

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
High current carrying capability: 300 mA continuous
Rail-to-rail switching operation
Fast switching times <25 ns
Typical power consumption (<0.1 μ W)

APPLICATIONS

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

GENERAL DESCRIPTION

The ADG804 is a low voltage 4-channel CMOS multiplexer comprising four single channels. This device offers ultralow on resistance of less than 0.8 Ω over the full temperature range. The digital inputs can handle 1.8 V logic with a 2.7 V to 3.6 V supply.

The ADG804 switches one of four inputs to a common output, D, as determined by the 3-bit binary address lines, A0, A1, and EN. A Logic 0 on the EN pin disables the device. The ADG804 has break-before-make switching.

The ADG804 is fully specified for 3.3 V, 2.5 V, and 1.8 V supply operation. It is available in a 10-lead MSOP package.

FUNCTIONAL BLOCK DIAGRAM

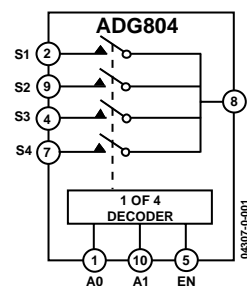


Figure 1.

PRODUCT HIGHLIGHTS

1. <0.8 Ω over full temperature range of -40°C to +125°C.
2. Single 1.65 V to 3.6 V operation.
3. Operational 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. 0

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REVISION HISTORY

Revision 0: Initial Version

SPECIFICATIONS

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

Table 1.

Parameter	+25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V_{DD}	V	
On Resistance (R_{ON})	0.5			Ω typ	$V_{DD} = 2.7\text{ V}$; $V_S = 0\text{ V to }V_{DD}$, $I_S = 10\text{ mA}$; Figure 18
	0.65	0.75	0.8	Ω max	
On Resistance Match between Channels (ΔR_{ON})	0.04			Ω typ	$V_{DD} = 2.7\text{ V}$; $V_S = 0.65\text{ V}$, $I_S = 10\text{ mA}$
		0.075	0.08	Ω max	
On Resistance Flatness ($R_{FLAT(ON)}$)	0.1			Ω typ	$V_{DD} = 2.7\text{ V}$; $V_S = 0\text{ V to }V_{DD}$,
		0.15	0.16	Ω max	$I_S = 10\text{ mA}$
LEAKAGE CURRENTS					
Source Off Leakage I_S (OFF)	± 0.1			nA typ	$V_{DD} = 3.6\text{ V}$
	± 1			nA max	$V_S = 0.6\text{ V}/3.3\text{ V}$; $V_D = 3.3\text{ V}/0.6\text{ V}$; Figure 19
Drain Off Leakage I_D (OFF)	± 0.1			nA typ	$V_S = 0.6\text{ V}/3.3\text{ V}$; $V_D = 3.3\text{ V}/0.6\text{ V}$; Figure 19
	± 1			nA max	
Channel On Leakage I_D, I_S (ON)	± 0.1			nA typ	$V_S = V_D = 0.6\text{ V or }3.3\text{ V}$; Figure 20
	± 1			nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			2	V min	
Input Low Voltage, V_{INL}			0.8	V max	
Input Current I_{INL} or I_{INH}	0.005			$\mu\text{A typ}$	$V_{IN} = V_{INL}$ or V_{INH}
			± 0.1	$\mu\text{A max}$	
C_{IN} , Digital Input Capacitance	4			pF typ	
DYNAMIC CHARACTERISTICS²					
$t_{TRANSITION}$	24			ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	30	32	35	ns max	$V_S = 1.5\text{ V}/0\text{ V}$; Figure 21
$t_{ON\text{ ENABLE}}$	23			ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	29	30	31	ns max	$V_S = 1.5\text{ V}/0\text{ V}$; Figure 23
$t_{OFF\text{ ENABLE}}$	5			ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
	6	7	8	ns max	$V_S = 1.5\text{ V}$; Figure 23
Break-Before-Make Time Delay (t_{BBM})	20			ns typ	$R_L = 50\ \Omega$, $C_L = 35\text{ pF}$
			5	ns min	$V_{S1} = V_{S2} = 1.5\text{ V}$; Figure 22
Charge Injection	28			pC typ	$V_S = 1.5\text{ V}$, $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$; Figure 24
Off Isolation	−67			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; Figure 25
Channel-to-Channel Crosstalk	−75			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$; Figure 27
Total Harmonic Distortion (THD+N)	0.02			%	$R_L = 32\ \Omega$, $f = 20\text{ Hz to }20\text{ kHz}$, $V_S = 2\text{ V p-p}$
Insertion Loss	0.06			dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 100\text{ kHz}$
−3 dB Bandwidth	33			MHz typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; Figure 26
C_S (OFF)	24			pF typ	
C_D (OFF)	105			pF typ	
C_D, C_S (ON)	125			pF typ	
POWER REQUIREMENTS					
I_{DD}	0.003			$\mu\text{A typ}$	$V_{DD} = 3.6\text{ V}$
		1.0	4	$\mu\text{A max}$	Digital inputs = 0 V or 3.6 V

¹ Temperature range, Y version: −40°C to +125°C.

