



3.2 Ω , 8-Channel / Dual 4-Channel, ± 15 V, ± 12 V, ± 5 V Precision Multiplexers

DESCRIPTION

The DG1408 is a precision analog multiplexer comprising eight single-ended channels. The DG1409 is a dual four single-ended channels analog multiplexer. Built on a new CMOS process, the Vishay Siliconix DG1408 and DG1409 offer low on-resistance of 3.2 Ω . The low and flat resistance over the full signal range provides excellent linearity and low signal distortion. The new CMOS platform also ensures ultra low power dissipation, minimized parasitic capacitance, and low charge injection.

The DG1408 and DG1409 can operate from either a single 4.5 V to 24 V power supply, or from dual ± 4.5 V to ± 15 V power supplies. The DG1408 connects one of eight inputs to a common output as determined by a 3-bit binary address (A0, A1, A2). The DG1409 connects one of four inputs to a common output for both multiplexers as determined by a 2-bit binary address (A0 and A1). Break-before-make switching action protects against momentary crosstalk between adjacent channels. The part does not require a VL logic supply, while all digital inputs have 0.8 V and 2 V logic thresholds to ensure low-voltage TTL / CMOS compatibility. Together with the compact package, these make the part a great fit for battery operated systems.

The DG1408 and DG1409 on channel conduct signal equally well in both directions. In the off state each channel blocks voltages up to the power supply rails. An enable (EN) function allows the user to reset the multiplexer / demultiplexer to all switches off for stacking several devices.

The advance performance of low insertion loss and low distortion make the device ideal for signal switching and relay replacement in a wide range of applications.

DG1408 and DG1409 are available in RoHS-compliant, halogen-free QFN16, 4 mm x 4 mm package.

FEATURES

- 35 V supply max. rating
- 3.2 Ω typical and 4.7 Ω max. on-resistance at 25 $^{\circ}$ C
- 0.5 Ω on-resistance flatness
- Channel to channel on-resistance match: 0.2 Ω
- Up to 250 mA continuous current
- Supports single and dual supply operation
- Fully specified at ± 15 V, ± 12 V, and ± 5 V
- Integrated VL supply
- Low voltage logic compatible inputs, $V_{IH} = 2$ V, $V_{IL} = 0.8$ V
- BBM (break-before-make switching)
- Low parasitic capacitance:
DG1408, $C_{S(off)} = 14$ pF, $C_{D(on)} = 123$ pF
DG1409, $C_{S(off)} = 14$ pF, $C_{D(on)} = 81$ pF
- Rail to rail signal handling
- QFN16, 4 mm x 4 mm packages
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE

BENEFITS

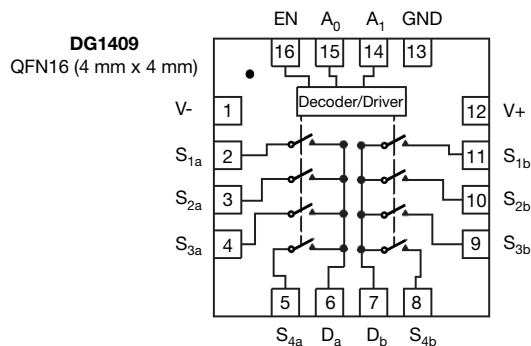
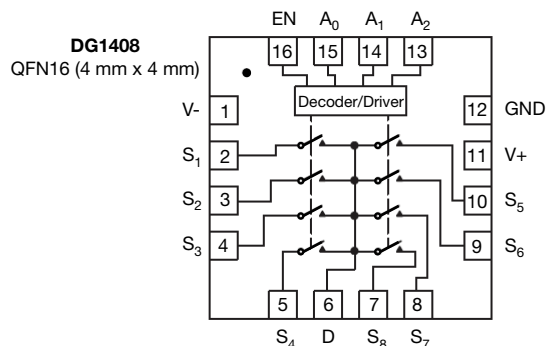
- Low insertion loss
- Low distortion
- Low power consumption
- Compact solution
- Low charge injection over the full signal range

APPLICATIONS

- Medical and healthcare equipment
- Data acquisition system
- Industrial control and automation
- Test and measurement equipment
- Communication systems
- Battery powered systems
- Sample and hold circuits
- Audio and video signal switching
- Relay replacement



FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE - DG1408

A2	A1	A0	EN	ON SWITCH
X	X	X	0	None
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

TRUTH TABLE - DG1409

A1	A0	EN	ON SWITCH
X	X	0	None
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

Note

- QFN exposed pad tied to V-

ORDERING INFORMATION

PART	CONFIGURATION	TEMPERATURE RANGE	PACKAGE	ORDERING PART NUMBER
DG1408	8:1 MUX	-40 °C to +125 °C	QFN (4 mm x 4 mm) 16L (variation 2)	DG1408EN-T1-GE4
DG1409	Dual 4:1 MUX			DG1409EN-T1-GE4

ABSOLUTE MAXIMUM RATINGS

ELECTRICAL PARAMETER	CONDITIONS	LIMITS	UNIT
V+	Reference to GND	-0.3 V to +25 V	V
V-	Reference to GND	+0.3 V to -25 V	
V+ to V-		+35	
Analog Inputs (S or D)		V- (-0.3 V) to V+ (+0.3 V)	
Digital Inputs		GND (-0.3 V) to V+ (+0.3 V)	
Maximum Continuous Switch Current	QFN (4 mm x 4 mm) 16L, T _A = 25 °C	250	mA
	QFN (4 mm x 4 mm) 16L, T _A = 125 °C	100	
Maximum Pulse Switch Current	Pulse at 1 ms, 10 % duty cycle	500	
Thermal Resistance	QFN (4 mm x 4 mm) 16L	32	°C/W
Temperature			
Operating Temperature		-40 to 125	°C
Max. Operating Junction Temperature		150	
Storage Temperature		-65 to 150	

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.

