

0.5 Ω CMOS 1.65 V to 3.6 V Dual SPDT/2:1 MUX

ADG836L

FEATURES

0.5 Ω typical on resistance 0.8 Ω maximum on resistance at 125°C 1.65 V to 3.6 V operation Automotive temperature range: -40°C to +125°C Guaranteed leakage specifications up to 125°C High current carrying capability: 300 mA continuous Rail-to-rail switching operation Fast switching times <20 ns 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 Communication systems

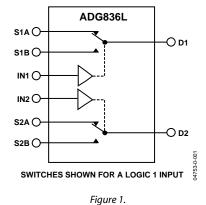
GENERAL DESCRIPTION

The ADG836L 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 0.8 Ω over the full temperature range. The ADG836L is fully specified for 3.3 V, 2.5 V, and 1.8 V supply operation.

Each switch conducts equally well in both directions when on and has an input signal range that extends to the supplies. The ADG836L exhibits break-before-make switching action.

The ADG836L is available in a 10-lead package.

FUNCTIONAL BLOCK DIAGRAM



PRODUCT HIGHLIGHTS

- 1. Less than 0.8 Ω over full temperature range of -40° C to $+125^{\circ}$ C.
- 2. Single 1.65 V to 3.6 V operation.
- 3. Compatible with 1.8 V CMOS logic.
- 4. High current handling capability (300 mA continuous current at 3.3 V).
- 5. Low THD + N (0.02% typ).
- 6. Small 10-lead MSOP package.

Rev. A

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REVISION HISTORY

5/04—Data Sheet Changed from Rev. 0 to Rev. A
Updated Ordering Guide14

4/04—Revision 0: Initial Version

SPECIFICATIONS

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

Parameter	+25°C	−40°C − +85°C	–40°C – +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V _{DD}	V	$V_{DD} = 2.7 V$
On Resistance (Ron)	0.5			Ωtyp	$V_{DD} = 2.7 \text{ V}, V_{S} = 0 \text{ V} \text{ to } V_{DD}, I_{S} = 10 \text{ mA}$
	0.65	0.75	0.8	Ωmax	(Figure 18)
On Resistance Match between Channels (ΔR_{ON})	0.04	0.075	0.08	Ω typ Ω max	$V_{DD} = 2.7 \text{ V}, \text{ V}_{\text{S}} = 0.65 \text{ V}, \text{ I}_{\text{S}} = 10 \text{ mA}$
On Resistance Flatness (R _{FLAT (ON)})	0.1			Ωtyp	$V_{DD} = 2.7 \text{ V}, V_S = 0 \text{ V} \text{ to } V_{DD}, I_S = 10 \text{ mA}$
		0.15	0.16	Ωmax	
LEAKAGE CURRENTS					$V_{DD} = 3.6 V$
Source Off Leakage Is (OFF)	±0.2			nA typ	$V_{\rm S} = 0.6 \text{ V}/3.3 \text{ V}, V_{\rm D} = 3.3 \text{ V}/0.6 \text{ V}$
2	±1	±10	±100	nA max	(Figure 19)
Channel On Leakage I _D , I _s (ON)	±0.2			nA typ	$V_{\rm S} = V_{\rm D} = 0.6$ V or 3.3 V (Figure 20)
5	±1	±15	±120	nA max	
DIGITAL INPUTS	1				
Input High Voltage, V _{INH}			2	V min	
Input Low Voltage, V _{INL}			0.8	V max	
Input Current, line or linh	0.005			μA typ	$V_{IN} = V_{INL}$ or V_{INH}
			±0.1	µA max	
C _{IN} , Digital Input Capacitance	4			pF typ	
DYNAMIC CHARACTERISTICS ²				P: 7P	
t _{on}	21			ns typ	$R_{L} = 50 \Omega, C_{L} = 35 pF$
	26	28	29	ns max	$V_s = 1.5 V/0 V$ (Figure 21)
toff	4	20	27	ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
	7	8	9	ns max	$V_s = 1.5 V$ (Figure 21)
Break-before-Make Time Delay	, 17	0	2	ns typ	$R_L = 50 \Omega, C_L = 35 pF$
(t _{BBM})			-		
	10		5	ns min	$V_{s1} = V_{s2} = 1.5 V$ (Figure 22)
Charge Injection	40			pC typ	$V_s = 1.5 V, R_s = 0 \Omega, C_L = 1 nF$ (Figure 23)
Off Isolation	-67			dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$ (Figure 24)
Channel-to-Channel Crosstalk	-90			dB typ	S1A–S2A/S1B–S2B (Figure 27)
					$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$
	-67			dB typ	S1A–S1B/S2A–S2B (Figure 26)
					$R_L = 50 \ \Omega, C_L = 5 \ pF, f = 100 \ kHz$
Total Harmonic Distortion (THD + N)	0.02			%	$R_L = 32 \Omega$, $f = 20 Hz$ to 20 kHz, $V_S = 2 V p$ -p
Insertion Loss	-0.05			dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25)
–3 dB Bandwidth	57			MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25)
Cs (OFF)	25			pF typ	
C _D , C _S (ON)	75			pF typ	
POWER REQUIREMENTS					V _{DD} = 3.6 V
I _{DD}	0.003			μA typ	Digital inputs = 0 V or 3.6 V
		1	4	µA max	

