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

ADG884

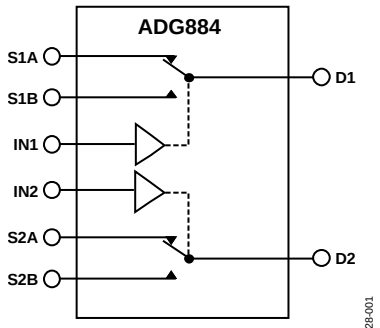
FEATURES

- 1.8 V to 5.5 V operation
- Ultralow on resistance
  - 0.28 Ω typical
  - 0.41 Ω maximum at 5 V supply
- Excellent audio performance, ultralow distortion
  - 0.1 Ω typical
  - 0.15 Ω 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 µW)

APPLICATIONS

- Cellular phones
- PDAs
- MP3 players
- Power routing
- Battery-powered systems
- PCMCIA cards
- Modems
- Audio and video signal routing
- Communications systems

FUNCTIONAL BLOCK DIAGRAM



SWITCHES SHOWN FOR A LOGIC 1 INPUT

Figure 1.

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 × 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.

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 × 1.5 mm WLCSP package, 3 mm × 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

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10/04—Revision 0: Initial Version

SPECIFICATIONS

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

Table 1.

Parameter	25°C	B Version Temperature Range[1]	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 V, V_S = 0 V to V_{DD}, I_S = 100 mA
	0.37	0.41	Ω max	See Figure 18
On Resistance Match Between Channels, ΔR_{ON}	0.01		Ω typ	V_{DD} = 4.5 V, V_S = 2 V, I_S = 100 mA
	0.035	0.05	Ω max	
On Resistance Flatness, R_{FLAT} (ON)	0.1		Ω typ	V_{DD} = 4.5 V, V_S = 0 V to V_{DD}
	0.13	0.15	Ω max	I_S = 100 mA
LEAKAGE CURRENTS				V_{DD} = 5.5 V
Source Off Leakage, I_S (OFF)	±0.2		nA typ	V_S = 0.6 V/4.5 V, V_D = 4.5 V/0.6 V; see Figure 19
Channel On Leakage, I_D, I_S (ON)	±0.2		nA typ	V_S = V_D = 0.6 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 CHARACTERISTICS[2]				
t_{ON}	42		ns typ	R_L = 50 Ω, C_L = 35 pF
	50	53	ns max	V_S = 3 V/0 V; see Figure 21
t_{OFF}	15		ns typ	R_L = 50 Ω, C_L = 35 pF
	20	21	ns max	V_S = 3 V; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	16		ns typ	R_L = 50 Ω, C_L = 35 pF
		10	ns min	V_{S1} = V_{S2} = 1.5 V; see Figure 22
Charge Injection	125		pC typ	V_S = 1.5 V, R_S = 0 Ω, C_L = 1 nF; see Figure 23
Off Isolation	−60		dB typ	R_L = 50 Ω, 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 Ω, C_L = 5 pF, f = 100 kHz; see Figure 27
	−60		dB typ	S1A to S1B/S2A to S2B, R_L = 50 Ω, C_L = 5 pF, f = 100 kHz; see Figure 25
Total Harmonic Distortion, THD + N	0.017		%	R_L = 32 Ω, f = 20 Hz to 20 kHz, V_S = 3.5 V p-p
Insertion Loss	−0.03		dB typ	R_L = 50 Ω, C_L = 5 pF; see Figure 25
−3 dB Bandwidth	18		MHz typ	R_L = 50 Ω, 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 V
I_{DD}	0.003		μA typ	Digital inputs = 0 V or 5.5 V
		1	μA max	

[1] Temperature ranges: B version: −40°C to +85°C for the MSOP and LFCSP_WD packages, and −25°C to +85°C for the WLCSP package.
[2] Guaranteed by design, not production tested.

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

Table 2.