RECOMMENDED OPERATING RANGE

ELECTRICAL	MINIMUM	MAXIMUM	UNIT
Single Supply (V+)	4.5	24	V
Dual Supplies (V+ and V-)	± 4.5	± 16.5	



ELECTRICAL CHARACTERISTICS								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 15 V, V ₋ = -15 V V _{AX} , V _{EN} = 2 V, 0.8 V		+25 °C	-40 °C to +85 °C	-40 °C to +125 °C	MIN. / TYP. / MAX.	UNIT
Analog Switch								
Analog Signal Range	V _{ANALOG}			V ₋ to V ₊			-	V
Drain-Source On-Resistance	R _{DS(on)}	V _S = ± 10 V, I _S = -10 mA, V ₊ = +13.5 V, V ₋ = -13.5 V		3.2	-	-	Typ.	Ω
	4.7			5.7	6.7	Max.		
On-Resistance Flatness	R _{flat(on)}			0.5	-	-	Typ.	
				0.7	0.8	0.9	Max.	
On-Resistance Matching	ΔR _{DS(on)}			0.2	-	-	Typ.	
				0.7	0.8	1	Max.	
Source Off Leakage Current	I _{S(off)}	V ₊ = +16.5 V, V ₋ = -16.5 V, V _S = ± 10 V, V _D = ± 10 V		± 0.02	-	-	Typ.	nA
				± 0.2	± 0.8	± 10	Max.	
Drain Off Leakage Current	I _{D(off)}			± 0.06	-	-	Typ.	
				± 0.3	± 3	± 20	Max.	
Drain On Leakage Current	I _{D(on)}	V ₊ = +16.5 V, V ₋ = -16.5 V, V _S = V _D = ± 10 V		± 0.08	-	-	Typ.	
				± 1	± 4	± 35	Max.	
Digital Control								
Input, High Voltage	V _{INH}			-	-	2	Min.	V
Input, Low Voltage	V _{INL}			-	-	0.8	Max.	
Input Leakage	I _{IN}	V _{IN} = V _{GND} or V ₊		0.005	-	-	Typ.	μA
				-	-	± 0.1	Max.	
Digital Input Capacitance	C _{IN}			3.5	-	-	Typ.	pF
Dynamic Characteristics								
Transition Time	t _{TRANS}	V _{S1} = +10 V / -10 V, V _{S8} = -10 V / +10 V, R _L = 100 Ω, C _L = 35 pF		140	-	-	Typ.	ns
				180	220	250	Max.	
Break-Before-Make Time	t _{OPEN}	V _{S1} = V _{S8} = 10 V, R _L = 100 Ω, C _L = 35 pF		50	-	-	Typ.	
				-	-	10	Min.	
Enable Turn-On Time	t _{ON(EN)}	V _{S1} = 10 V, V _{S2} - V _{S8} = 0 V, R _L = 100 Ω, C _L = 35 pF		125	-	-	Typ.	
				150	170	190	Max.	
Enable Turn-Off Time	t _{OFF(EN)}			100	-	-	Typ.	
				120	140	160	Max.	
Charge Injection	Q _{INJ}	C _{INJ} = 1 nF, R _{GEN} = 0 Ω, V _S = 0 V		100	-	-	Typ.	pC
Off Isolation	OIRR	C _L = 5 pF, R _L = 50 Ω, 1 MHz		-60	-	-	Typ.	dB
Cross Talk	X _{TALK}			-64	-	-		
Total Harmonic Distortion	THD	R _L = 100 Ω, 15 V _{p-p} , f = 20 Hz to 20 kHz		0.02	-	-	Typ.	%
-3dB, Bandwidth	BW	R _L = 50 Ω		DG1408 46	-	-	Typ.	MHz
				DG1409 68	-	-		
Source Off Capacitance	C _{S(off)}	f = 1 MHz, V _S = 0 V		14	-	-	Typ.	pF
Drain Off Capacitance	C _{D(off)}			DG1408 89	-	-	Typ.	
				DG1409 46	-	-		
Drain On Capacitance	C _{D(on)}			DG1408 123	-	-	Typ.	
				DG1409 81	-	-		
Power Supply								
Power Supply Range		GND = 0 V		± 4.5 / ± 16.5			Min. / Max.	V
Positive Supply Current	I ₊	V _{AX} , V _{EN} = 0 V, V ₊ , V ₊ = +16.5 V, V ₋ = -16.5 V		17	14.5	14	Typ.	μA
				-	-	30	Max.	
		V _{AX} , V _{EN} = 5 V, V ₊ = +16.5 V, V ₋ = -16.5 V		17	14.5	14	Typ.	
				-	-	50	Max.	
Negative Supply Current	I ₋	V _{AX} , V _{EN} = 0 V, V ₊ , V ₊ = +16.5 V, V ₋ = -16.5 V		0.002	0.22	0.4	Typ.	
				-	-	1	Max.	



