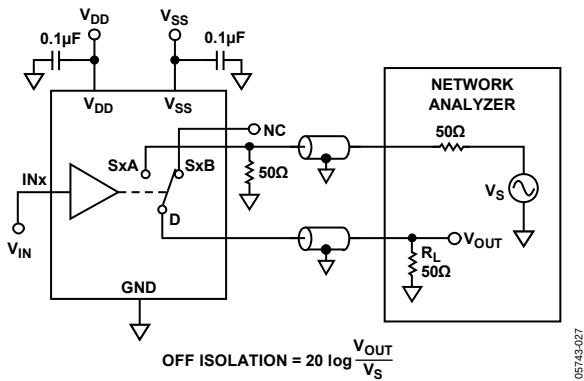
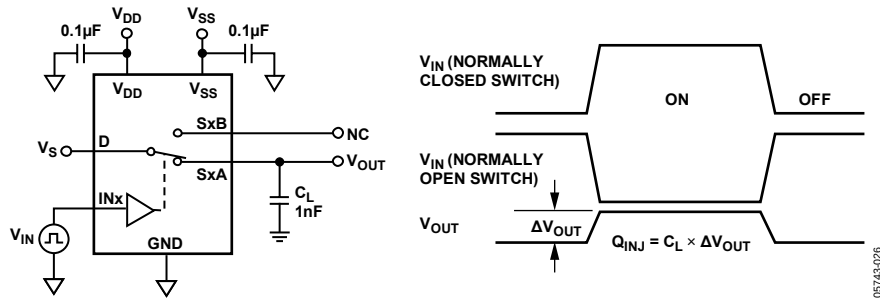
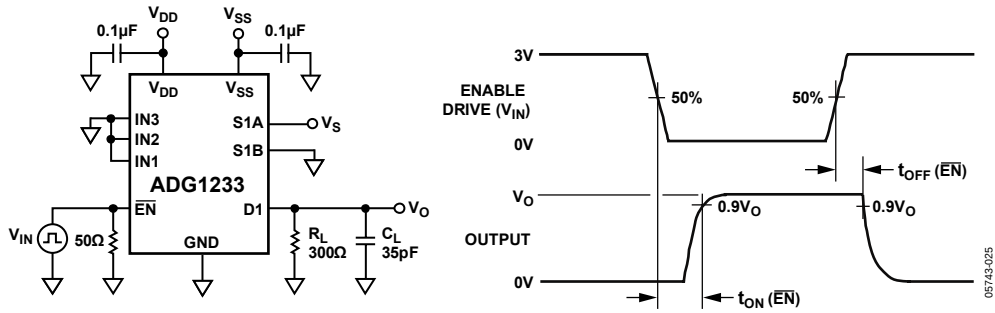
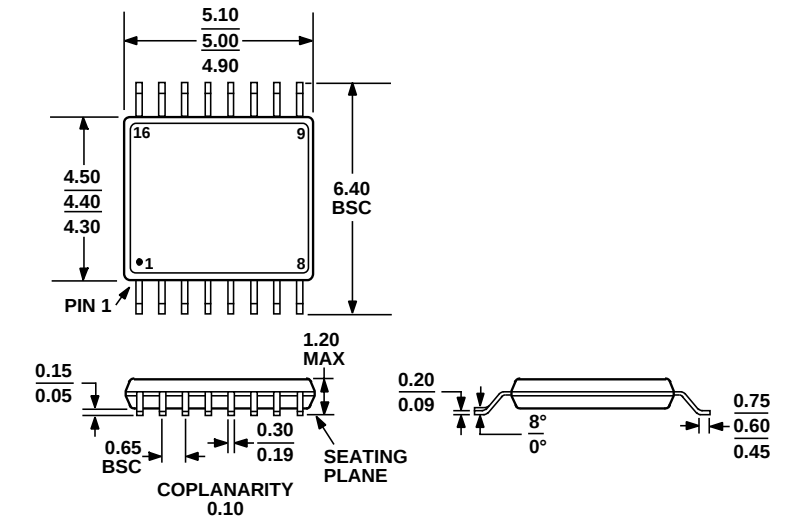


Figure 28. Break-Before-Make Delay

ADG1233/ADG1234



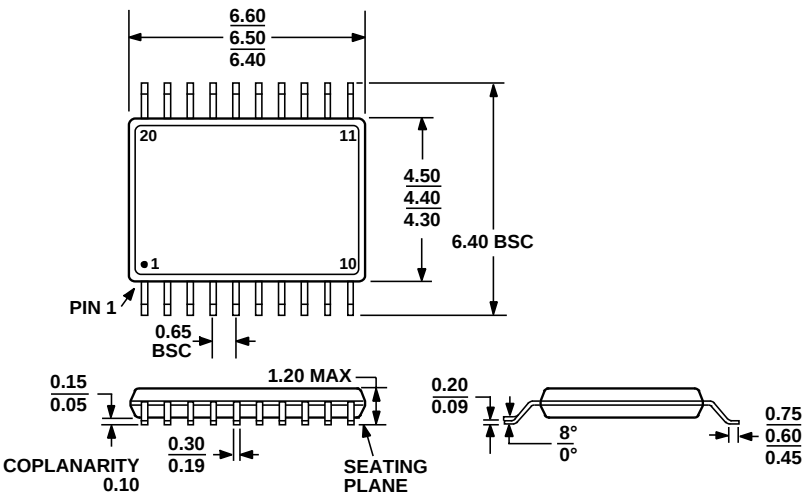
OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

