



0.5 Ω CMOS, Dual 2:1 MUX/SPDT Audio Switch

ADG884

FEATURES

- 1.8 V to 5.5 V operation**
- Ultralow on resistance**
 - 0.34 Ω typ
 - 0.38 Ω max at 5 V supply
- Excellent audio performance, ultralow distortion**
 - 0.1 Ω typ
 - 0.15 Ω max 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
- PDA's
- 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 single-pole, double-throw (SPDT) switches. This device offers ultralow on resistance of less than 0.4 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 bump, 2.0 mm \times 1.50 mm WLCSP package, a 10-lead LFCSP 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

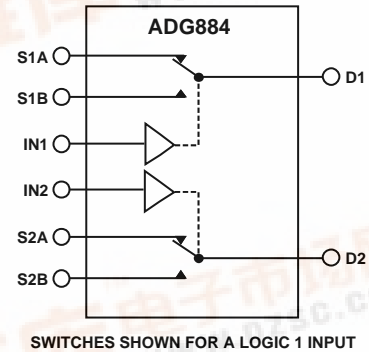


Figure 1.

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 package, and 10-lead MSOP package.

Table 1. ADG884 Truth Table

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

TABLE OF CONTENTS

Specifications.....	3	Terminology.....	11
Absolute Maximum Ratings.....	6	Test Circuits.....	12
ESD Caution.....	6	Outline Dimensions	14
Pin Configurations and Function Descriptions	7	Ordering Guide	15
Typical Performance Characteristics	8		

REVISION HISTORY

6/05—Rev. 0 to Rev. A

Updated Outline Dimensions	14
Changes to Ordering Guide	15

10/04—Revision 0: Initial Version

SPECIFICATIONS

$V_{DD} = 5\text{ V} \pm 10\%$, $GND = 0\text{ V}$, unless otherwise noted.¹

Table 2.

Parameter	25°C	−40°C to +85°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On Resistance, R_{ON}	0.28		Ω typ	$V_{DD} = 4.5\text{ V}$, $V_S = 0\text{ V}$ to V_{DD} , $I_S = 100\text{ mA}$
	0.34	0.38	Ω max	See Figure 18
On Resistance Match Between Channels, ΔR_{ON}	0.01		Ω typ	$V_{DD} = 4.5\text{ V}$, $V_S = 2\text{ V}$, $I_S = 100\text{ mA}$
	0.035	0.05	Ω max	
On Resistance Flatness, R_{FLAT} (ON)	0.1		Ω typ	$V_{DD} = 4.5\text{ V}$, $V_S = 0\text{ V}$ to V_{DD}
	0.13	0.15	Ω max	$I_S = 100\text{ mA}$
LEAKAGE CURRENTS				
Source Off Leakage, I_S (OFF)	± 0.2		nA typ	$V_{DD} = 5.5\text{ V}$
Channel On Leakage, I_D , I_S (ON)	± 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
				$V_S = V_D = 0.6\text{ V}$ or 4.5 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 CHARACTERISTICS²				
t_{ON}	42		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	50	53	ns max	$V_S = 3\text{ V}/0\text{ V}$; see Figure 21
t_{OFF}	15		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	20	21	ns max	$V_S = 3\text{ V}$; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	16		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
		10	ns min	$V_{S1} = V_{S2} = 1.5\text{ V}$; see Figure 22
Charge Injection	125		pC typ	$V_S = 1.5\text{ V}$, $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$; see Figure 23
Off Isolation	−60		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 24
Channel-to-Channel Crosstalk	−120		dB typ	S1A–S2A/S1B–S2B, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 27
	−60		dB typ	S1A–S1B/S2A–S2B, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 25
Total Harmonic Distortion, THD + N	0.017		%	$R_L = 32\ \Omega$, $f = 20\text{ Hz}$ to 20 kHz , $V_S = 3.5\text{ V p-p}$
Insertion Loss	−0.03		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; see Figure 26
−3 dB Bandwidth	18		MHz typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; see Figure 26
C_S (OFF)	103		pF typ	
C_D , C_S (ON)	295		pF typ	
POWER REQUIREMENTS				
I_{DD}	0.003		μA typ	$V_{DD} = 5.5\text{ V}$
		1	μA max	Digital inputs = 0 V or 5.5 V

¹ Temperature range of the B version is -40°C to $+85^\circ\text{C}$.

² Guaranteed by design, not subject to production test.

ADG884

$V_{DD} = 3.4 \text{ V to } 4.2 \text{ V}$; $GND = 0 \text{ V}$, unless otherwise noted.¹

Table 3.