 1 Temperature range for Y version is –40°C to +125°C. 2 Guaranteed by design, not subject to production test.

Parameter	+25°C	−40°C − +85°C	–40°C – +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V _{DD}	V	
On Resistance (R _{ON})	0.65			Ωtyp	$V_{DD} = 2.3 V$, $V_{S} = 0 V$ to V_{DD} , $I_{S} = 10 mA$
	0.72	0.8	0.88	Ωmax	(Figure 18)
On Resistance Match between	0.04			Ωtyp	$V_{DD} = 2.3 \text{ V}, \text{ V}_{\text{S}} = 0.7 \text{ V}, \text{ I}_{\text{S}} = 10 \text{ mA}$
Channels (ΔR_{ON})		0.08	0.085	Ωmax	
On Resistance Flatness (R _{FLAT (ON)})	0.16			Ωtyp	$V_{DD} = 2.3 V$, $V_s = 0 V$ to V_{DD} , $I_s = 10 mA$
		0.23	0.24	Ωmax	
LEAKAGE CURRENTS					$V_{DD} = 2.7 \text{ V}$
Source Off Leakage Is (OFF)	±0.2			nA typ	$V_{s} = 0.6 V/2.4 V, V_{D} = 2.4 V/0.6 V$
5	±0.4	±4	±45	nA max	(Figure 19)
Channel On Leakage I _D , I _S (ON)	±0.2			nA typ	$V_{\rm S} = V_{\rm D} = 0.6$ V or 2.4 V (Figure 20)
	±0.6	±12	±90	nA max	
DIGITAL INPUTS					
Input High Voltage, VINH			1.7	V min	
Input Low Voltage, V _{INL}			0.7	V max	
Input Current			•	t max	
l _{INL} or l _{INH}	0.005			µA typ	$V_{\rm IN} = V_{\rm INI}$ or $V_{\rm INH}$
	0.005		±0.1	µA max	
C _{IN} , Digital Input Capacitance	4		-0.1	pF typ	
DYNAMIC CHARACTERISTICS ²				P: 9P	
ton	23			ns typ	$R_L = 50 \Omega, C_L = 35 pF$
CON	29	30	31	ns max	$V_s = 1.5 V/0 V$ (Figure 21)
toff	5	50	51	ns typ	$R_L = 50 \Omega, C_L = 35 pF$
Corr	7	8	9	ns max	$V_s = 1.5 V$ (Figure 21)
Break-before-Make Time Delay	17	0	<i>y</i>	ns typ	$R_L = 50 \Omega, C_L = 35 pF$
(tввм)	.,			instyp	$n_{\rm L} = 30.32, c_{\rm L} = 35.61$
()			5	ns min	$V_{s1} = V_{s2} = 1.5 V$ (Figure 22)
Charge Injection	30			pC typ	$V_{s} = 1.25 V$, $R_{s} = 0 \Omega$, $C_{L} = 1 nF$ (Figure 23)
Off Isolation	-67			dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 \text{ kHz}$ (Figure 24
Channel-to-Channel Crosstalk	-90			dB typ	S1A–S2A/S1B–S2B;
					$R_L = 50 \text{ V}, C_L = 5 \text{ pF}, f = 100 \text{ kHz}; Figure 27$
	-67			dB typ	S1A–S1B/S2A–S2B;
					$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$ Figure 25
Total Harmonic Distortion (THD + N)	0.022			%	$R_L = 32 \Omega$, $f = 20 Hz$ to 20 kHz , $V_S = 1.5 \text{ V p}$ -
Insertion Loss	-0.06			dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25)
–3 dB Bandwidth	57			MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25)
C _s (OFF)	25			pF typ	,,
C_D, C_S (ON)	75			pF typ	
POWER REQUIREMENTS				1. 76	$V_{DD} = 2.7 V$
	0.003			μA typ	Digital inputs = $0 \text{ V} \text{ or } 2.7 \text{ V}$
	0.000	1	4	μA max	
	1	•	•	printing.	