Parameter	25°C	B Version Temperature Range[1]	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On Resistance, R_{ON}	0.33		Ω typ	V_{DD} = 3.4 V, V_S = 0 V to V_{DD}, I_S = 100 mA
	0.4	0.47	Ω max	See Figure 18
On Resistance Match Between Channels, ΔR_{ON}	0.013		Ω typ	V_{DD} = 3.4 V, V_S = 2 V, I_S = 100 mA
	0.042	0.065	Ω max	
On Resistance Flatness, R_{FLAT} (ON)	0.13		Ω typ	V_{DD} = 3.4 V, V_S = 0 V to V_{DD}
	0.155	0.175	Ω max	I_S = 100 mA
LEAKAGE CURRENTS				V_{DD} = 4.2 V
Source Off Leakage, I_S (OFF)	±0.2		nA typ	V_S = 0.6 V/3.9 V, V_D = 3.9 V/0.6 V; see Figure 19
Channel On Leakage, I_D, I_S (ON)	±0.2		nA typ	V_S = V_D = 0.6 V or 3.9 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]				
t_{ON}	42		ns typ	R_L = 50 Ω, C_L = 35 pF
	50	54	ns max	V_S = 1.5 V/0 V; see Figure 21
t_{OFF}	15		ns typ	R_L = 50 Ω, C_L = 35 pF
	21	24	ns max	V_S = 1.5 V; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	17		ns typ	R_L = 50 Ω, C_L = 35 pF
		10	ns min	V_{S1} = V_{S2} = 1.5 V; see Figure 22
Charge Injection	100		pC typ	V_S = 1.5 V, R_S = 0 Ω, C_L = 1 nF; see Figure 23
Off Isolation	−60		dB typ	R_L = 50 Ω, 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 Ω, C_L = 5 pF, f = 100 kHz; see Figure 27
	−60		dB typ	S1A to S1B/S2A to S2B, R_L = 50 Ω, C_L = 5 pF, f = 100 kHz; see Figure 25
Total Harmonic Distortion, THD + N	0.01		%	R_L = 32 Ω, f = 20 Hz to 20 kHz, V_S = 2 V p-p
Insertion Loss	−0.03		dB typ	R_L = 50 Ω, C_L = 5 pF; see Figure 25
−3 dB Bandwidth	18		MHz typ	R_L = 50 Ω, 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} = 4.2 V
I_{DD}	0.003		μA typ	Digital inputs = 0 V or 4.2 V
		1	μA max	

[1] Temperature ranges: B version: −40°C to +85°C for the MSOP and LFCSP_WD packages, and −25°C to +85°C for the WLCSP package.
[2] Guaranteed by design, not production tested.

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

Table 3.

Parameter	25°C	B Version Temperature Range[1]	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 V, V_S = 0 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		Ω typ	V_{DD} = 2.7 V, V_S = 0.6 V
	0.07	0.1	Ω max	I_S = 100 mA
On Resistance Flatness, R_{FLAT} (ON)	0.18		Ω typ	V_{DD} = 2.7 V, V_S = 0 V to V_{DD}
		0.25	Ω max	I_S = 100 mA
LEAKAGE CURRENTS				V_{DD} = 3.6 V
Source Off Leakage, I_S (OFF)	±0.2		nA typ	V_S = 0.6 V/3.3 V, V_D = 3.3 V/0.6 V; see Figure 19
Channel On Leakage, I_D, I_S (ON)	±0.2		nA typ	V_S = V_D = 0.6 V or 3.3 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 CHARACTERISTICS[2]				
t_{ON}	42		ns typ	R_L = 50 Ω, C_L = 35 pF
	56	62	ns max	V_S = 1.5 V/0 V; see Figure 21
t_{OFF}	14		ns typ	R_L = 50 Ω, C_L = 35 pF
	19	21	ns max	V_S = 1.5 V; see Figure 21
Break-Before-Make Time Delay, t_{BBM}	24		ns typ	R_L = 50 Ω, C_L = 35 pF
		10	ns min	V_{S1} = V_{S2} = 1.5 V; see Figure 22
Charge Injection	85		pC typ	V_S = 1.25 V, R_S = 0 Ω, C_L = 1 nF; see Figure 23
Off Isolation	−60		dB typ	R_L = 50 Ω, 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 V, C_L = 5 pF, f = 100 kHz; see Figure 27
	−60		dB typ	S1A to S1B/S2A to S2B, R_L = 50 Ω, C_L = 5 pF, f = 100 kHz; see Figure 25
Total Harmonic Distortion, THD + N	0.03		%	R_L = 32 Ω, f = 20 Hz to 20 kHz, V_S = 1.5 V p-p
Insertion Loss	−0.03		dB typ	R_L = 50 Ω, C_L = 5 pF; see Figure 25
−3 dB Bandwidth	18		MHz typ	R_L = 50 Ω, 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 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°C for the MSOP and LFCSP_WD packages, and −25°C to +85°C for the WLCSP package.
[2] Guaranteed by design, not production tested.

