

Precision 8-Ch/Dual 4-Ch Low Voltage Analog Multiplexers

DESCRIPTION

The DG3408, DG3409 uses BiCMOS wafer fabrication technology that allows the DG3408/3409 to operate on single and dual supplies. Single supply voltage ranges from 3 V to 12 V while dual supply operation is recommended with ± 3 V to ± 6 V.

The DG3408 is an 8-channel single-ended analog multiplexer designed to connect one of eight inputs to a common output as determined by a 3-bit binary address (A_0, A_1, A_2). The DG3409 is a dual 4-channel differential analog multiplexer designed to connect one of four differential inputs to a common dual output as determined by its 2-bit binary address (A_0, A_1). Break-before-make switching action to protect against momentary crosstalk between adjacent channels.

FEATURES

- 2.7 V to 12 V single supply or ± 3 to ± 6 V dual supply operation
- Low on-resistance - R_{ON} : 3.9 Ω typ.
- Fast switching: t_{ON} - 42 ns, t_{OFF} - 24 ns
- Break-before-make guaranteed
- Low leakage
- TTL, CMOS, LV logic (3 V) compatible
- 2000 V ESD protection (HBM)
- MICRO FOOT® package
- Lead (Pb)-free solder bumps
- Compliant to RoHS Directive 2002/95/EC



RoHS
COMPLIANT

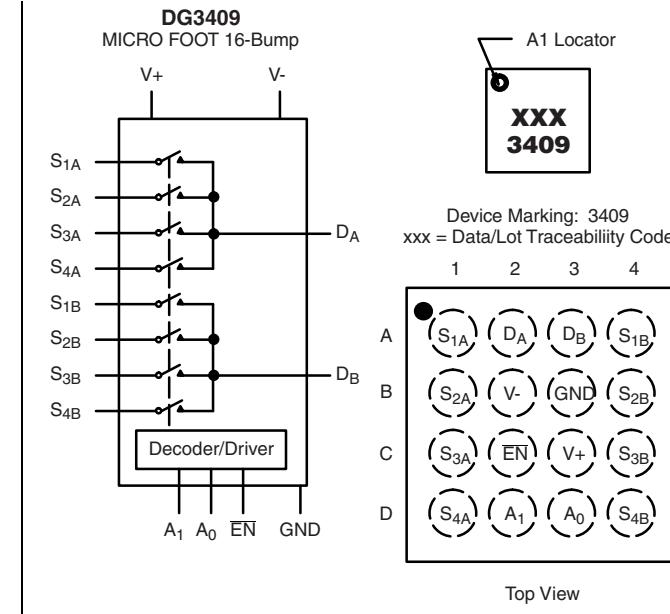
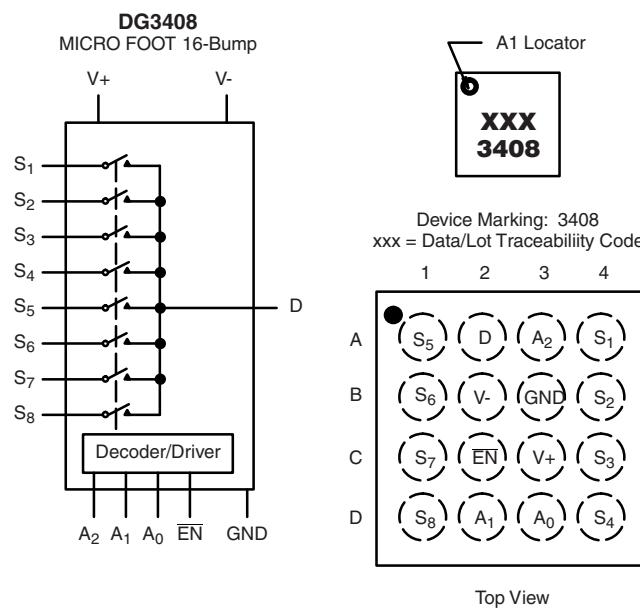
BENEFITS

- High accuracy
- Single and dual power rail capacity
- Wide operating voltage range
- Simple logic interface

APPLICATIONS

- Data acquisition systems
- Battery operated equipment
- Portable test equipment
- Sample and hold circuits
- Communication systems
- SDSL, DSLAM
- Audio and video signal routing

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



DG3408, DG3409

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TRUTH TABLE (DG3408)

A ₂	A ₁	A ₀	\bar{EN}	On Switch
X	X	X	1	None
0	0	0	0	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4
1	0	0	0	5
1	0	1	0	6
1	1	0	0	7
1	1	1	0	8

TRUTH TABLE (DG3409)

A ₁	A ₀	\bar{EN}	On Switch
X	X	1	None
0	0	0	1
0	1	0	2
1	0	0	3
1	1	0	4

X = Do not care

For low and high voltage levels for V_{AX} and V_{EN} consult "Digital Control" Parameters for Specific V+ operation. See Specifications Tables for:

Single Supply 12 V

Dual Supply $V+ = 5$ V, $V- = -5$ V

Single Supply 5 V

Single Supply 3 V

ORDERING INFORMATION (DG3408)

Temperature Range	Package	Part Number
- 40 °C to 85 °C	MICRO FOOT: 16-Bump (4 x 4, 0.5 mm Pitch, 238 μ m Bump Height)	DG3408DB-T2-E1 (Lead (Pb)-free)

ORDERING INFORMATION (DG3409)

Temperature Range	Package	Part Number
- 40 °C to 85 °C	MICRO FOOT: 16-Bump (4 x 4, 0.5 mm Pitch, 238 μ m Bump Height)	DG3409DB-T2-E1 (Lead (Pb)-free)

ABSOLUTE MAXIMUM RATINGS ($T_A = 25$ °C, unless otherwise noted)

Parameter	Limit	Unit
Voltage Referenced V+ to V-	14	V
GND	7	
Digital Inputs ^a , V_S , V_D	(V-) - 0.3 V to (V) + 0.3 V	
Current (Any Terminal Except S or D)	30	mA
Continuous Current, S or D	100	
Peak Current, S or D (Pulsed at 1 ms, 10 % duty cycle max).	200	
Package Solder Reflow Conditions ^b	250	°C
Storage Temperature	- 65 to 150	
Power Dissipation (Package) ^c , ($T_A = 70$ °C)	719	mW
16-Bump (4 x 4 mm) MICRO FOOT ^d		

Notes:

a. Signals on S_X , D_X or IN_X exceeding $V+$ or $V-$ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

b. Refer to IPC/JEDEC (J-STD-020).

c. All bumps soldered or welded to PC board.

d. Derate 9 mW/°C above 70 °C.