² Guaranteed by design, not subject to production test.

ADG804

$V_{DD} = 2.5 \text{ V} \pm 0.2 \text{ V}$, $GND = 0 \text{ V}$, unless otherwise noted.¹

Table 2.

Parameter	+25°C	–40°C to +85°C	–40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V _{DD}	V	
On Resistance (R _{ON})	0.65			Ω typ	V _{DD} = 2.3 V; V _S = 0 V to V _{DD} ; I _S = 10 mA; Figure 18
	0.77	0.8	0.88	Ω max	
On Resistance Match between Channels (ΔR _{ON})	0.4			Ω typ	V _{DD} = 2.3 V; V _S = 0.7 V; I _S = 10 mA
		0.08	0.085	Ω max	
On Resistance Flatness (R _{FLAT(ON)})	0.16			Ω typ	V _{DD} = 2.3 V; V _S = 0 V to V _{DD} ; I _S = 10 mA
		0.23	0.24	Ω max	
LEAKAGE CURRENTS					
Source Off Leakage I _S (OFF)	±0.1			nA typ	V _{DD} = 2.7 V V _S = 0.6 V/2.4 V, V _D = 2.4 V/0.6 V; Figure 19
	±1			nA max	
Drain Off Leakage I _D (OFF)	±0.1			nA typ	V _S = 0.6/2.4 V, V _D = 2.4/0.6 V; Figure 19
	±1			nA max	
Channel On Leakage I _D , I _S (ON)	±0.1			nA typ	V _S = V _D = 0.6 V or 2.4 V; Figure 20
	±1			nA max	
DIGITAL INPUTS					
Input High Voltage, V _{INH}			1.7	V min	V _{IN} = V _{INL} or V _{INH}
Input Low Voltage, V _{INL}			0.7	V max	
Input Current I _{INL} or I _{INH}	0.005			μA typ	
			±0.1	μA max	
C _{IN} , Digital Input Capacitance	4			pF typ	
DYNAMIC CHARACTERISTICS ²					
T _{TRANSITION}	25			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 V/0 V; Figure 21
	31	33	35	ns max	
t _{ON} ENABLE	25			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 V/0 V; Figure 22
	30	32	34	ns max	
t _{OFF} ENABLE	5			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 V; Figure 22
	7	8	9	ns max	
Break-Before-Make Time Delay (t _{BBM})	20			ns typ	R _L = 50 Ω, C _L = 35 pF V _{S1} = V _{S2} = 1.5 V; Figure 22
			5	ns min	
Charge Injection	20			pC typ	V _S = 1.25 V, R _S = 0 Ω, C _L = 1 nF; Figure 24
Off Isolation	–67			dB typ	
Channel-to-Channel Crosstalk	–75			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz; Figure 25
Total Harmonic Distortion (THD + N)	0.022			%	
Insertion Loss	–0.06			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz; Figure 27
–3 dB Bandwidth	33			MHz typ	
C _S (OFF)	25			pF typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz R _L = 50 Ω, C _L = 5 pF; Figure 26
C _D (OFF)	110			pF typ	
C _D , C _S (ON)	128			pF typ	
POWER REQUIREMENTS					
I _{DD}	0.003			μA typ	V _{DD} = 2.7 V Digital inputs = 0 V or 2.7 V
		1	4	μA max	

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

² Guaranteed by design, not subject to production test.

$V_{DD} = 1.65 \text{ V} \pm 1.95 \text{ V}$, GND = 0 V, unless otherwise noted.¹

Table 3.

