

$0.5~\Omega$ CMOS, Dual 2:1 MUX/SPDT Audio Switch

ADG884

FEATURES

1.8 V to 5.5 V operation Ultralow on resistance 0.28 Ω typical

0.41 Ω maximum at 5 V supply

Excellent audio performance, ultralow distortion

0.1 Ω typical

 0.15Ω maximum R_{ON} flatness

High current carrying capability

400 mA continuous

600 mA peak current at 5 V supply

Rail-to-rail switching operation

Typical power consumption (<0.1 μ W)

APPLICATIONS

Cellular phones

PDAs

MP3 players

Power routing

Battery-powered systems

PCMCIA cards

Modems

Audio and video signal routing

Communications systems

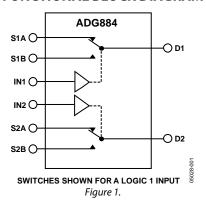
GENERAL DESCRIPTION

The ADG884 is a low voltage CMOS device containing two independently selectable SPDT (single-pole, double-throw) switches. This device offers ultralow on resistance of 0.41 Ω over the full temperature range, making the part an ideal solution for applications that require minimal distortion through the switch. The ADG884 also has the capability of carrying large amounts of current, typically 600 mA at 5 V operation.

The ADG884 is available in a 10 ball, 2 mm \times 1.5 mm WLCSP package, a 10-lead LFCSP_WD package, and a 10-lead MSOP package. These tiny packages make the ADG884 the ideal solution for space-constrained applications.

When on, each switch conducts equally well in both directions and has an input signal range that extends to the supplies. The ADG884 exhibits break-before-make switching action.

FUNCTIONAL BLOCK DIAGRAM



PRODUCT HIGHLIGHTS

- 1. Single 1.8 V to 5.5 V operation.
- 2. High current handling capability (400 mA continuous current at 3.3 V).
- 3. 1.8 V logic-compatible.
- 4. Low THD + N (0.01% typ).
- 5. Tiny 2 mm \times 1.5 mm WLCSP package, 3 mm \times 3 mm 10-lead LFCSP_WD package, and 10-lead MSOP package.

Rev. B

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6/05—Rev. 0 to Rev. A

SPECIFICATIONS

 V_{DD} = 5 V \pm 10%, GND = 0 V, unless otherwise noted.

Table 1.

		B Version		
Parameter	25°C	Temperature Range ¹	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V _{DD}	V	
On Resistance, R _{ON}	0.28		Ωtyp	$V_{DD} = 4.5 \text{ V}, V_S = 0 \text{ V to } V_{DD}, I_S = 100 \text{ mA}$
	0.37	0.41	Ω max	See Figure 18
On Resistance Match Between				
Channels, ΔR_{ON}	0.01		Ωtyp	$V_{DD} = 4.5 \text{ V}, V_S = 2 \text{ V}, I_S = 100 \text{ mA}$
	0.035	0.05	Ω max	
On Resistance Flatness, R _{FLAT} (ON)	0.1		Ωtyp	$V_{DD} = 4.5 \text{ V}, V_S = 0 \text{ V to } V_{DD}$
	0.13	0.15	Ω max	$I_S = 100 \text{ mA}$
LEAKAGE CURRENTS				$V_{DD} = 5.5 \text{ V}$
Source Off Leakage, Is (OFF)	±0.2		nA typ	$V_S = 0.6 \text{ V}/4.5 \text{ V}, V_D = 4.5 \text{ V}/0.6 \text{ V}$; see Figure 19
Channel On Leakage, ID, Is (ON)	±0.2		nA typ	$V_S = V_D = 0.6 \text{ V or } 4.5 \text{ V; see Figure } 20$
DIGITAL INPUTS				
Input High Voltage, V _{INH}		2.0	V min	
Input Low Voltage, V _{INL}		0.8	V max	
Input Current, I _{INL} or I _{INH}	0.005		μA typ	$V_{IN} = V_{INL} \text{ or } V_{INH}$
		±0.1	μA max	
Digital Input Capacitance, C _{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS ²				
ton	42		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	50	53	ns max	$V_S = 3 \text{ V/0 V}$; see Figure 21
toff	15		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	20	21	ns max	$V_S = 3 \text{ V}$; see Figure 21
Break-Before-Make Time Delay, tbbm	16		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
		10	ns min	$V_{S1} = V_{S2} = 1.5 \text{ V}$; see Figure 22
Charge Injection	125		pC typ	$V_S = 1.5 \text{ V}, R_S = 0 \Omega, C_L = 1 \text{ nF}; \text{ see Figure 23}$
Off Isolation	-60		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 24
Channel-to-Channel Crosstalk	-120		dB typ	S1A to S2A/S1B to S2B, $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 27
	-60		dB typ	S1A to S1B/S2A to S2B, $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 25
Total Harmonic Distortion, THD + N	0.017		%	$R_L = 32 \Omega$, $f = 20 Hz$ to 20 kHz, $V_S = 3.5 V$ p-p
Insertion Loss	-0.03		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 25
−3 dB Bandwidth	18		MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 26
C _s (OFF)	103		pF typ	
C_D , C_S (ON)	295		pF typ	
POWER REQUIREMENTS				$V_{DD} = 5.5 \text{ V}$
lod	0.003		μA typ	Digital inputs = 0 V or 5.5 V
		1	μA max	