SPECIFICATIONS (Single Supply 12 V)									
Parameter	Symbol	Test Conditions Unless Otherwise Specified		Temp. ^b	Limits - 40 °C to 85 °C			Unit	
		V ₊ = 12 V, ± 10 %, V ₋ = 0 V	V _A , V _{EN} = 0.8 V or 2.4 V ^f		Min. ^c	Typ. ^d	Max. ^c		
Analog Switch									
Analog Signal Range ^e	V _{ANALOG}				Full	0	12	V	
On-Resistance	R _{ON}	V ₊ = 10.8 V, V _D = 2 V or 9 V, I _S = 50 mA Sequence Each Switch On			Room Full	4	7	Ω	
R _{ON} Match Between Channels ^g	ΔR _{ON}				Room		3.6		
On-Resistance Flatness ⁱ	R _{ON} Flatness	V ₊ = 10.8 V, V _D = 2 V or 9 V, I _S = 50 mA			Room		8		
Switch Off Leakage Current	I _{S(off)}				Room Full	- 2 - 20	2 20	nA	
	I _{D(off)}	V _{EN} = 2.4 V, V _D = 11 V or 1 V, V _S = 1 V or 11 V			Room Full	- 2 - 20	2 20		
Channel On Leakage Current	I _{D(on)}	V _{EN} = 0 V, V _S = V _D = 1 V or 11 V			Room Full	- 2 - 20	2 20		
Digital Control									
Logic High Input Voltage	V _{INH}				Full	2.4		V	
Logic Low Input Voltage	V _{INL}				Full		0.8		
Input Current	I _{IN}	V _{AX} = V _{EN} = 2.4 V or 0.8 V			Full	- 1	1	μA	
Dynamic Characteristics									
Transition Time	t _{TRANS}	V _{S1} = 8 V, V _{S8} = 0 V, (DG3408) V _{S1b} = 8 V, V _{S4b} = 0 V, (DG3409) see figure 2			Room Full	42	71 75	ns	
Break-Before-Make Time	t _{BBM}	V _{S(all)} = V _{DA} = 5 V see figure 4			Room Full	2	24		
Enable Turn-On Time	t _{ON(EN)}	V _{AX} = 0 V, V _{S1} = 5 V (DG3408) V _{AX} = 0 V, V _{S1b} = 5 V (DG3409) see figure 3			Room Full	42	70 75		
Enable Turn-Off Time	t _{OFF(EN)}				Room Full	24	44 46		
Charge Injection ^e	Q	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω			Room	29		pC	
Off Isolation ^{e, h}	OIRR	f = 100 kHz, R _L = 1 kΩ			Room		- 80	dB	
Crosstalk ^e	X _{TALK}				Room		- 85		
Source Off Capacitance ^e	C _{S(off)}	f = 1 MHz, V _S = 0 V, V _{EN} = 2.4 V		DG3408	Room	21		pF	
				DG3409	Room	23			
Drain Off Capacitance ^e	C _{D(off)}	f = 1 MHz, V _D = 0 V, V _{EN} = 2.4 V		DG3408	Room	211			
				DG3409	Room	112			
Drain On Capacitance ^e	C _{D(on)}	f = 1 MHz, V _D = 0 V, V _{EN} = 0 V		DG3408	Room	238			
				DG3409	Room	137			
Power Supplies									
Power Supply Current	I ₊	V _{EN} = V _A = 0 V or V ₊			Room		1	μA	

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**SPECIFICATIONS** (Dual Supply $V_+ = 5 \text{ V}$, $V_- = -5 \text{ V}$)

Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 5 \text{ V}$, $V_- = -5 \text{ V}$, $\pm 10 \%$ $V_A, V_{\bar{E}N} = 0.8 \text{ V}$ or 2 V^f	Temp. ^b	Limits			Unit
				-40 °C to 85 °C	Min. ^c	Typ. ^d	
Analog Switch							
Analog Signal Range ^e	V_{ANALOG}		Full	- 5		5	V
On-Resistance	R_{ON}	$V_+ = 4.5 \text{ V}$, $V_- = -4.5 \text{ V}$, $V_D = \pm 3.5 \text{ V}$, $I_S = 50 \text{ mA}$, sequence each switch on	Room Full		5	8	Ω
R_{ON} Match Between Channels ^g	ΔR_{ON}		Room			3.6	
On-Resistance Flatness ⁱ	R_{ON} Flatness		Room			8.2	
Switch Off Leakage Current ^a	$I_{S(\text{off})}$	$V_+ = 5.5 \text{ V}$, $V_- = -5.5 \text{ V}$ $V_{\bar{E}N} = 2.4 \text{ V}$, $V_D = \pm 4.5 \text{ V}$, $V_S = \pm 4.5 \text{ V}$	Room Full	- 2 - 20		2 20	nA
	$I_{D(\text{off})}$		Room Full	- 2 - 20		2 20	
Channel On Leakage Current ^a	$I_{D(\text{on})}$	$V_+ = 5.5 \text{ V}$, $V_- = -5.5 \text{ V}$ $V_{\bar{E}N} = 0 \text{ V}$, $V_D = \pm 4.5 \text{ V}$, $V_S = \pm 4.5 \text{ V}$	Room Full	- 2 - 20		2 20	
Digital Control							
Logic High Input Voltage	V_{INH}		Full	2			V
Logic Low Input Voltage	V_{INL}		Full			0.8	
Input Current ^a	I_{IN}	$V_{AX} = V_{\bar{E}N} = 2 \text{ V}$ or 0.8 V	Full	- 1		1	μA
Dynamic Characteristics							
Transition Time ^e	t_{TRANS}	$V_{S1} = 3.5 \text{ V}$, $V_{S8} = -3.5 \text{ V}$, (DG3408) $V_{S1b} = 3.5 \text{ V}$, $V_{S4b} = -3.5 \text{ V}$, (DG3409) see figure 2	Room Full		68	89 94	ns
Break-Before-Make Time ^e	t_{BBM}	$V_{S(\text{all})} = V_{DA} = 3.5 \text{ V}$ see figure 4	Room Full	1	16		
Enable Turn-On Time ^e	$t_{\text{ON}(\bar{E}N)}$	$V_{AX} = 0 \text{ V}$, $V_{S1} = 3.5 \text{ V}$ (DG3408) $V_{AX} = 0 \text{ V}$, $V_{S1b} = 3.5 \text{ V}$ (DG3409) see figure 3	Room Full		68	88 94	
Enable Turn-Off Time ^e	$t_{\text{OFF}(\bar{E}N)}$		Room Full		58	78 81	
Source Off Capacitance ^e	$C_{S(\text{off})}$	$f = 1 \text{ MHz}$, $V_S = 0 \text{ V}$, $V_{\bar{E}N} = 2 \text{ V}$	DG3408	Room		23	pF
			DG3409	Room		23	
Drain Off Capacitance ^e	$C_{D(\text{off})}$	$f = 1 \text{ MHz}$, $V_D = 0 \text{ V}$, $V_{\bar{E}N} = 2 \text{ V}$	DG3408	Room		223	
			DG3409	Room		113	
Drain On Capacitance ^e	$C_{D(\text{on})}$	$f = 1 \text{ MHz}$, $V_D = 0 \text{ V}$, $V_{\bar{E}N} = 0 \text{ V}$	DG3408	Room		246	
			DG3409	Room		137	
Power Supplies							
Power Supply Current	I+	$V_{\bar{E}N} = V_A = 0 \text{ V}$ or V_+	Room			1	μA
	I-		Room	- 1			