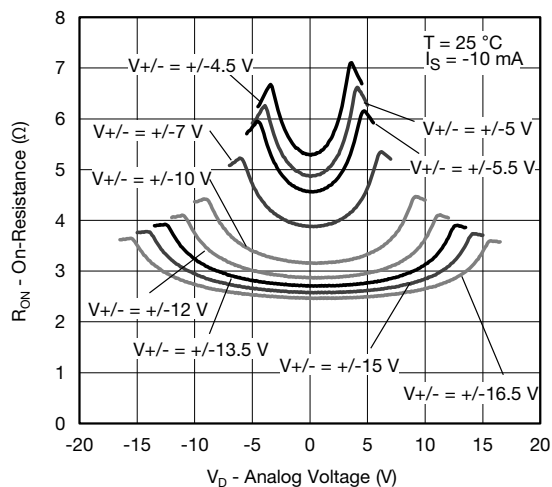
ELECTRICAL CHARACTERISTICS								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 12 V, V ₋ = 0 V V _{AX} , V _{EN} = 2 V, 0.8 V	+25 °C	-40 °C to +85 °C	-40 °C to +125 °C	MIN. / TYP. / MAX.	UNIT	
Analog Switch								
Analog Signal Range	V _{ANALOG}		0 to V ₊			-	V	
Drain-Source On-Resistance	R _{DS(on)}	V _S = 0 V / 10 V, I _S = -10 mA, V ₊ = +10.8 V, V ₋ = 0 V	5.5	-	-	Typ.	Ω	
			8	9	11	Max.		
On-Resistance Flatness	R _{flat(on)}		1	-	-	Typ.		
			2	2.5	3	Max.		
On-Resistance Matching	ΔR _{DS(on)}		0.2	-	-	Typ.		
			0.7	0.8	1	Max.		
Source Off Leakage Current	I _{S(off)}	V ₊ = +13.2 V, V ₋ = 0 V, V _S = 1 V / 10 V, V _D = 10 V / 1 V	± 0.02	-	-	Typ.	nA	
			± 0.2	± 0.6	± 5	Max.		
Drain Off Leakage Current	I _{D(off)}		± 0.02	-	-	Typ.		
			± 0.3	± 2	± 20	Max.		
Drain On Leakage Current	I _{D(on)}	V _S = V _D = 1 V / 10 V	± 0.05	-	-	Typ.		
			± 0.6	± 3	± 20	Max.		
Digital Control								
Input, High Voltage	V _{INH}		-	-	2	Min.	V	
Input, Low Voltage	V _{INL}		-	-	0.8	Max.		
Input Leakage	I _{IN}	V _{IN} = V _{GND} or V ₊	0.001	-	-	Typ.	μA	
			-	-	± 0.1	Max.		
Digital Input Capacitance	C _{IN}		3.5	-	-	Typ.	pF	
Dynamic Characteristics								
Transition Time	t _{TRANS}	V _{S1} = 8 V / 0 V, V _{S8} = 0 V / 8 V, R _L = 100 Ω, C _L = 35 pF	160	-	-	Typ.	ns	
			240	290	330	Max.		
Break-Before-Make Time	t _{OPEN}	V _{S1} = V _{S8} = 8 V, R _L = 100 Ω, C _L = 35 pF	95	-	-	Typ.		
			-	-	10	Min.		
Enable Turn-On Time	t _{ON(EN)}	V _{S1} = 8 V, V _{S2} - V _{S8} = 0 V, R _L = 100 Ω, C _L = 35 pF	190	-	-	Typ.		
			250	290	330	Max.		
Enable Turn-Off Time	t _{OFF(EN)}		105	-	-	Typ.		
			160	200	240	Max.		
Charge Injection	Q _{INj}	C _{INJ} = 1 nF, R _{GEN} = 0 Ω, V _S = 6 V	30	-	-	Typ.	pC	
Off Isolation	OIRR	C _L = 5 pF, R _L = 50 Ω, 1 MHz	-59	-	-	Typ.	dB	
Cross Talk	X _{TALK}		-63	-	-			
Total Harmonic Distortion	THD	R _L = 100 Ω, 6 V _{p-p} , f = 20 Hz to 20 kHz	0.05	-	-	Typ.	%	
-3dB, Bandwidth	BW	R _L = 50 Ω	DG1408 41	-	-	Typ.	MHz	
			DG1409 62	-	-			
Source Off Capacitance	C _{S(off)}	f = 1 MHz, V _S = 6 V	18	-	-	Typ.	pF	
Drain Off Capacitance	C _{D(off)}		DG1408 113	-	-	Typ.		
			DG1409 59	-	-			
Drain On Capacitance	C _{D(on)}		DG1408 147	-	-	Typ.		
			DG1409 93	-	-			
Power Supply								
Power Supply Range		GND = 0 V, V ₋ = 0 V	4.5 / 24			Min. / Max.	V	
Positive Supply Current	I ₊	V _{AX} , V _{EN} = 0 V, V ₊ , V ₊ = +13.2 V, V ₋ = 0 V	11	9.5	9	Typ.	μA	
			-	-	20	Max.		
		V _{AX} , V _{EN} = 5 V, V ₊ = 13.2 V, V ₋ = 0 V	11	9.5	9	Typ.		
			-	-	40	Max.		

**ELECTRICAL CHARACTERISTICS**

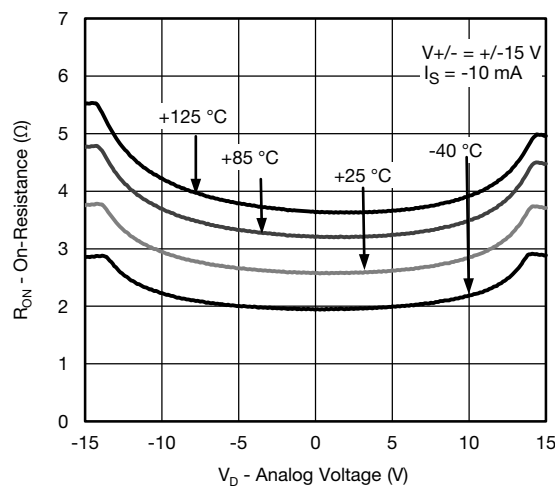
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V ₊ = 5 V, V ₋ = -5 V V _{AX} , V _{EN} = 2 V, 0.8 V	+25 °C	-40 °C to +85 °C	-40 °C to +125 °C	MIN. / TYP. / MAX.	UNIT
Analog Switch							
Analog Signal Range	V _{ANALOG}		V ₋ to V ₊			-	V
Drain-Source On-Resistance	R _{DS(on)}	V _S = ± 3.5 V, I _S = -10 mA, V ₊ = +4.5 V, V ₋ = -4.5 V	7	-	-	Typ.	Ω
			9	10	12	Max.	
On-Resistance Flatness	R _{flat(on)}		1.5	-	-	Typ.	
			2.5	3	3	Max.	
On-Resistance Matching	ΔR _{DS(on)}		0.2	-	-	Typ.	
			0.7	0.8	1	Max.	
Source Off Leakage Current	I _{S(off)}	V ₊ = +5.5 V, V ₋ = -5.5 V, V _S = ± 4.5 V, V _D = ± 4.5 V	± 0.01	-	-	Typ.	nA
			± 0.2	± 0.8	± 10	Max.	
Drain Off Leakage Current	I _{D(off)}		± 0.02	-	-	Typ.	
			± 0.3	± 3	± 20	Max.	
Drain On Leakage Current	I _{D(on)}	V ₊ = +5.5 V, V ₋ = -5.5 V, V _S = V _D = ± 4.5 V	± 0.05	-	-	Typ.	
			± 1	± 4	± 35	Max.	
Digital Control							
Input, High Voltage	V _{INH}		-	-	2	Min.	V
Input, Low Voltage	V _{INL}		-	-	0.8	Max.	
Input Leakage	I _{IN}	V _{IN} = V _{GND} or V ₊	0.001	-	-	Typ.	μA
			-	-	± 0.1	Max.	
Digital Input Capacitance	C _{IN}		3.5	-	-	Typ.	pF
Dynamic Characteristics							
Transition Time	t _{TRANS}	V _{S1} = +3 V / -3 V, V _{S8} = -3 V / +3 V, R _L = 100 Ω, C _L = 35 pF	275	-	-	Typ.	ns
			350	400	440	Max.	
Break-Before-Make Time	t _{OPEN}	V _{S1} = V _{S8} = 3 V, R _L = 100 Ω, C _L = 35 pF	110	-	-	Typ.	
			-	-	10	Min.	
Enable Turn-On Time	t _{ON(EN)}	V _{S1} = 3 V, V _{S2} - V _{S8} = 0 V, R _L = 100 Ω, C _L = 35 pF	245	-	-	Typ.	
			290	350	390	Max.	
Enable Turn-Off Time	t _{OFF(EN)}		185	-	-	Typ.	
			240	300	340	Max.	
Charge Injection	Q _{INJ}	C _{INJ} = 1 nF, R _{GEN} = 0 Ω, V _S = 0 V	25	-	-	Typ.	pC
Off Isolation	OIRR	C _L = 5 pF, R _L = 50 Ω, 1 MHz	-60	-	-	Typ.	dB
Cross Talk	X _{TALK}		-64	-	-		
Total Harmonic Distortion	THD	R _L = 100 Ω, 5 V _{P-P} , f = 20 Hz to 20 kHz	0.065	-	-	Typ.	%
-3dB, Bandwidth	BW	R _L = 50 Ω	DG1408 40	-	-	Typ.	MHz
			DG1409 61	-	-		
Source Off Capacitance	C _{S(off)}	f = 1 MHz, V _S = 0 V	18	-	-	Typ.	pF
Drain Off Capacitance	C _{D(off)}		DG1408 118	-	-	Typ.	
			DG1409 61	-	-		
Drain On Capacitance	C _{D(on)}		DG1408 152	-	-	Typ.	
			DG1409 95	-	-		
Power Supply							
Power Supply Range		GND = 0 V	± 4.5 / ± 16.5			Min. / Max.	V
Positive Supply Current	I ₊	V _{AX} , V _{EN} = 0 V, V ₊ , V ₊ = +5.5 V, V ₋ = -5.5 V	0.5	0.7	1	Typ.	μA
			-	-	20	Max.	
		V _{AX} , V _{EN} = 3 V, V ₊ = +5.5 V, V ₋ = -5.5 V	0.7	1.3	2	Typ.	
			-	-	50	Max.	
Negative Supply Current	I ₋	V _{AX} , V _{EN} = 0 V, V ₊ , V ₊ = +5.5 V, V ₋ = -5.5 V	0.0002	0.013	0.026	Typ.	
			-	-	1	Max.	