Parameter	+25°C	–40°C to +85°C	–40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					
Analog Signal Range			0 V to V _{DD}	V	V _{DD} = 1.8 V; V _S = 0 V to V _{DD} , I _S = 10 mA
On Resistance (R _{ON})	1			Ω typ	
	1.4	2.2	2.2	Ω max	
	2.2	4	4	Ω max	V _{DD} = 1.65 V, V _S = 0 V to V _{DD} , I _S = 10 mA; Figure 18
On Resistance Match between Channels (ΔR _{ON})	0.1			Ω typ	V _{DD} = 1.65 V, V _S = 0.7 V, I _S = 10 mA
LEAKAGE CURRENTS					
Source Off Leakage I _S (OFF)	±0.1			nA typ	V _{DD} = 1.95 V V _S = 0.6 V/1.65 V, V _D = 1.65 V/0.6 V; Figure 19
	±1			nA max	
Drain Off Leakage I _D (OFF)	±0.1			nA typ	V _S = 0.6/1.65 V, V _D = 1.65/0.6 V; Figure 19
	±1			nA max	
Channel On Leakage I _D , I _S (ON)	±0.1			nA typ	V _S = V _D = 0.6 V or 1.65 V; Figure 20
	±1			nA max	
DIGITAL INPUTS					
Input High Voltage, V _{INH}			0.65 V _{DD}	V min	V _{IN} = V _{INL} or V _{INH}
Input Low Voltage, V _{INL}			0.35 V _{DD}	V max	
Input Current I _{INL} or I _{INH}	0.005			μA typ	
			±0.1	μA max	
C _{IN} , Digital Input Capacitance	4			pF typ	
DYNAMIC CHARACTERISTICS ²					
t _{TRANSITION}	32			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 V/0 V; Figure 21
	40	42	44	ns max	
t _{ON} ENABLE	34			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 Ω/0 V; Figure 22
	39	40	41	ns max	
t _{OFF} ENABLE	8			ns typ	R _L = 50 Ω, C _L = 35 pF V _S = 1.5 V; Figure 22
	10	11	13	ns max	
Break-Before-Make Time Delay (t _{BBM})	22			ns typ	R _L = 50 Ω, C _L = 35 pF V _{S1} = V _{S2} = 1 V; Figure 22
			5	ns min	
Charge Injection	12			pC typ	V _S = 1 V, R _S = 0 V, C _L = 1 nF; Figure 24
Off Isolation	–67			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz; Figure 25
Channel-to-Channel Crosstalk	–75			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz, Figure 27
Total Harmonic Distortion (THD + N))	0.14			%	R _L = 32 Ω, f = 20 Hz to 20 kHz, V _S = 1.2 V p-p
Insertion Loss	0.08			dB typ	R _L = 50 Ω, C _L = 5 pF, f = 100 kHz
–3 dB Bandwidth	30			MHz typ	R _L = 50 Ω, C _L = 5 pF; Figure 26
C _S (OFF)	26			pF typ	
C _D (OFF)	115			pF typ	
C _D , C _S (ON)	130			pF typ	
POWER REQUIREMENTS					
I _{DD}	0.003			μA typ	V _{DD} = 1.95 V Digital inputs = 0 V or 1.95 V
		1.0	4	μA max	

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

² Guaranteed by design, not subject to production test.

ABSOLUTE MAXIMUM RATINGS

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

Table 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	(Pulsed at 1 ms, 10% Duty Cycle Max)
3.3 V Operation	500 mA
2.5 V Operation	460 mA
1.8 V Operation	420 mA
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	235°C
<20 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 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.

Table 5. ADG804 Truth Table

A1	A0	EN	ON Switch
x	x	0	None
0	0	1	S1
0	1	1	S2
1	0	1	S3
1	1	1	S4

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 CONFIGURATION

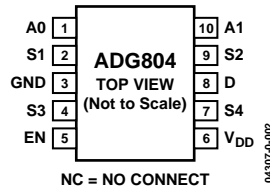


Figure 2. 10-Lead MSOP (RM-10)

Table 6. Terminology

V_{DD}	Most positive power supply potential.
I_{DD}	Positive supply current.
GND	Ground (0 V) reference.
S	Source terminal. May be an input or an output.
D	Drain terminal. May be an input or an output.
EN	Active high logic control input.
A0, A1	Logic control inputs. Used to select which source terminal, S1 to S4, is connected to the drain, D.
V_D, V_S	Analog voltage on terminals D, S.
R_{ON}	Ohmic resistance between D and S.
$R_{FLAT (ON)}$	Flatness is defined as the difference between the maximum and minimum value of on resistance as measured over the specified analog signal range.
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.
$t_{ON} (EN)$	Delay time between the 50% and the 90% points of the digital input and switch on condition.
$t_{OFF} (EN)$	Delay time between the 50% and the 90% points of the digital input and switch off condition.
$t_{TRANSITION}$	Delay time between the 50% and the 90% points of the digital input and switch on condition when switching from one address state to the other.
t_{BBM}	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 which 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