 $^{^1}$ Temperature ranges: B version: -40°C to $+85^\circ\text{C}$ for the MSOP and LFCSP_WD packages, and -25°C to $+85^\circ\text{C}$ for the WLCSP package. 2 Guaranteed by design, not production tested.

 $V_{DD} = 3.4 \text{ V}$ to 4.2 V; GND = 0 V, unless otherwise noted.

Table 2.

		B Version		
Parameter	25°C	Temperature Range ¹	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		$0 V to V_{DD}$	V	
On Resistance, Ron	0.33		Ω typ	$V_{DD} = 3.4 \text{ V}, V_S = 0 \text{ V to } V_{DD}, I_S = 100 \text{ mA}$
	0.4	0.47	Ω max	See Figure 18
On Resistance Match Between				
Channels, ΔR_{ON}	0.013		Ωtyp	$V_{DD} = 3.4 \text{ V}, V_S = 2 \text{ V}, I_S = 100 \text{ mA}$
	0.042	0.065	Ω max	
On Resistance Flatness, R _{FLAT} (ON)	0.13		Ω typ	$V_{DD} = 3.4 \text{ V}, V_S = 0 \text{ V to } V_{DD}$
	0.155	0.175	Ω max	$I_S = 100 \text{ mA}$
LEAKAGE CURRENTS				$V_{DD} = 4.2 \text{ V}$
Source Off Leakage, I _s (OFF)	±0.2		nA typ	$V_S = 0.6 \text{ V}/3.9 \text{ V}, V_D = 3.9 \text{ V}/0.6 \text{ V}; \text{ see Figure 19}$
Channel On Leakage, ID, Is (ON)	±0.2		nA typ	$V_S = V_D = 0.6 \text{ V or } 3.9 \text{ V; see Figure 20}$
DIGITAL INPUTS				
Input High Voltage, V _{INH}		2.0	V min	
Input Low Voltage, V _{INL}		0.8	V max	
Input Current, I _{INL} or I _{INH}	0.005		μA typ	$V_{IN} = V_{INL}$ or V_{INH}
		±0.1	μA max	
Digital Input Capacitance, C _{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS ²				
ton	42		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	50	54	ns max	$V_S = 1.5 \text{ V/0 V}$; see Figure 21
t _{OFF}	15		ns typ	$R_L = 50 \Omega, C_L = 35 pF$
	21	24	ns max	$V_s = 1.5 \text{ V}$; see Figure 21
Break-Before-Make Time Delay, t _{BBM}	17		ns typ	$R_L = 50 \Omega, C_L = 35 pF$
		10	ns min	$V_{S1} = V_{S2} = 1.5 \text{ V}$; see Figure 22
Charge Injection	100		pC typ	$V_S = 1.5 \text{ V}$, $R_S = 0 \Omega$, $C_L = 1 \text{ nF}$; see Figure 23
Off Isolation	-60		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 24
Channel-to-Channel Crosstalk	-120		dB typ	S1A to S2A/S1B to S2B, $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 27
	-60		dB typ	S1A to S1B/S2A to S2B, $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 25
Total Harmonic Distortion, THD + N	0.01		%	$R_L = 32 \Omega$, $f = 20 Hz$ to 20 kHz, $V_S = 2 V p-p$
Insertion Loss	-0.03		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 25
−3 dB Bandwidth	18		MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 26
Cs (OFF)	110		pF typ	_
C_D , C_S (ON)	300		pF typ	
POWER REQUIREMENTS				$V_{DD} = 4.2 \text{ V}$
I _{DD}	0.003		μA typ	Digital inputs = 0 V or 4.2 V
		1	μA max	