Parameter	25°C	-40°C to +85°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analogue Signal Range		0 V to V_{DD}	V	
On Resistance, R_{ON}	0.33		Ω typ	$V_{DD} = 3.4 \text{ V}$, $V_S = 0 \text{ V to } V_{DD}$, $I_S = 100 \text{ mA}$
	0.38	0.45	Ω max	See Figure 18
On Resistance Match Between Channels, ΔR_{ON}	0.013		Ω typ	$V_{DD} = 3.4 \text{ V}$, $V_S = 2 \text{ V}$, $I_S = 100 \text{ mA}$
	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				
Source Off Leakage, I_S (OFF)	± 0.2		nA typ	$V_{DD} = 4.2 \text{ V}$
Channel On Leakage, I_D , I_S (ON)	± 0.2		nA typ	$V_S = 0.6 \text{ V}/3.9 \text{ V}$, $V_D = 3.9 \text{ V}/0.6 \text{ V}$; see Figure 19
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 CHARACTERISTICS²				
t_{ON}	42		ns typ	$R_L = 50 \Omega$, $C_L = 35 \text{ pF}$
	50	54	ns max	$V_S = 1.5 \text{ V}/0 \text{ V}$; see Figure 21
t_{OFF}	15		ns typ	$R_L = 50 \Omega$, $C_L = 35 \text{ pF}$
	21	24	ns max	$V_S = 1.5 \text{ V}$; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	17		ns typ	$R_L = 50 \Omega$, $C_L = 35 \text{ pF}$
		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	$R_L = 50 \Omega$, $C_L = 5 \text{ pF}$, $f = 100 \text{ kHz}$; see Figure 24
Channel-to-Channel Crosstalk	-120		dB typ	S1A-S2A/S1B-S2B, $R_L = 50 \Omega$, $C_L = 5 \text{ pF}$, $f = 100 \text{ kHz}$; see Figure 27
	-60		dB typ	S1A-S1B/S2A-S2B, $R_L = 50 \Omega$, $C_L = 5 \text{ pF}$, $f = 100 \text{ kHz}$; see Figure 25
Total Harmonic Distortion, THD + N	0.01		%	$R_L = 32 \Omega$, $f = 20 \text{ Hz to } 20 \text{ kHz}$, $V_S = 2 \text{ V p-p}$
Insertion Loss	-0.03		dB typ	$R_L = 50 \Omega$, $C_L = 5 \text{ pF}$; see Figure 26
-3 dB Bandwidth	18		MHz typ	$R_L = 50 \Omega$, $C_L = 5 \text{ pF}$; see Figure 26
C_S (OFF)	110		pF typ	
C_D , C_S (ON)	300		pF typ	
POWER REQUIREMENTS				
I_{DD}	0.003		μA typ	$V_{DD} = 4.2 \text{ V}$
		1	μA max	Digital inputs = 0 V or 4.2 V

¹ Temperature range of the B version is -40°C to +85°C.

² Guaranteed by design, not subject to production test.

$V_{DD} = 2.7\text{ V to }3.6\text{ V}$, $GND = 0\text{ V}$, unless otherwise noted.¹

Table 4.

Parameter	25°C	−40°C to +85°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On Resistance, R_{ON}	0.4		Ω typ	$V_{DD} = 2.7\text{ V}$, $V_S = 0\text{ V to }V_{DD}$
	0.5	0.6	Ω max	$I_S = 100\text{ mA}$; see Figure 18
On Resistance Match Between Channels, ΔR_{ON}	0.02		Ω typ	$V_{DD} = 2.7\text{ V}$, $V_S = 0.6\text{ V}$
	0.07	0.1	Ω max	$I_S = 100\text{ mA}$
On Resistance Flatness, R_{FLAT} (ON)	0.18		Ω typ	$V_{DD} = 2.7\text{ V}$, $V_S = 0\text{ V to }V_{DD}$
		0.25	Ω max	$I_S = 100\text{ mA}$
LEAKAGE CURRENTS				
Source Off Leakage, I_S (OFF)	± 0.2		nA typ	$V_{DD} = 3.6\text{ V}$
Channel On Leakage, I_D , I_S (ON)	± 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
				$V_S = V_D = 0.6\text{ V or }3.3\text{ V}$; 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	$V_{IN} = V_{INL}$ or V_{INH}
		± 0.1	μA max	
Digital Input Capacitance, C_{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS²				
t_{ON}	42		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	56	62	ns max	$V_S = 1.5\text{ V}/0\text{ V}$; see Figure 21
t_{OFF}	14		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	19	21	ns max	$V_S = 1.5\text{ V}$; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	24		ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
		10	ns min	$V_{S1} = V_{S2} = 1.5\text{ V}$; see Figure 22
Charge Injection	85		pC typ	$V_S = 1.25\text{ V}$, $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$; see Figure 23
Off Isolation	−60		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 24
Channel-to-Channel Crosstalk	−120		dB typ	S1A–S2A/S1B–S2B, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 27
	−60		dB typ	S1A–S1B/S2A–S2B, $R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; see Figure 25
Total Harmonic Distortion, THD + N	0.03		%	$R_L = 32\ \Omega$, $f = 20\text{ Hz to }20\text{ kHz}$, $V_S = 1.5\text{ V p-p}$
Insertion Loss	−0.03		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; see Figure 26
−3 dB Bandwidth	18		MHz typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; see Figure 26
C_S (OFF)	110		pF typ	
C_D , C_S (ON)	300		pF typ	
POWER REQUIREMENTS				
I_{DD}	0.003		μA typ	$V_{DD} = 3.6\text{ V}$
		1	μA max	Digital inputs = 0 V or 3.6 V