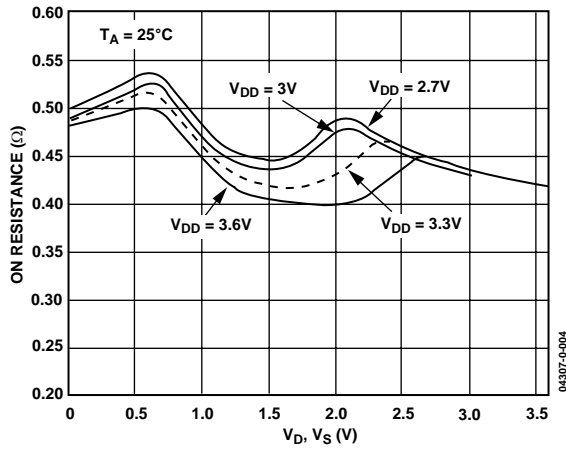


Figure 3. On Resistance vs. V_D (V_S) $V_{DD} = 2.7\text{ V to } 3.6\text{ V}$

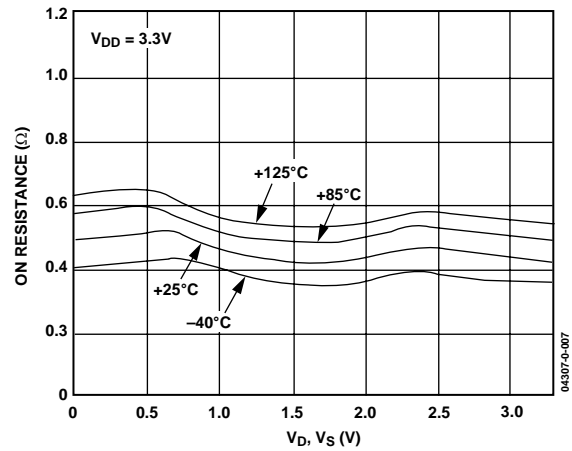


Figure 6. On Resistance vs. V_D (V_S) for Different Temperature, $V_{DD} = 3.3\text{ V}$

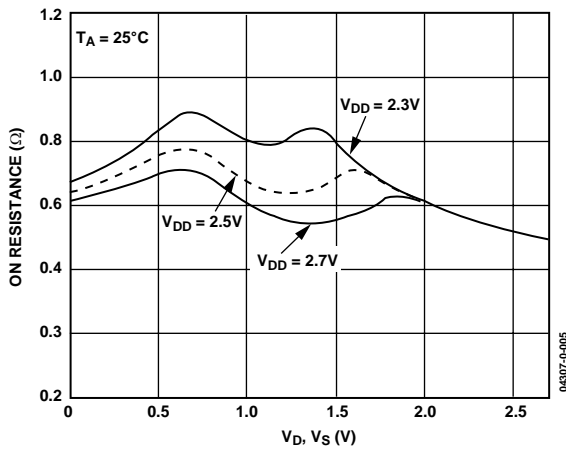


Figure 4. On Resistance vs. V_D (V_S) $V_{DD} = 2.5\text{ V} \pm 0.2\text{ V}$

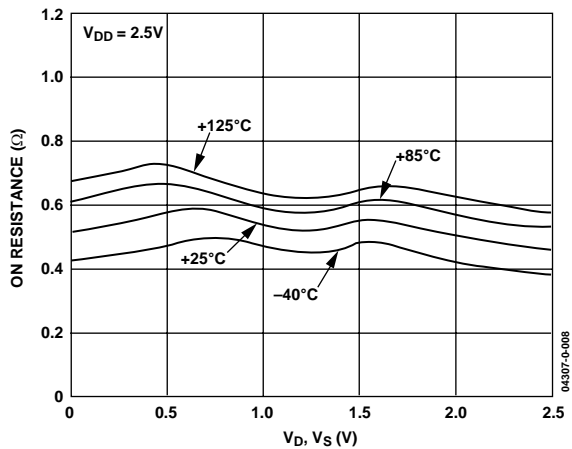


Figure 7. On Resistance vs. V_D (V_S) for Different Temperature, $V_{DD} = 2.5\text{ V}$