SPECIFICATIONS (Single Supply 5 V)									
Parameter	Symbol	Test Conditions Unless Otherwise Specified		Temp. ^b	Limits - 40 °C to 85 °C				
		V ₊ = 5 V, ± 10 %, V ₋ = 0 V	V _A , V _{EN} = 0.8 V or 2 V ^f		Min. ^c	Typ. ^d	Max. ^c		
Analog Switch									
Analog Signal Range ^e	V _{ANALOG}				Full	0	5	V	
On-Resistance	R _{ON}	V ₊ = 4.5 V, V _D or V _S = 1 V or 3.5 V, I _S = 50 mA			Room Full	7 11	10.5 11	Ω	
R _{ON} Match Between Channels ^g	ΔR _{ON}	V ₊ = 4.5 V, V _D = 1 V or 3.5 V, I _S = 50 mA			Room		3.6		
On-Resistance Flatness ⁱ	R _{ON} Flatness				Room		9		
Switch Off Leakage Current ^a	I _{S(off)}				Room Full	- 2 - 20	2 20	nA	
	I _{D(off)}				Room Full	- 2 - 20	2 20		
Channel On Leakage Current ^a	I _{D(on)}	V ₊ = 5.5 V V _D = V _S = 1 V or 4 V, sequence each switch on		Room Full	- 2 - 20	2 20			
Digital Control									
Logic High Input Voltage	V _{INH}	V ₊ = 5 V			Full	2		V	
Logic Low Input Voltage	V _{INL}				Full		0.8		
Input Current ^a	I _{IN}	V _{AX} = V _{EN} = 2 V or 0.8 V			Full	- 1	1	μA	
Dynamic Characteristics									
Transition Time ^e	t _{TRANS}	V _{S1} = 3.5 V, V _{S8} = 0 V, (DG3408) V _{S1b} = 3.5 V, V _{S4b} = 0 V, (DG3409) see figure 2			Room Full	73	94 104	ns	
Break-Before-Make Time ^e	t _{OPEN}	V _{S(all)} = V _{DA} = 3.5 V see figure 4			Room Full	2	29		
Enable Turn-On Time ^e	t _{ON(EN)}	V _{AX} = 0 V, V _{S1} = 3.5 V (DG3408) V _{AX} = 0 V, V _{S1b} = 3.5 V (DG3409) see figure 3			Room Full	74	94 104		
Enable Turn-Off Time ^e	t _{OFF(EN)}				Room Full	38	57 61		
Charge Injection ^e	Q	C _L = 1 nF, R _{GEN} = 0 Ω, V _{GEN} = 0 V			Room	20		pC	
Off Isolation ^{e, h}	OIRR	R _L = 1 kΩ, f = 100 kHz			Room		- 81	dB	
Crosstalk ^e	X _{TALK}				Room		- 85		
Source Off Capacitance ^e	C _{S(off)}	f = 1 MHz, V _S = 0 V, V _{EN} = 0 V		DG3408	Room	22		pF	
				DG3409	Room	24			
Drain Off Capacitance ^e	C _{D(off)}	f = 1 MHz, V _D = 0 V, V _{EN} = 2 V		DG3408	Room	223			
				DG3409	Room	113			
Drain On Capacitance ^e	C _{D(on)}	f = 1 MHz, V _D = 0 V, V _{EN} = 0 V		DG3408	Room	244			
				DG3409	Room	143			
Power Supplies									
Power Supply Current	I ₊	V _{EN} = V _A = 0 V or V ₊			Room		1	μA	

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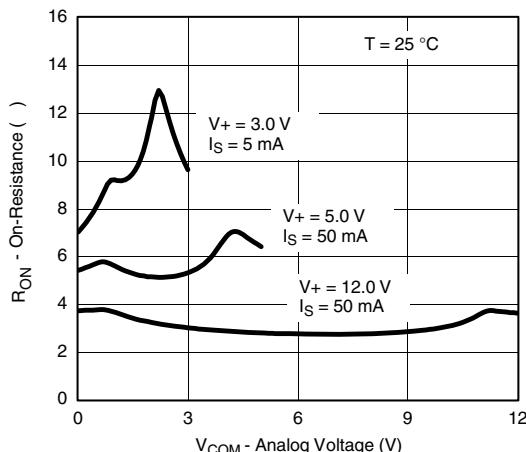
SPECIFICATIONS (Single Supply 3 V)							
Parameter	Symbol	Test Conditions Unless Otherwise Specified		Temp. ^b	Limits		
		V ₊ = 3 V, ± 10 %, V ₋ = 0 V	V _{EN} = 0.4 V or 1.8 V ^f		Min. ^c	Typ. ^d	Max. ^c
Analog Switch							
Analog Signal Range ^e	V _{ANALOG}			Full	0		3
On-Resistance	R _{ON}	V ₊ = 2.7 V, V _D = 0.5 or 2.2 V, I _S = 5 mA		Room Full		12	25.5 26.5
R _{ON} Match Between Channels ^g	ΔR _{ON}	V ₊ = ± 2.7 V, V _D = 0.5 V or 2.2 V, I _S = 5 mA		Room			3.6
On-Resistance Flatness ⁱ	R _{ON} Flatness			Room			13
Switch Off Leakage Current ^a	I _{S(off)}	V ₊ = 3.3 V V _S = 2 or 1 V, V _D = 1 or 2 V		Room Full	- 2 - 20		2 20
	I _{D(off)}			Room Full	- 2 - 20		2 20
Channel On Leakage Current ^a	I _{D(on)}	V ₊ = 3.3 V V _D = V _S = 1 or 2 V, sequence each switch on		Room Full	- 2 - 20		2 20
Digital Control							
Logic High Input Voltage	V _{INH}			Full	1.8		
Logic Low Input Voltage	V _{INL}			Full			0.4
Input Current ^a	I _{IN}	V _{AX} = V _{EN} = 1.8 V or 0.4 V		Full	- 1		1
Dynamic Characteristics							
Transition Time	t _{TRANS}	V _{S1} = 1.5 V, V _{S8} = 0 V, (DG3408) V _{S1b} = 1.5 V, V _{S4b} = 0 V, (DG3409) see figure 2		Room Full		140	165 182
Break-Before-Make Time	t _{BBM}	V _{S(all)} = V _{DA} = 1.5 V see figure 4		Room Full	2	63	
Enable Turn-On Time	t _{ON(EN)}	V _{AX} = 0 V, V _{S1} = 1.5 V (DG3408) V _{AX} = 0 V, V _{S1b} = 1.5 V (DG3409) see figure 3		Room Full		140	162 178
Enable Turn-Off Time	t _{OFF(EN)}			Room Full		76	97 104
Charge Injection ^e	Q	C _L = 1 nF, R _{GEN} = 0, V _{GEN} = 0 V		Room		7	
Off Isolation ^{e, h}	OIRR	f = 100 kHz, R _L = 1 kΩ		Room		- 81	
Crosstalk ^e	X _{TALK}			Room		- 85	
Source Off Capacitance ^e	C _{S(off)}	f = 1 MHz, V _S = 0 V, V _{EN} = 1.8 V		DG3408	Room	23	
				DG3409	Room	25	
Drain Off Capacitance ^e	C _{D(off)}	f = 1 MHz, V _D = 0 V, V _{EN} = 1.8 V		DG3408	Room	230	
				DG3409	Room	120	
Drain On Capacitance ^e	C _{D(on)}	f = 1 MHz, V _D = 0 V, V _{EN} = 0 V		DG3408	Room	256	
				DG3409	Room	147	
Power Supplies							
Power Supply Current	I ₊	V _{EN} = V _A = 0 V or V ₊		Room			1
Power Supply Current							