¹ Temperature range of the B version is -40°C to $+85^\circ\text{C}$.

² Guaranteed by design, not subject to production test.

ADG884

ABSOLUTE MAXIMUM RATINGS

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

Table 5.

Parameter	Rating
V_{DD} to GND	-0.3 V to +6 V
Analog Inputs ¹	-0.3 V to $V_{DD} + 0.3$ V
Digital Inputs ¹	-0.3 V to 6 V or 10 mA (whichever 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 Industrial (B Version)	-40°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 Package (4-Layer Board)	
θ_{JA} Thermal Impedance	76°C/W
θ_{JC} Thermal Impedance	13.5°C/W
IR Reflow, Peak Temperature <20 s	235°C

¹ Overvoltages at IN, 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 may 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.



PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

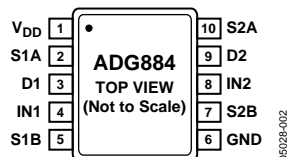


Figure 2. LFCSP and MSOP Pin Configuration

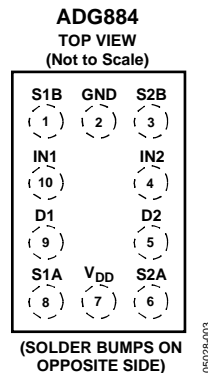


Figure 3. WLCSP Pin Configuration

Table 6. Pin Function Descriptions

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

TYPICAL PERFORMANCE CHARACTERISTICS

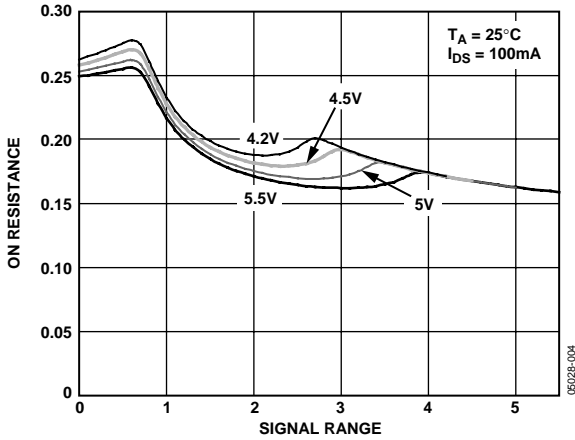


Figure 4. On Resistance vs. V_D (Vs), $V_{DD} = 4.2$ V to 5.5 V

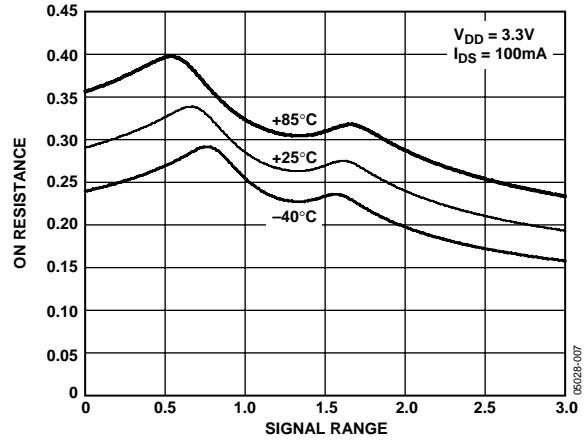


Figure 7. On Resistance vs. V_D (Vs) for Different Temperature, $V_{DD} = 3.3$ V

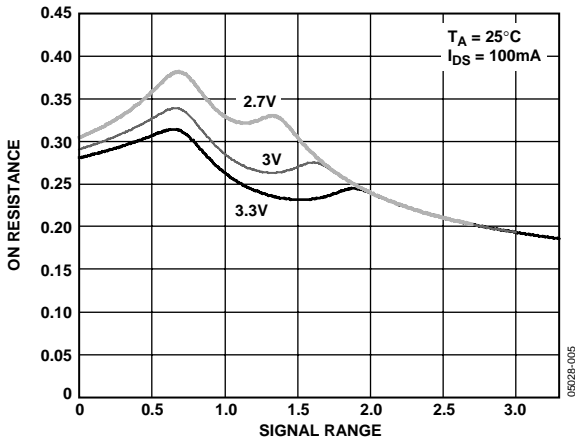


Figure 5. On Resistance vs. V_D (Vs), $V_{DD} = 2.7$ V to 3.3 V

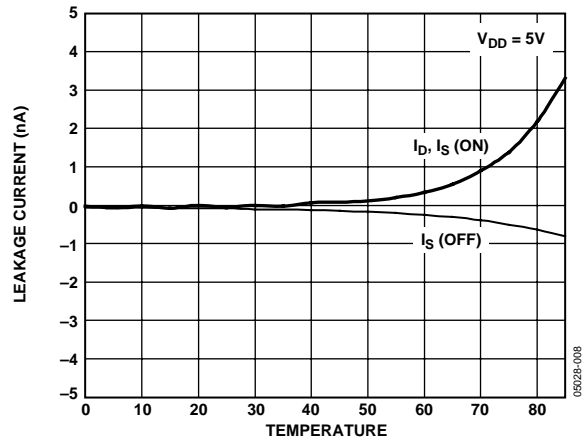


Figure 8. Leakage Current vs. Temperature, $V_{DD} = 5$ V

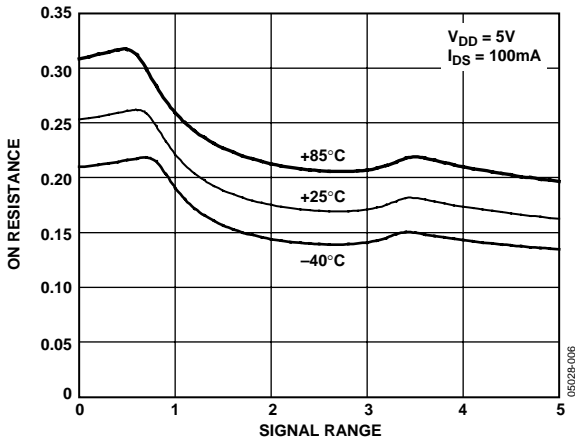


Figure 6. On Resistance vs. V_D (Vs) for Different Temperature, $V_{DD} = 5$ V

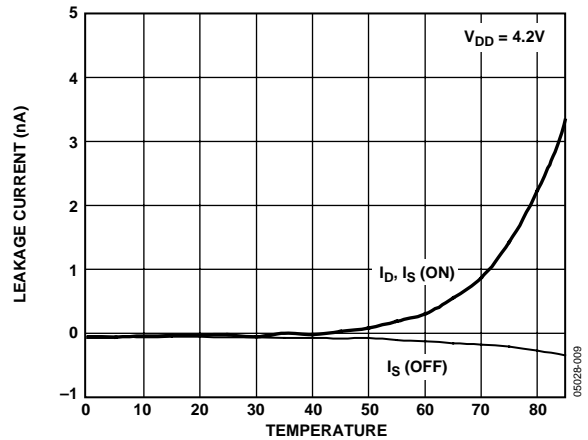


Figure 9. Leakage Current vs. Temperature, $V_{DD} = 4.2$ V