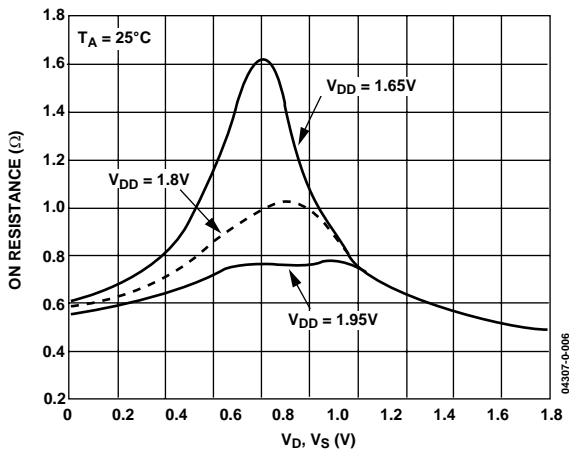


Figure 5. On Resistance vs. V_D (V_S) $V_{DD} = 1.8 \pm 0.15\text{ V}$

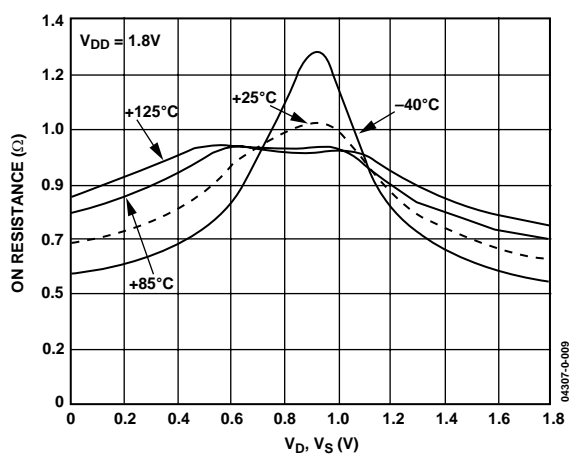


Figure 8. On Resistance vs. V_D (V_S) for Different Temperature, $V_{DD} = 1.8\text{ V}$