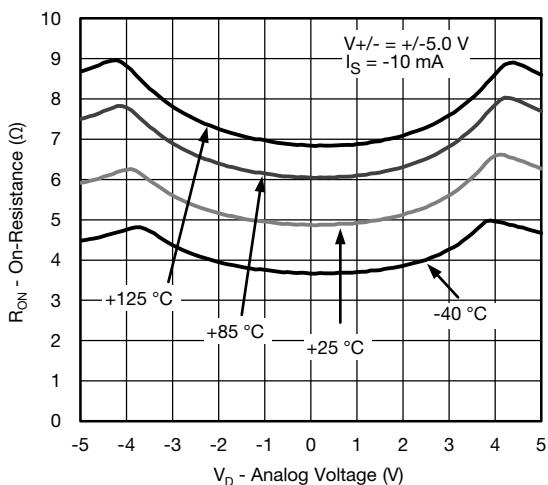
TYPICAL CHARACTERISTICS ($T_A = 25\text{ }^{\circ}\text{C}$, unless otherwise noted)



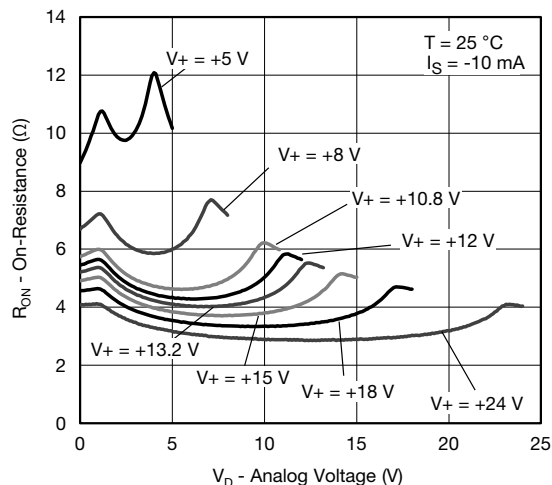
On-Resistance vs. Analog Voltage



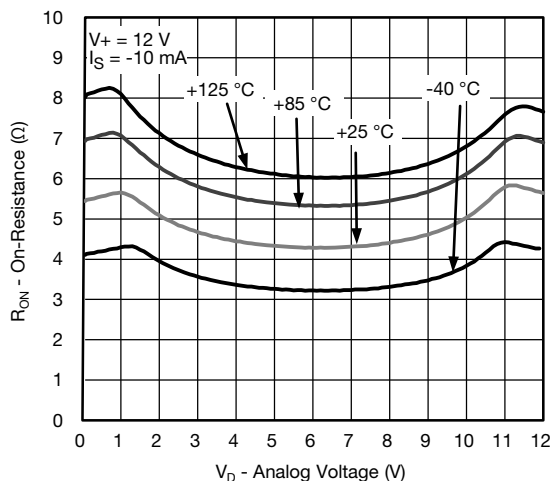
On-Resistance vs. Analog Voltage



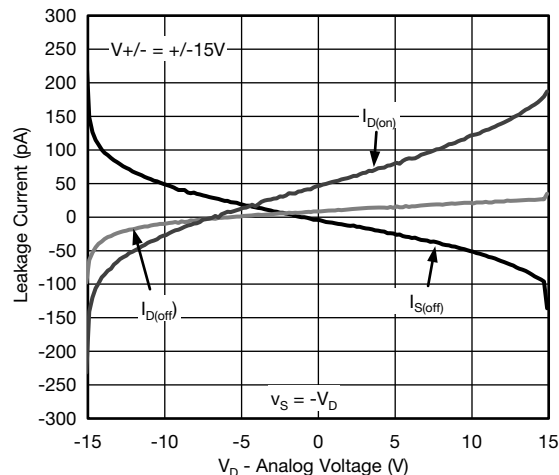
On-Resistance vs. Analog Voltage



On-Resistance vs. Analog Voltage



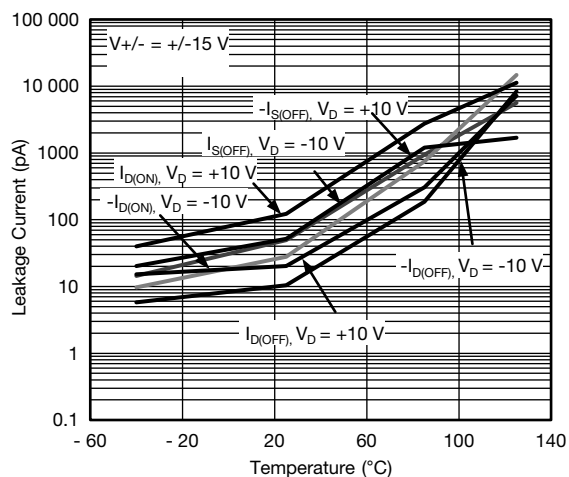
On-Resistance vs. Analog Voltage



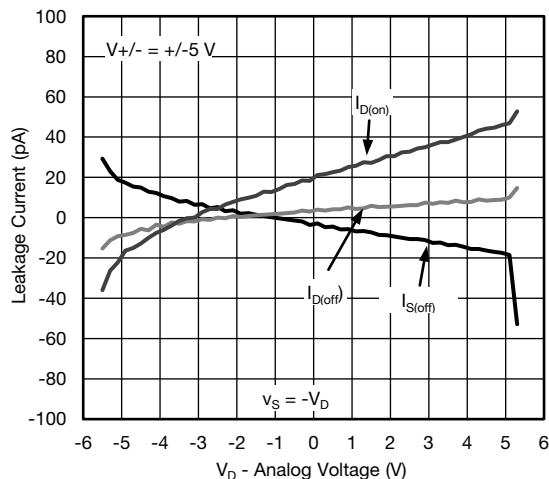
Leakage Current vs. Analog Voltage



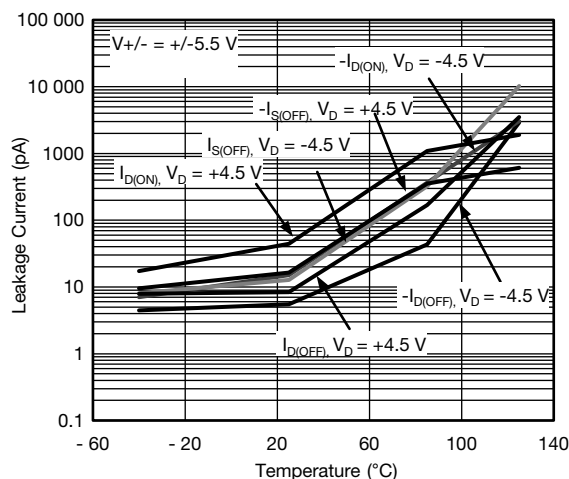
TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)