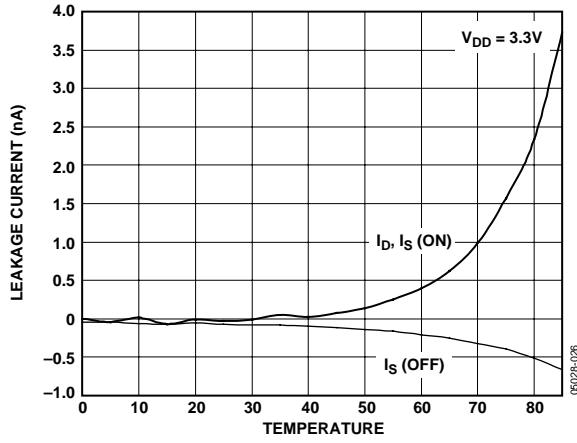


Figure 10. Leakage Current vs. Temperature, $V_{DD} = 3.3V$

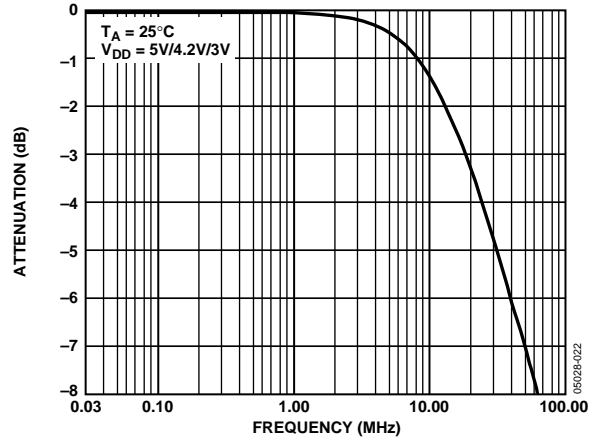


Figure 13. Bandwidth

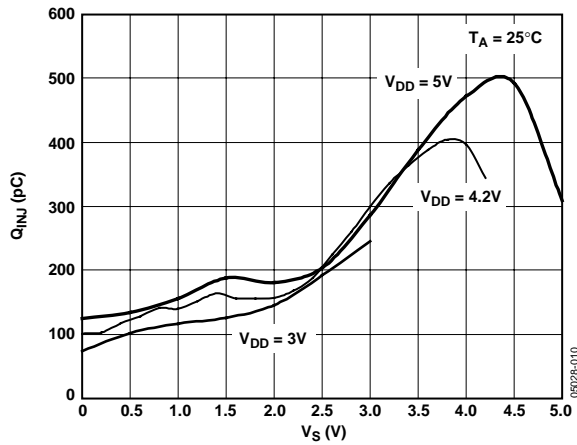


Figure 11. Charge Injection vs. Source Voltage

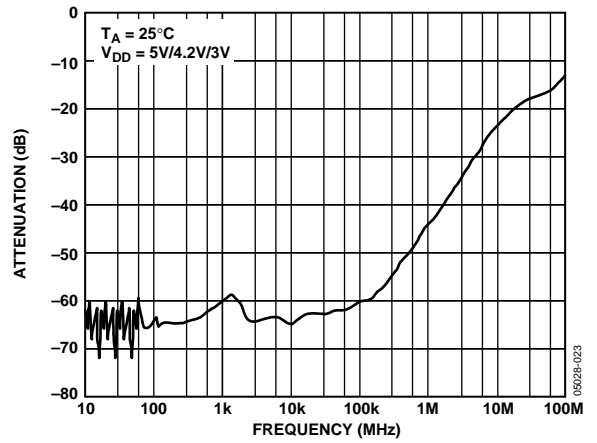


Figure 14. Off Isolation vs. Frequency

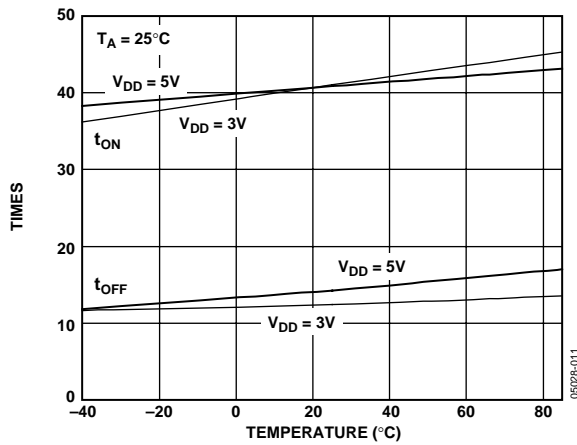


Figure 12. t_{ON}/t_{OFF} Times vs. Temperature

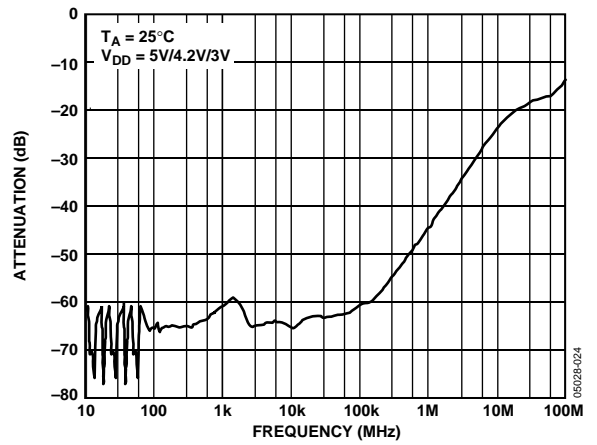


Figure 15. Crosstalk vs. Frequency

ADG884

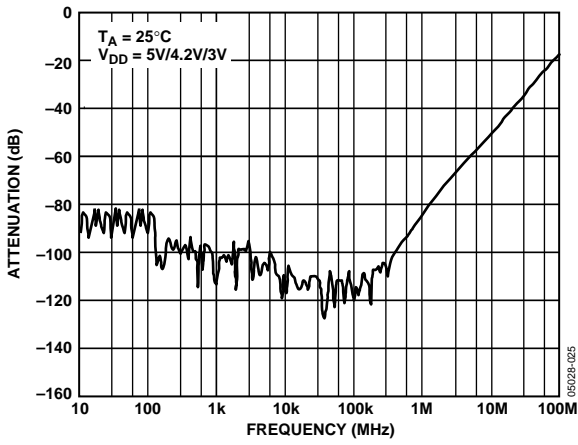


Figure 16. AC PSRR

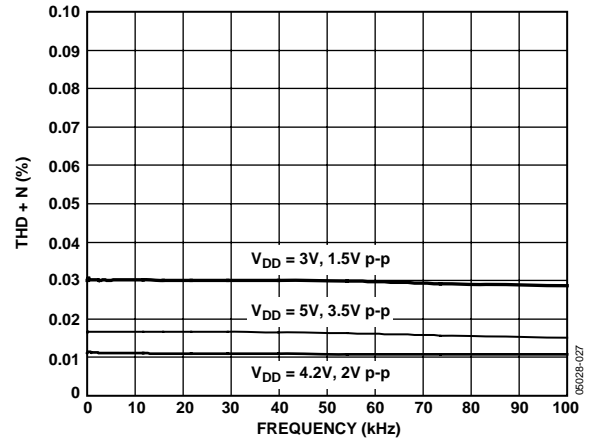


Figure 17. THD + N

TERMINOLOGY

I_{DD}

Positive supply current.

V_D (V_S)

Analog voltage on Terminals D, S.

R_{ON}

Ohmic resistance between D and 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.