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 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 (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	
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

[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 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.

PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

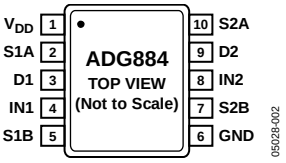


Figure 2. 10-Lead LFCSP_WD and 10-Lead MSOP Pin Configuration

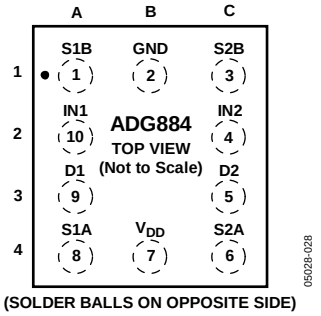


Figure 3. 10-Ball WLCSP Pin Configuration

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

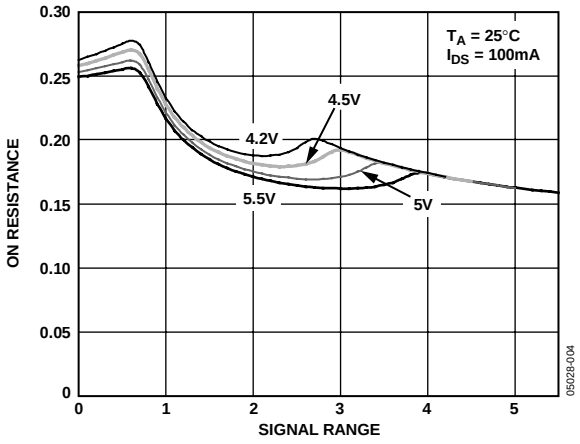


Figure 4. On Resistance vs. V_D (V_S), V_{DD} = 4.2 V to 5.5 V

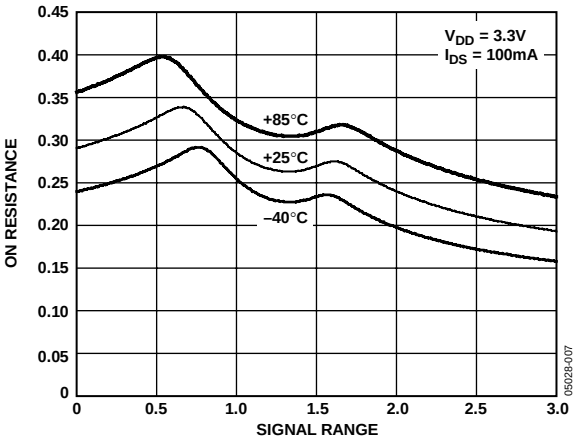


Figure 7. On Resistance vs. V_D (V_S) for Different Temperature, V_{DD} = 3.3 V

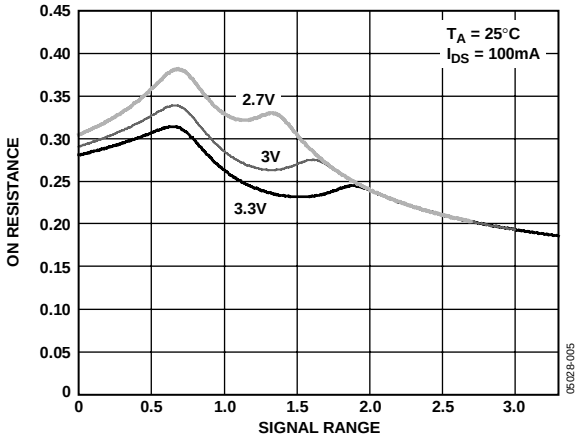


Figure 5. On Resistance vs. V_D (V_S), V_{DD} = 2.7 V to 3.3 V

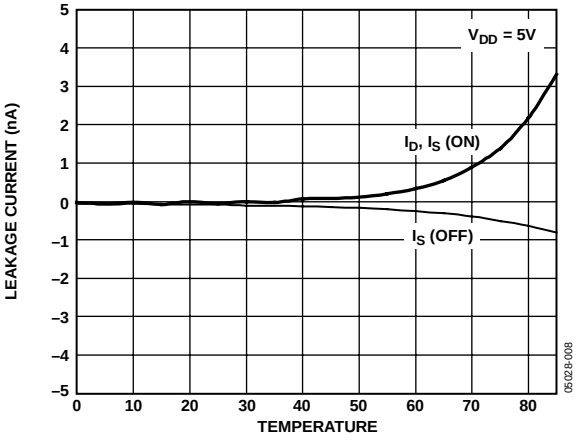


Figure 8. Leakage Current vs. Temperature, V_{DD} = 5 V

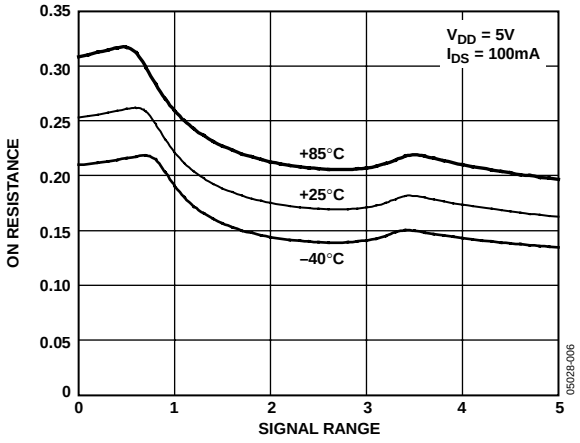


Figure 6. On Resistance vs. V_D (V_S) for Different Temperature, V_{DD} = 5 V