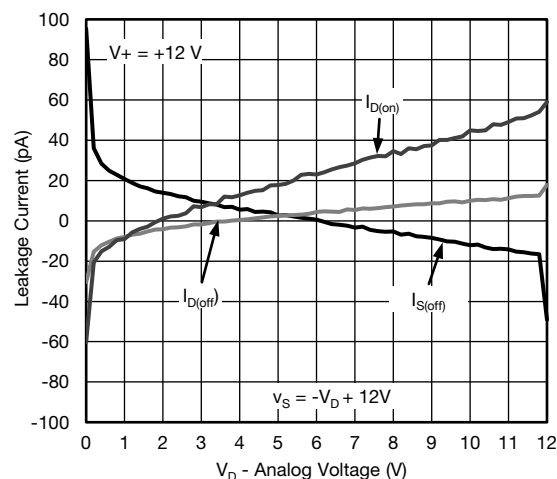
Leakage Current vs. Temperature



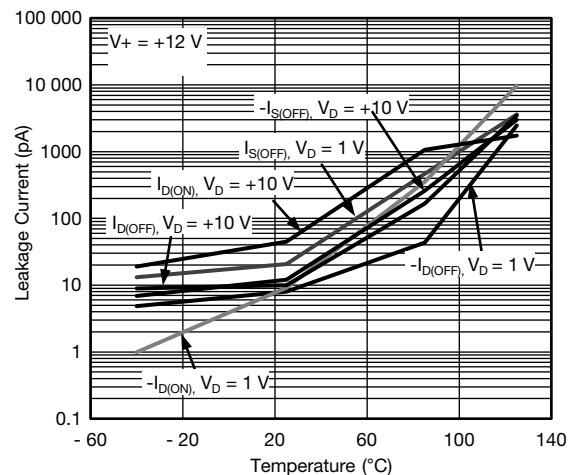
Leakage Current vs. Temperature



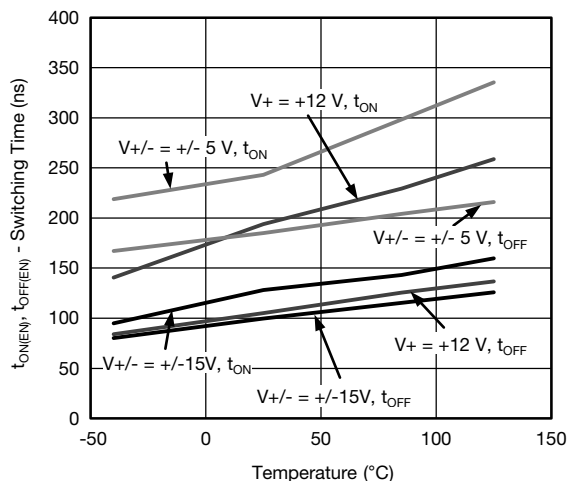
Leakage Current vs. Temperature



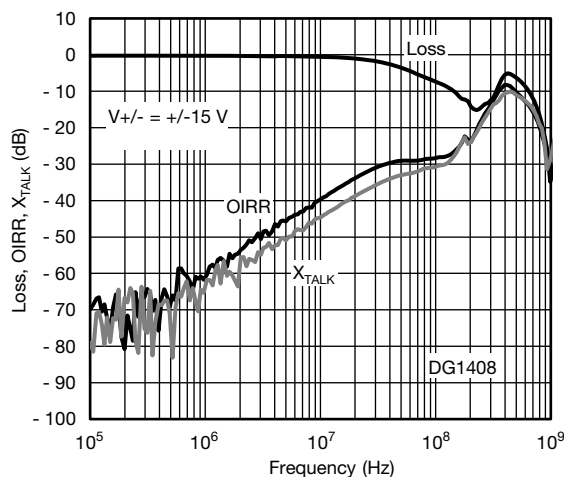
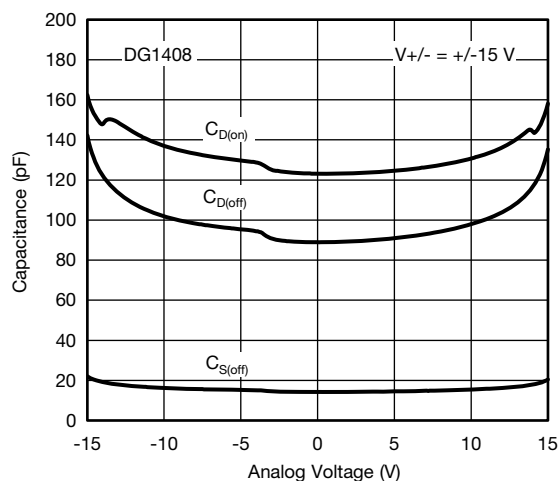
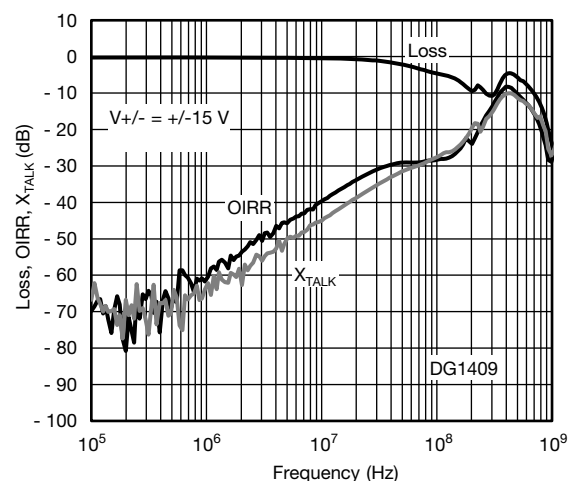
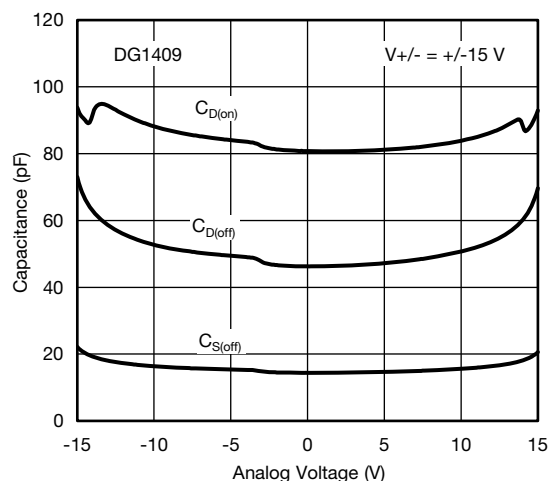
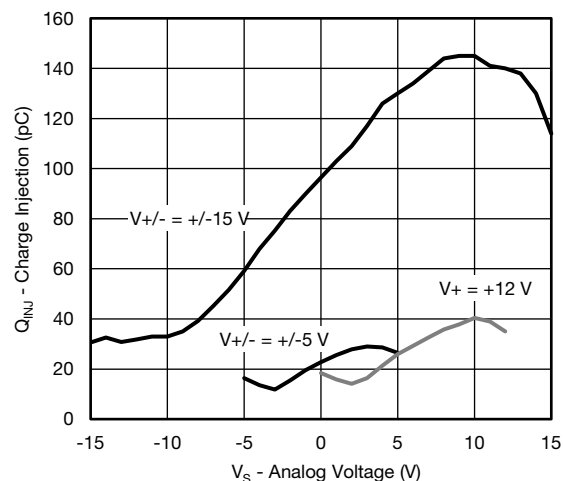
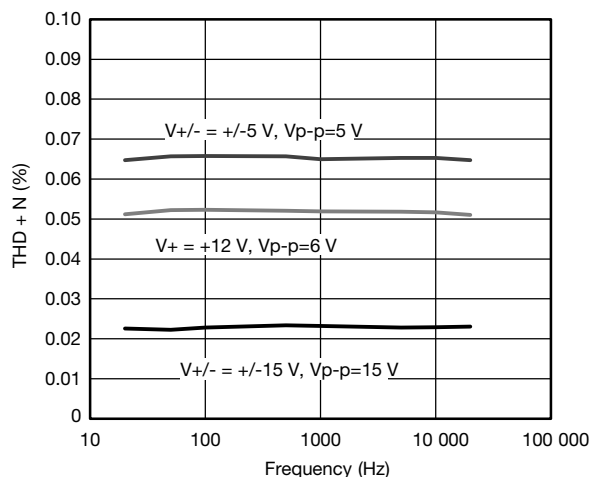
Leakage Current vs. Analog Voltage