I_S (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_{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.

C_S (OFF)

Off switch source capacitance. Measured with reference to ground.

C_D (OFF)

Off switch drain capacitance. Measured with reference to ground.

C_D, C_S (ON)

On switch capacitance. Measured with reference to ground.

C_{IN}

Digital input capacitance.

t_{ON}

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

t_{OFF}

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

t_{B2B}

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 through 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.

TEST CIRCUITS

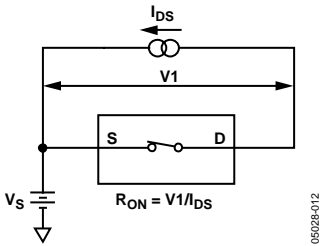


Figure 18. On Resistance

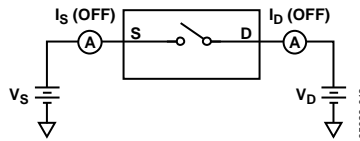


Figure 19. Off Leakage

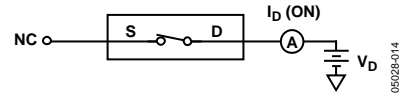


Figure 20. On Leakage

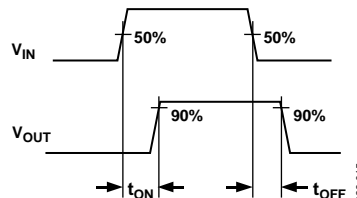
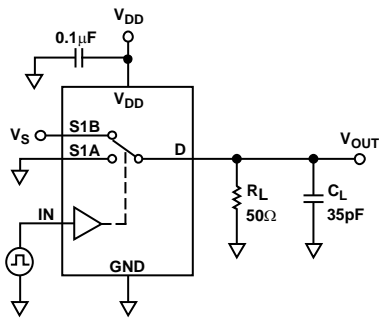