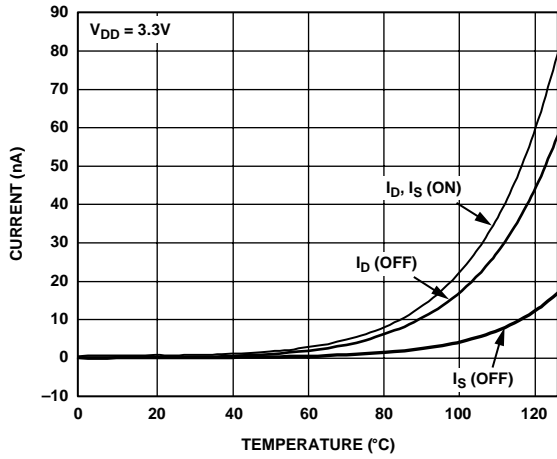


Figure 9. Leakage Current vs. Temperature, $V_{DD} = 3.3V$

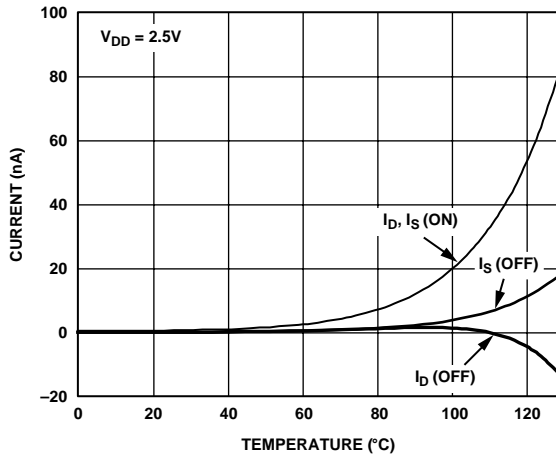


Figure 10. Leakage Current vs. Temperature, $V_{DD} = 2.5V$

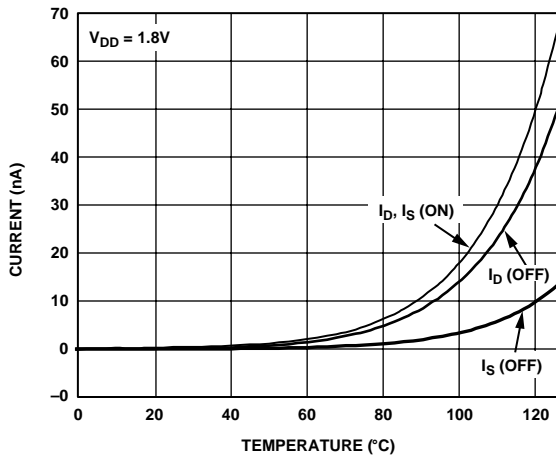


Figure 11. Leakage Current vs. Temperature, $V_{DD} = 1.8V$

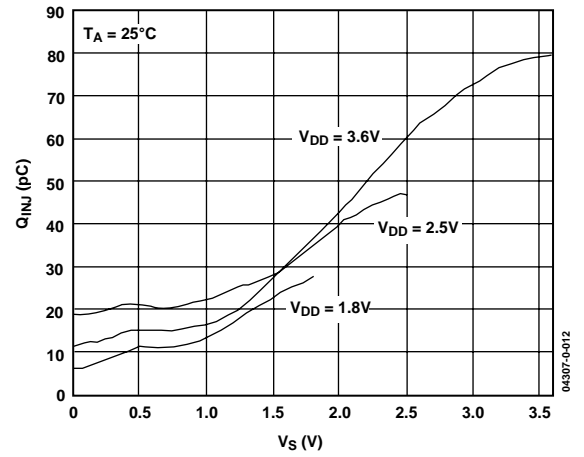


Figure 12. Charge Injection vs. Source Voltage, $V_{DD} = 1.8V$

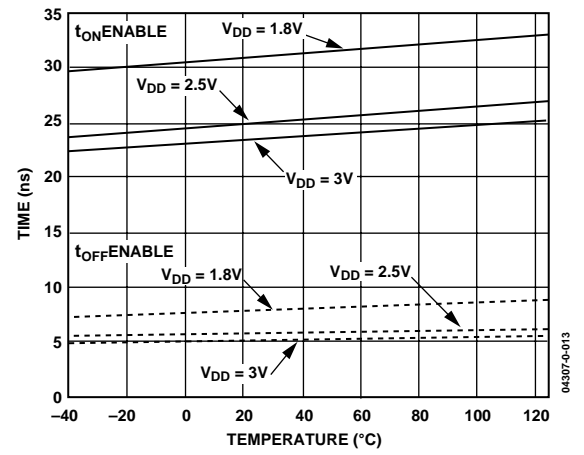


Figure 13. t_{ON}/t_{OFF} Times vs. Temperature

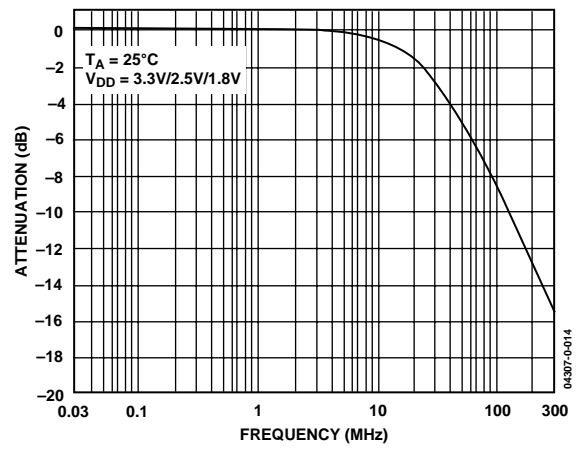


Figure 14. Bandwidth

04307-0-010

04307-0-011

04307-0-017

04307-0-012

04307-0-013

04307-0-014

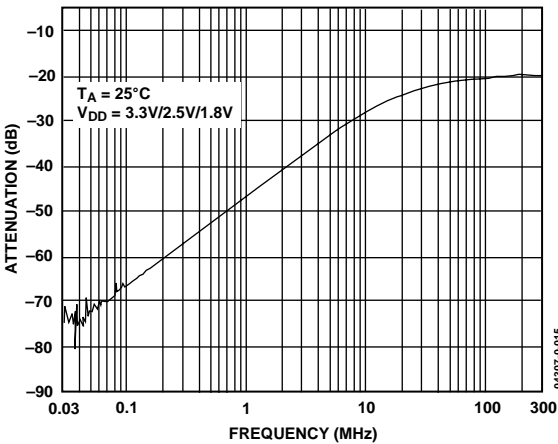


Figure 15. Off Isolation vs. Frequency

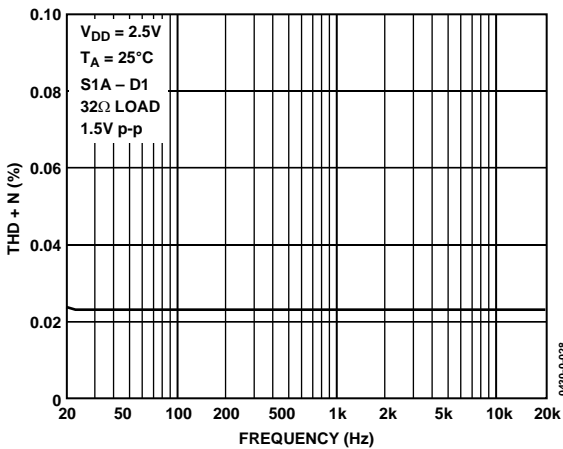