Notes:

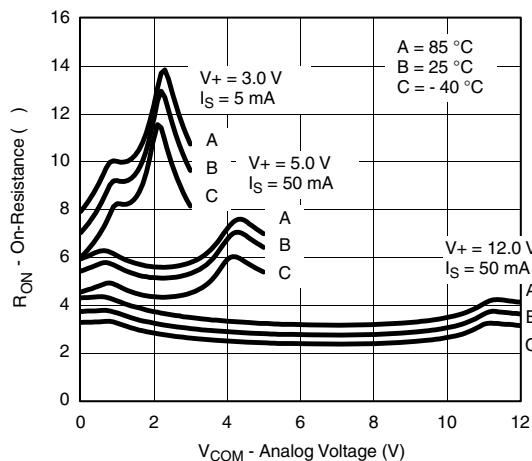
- Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- Guaranteed by design, not subject to production test.
- V_{IN} = input voltage to perform proper function.
- ΔR_{ON} = R_{ON} Max - R_{ON} Min.
- Worst case isolation occurs on Channel 4 due to proximity to the drain pin.
- R_{ON} flatness is measured as the difference between the minimum and maximum measured values across a defined Analog signal.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

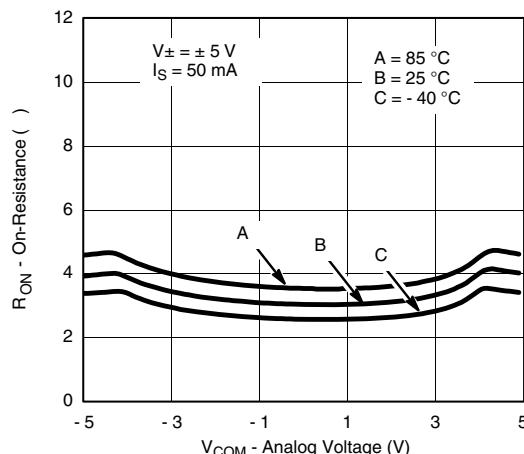
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