Figure 21. Switching Times, t_{ON} , t_{OFF}

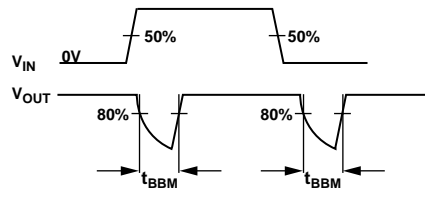
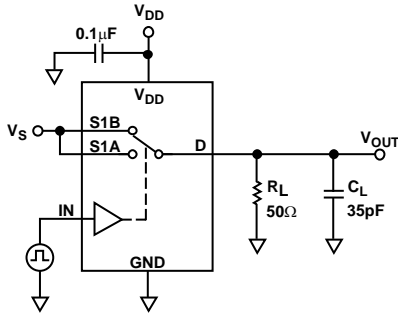


Figure 22. Break-Before-Make Time Delay, t_{BBM}

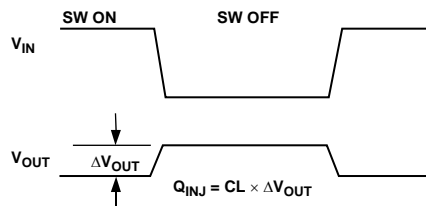
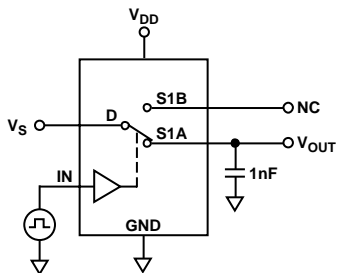


Figure 23. Charge Injection

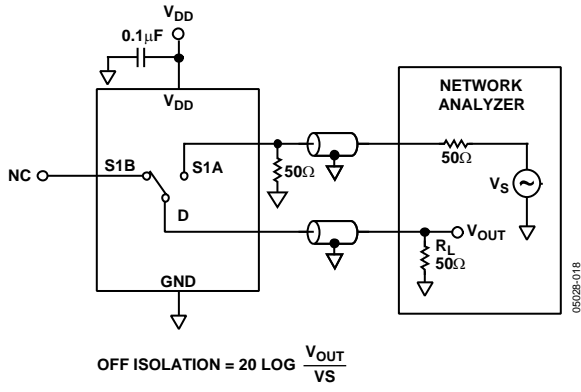


Figure 24. Off Isolation

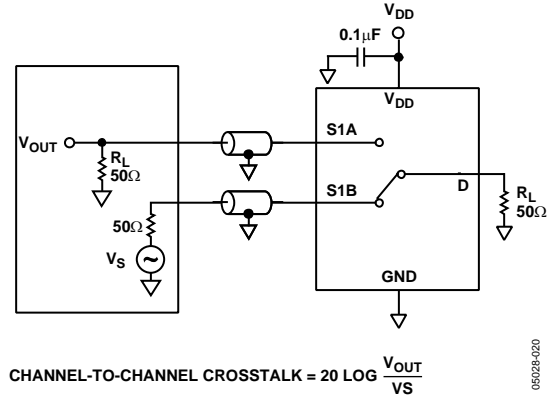


Figure 26. Bandwidth

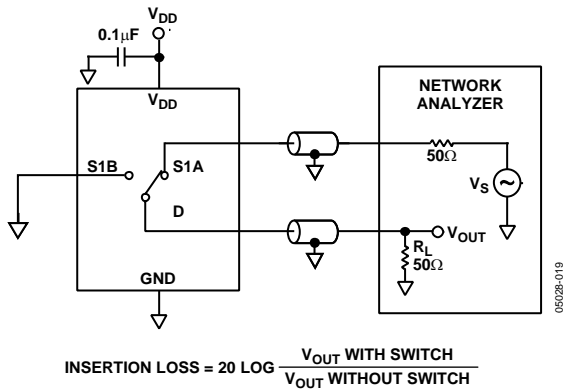


Figure 25. Channel-to-Channel Crosstalk (S1A-S1B)

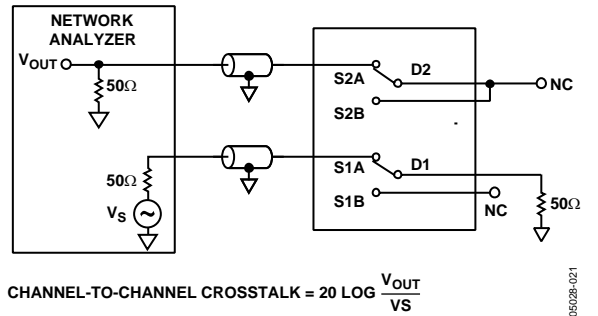


Figure 27. Channel-to-Channel Crosstalk (S1A-S2A)