Table 2. V_{DD} = 2.5 V ± 0.2 V, GND = 0 V, unless otherwise noted.¹

 1 Temperature range for Y version is –40°C to +125°C. 2 Guaranteed by design, not subject to production test.

Parameter	+25°C	–40°C − +85°C	−40°C − +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			$0 V$ to V_{DD}	V	
On Resistance (Ron)	1			Ω typ	$V_{DD} = 1.8 \text{ V}, \text{ V}_{\text{S}} = 0 \text{ V} \text{ to } \text{V}_{\text{DD}}, \text{ I}_{\text{S}} = 10 \text{ mA}$
	1.4	2.2	2.2	Ωmax	(Figure 18)
	2	4	4	Ωtyp	$V_{DD} = 1.65 \text{ V}, \text{ V}_{\text{S}} = 0 \text{ V} \text{ to } \text{V}_{DD}, \text{ I}_{\text{S}} = 10 \text{ mA}$
On Resistance Match between	0.1			Ωtyp	$V_{DD} = 1.65 \text{ V}, V_S = 0.7 \text{ V}, I_S = 10 \text{ mA}$
Channels (ΔR _{ON})					
LEAKAGE CURRENTS					$V_{DD} = 1.95 V$
Source Off Leakage Is (OFF)	±0.2			nA typ	$V_{s} = 0.6 \text{ V}/1.65 \text{ V}, V_{D} = 1.65 \text{ V}/0.6 \text{ V}$
	±0.4	±4	±25	nA max	(Figure 19)
Channel On Leakage I _D , I _S (ON)	±0.2			nA typ	$V_S = V_D = 0.6 \text{ V or } 1.65 \text{ V Figure } 20$
	±0.6	±10	±75	nA max	
DIGITAL INPUTS					
Input High Voltage, VINH			0.65 V _{DD}	V min	
Input Low Voltage, VINL			0.35 V _{DD}	V max	
Input Current					
linl or linh	0.005			μA typ	$V_{\text{IN}} = V_{\text{INL}} \text{ or } V_{\text{INH}}$
			±0.1	µA max	
C _{IN} , Digital Input Capacitance	4			pF typ	
DYNAMIC CHARACTERISTICS ²					
t _{ON}	28			ns typ	$R_L = 50 \ \Omega, \ C_L = 35 \ pF$
	37	38	39	ns max	$V_s = 1.5 \Omega/0 V$ (Figure 21)
t _{OFF}	7			ns typ	$R_L = 50 \ \Omega, \ C_L = 35 \ pF$
	9	10	11	ns max	V _s = 1.5 V (Figure 21)
Break-before-Make Time Delay (t _{ввм})	21			ns typ	$R_L = 50 \Omega$, $C_L = 35 pF$
			5	ns min	$V_{s1} = V_{s2} = 1 V$ (Figure 22)
Charge Injection	20			pC typ	$V_s = 1 V$, $R_s = 0 V$, $C_L = 1 nF$ (Figure 23)
Off Isolation	-67			dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$, (Figure 24)
Channel-to-Channel Crosstalk	-90			dB typ	S1A–S2A/S1B–S2B;
					$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$ (Figure 27)
	-67			dB typ	S1A–S1B/S2A–S2B;
					$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 100 kHz$ (Figure 25)
Total Harmonic Distortion (THD + N)	0.14			%	$\begin{split} R_L &= 32 \; \Omega, f = 20 \; Hz \; to \; 20 \; kHz, \\ V_S &= 1.2 \; V \; p\text{-}p \end{split}$

Table 3. V_{DD} = 1.65 V ± 1.95 V, GND = 0 V, unless otherwise noted.¹

-0.08

57

25

75

0.003

1.0

Insertion Loss

Cs (OFF)

 I_{DD}

C_D, C_S(ON)

-3 dB Bandwidth

POWER REQUIREMENTS

 1 Temperature range for Y version is $-40^\circ C$ to $+125^\circ C.$ 2 Guaranteed by design, not subject to production test.