Figure 17. Total Harmonic Distortion + Noise

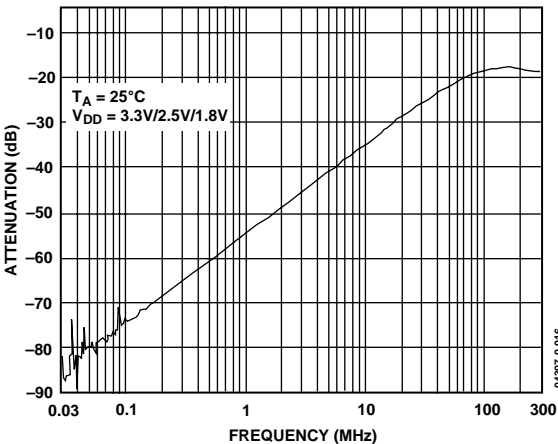


Figure 16. Crosstalk vs. Frequency

TEST CIRCUITS

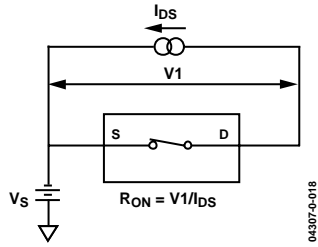


Figure 18. On Resistance

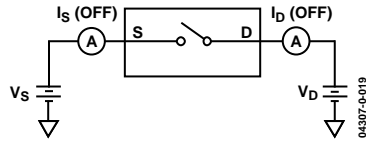


Figure 19. Off Leakage

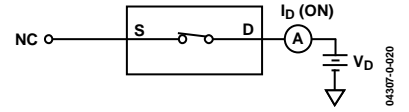


Figure 20. On Leakage

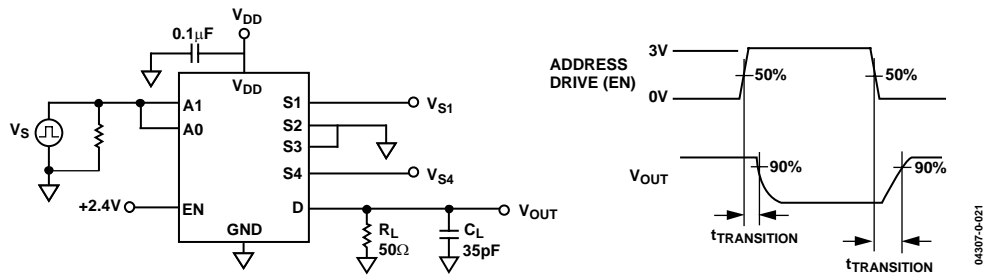


Figure 21. Switching Time of Multiplexer, $t_{\text{TRANSITION}}$

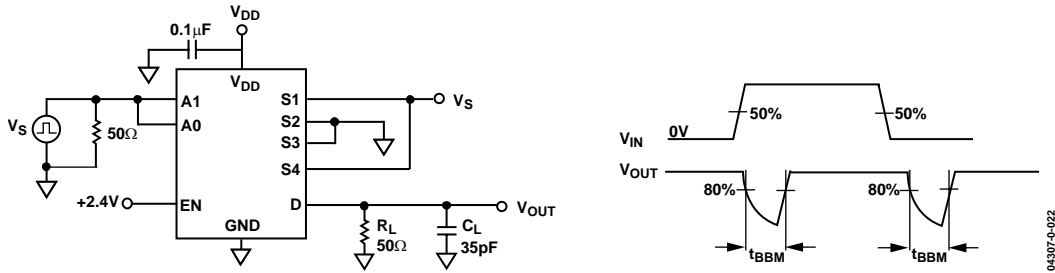


Figure 22. Break-Before-Make Time Delay, t_{BBM}

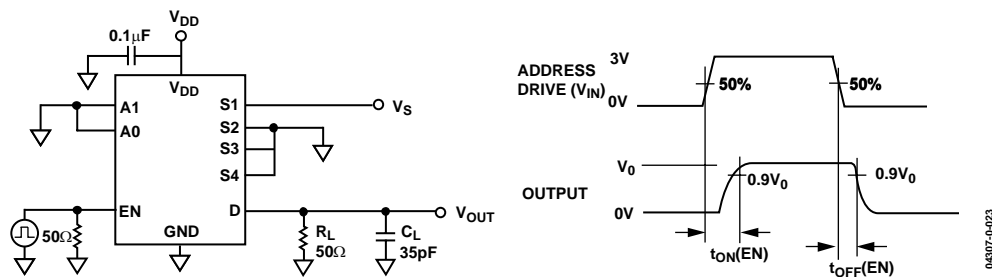


Figure 23. Enable Delay, $t_{\text{ON}}(\text{EN})$, $t_{\text{OFF}}(\text{EN})$

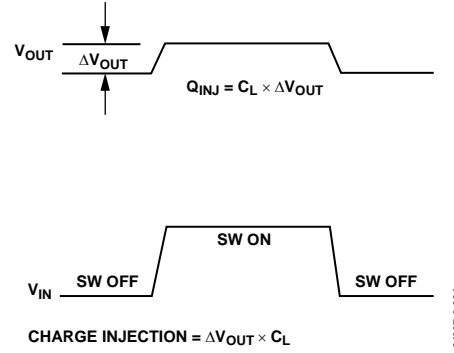
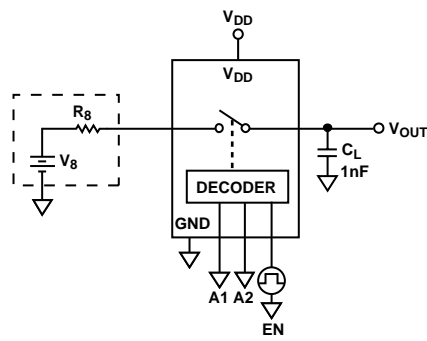


Figure 24. Charge Injection

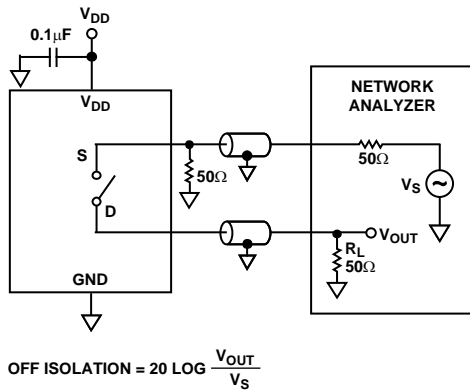