OUTLINE DIMENSIONS

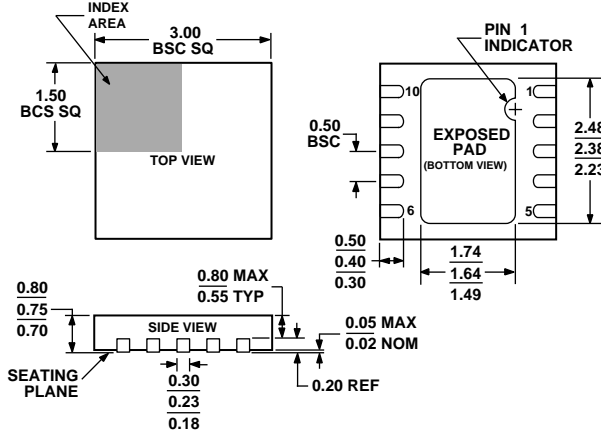
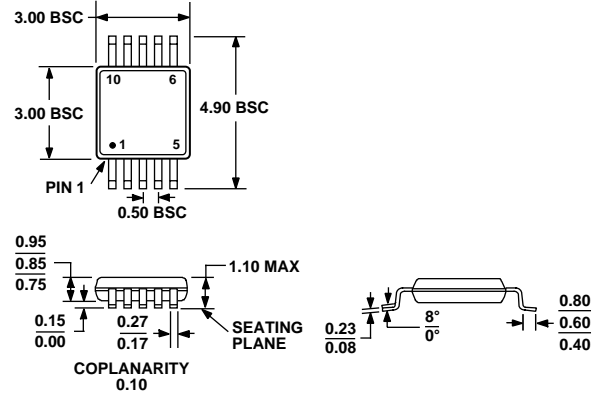


Figure 28. 10-Lead Lead Frame Chip Scale Package [LFCSP_WD]
 3 x 3 mm Body, Very Very Thin, Dual Lead
 (CP-10-9)
 Dimensions shown in millimeters



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

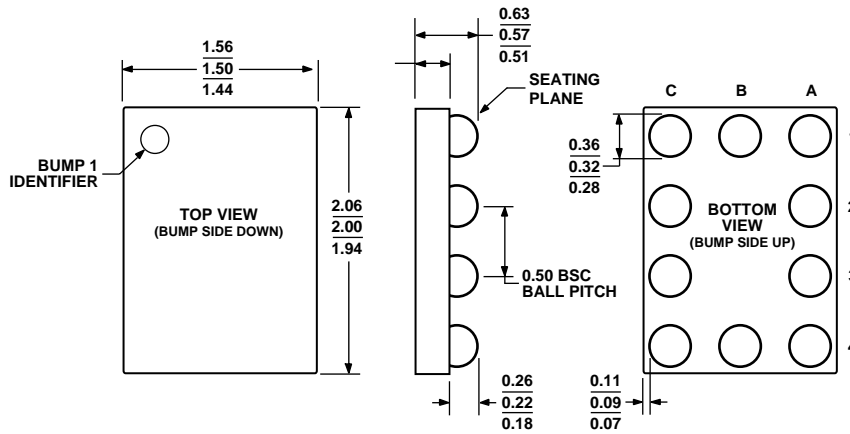


Figure 30. 10-Ball Wafer Level Chip Scale Package [WLCSFP]
 (CB-10)
 Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding ¹
ADG884BRMZ ²	-40°C to +85°C	Mini Small Outline Package (MSOP)	RM-10	S9C
ADG884BRMZ-REEL ²	-40°C to +85°C	Mini Small Outline Package (MSOP)	RM-10	S9C
ADG884BRMZ-REEL7 ²	-40°C to +85°C	Mini Small Outline Package (MSOP)	RM-10	S9C
ADG884BCPZ-REEL ²	-40°C to +85°C	Lead Frame Chip Scale Package (LFCSP_WD)	CP-10-9	S9C
ADG884BCPZ-REEL7 ²	-40°C to +85°C	Lead Frame Chip Scale Package (LFCSP_WD)	CP-10-9	S9C
ADG884BCBZ-500RL7 ^{2,3}	-40°C to +85°C	Micro Chip Scale Package (WLCSP)	CB-10	S0W
ADG884BCBZ-REEL ^{2,3}	-40°C to +85°C	Micro Chip Scale Package (WLCSP)	CB-10	S0W
ADG884BCBZ-REEL7 ^{2,3}	-40°C to +85°C	Micro Chip Scale Package (WLCSP)	CB-10	S0W

¹ Branding on this package is limited to three characters due to space constraints.

² Z = Pb-free package.

³ Contact Sales for availability; product under development.

ADG884

NOTES