 $^{^{1}} Temperature\ ranges: B\ version: -40^{\circ}C\ to\ +85^{\circ}C\ for\ the\ MSOP\ and\ LFCSP_WD\ packages, and\ -25^{\circ}C\ to\ +85^{\circ}C\ for\ the\ WLCSP\ package.$

² Guaranteed by design, not production tested.

 $V_{\rm DD}$ = 2.7 V to 3.6 V, GND = 0 V, unless otherwise noted.

Table 3.

		B Version		
Parameter	25°C	Temperature Range ¹	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V _{DD}	V	
On Resistance, Ron	0.4		Ω typ	$V_{DD} = 2.7 \text{ V}, V_S = 0 \text{ V to } V_{DD}$
	0.51	0.61	Ω max	I _s = 100 mA; see Figure 18
On Resistance Match Between				
Channels, ΔR_{ON}	0.02		Ωtyp	$V_{DD} = 2.7 \text{ V}, V_S = 0.6 \text{ V}$
	0.07	0.1	Ω max	$I_S = 100 \text{ mA}$
On Resistance Flatness, RFLAT (ON)	0.18		Ωtyp	$V_{DD} = 2.7 \text{ V, } V_S = 0 \text{ V to } V_{DD}$
		0.25	Ω max	$I_S = 100 \text{ mA}$
LEAKAGE CURRENTS				$V_{DD} = 3.6 \text{ V}$
Source Off Leakage, I _S (OFF)	±0.2		nA typ	$V_S = 0.6 \text{ V}/3.3 \text{ V}, V_D = 3.3 \text{ V}/0.6 \text{ V}$; see Figure 19
Channel On Leakage, ID, Is (ON)	±0.2		nA typ	$V_S = V_D = 0.6 \text{ V or } 3.3 \text{ V; see Figure } 20$
DIGITAL INPUTS				
Input High Voltage, V _{INH}		1.3	V min	
Input Low Voltage, V _{INL}		0.8	V max	
Input Current, I _{INL} or I _{INH}	0.005		μA typ	$V_{IN} = V_{INL} \text{ or } V_{INH}$
		±0.1	μA max	
Digital Input Capacitance, C _{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS ²				
ton	42		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	56	62	ns max	$V_S = 1.5 \text{ V/0 V}$; see Figure 21
toff	14		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	19	21	ns max	$V_S = 1.5 \text{ V}$; see Figure 21
Break-Before-Make Time Delay, tbbm	24		ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
		10	ns min	$V_{S1} = V_{S2} = 1.5 \text{ V}$; see Figure 22
Charge Injection	85		pC typ	$V_S = 1.25 \text{ V}, R_S = 0 \Omega, C_L = 1 \text{ nF}; \text{ see Figure 23}$
Off Isolation	-60		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 24
Channel-to-Channel Crosstalk	-120		dB typ	S1A to S2A/S1B to S2B, $R_L = 50 \text{ V}$, $C_L = 5 \text{ pF}$, $f = 100 \text{ kHz}$; see Figure 27
	-60		dB typ	S1A to S1B/S2A to S2B, $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$; see Figure 25
Total Harmonic Distortion, THD + N	0.03		%	$R_L = 32 \Omega$, $f = 20 Hz$ to $20 kHz$, $V_S = 1.5 V p-p$
Insertion Loss	-0.03		dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 25
-3 dB Bandwidth	18		MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$; see Figure 26
C _s (OFF)	110		pF typ	
C_D , C_S (ON)	300		pF typ	
POWER REQUIREMENTS				$V_{DD} = 3.6 \text{ V}$
I _{DD}	0.003		μA typ	Digital inputs = 0 V or 3.6 V
		1	μA max	