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

Dimensions shown in millimeters

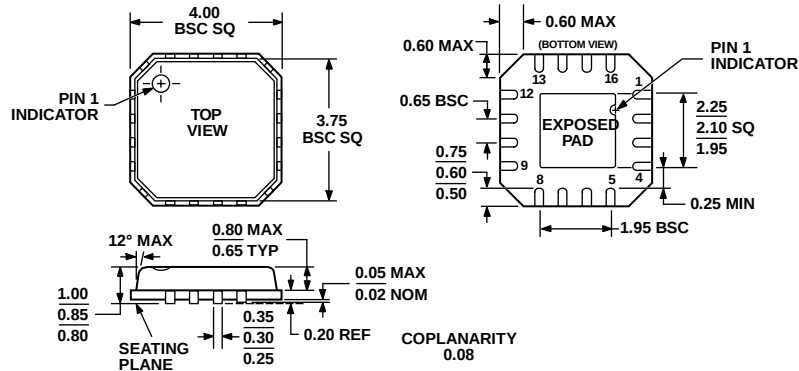


COMPLIANT TO JEDEC STANDARDS MO-153-AC

Figure 36. 20-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-20)

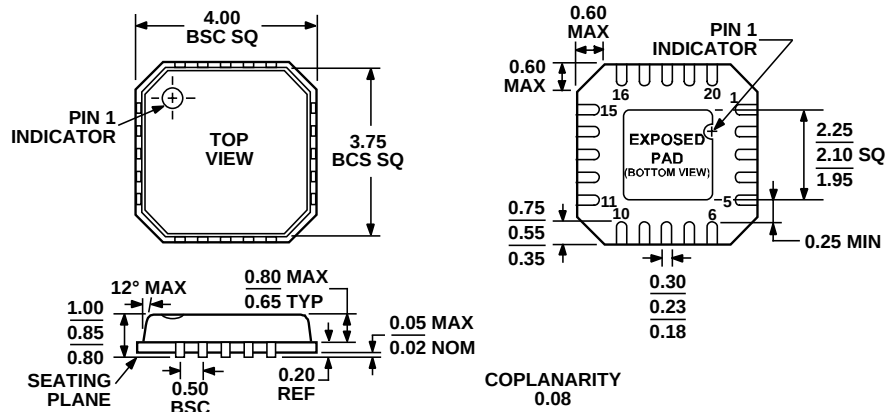
Dimensions shown in millimeters

ADG1233/ADG1234



COMPLIANT TO JEDEC STANDARDS MO-220-VGGC

Figure 37. 16-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
4 mm × 4 mm Body, Very Thin Quad
(CP-16-4)
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-220-VGGD-1

Figure 38. 20-Lead Lead Frame Chip Scale Package [LFCSP_VQ]
4 mm × 4 mm Body, Very Thin Quad
(CP-20-1)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADG1233YRUZ ¹	–40°C to +125°C	16-Lead Thin Shrink Small Outline Package (TSSOP)	RU-16
ADG1233YRUZ-REEL7 ¹	–40°C to +125°C	16-Lead Thin Shrink Small Outline Package (TSSOP)	RU-16
ADG1233YCPZ-REEL ¹	–40°C to +125°C	16-Lead Lead Frame Chip Scale Package (LFCSP_VQ)	CP-16-4
ADG1233YCPZ-REEL7 ¹	–40°C to +125°C	16-Lead Lead Frame Chip Scale Package (LFCSP_VQ)	CP-16-4
ADG1234YRUZ ¹	–40°C to +125°C	20-Lead Thin Shrink Small Outline Package (TSSOP)	RU-20
ADG1234YRUZ-REEL7 ¹	–40°C to +125°C	20-Lead Thin Shrink Small Outline Package (TSSOP)	RU-20
ADG1234YCPZ-REEL ¹	–40°C to +125°C	20-Lead Lead Frame Chip Scale Package (LFCSP_VQ)	CP-20-1
ADG1234YCPZ-REEL7 ¹	–40°C to +125°C	20-Lead Lead Frame Chip Scale Package (LFCSP_VQ)	CP-20-1

¹ Z = Pb-free part.