4

dB typ

pF typ

pF typ

µA typ

μA max

MHz typ

 $R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25) $R_L = 50 \Omega$, $C_L = 5 pF$ (Figure 25)

Digital inputs = 0 V or 1.95 V

 $V_{\text{DD}} = 1.95 \; V$

ABSOLUTE MAXIMUM RATINGS

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

Table 4.

Parameter	Rating
V _{DD} to GND	–0.3 V to +4.6 V
Analog Inputs ¹	-0.3 V to V _{DD} + 0.3 V
Digital Inputs ¹	–0.3 V to 4.6 V or 10 mA, whichever occurs first
Peak Current, S or D	
3.3 V Operation	500 mA
2.5 V Operation	460 mA
1.8 V Operation	420 mA (pulsed at 1 ms, 10% Duty Cycle Max)
Continuous Current, S or D	
3.3 V Operation	300 mA
2.5 V Operation	275 mA
1.8 V Operation	250 mA
Operating Temperature Range	
Automotive (Y Version)	–40°C to +125°C
Storage Temperature Range	–65°C to +150°C
Junction Temperature	150°C
MSOP Package	
θ_{JA} Thermal Impedance	206°C/W
θ_{JC} Thermal Impedance	44°C/W
IR Reflow, Peak Temperature <20 sec	235°C

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 listed in the operational sections 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.

TRUTH TABLE

Table 5.	
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Logic	Switch A	Switch B
0	Off	On
1	On	Off

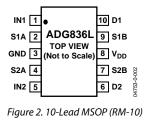
¹ Overvoltages at IN, S, or D are clamped by internal diodes. Current should be limited to the maximum ratings given.

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 TERMINOLOGY



Mnemonic	Description
V _{DD}	Most positive power supply potential.
IDD	Positive supply current.
GND	Ground (0 V) reference.
S	Source terminal. May be an input or output.
D	Drain terminal. May be an input or output.
IN	Logic control input.
V _D (V _S)	Analog voltage on terminals D and S.
Ron	Ohmic resistance between terminals D and S.
RFLAT (ON)	Flatness is defined as the difference between the maximum and minimum value of on resistance as measured
ΔR _{on}	On resistance match between any two channels.
Is (OFF)	Source leakage current with the switch off.
I⊳ (OFF)	Drain leakage current with the switch off.
Id, Is (ON)	Channel leakage current with the switch on.
V _{INL}	Maximum input voltage for Logic 0.
VINH	Minimum input voltage for Logic 1.
I _{INL} (I _{INH})	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.
C _D , C _S (ON)	On switch capacitance. Measured with reference to ground.
C _{IN}	Digital input capacitance.
ton	Delay time between the 50% and the 90% points of the digital input and switch on condition.
t _{OFF}	Delay time between the 50% and the 90% points of the digital input and switch off condition.
t _{ввм}	On or off time measured between the 80% points of both switches when switching from one to another.
Charge Injection	A measure of the glitch impulse transferred from the digital input to the analog output during on-off switching.
Off Isolation	A measure of unwanted signal coupling through an off switch.
Crosstalk	A measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.
–3 dB Bandwidth	The frequency at which the output is attenuated by 3 dB.
On Response	The frequency response of the on switch.
Insertion Loss	The loss due to the on resistance of the switch.
THD + N	The ratio of the harmonic amplitudes plus noise of a signal, to the fundamental.