Leakage Current vs. Analog Voltage

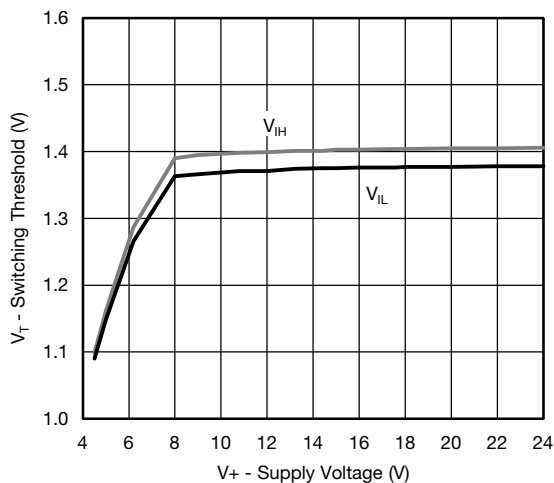


Switching Time vs. Temperature

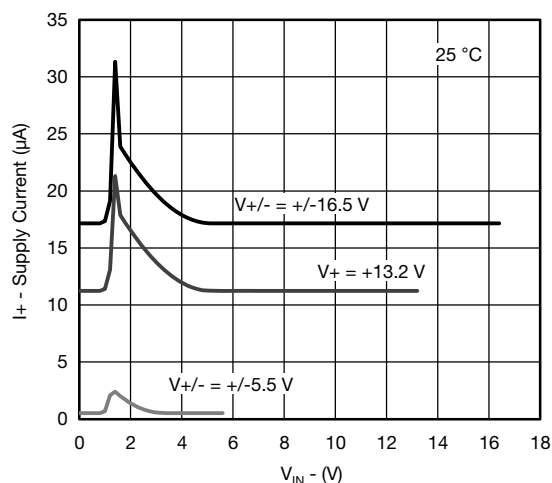
TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Loss, OIRR, X_{TALK} vs. Frequency

Capacitance vs. Analog Voltage

Loss, OIRR, X_{TALK} vs. Frequency

Capacitance vs. Analog Voltage

Charge Injection vs. Source Voltage

THD vs. Frequency



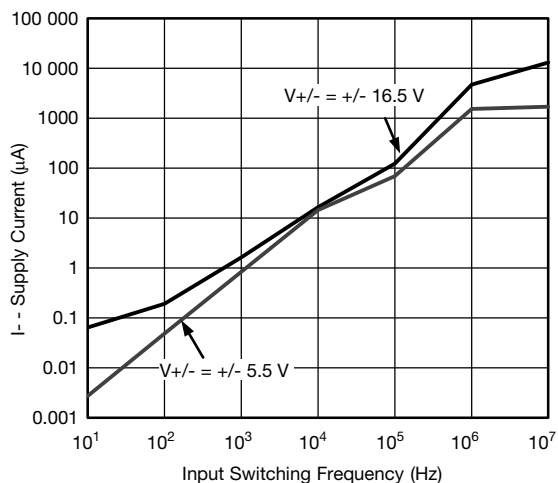
TYPICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)