 $^{^1}$ Temperature range B version: -40°C to $+85^\circ\text{C}$ for the MSOP and LFCSP_WD packages, and -25°C to $+85^\circ\text{C}$ for the WLCSP package. 2 Guaranteed by design, not production tested.

ABSOLUTE MAXIMUM RATINGS

 $T_A = 25$ °C, unless otherwise noted.

Table 4.

i abie 4.	
Parameter	Rating
V _{DD} to GND	−0.3 V to +6 V
Analog Inputs, ¹ Digital Inputs	-0.3 V to V _{DD} + 0.3 V or 30 mA (which- ever occurs first)
Peak Current, S or D	
5 V Operation	600 mA (pulsed at 1 ms, 10% duty cycle max)
Continuous Current, S or D	
5 V Operation	400 mA
Operating Temperature Range	
Extended Industrial (B Version)	
MSOP and LFCSP_WD packages	-40°C to +85°C
Industrial (B version)	
WLCSP package	-25°C to +85°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature	150°C
10-Lead MSOP Package	
θ_{JA} Thermal Impedance	206°C/W
θ _{JC} Thermal Impedance	44°C/W
10-Lead WLCSP Package (4-Layer Board)	
θ_{JA} Thermal Impedance	120°C/W
10-Lead LFCSP_WD Package (4-Layer Board)	
θ_{JA} Thermal Impedance	76°C/W
θ _{JC} Thermal Impedance	13.5°C/W
Reflow Soldering (Pb-Free)	
Peak Temperature	260(+0/-5)°C
Time at Peak Temperature	10 sec to 40 sec

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

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

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.



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

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS



Figure 2. 10-Lead LFCSP_WD and 10-Lead MSOP Pin Configuration

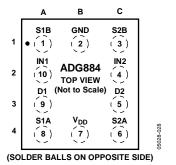


Figure 3. 10-Ball WLCSP Pin Configuration

Table 5. LFCSP and MSOP Pin Function Descriptions

LFCSP, MSOP Pin No.	Mnemonic	Description
1	V_{DD}	Most Positive Power Supply Potential.
2	S1A	Source Terminal. Can be an input or output.
3	D1	Drain Terminal. Can be an input or output.
4	IN1	Logic Control Input.
5	S1B	Source Terminal. Can be an input or output.
6	GND	Ground (0 V) Reference.
7	S2B	Source Terminal. Can be an input or output.
8	IN2	Login Control Input.
9	D2	Drain Terminal. Can be an input or output.
10	S2A	Source Terminal. Can be an input or output.

Table 6. WLCSP Package Pin Function Description

WLCSP	Package		
Ball Number	Location	Mnemonic	Description
1	A1	S1B	Source Terminal. Can be an input or output.
2	B1	GND	Ground (0 V) Reference.
3	C1	S2B	Source Terminal. Can be an input or output.
4	C2	IN2	Login Control Input.
5	C3	D2	Drain Terminal. Can be an input or output.
6	C4	S2A	Source Terminal. Can be an input or output.
7	B4	V_{DD}	Most Positive Power Supply Potential.
8	A4	S1A	Source Terminal. Can be an input or output.
9	A3	D1	Drain Terminal. Can be an input or output.
10	A2	IN1	Logic Control Input.