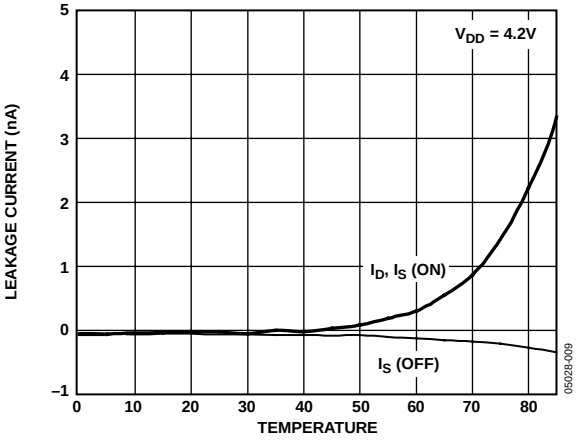


Figure 9. Leakage Current vs. Temperature, V_{DD} = 4.2 V

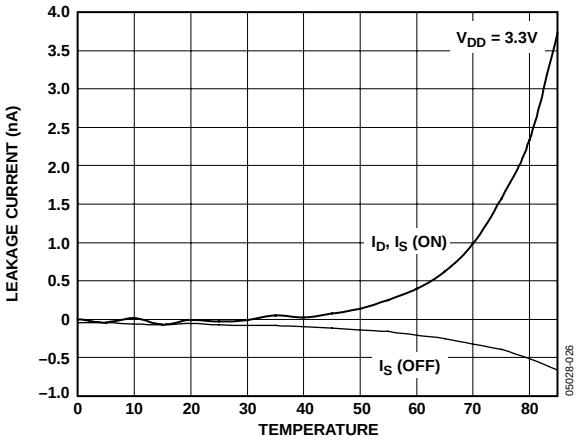


Figure 10. Leakage Current vs. Temperature, V_{DD} = 3.3 V

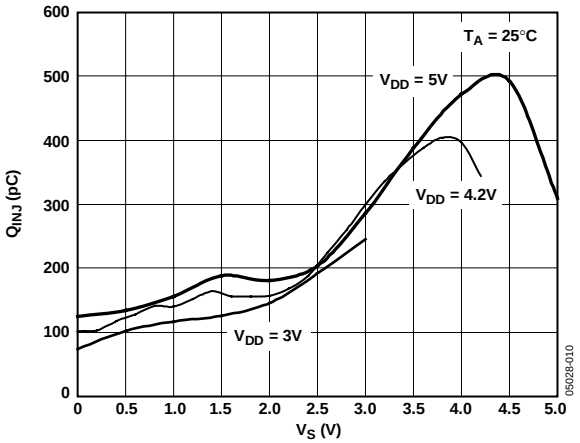


Figure 11. Charge Injection vs. Source Voltage

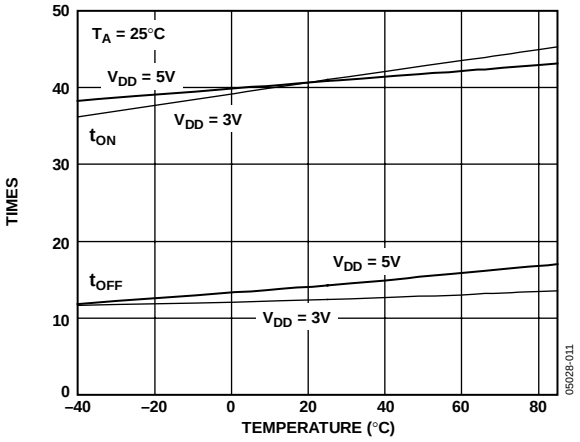


Figure 12. t_{ON}/t_{OFF} Times vs. Temperature

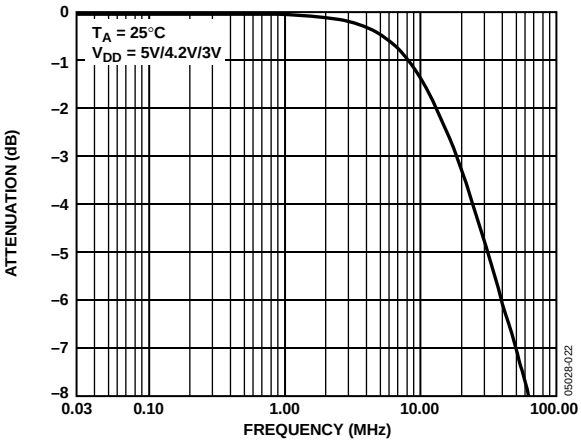


Figure 13. Bandwidth

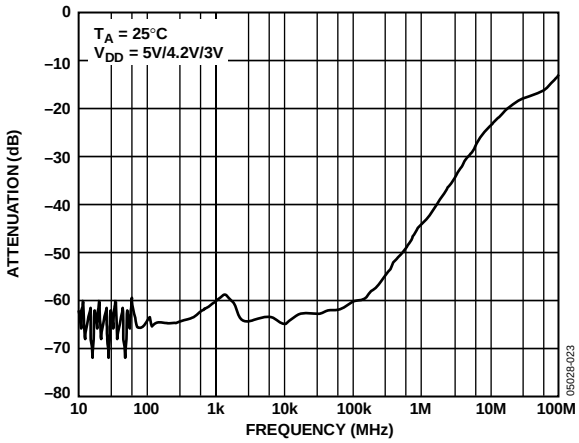


Figure 14. Off Isolation vs. Frequency