TYPICAL PERFORMANCE CHARACTERISTICS

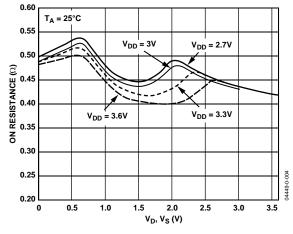


Figure 3. On Resistance vs. V_D (V_S), $V_{DD} = 2.7$ V to 3.6 V

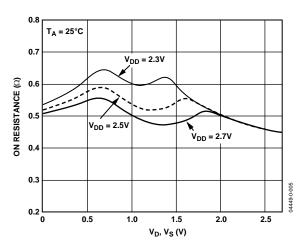


Figure 4. On Resistance vs. V_D (V_S), $V_{DD} = 2.5 V \pm 0.2 V$

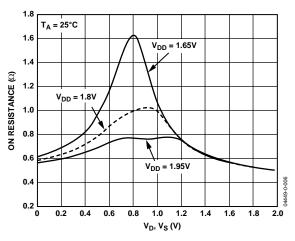


Figure 5. On Resistance vs. V_D (V_S), $V_{DD} = 1.8 V \pm to 0.15 V$

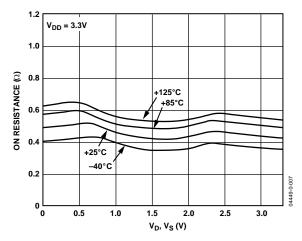


Figure 6. On Resistance vs. V_D (V_s) for Different Temperature, V_{DD} = 3.3 V

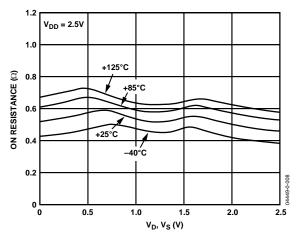


Figure 7. On Resistance vs. V_D (V_s) for Different Temperature, V_{DD} = 2.5 V

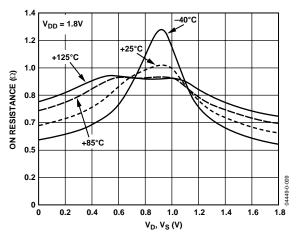


Figure 8. On Resistance vs. V_D (V_s) for Different Temperature, V_{DD} = 1.8 V

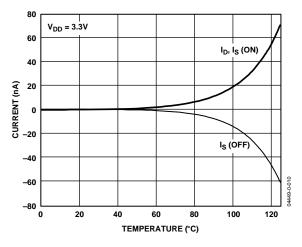


Figure 9. Leakage Current vs. Temperature, $V_{DD} = 3.3 V$

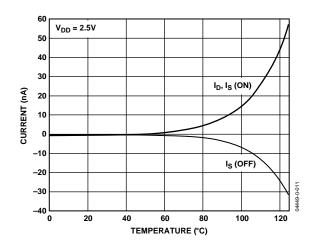


Figure 10. Leakage Current vs. Temperature, $V_{DD} = 2.5 V$

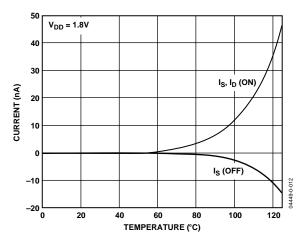


Figure 11. Leakage Current vs. Temperature, V_{DD} = 1.8 V

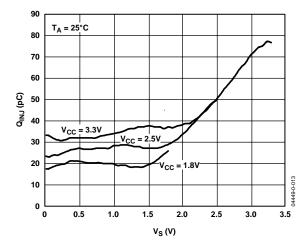


Figure 12. Charge Injection vs. Source Voltage

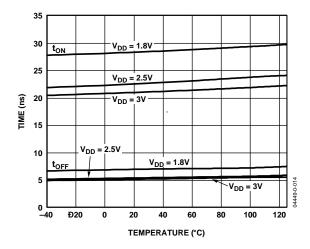


Figure 13. t_{ON}/t_{OFF} Times vs. Temperature