Table 7. ADG884 Truth Table

Logic (IN1/IN2)	Switch 1A/2A	Switch 1B/2B
0	Off	On
1	On	Off

TYPICAL PERFORMANCE CHARACTERISTICS

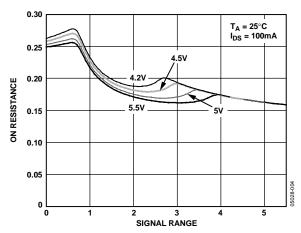


Figure 4. On Resistance vs. V_D (V_S), $V_{DD} = 4.2 \text{ V to } 5.5 \text{ V}$

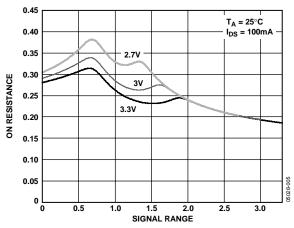


Figure 5. On Resistance vs. V_D (V_S), $V_{DD} = 2.7 \text{ V to } 3.3 \text{ V}$

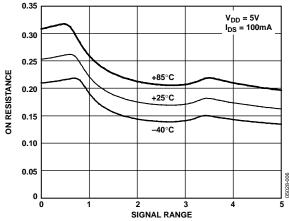


Figure 6. On Resistance vs. V_D (V_S) for Different Temperature, $V_{DD} = 5 V$

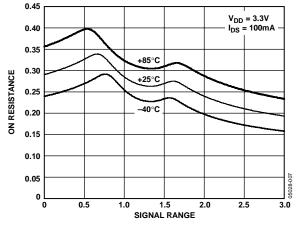


Figure 7. On Resistance vs. V_D (V_S) for Different Temperature, $V_{DD} = 3.3 \text{ V}$