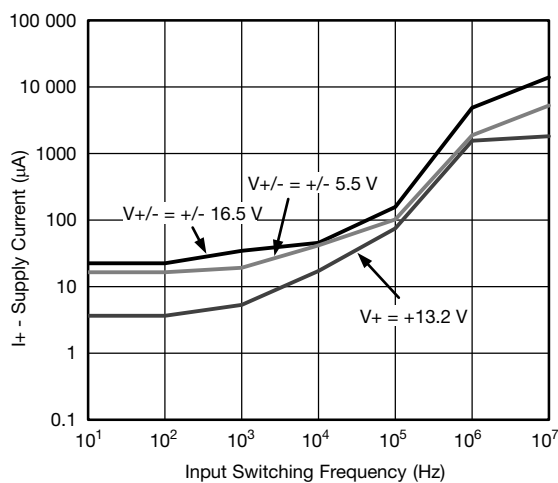
Switching Threshold vs. Supply Voltage



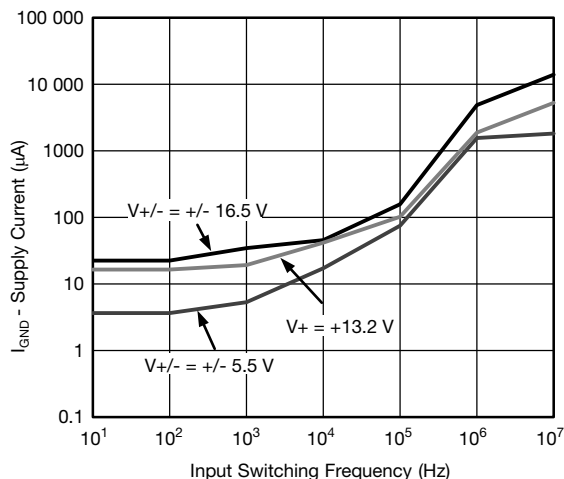
Positive Supply Current vs. Switching Frequency



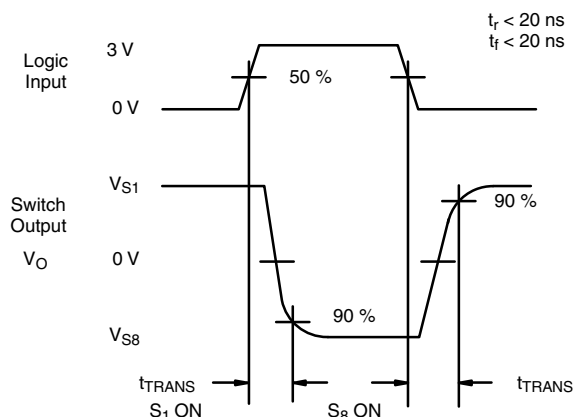
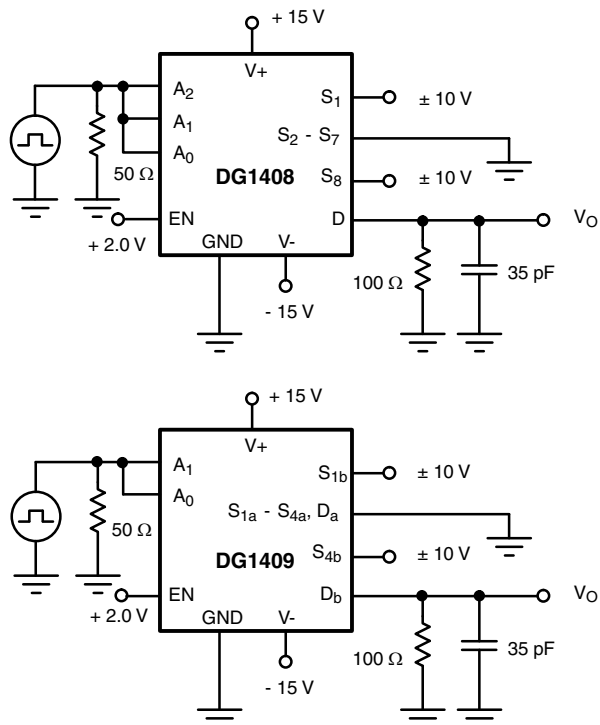
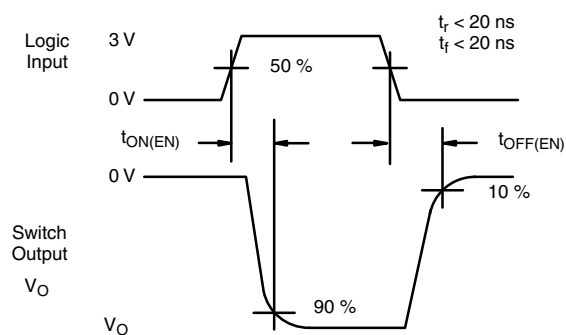
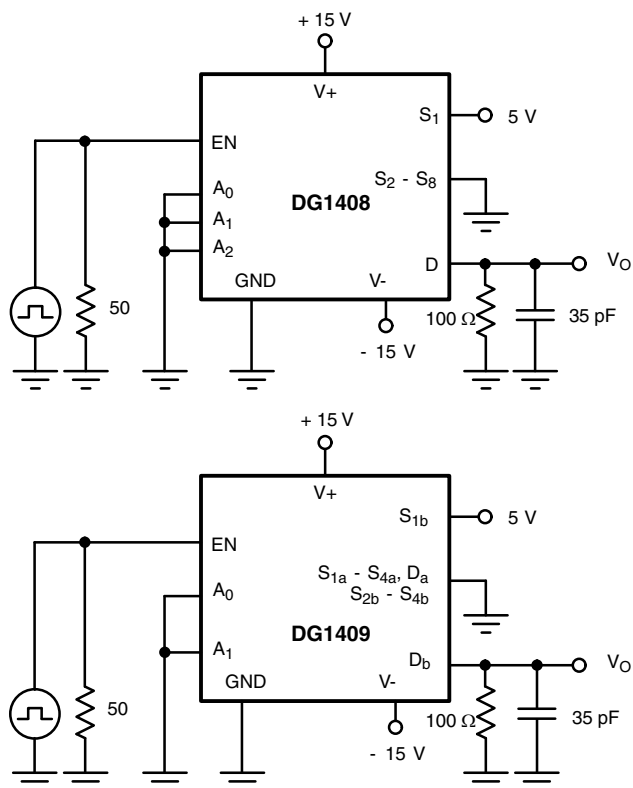
Negative Supply Current vs. Switching Frequency