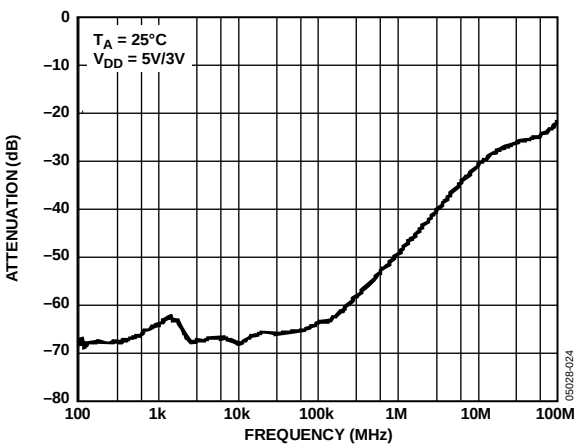


Figure 15. Crosstalk vs. Frequency

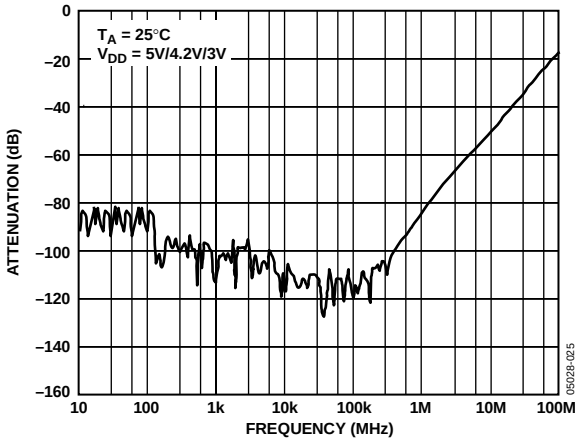


Figure 16. AC PSRR

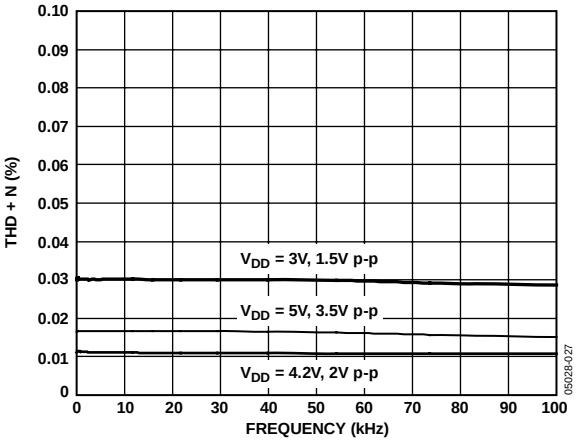


Figure 17. THD + N

TEST CIRCUITS

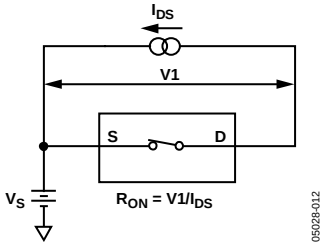


Figure 18. On Resistance

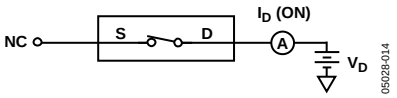


Figure 20. On Leakage

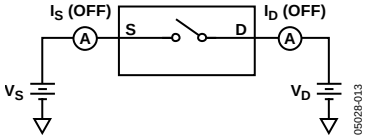


Figure 19. Off Leakage

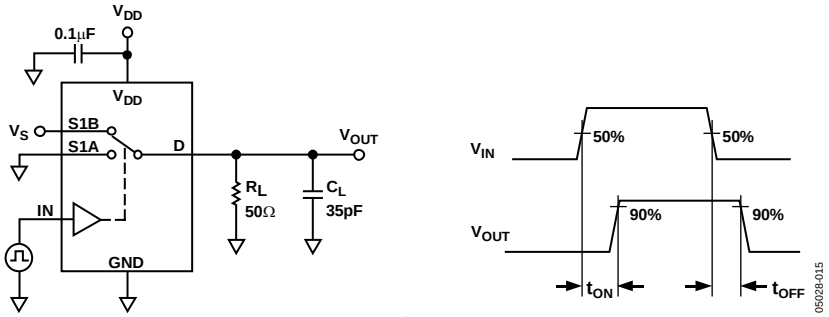


Figure 21. Switching Times, t_{ON}, t_{OFF}

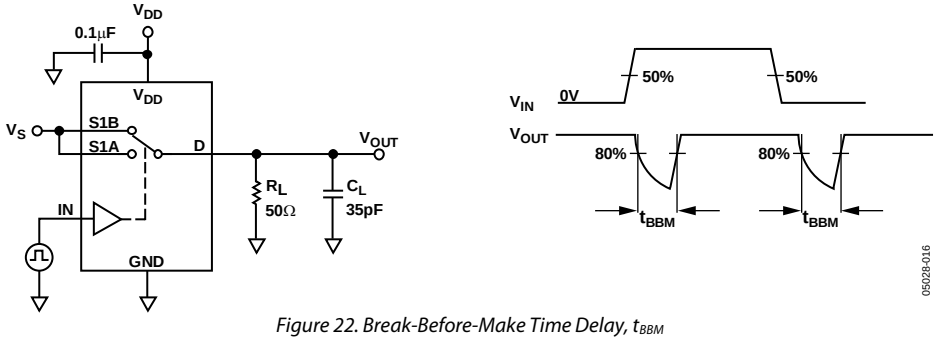


Figure 22. Break-Before-Make Time Delay, t_{BBM}