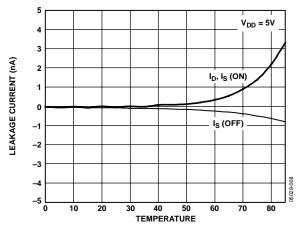


Figure 8. Leakage Current vs. Temperature, $V_{DD} = 5 V$

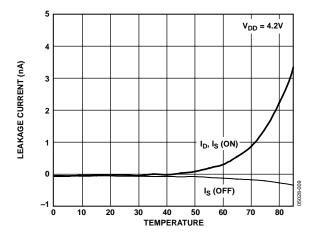


Figure 9. Leakage Current vs. Temperature, $V_{DD} = 4.2 \text{ V}$

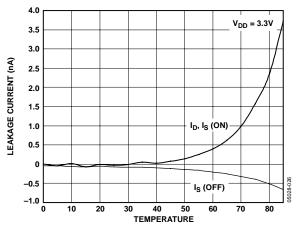


Figure 10. Leakage Current vs. Temperature, $V_{DD} = 3.3 \text{ V}$

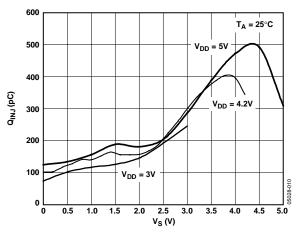


Figure 11. Charge Injection vs. Source Voltage

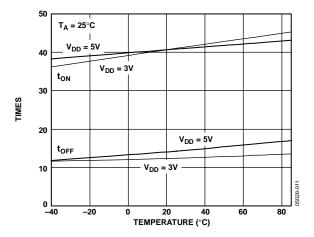


Figure 12. ton/toff Times vs. Temperature

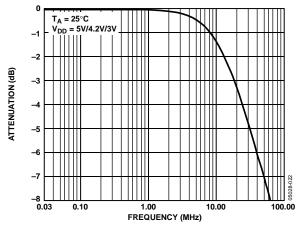


Figure 13. Bandwidth

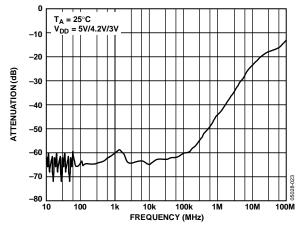


Figure 14. Off Isolation vs. Frequency

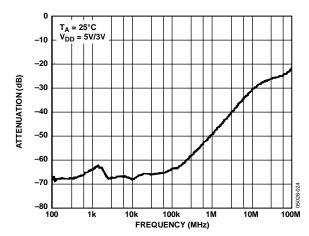


Figure 15. Crosstalk vs. Frequency

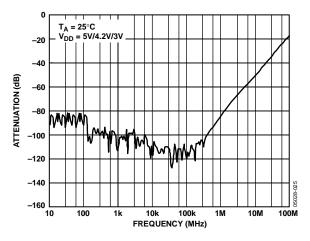


Figure 16. AC PSRR

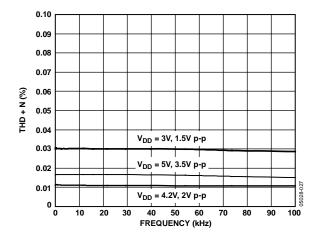
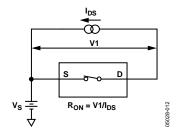


Figure 17. THD + N

TEST CIRCUITS



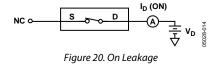


Figure 18. On Resistance

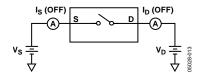
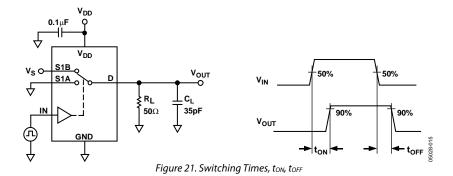


Figure 19. Off Leakage



V_{DD}

Figure 22. Break-Before-Make Time Delay, t_{BBM}

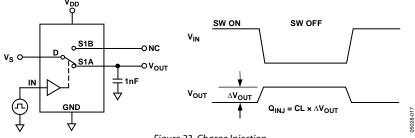


Figure 23. Charge Injection

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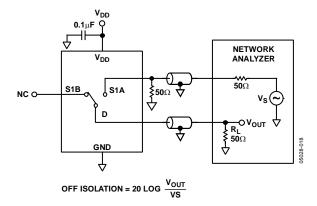


Figure 24. Off Isolation

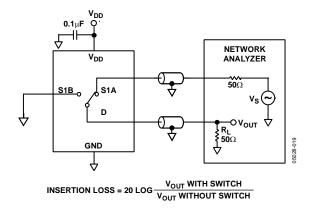


Figure 25. Channel-to-Channel Crosstalk (S1B to S1B)

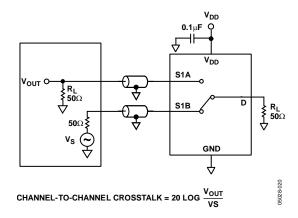


Figure 26. Bandwidth

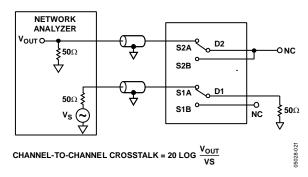


Figure 27. Channel-to-Channel Crosstalk (S1A to S2A)

TERMINOLOGY

 \mathbf{I}_{DD}

Positive supply current.

 $V_D(V_S)$

Analog voltage on Terminal D and Terminal S.

RON

Ohmic resistance between Terminal D and Terminal S.

 R_{FLAT} (ON)

The difference between the maximum and minimum values of on resistance as measured on the switch.

 ΔR_{ON}

On resistance match between any two channels.

Is (OFF)

Source leakage current with the switch off.

I_D (OFF)

Drain leakage current with the switch off.

 I_D , I_S (ON)

Channel leakage current with the switch on.

 V_{INI}

Maximum input voltage for Logic 0.

 V_{INH}

Minimum input voltage for Logic 1.

 $I_{\text{INL}}\left(I_{\text{INH}}\right)$

Input current of the digital input.