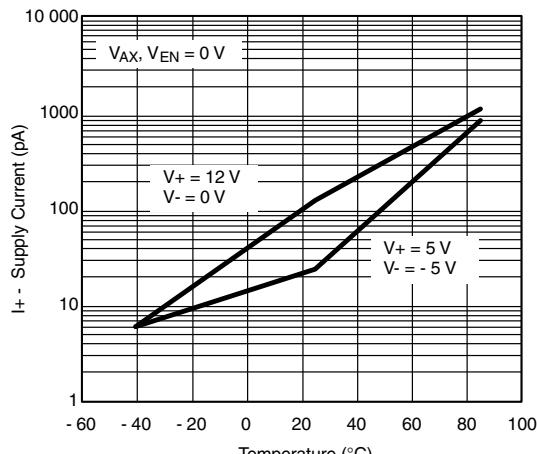
RON vs. VCOM and Single Supply Voltage



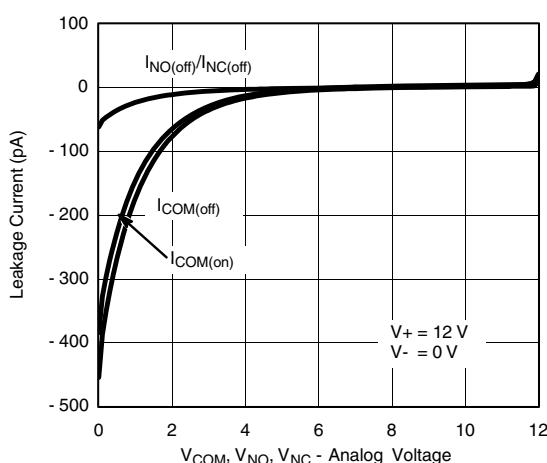
RON vs. Analog Voltage and Temperature



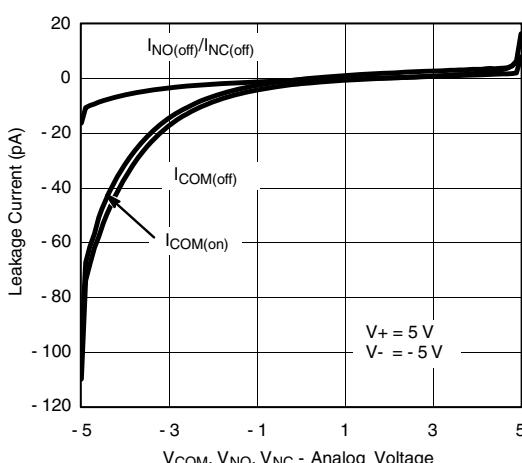
RON vs. Analog Voltage and Temperature



Supply Current vs. Temperature



Leakage Current vs. Analog Voltage



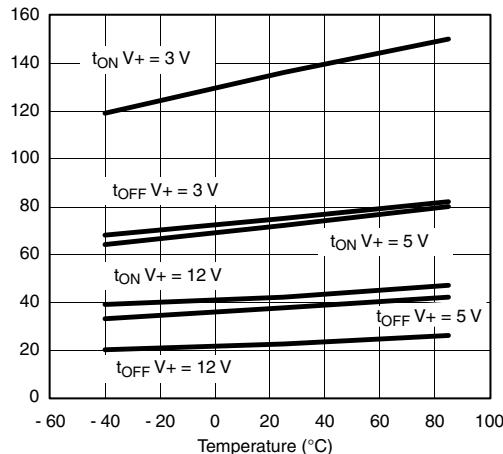
Leakage Current vs. Analog Voltage

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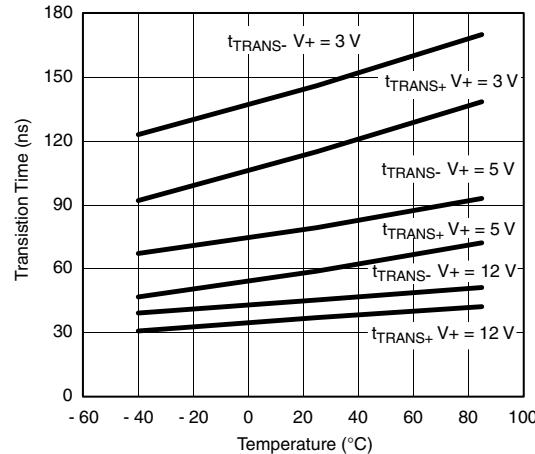
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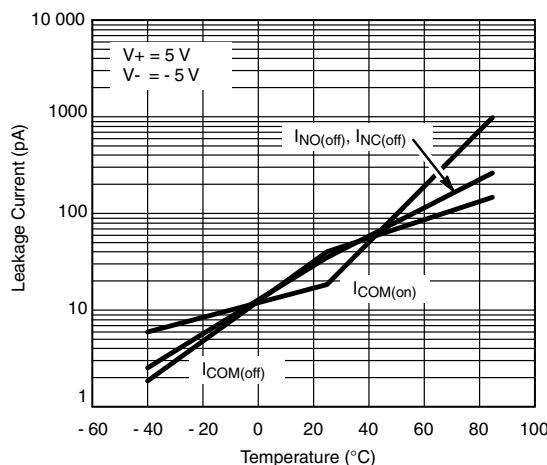
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



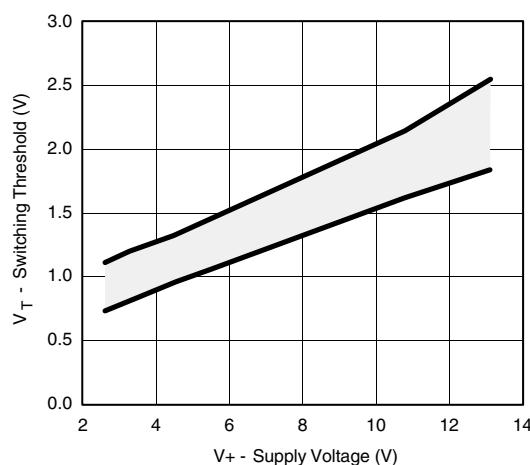
Switching Time vs. Temperature and Single Supply Voltage



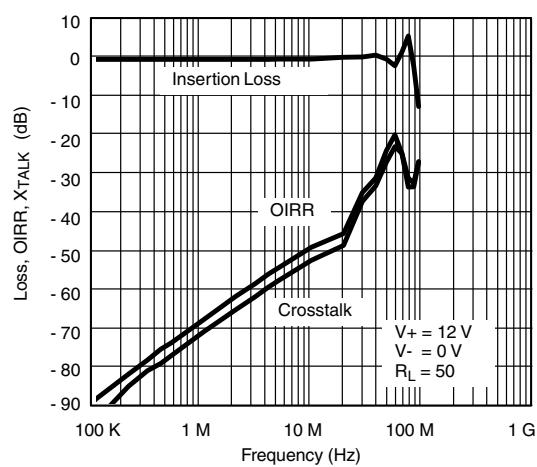
Transition Time vs. Temperature and Single Supply Voltage



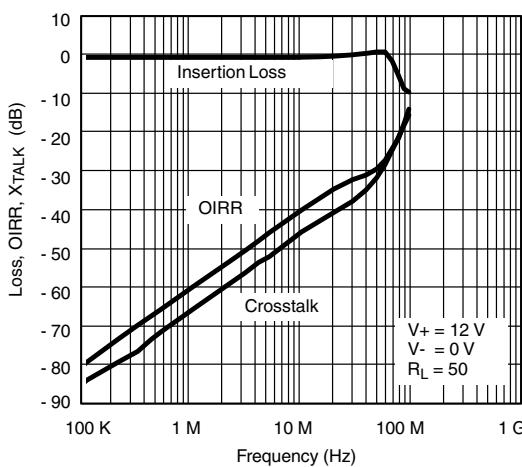
Leakage Current vs. Temperature



Switching Threshold vs. Supply Voltage

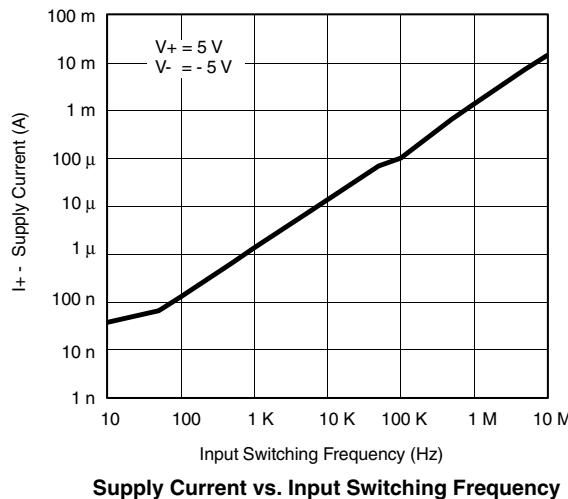


Insertion Loss, Off Isolation and Crosstalk vs. Frequency (DG3408)



Insertion Loss, Off Isolation and Crosstalk vs. Frequency (DG3409)

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



SCHEMATIC DIAGRAM (Typical Channel)