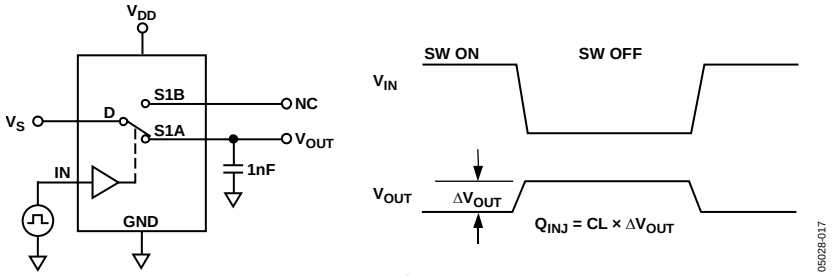


Figure 23. Charge Injection

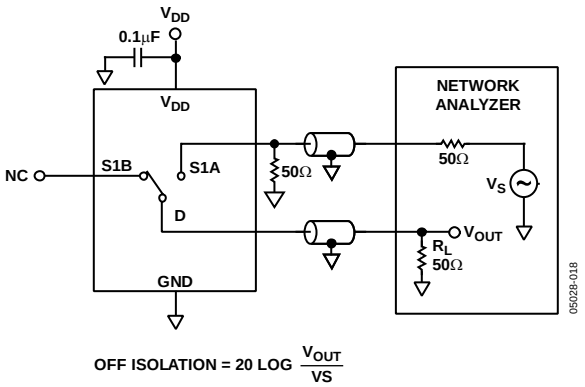


Figure 24. Off Isolation

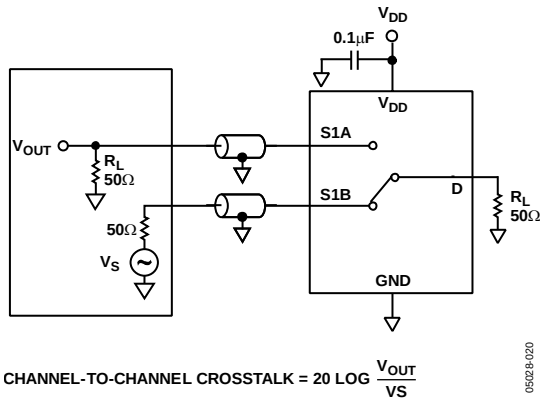


Figure 26. Bandwidth

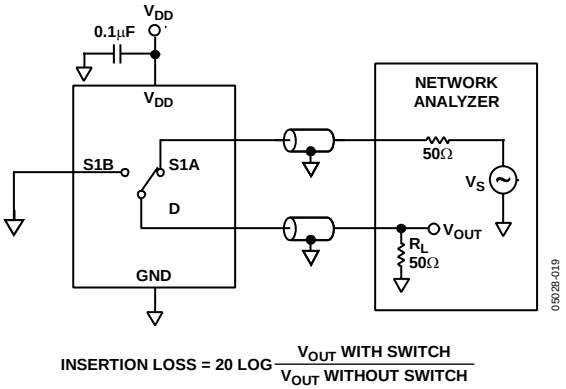


Figure 25. Channel-to-Channel Crosstalk (S1B to S1B)

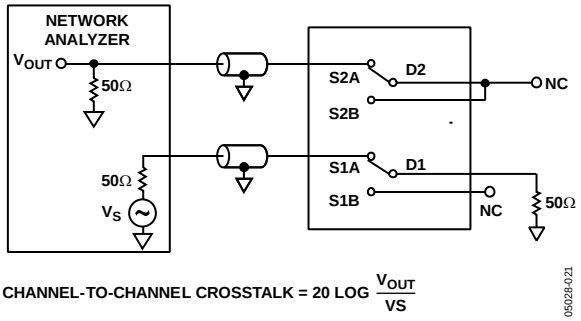


Figure 27. Channel-to-Channel Crosstalk (S1A to S2A)

TERMINOLOGY

I_{DD}
Positive supply current.

V_D (V_S)
Analog voltage on Terminal D and Terminal S.

R_{ON}
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.