Cs (OFF)

Off switch source capacitance. Measured with reference to ground.

 C_D (OFF)

Off switch drain capacitance. Measured with reference to ground.

CD, Cs (ON)

On switch capacitance. Measured with reference to ground.

CIN

Digital input capacitance.

ton

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

toff

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

 t_{BBM}

On or off time measured between the 80% points of both switches when switching from one to another.

Charge Injection

Measure of the glitch impulse transferred from the digital input to the analog output during on/off switching.

Off Isolation

Measure of unwanted signal coupling through an off switch.

Crosstalk

Measure of unwanted signal that is coupled from one channel to another as a result of parasitic capacitance.

-3 dB Bandwidth

Frequency at which the output is attenuated by 3 dB.

On Response

Frequency response of the on switch.

Insertion Loss

The loss due to the on resistance of the switch.

THD + N

Ratio of the harmonics amplitude plus noise of a signal to the fundamental.

OUTLINE DIMENSIONS

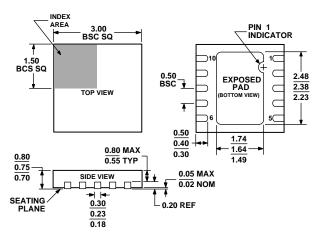
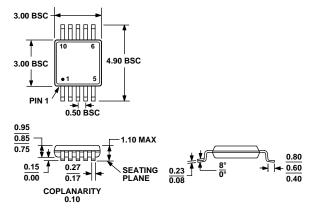


Figure 28. 10-Lead Lead Frame Chip Scale Package [LFCSP_WD] 3 mm x 3 mm Body, Very Very Thin, Dual Lead (CP-10-9) Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-187-BA
Figure 29. 10-Lead Mini Small Outline Package [MSOP]
(RM-10)
Dimensions shown in millimeters

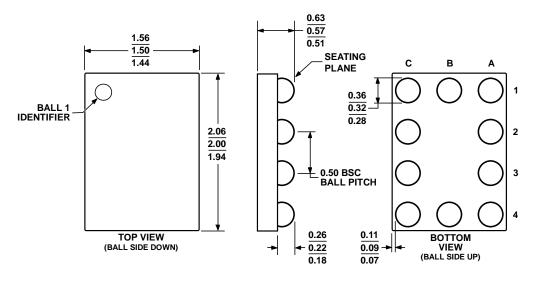


Figure 30. 10-Ball Wafer Level Chip Scale Package [WLCSP] (CB-10) Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding ¹
ADG884BRMZ ²	-40°C to +85°C	10-Lead Mini Small Outline Package [MSOP]	RM-10	S9C
ADG884BRMZ-REEL ²	-40°C to +85°C	10-Lead Mini Small Outline Package [MSOP]	RM-10	S9C
ADG884BRMZ-REEL7 ²	-40°C to +85°C	10-Lead Mini Small Outline Package [MSOP]	RM-10	S9C
ADG884BCPZ-REEL ²	-40°C to +85°C	10-Lead Lead Frame Chip Scale Package [LFCSP_WD]	CP-10-9	S9C
ADG884BCPZ-REEL7 ²	-40°C to +85°C	10-Lead Lead Frame Chip Scale Package [LFCSP_WD]	CP-10-9	S9C
ADG884BCBZ-500RL7 ²	-25°C to +85°C	10-Ball Wafer Level Chip Scale Package [WLCSP]	CB-10	S9C
ADG884BCBZ-REEL ²	−25°C to +85°C	10-Ball Wafer Level Chip Scale Package [WLCSP]	CB-10	S9C
ADG884BCBZ-REEL7 ²	−25°C to +85°C	10-Ball Wafer Level Chip Scale Package [WLCSP]	CB-10	S9C
EVAL-ADG884EB		Evaluation Board		

 $^{^{\}rm 1}$ Branding on this package is limited to three characters due to space constraints. $^{\rm 2}$ Z = Pb-free part.

NOTES