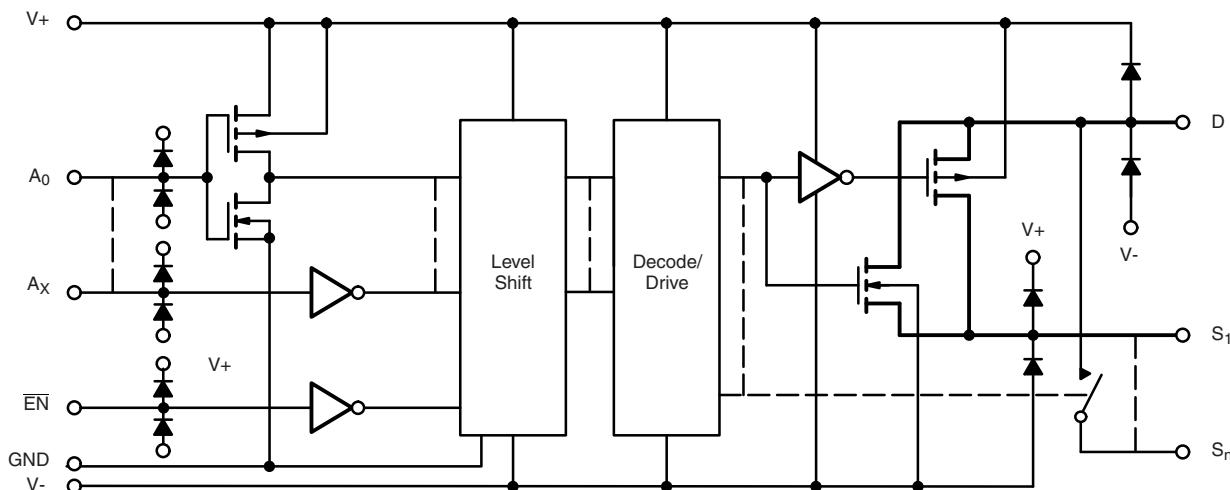
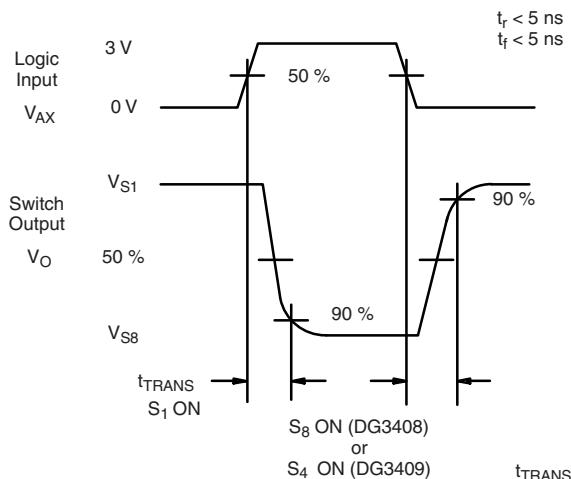
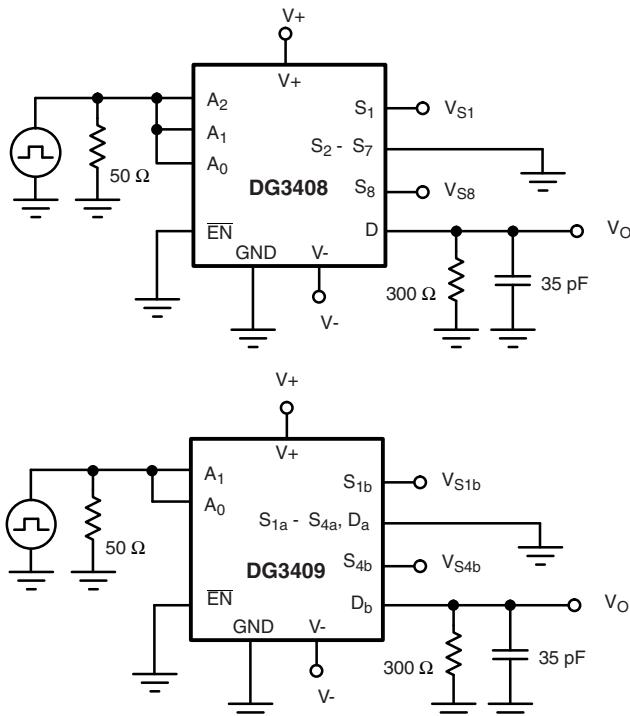


Figure 1.

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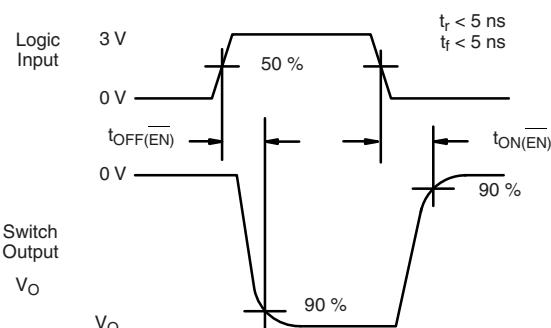
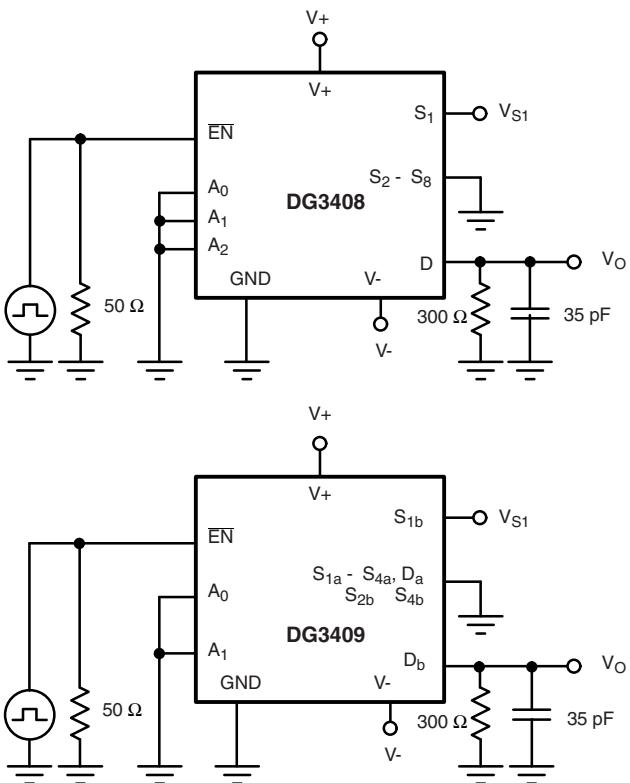
TEST CIRCUITS



Return to Specifications:

Single Supply 12 V
Dual Supply $V_+ = 5 V$, $V_- = -5 V$
Single Supply 5 V
Single Supply 3 V

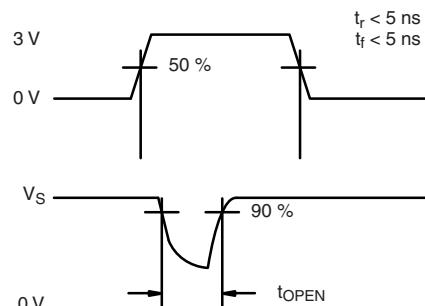
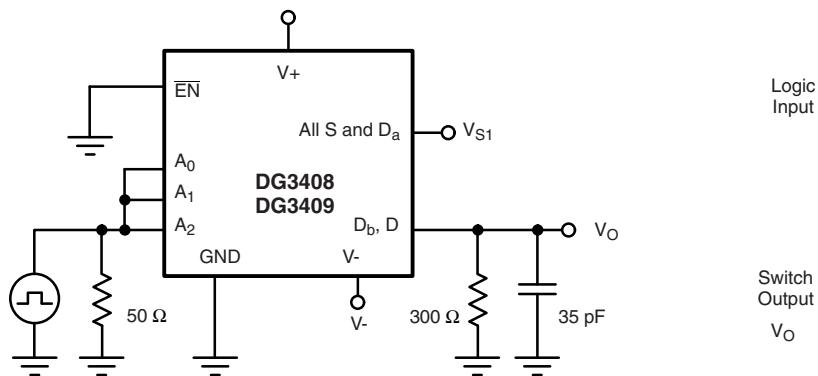
Figure 2. Transition Time



Return to Specifications:

Single Supply 12 V
Dual Supply $V_+ = 5 V$, $V_- = -5 V$
Single Supply 5 V
Single Supply 3 V