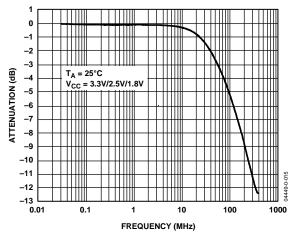


Figure 14. Bandwidth

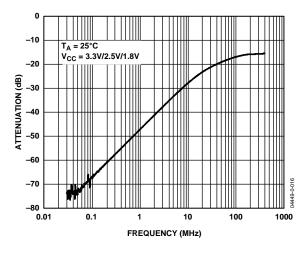


Figure 15. Off Isolation vs. Frequency

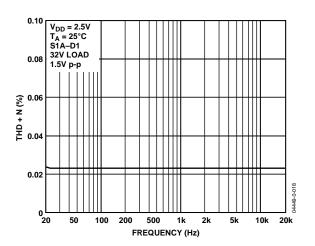


Figure 17. Total Harmonic Distortion + Noise

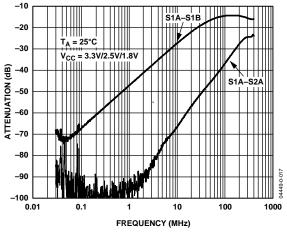
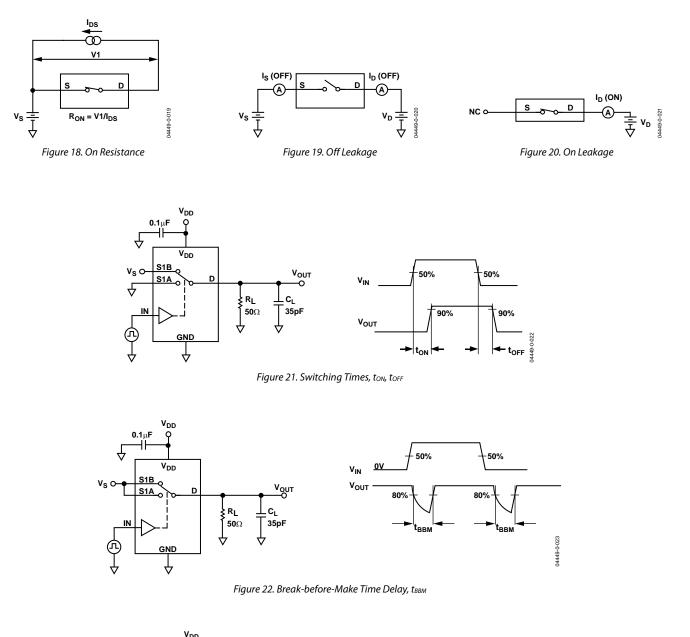


Figure 16. Crosstalk vs. Frequency

TEST CIRCUITS



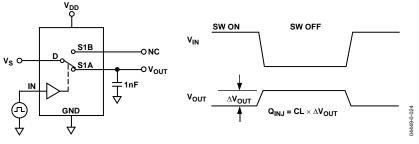


Figure 23. Charge Injection

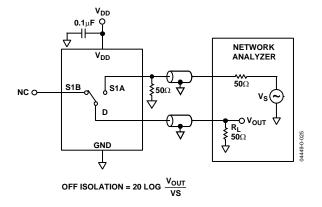


Figure 24. Off Isolation

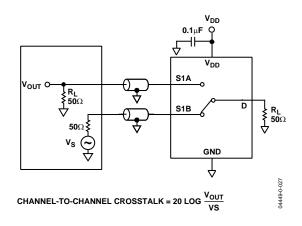


Figure 25. Channel-to-Channel Crosstalk (S1A–S1B)

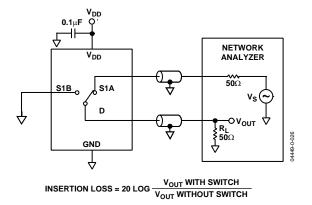
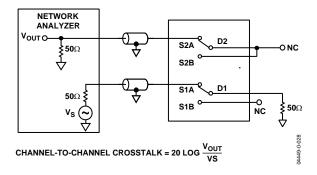
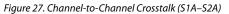


Figure 26. Bandwidth





OUTLINE DIMENSIONS

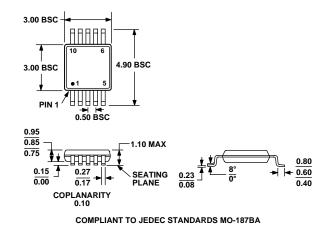


Figure 28. 10-Lead Mini Small Outline Package [MSOP] (RM-10) Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding
ADG836LYRM	-40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	SQA
ADG836LYRM-REEL	-40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	SQA
ADG836LYRM-REEL7	-40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	SQA

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