Figure 25. Off Isolation

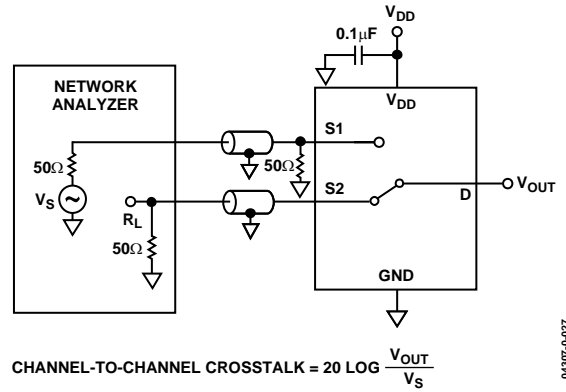


Figure 27. Channel-to-Channel Crosstalk

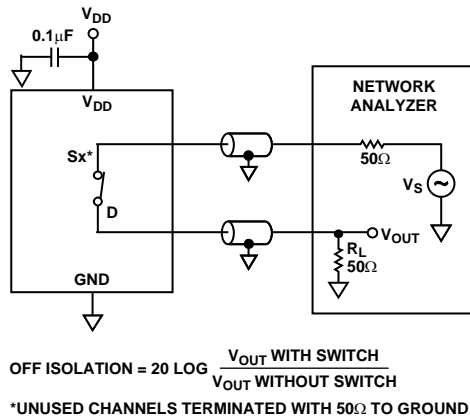


Figure 26. Bandwidth

OUTLINE DIMENSIONS

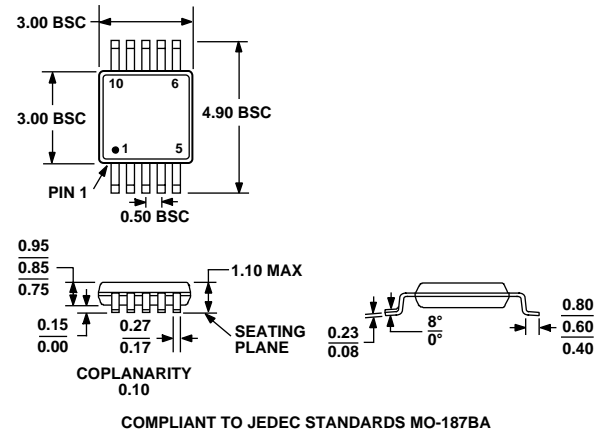


Figure 28. 10-Lead Mini Small Outline Package [MSOP]
(RM-10)
Dimensions shown in millimeters

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding ¹
ADG804YRM	–40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	S1A
ADG804YRM-REEL	–40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	S1A
ADG804YRM-REEL7	–40°C to +125°C	Mini Small Outline Package (MSOP)	RM-10	S1A

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

NOTES

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ADG804

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