Figure 3. Enable Switching Time

TEST CIRCUITS


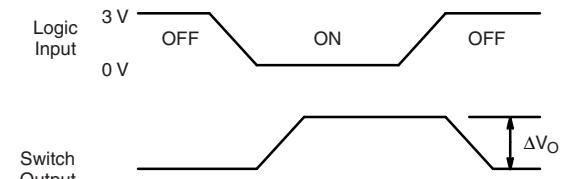
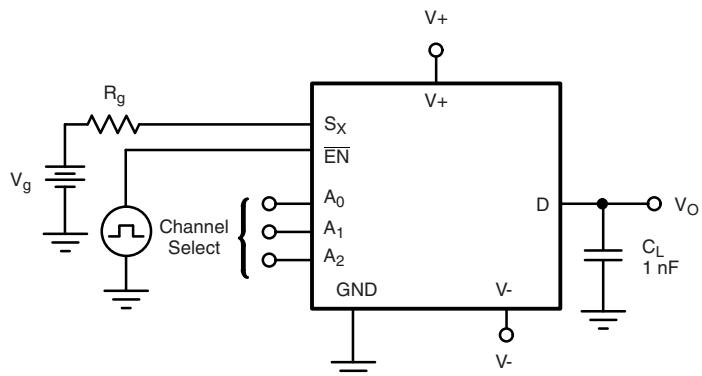
Return to Specifications:

Single Supply 12 V

Dual Supply V+ = 5 V, V- = -5 V

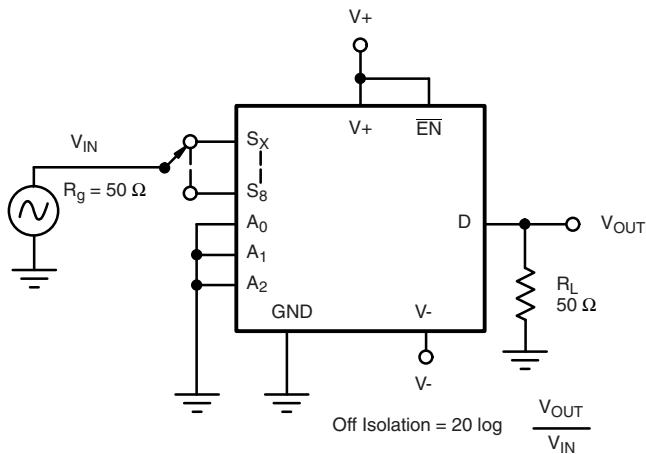
Single Supply 5 V

Single Supply 3 V

Figure 4. Break-Before-Make Interval


$$\Delta V_0 \text{ is the measured voltage due to charge transfer error } Q, \text{ when the channel turns off.}$$

$$Q = C_L \times \Delta V_0$$

Figure 5. Charge Injection

Figure 6. Off Isolation

TEST CIRCUITS

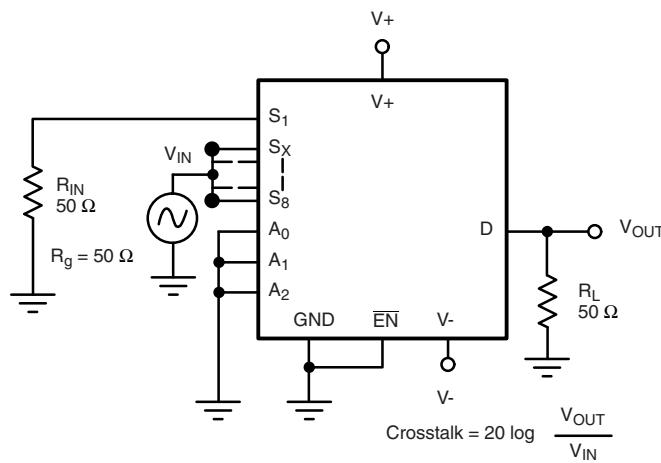


Figure 7. Crosstalk

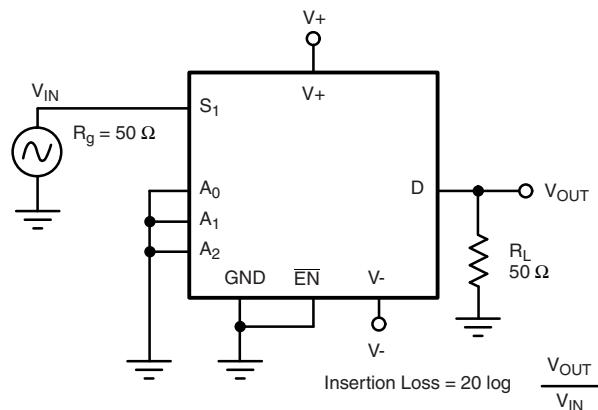


Figure 8. Insertion Loss

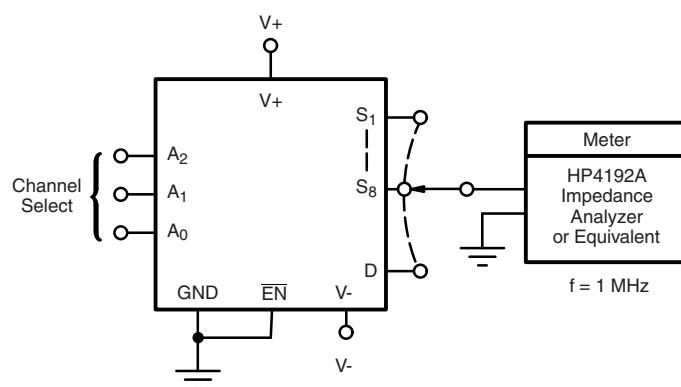
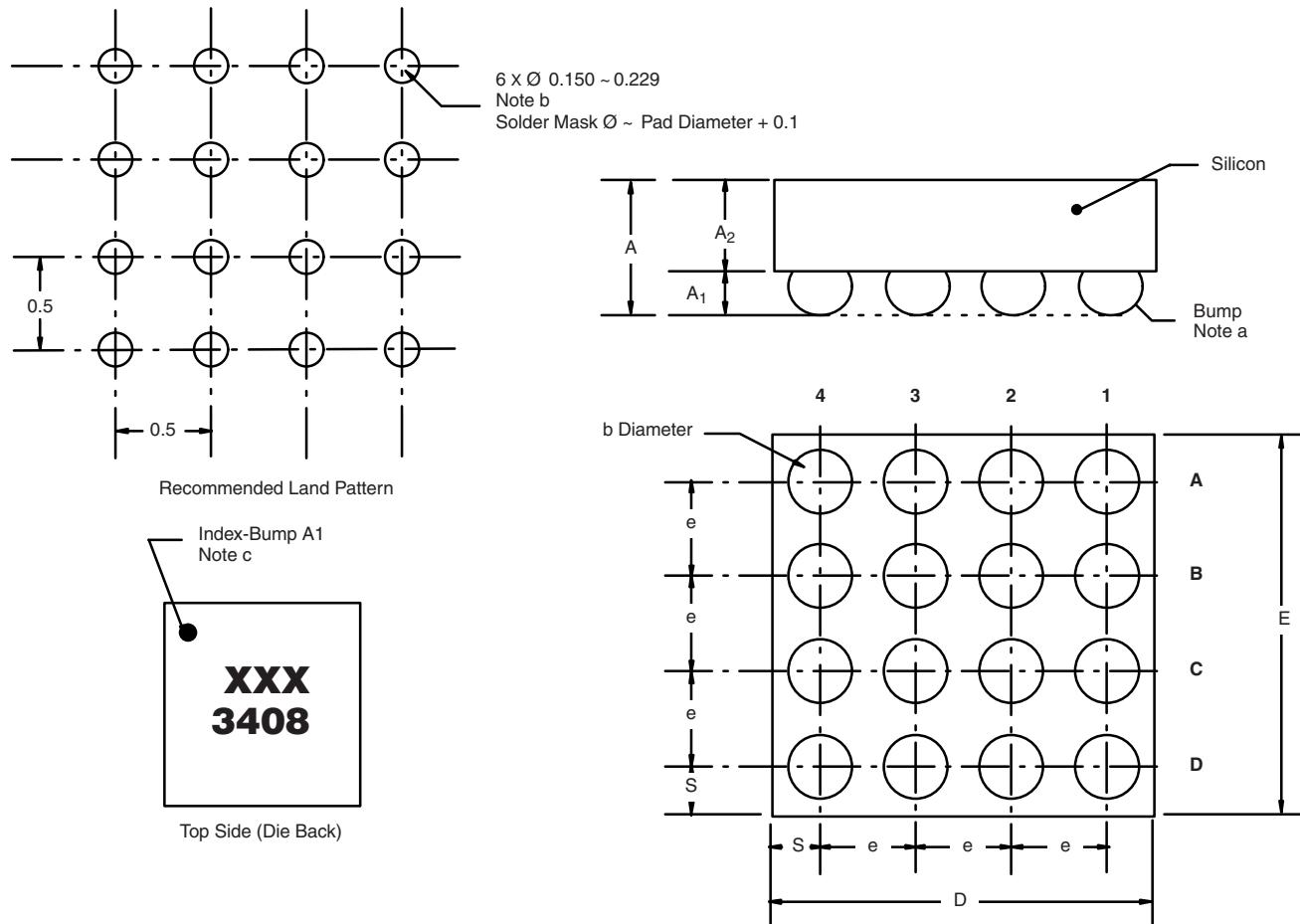