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_{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

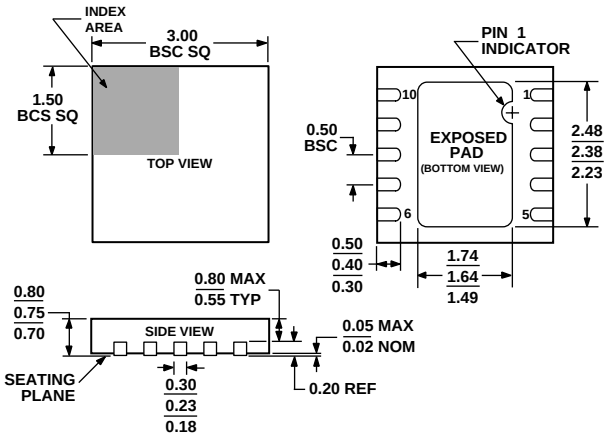
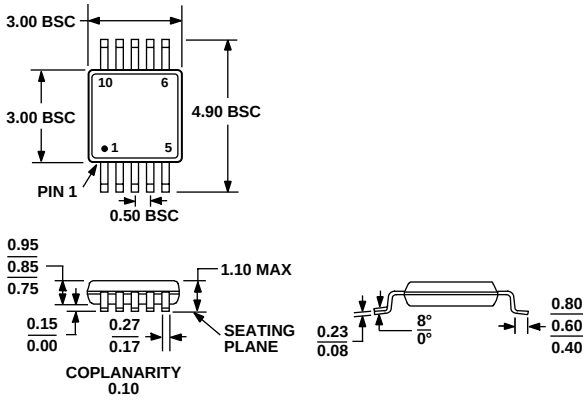


Figure 28. 10-Lead Lead Frame Chip Scale Package [LFCSP_WD]
3 mm x 3 mm Body, Very Very Thin, Dual Lead
(CP-10-9)
Dimensions shown in millimeters



COMPLIANT TO JEDEC STANDARDS MO-187-BA

Figure 29. 10-Lead Mini Small Outline Package [MSOP]
(RM-10)
Dimensions shown in millimeters

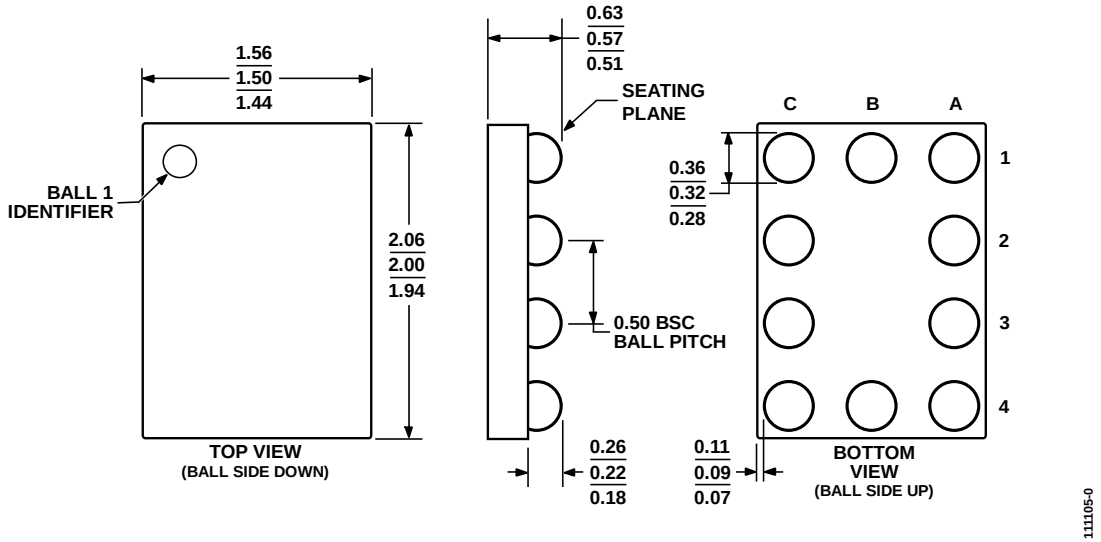


Figure 30. 10-Ball Wafer Level Chip Scale Package [WLCSP]
(CB-10)
Dimensions shown in millimeters

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		

[1] Branding on this package is limited to three characters due to space constraints.
[2] Z = Pb-free part.

NOTES

D05028-0-7/06(B)