Figure 9. Source Drain Capacitance

PACKAGE OUTLINE
MICRO FOOT: 16-BUMP (4 x 4, 0.5 mm PITCH, 0.238 mm BUMP HEIGHT)


Notes (Unless Otherwise Specified):

- a. Bump is Lead Free Sn/Ag/Cu.
- b. Non-solder mask defined copper landing pad.
- c. Laser Mark on silicon die back; back-lapped, no coating. Shown is not actual marking; sample only.

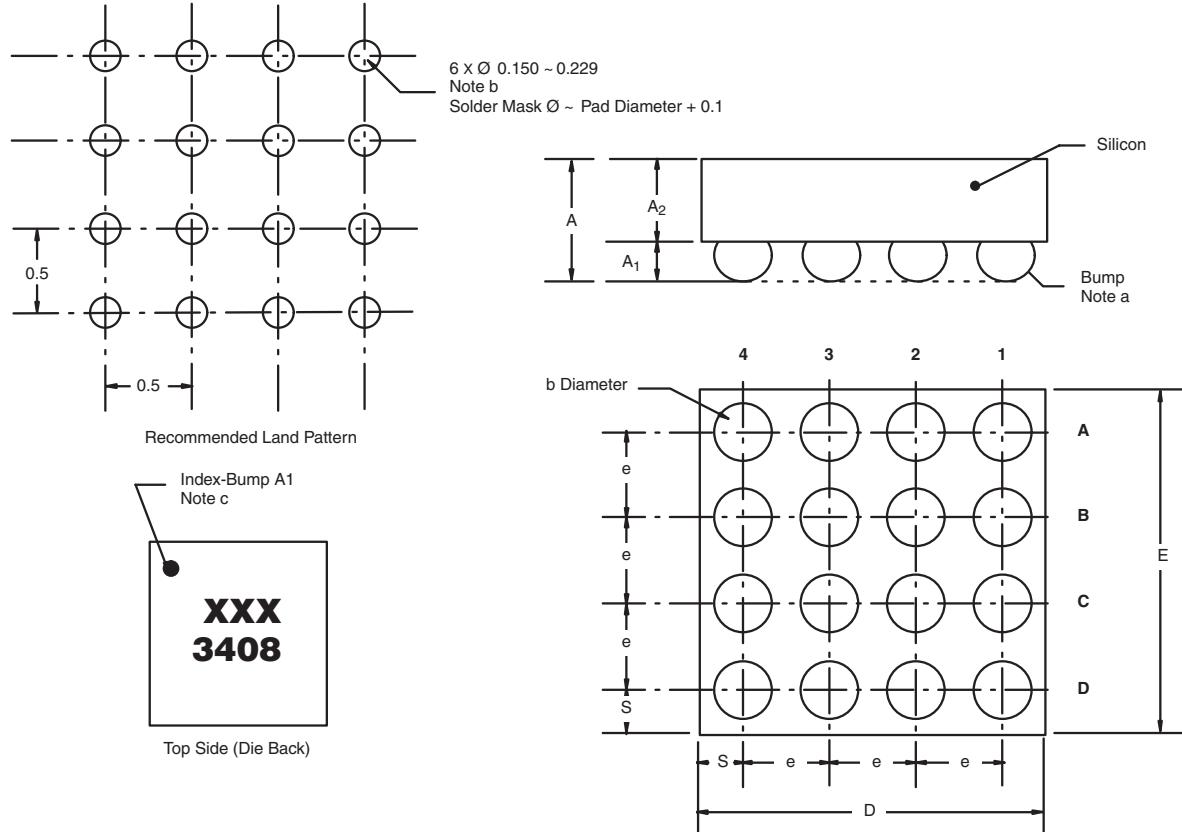
Dim.	Millimeters ^a		Inches	
	Min.	Max.	Min.	Max.
A	0.688	0.753	0.0271	0.0296
A₁	0.218	0.258	0.0086	0.0102
A₂	0.470	0.495	0.0185	0.0195
b	0.306	0.346	0.0120	0.0136
D	1.980	2.020	0.0780	0.0795
E	1.980	2.020	0.0780	0.0795
e	0.5 BASIC		0.0197 BASIC	
S	0.230	0.270	0.0091	0.0106

Notes:

- a. Use millimeters as the primary measurement.

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MICRO FOOT: 16-BUMP (4 mm x 4 mm, 0.5 mm PITCH, 0.238 mm BUMP HEIGHT)



Notes

(unless otherwise specified)

- a. Bump is lead (Pb)-free Sn/Ag/Cu.
- b. Non-solder mask defined copper landing pad.
- c. Laser mark on silicon die back; back-lapped, no coating. Shown is not actual marking; sample only.

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Note

- a. Use millimeters as the primary measurement.

ECN: S11-1065-Rev. A, 13-Jun-11
DWG: 6000

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