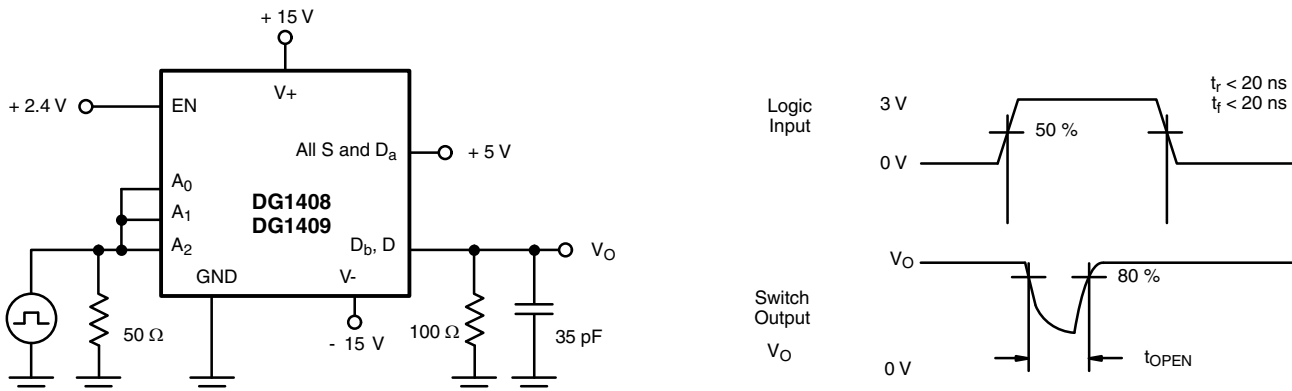
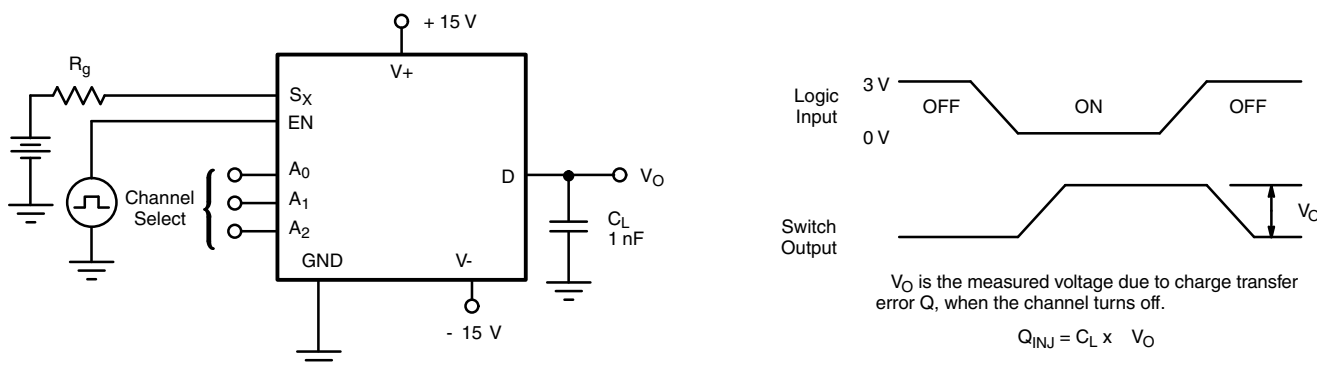
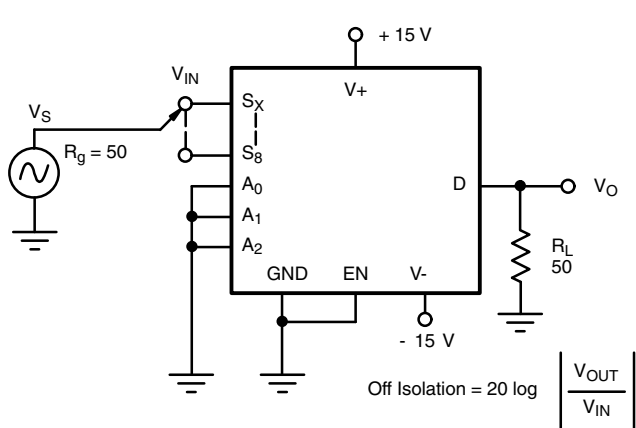
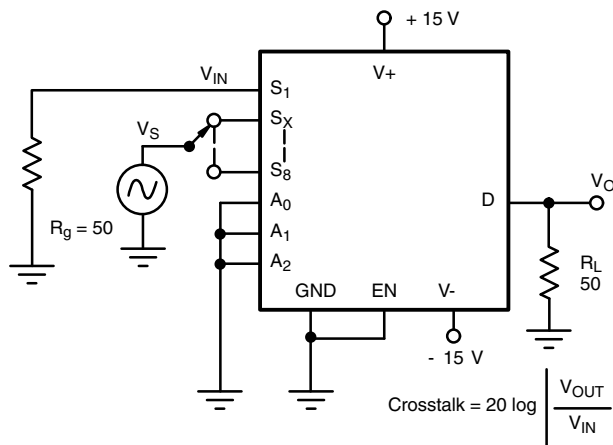


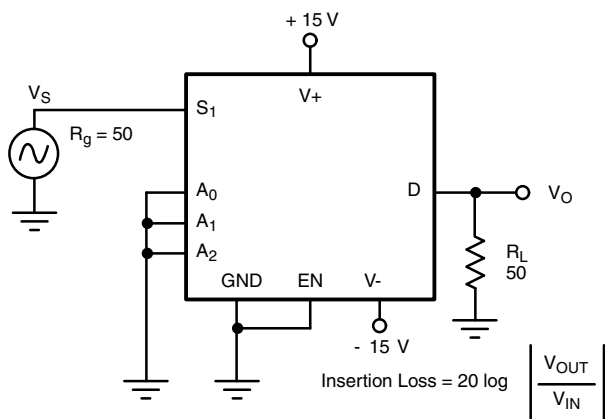
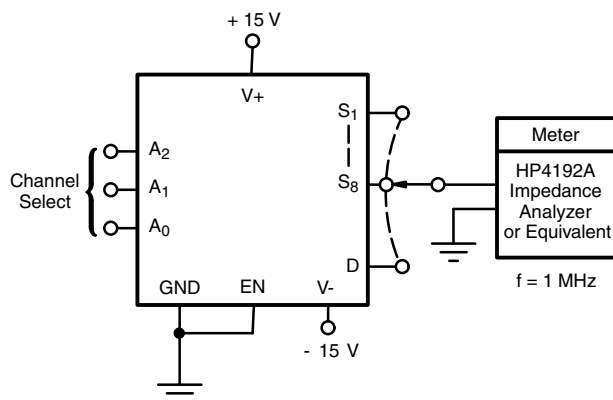
Positive Supply Current vs. Input Logic Voltage



Ground Current vs. Switching Frequency

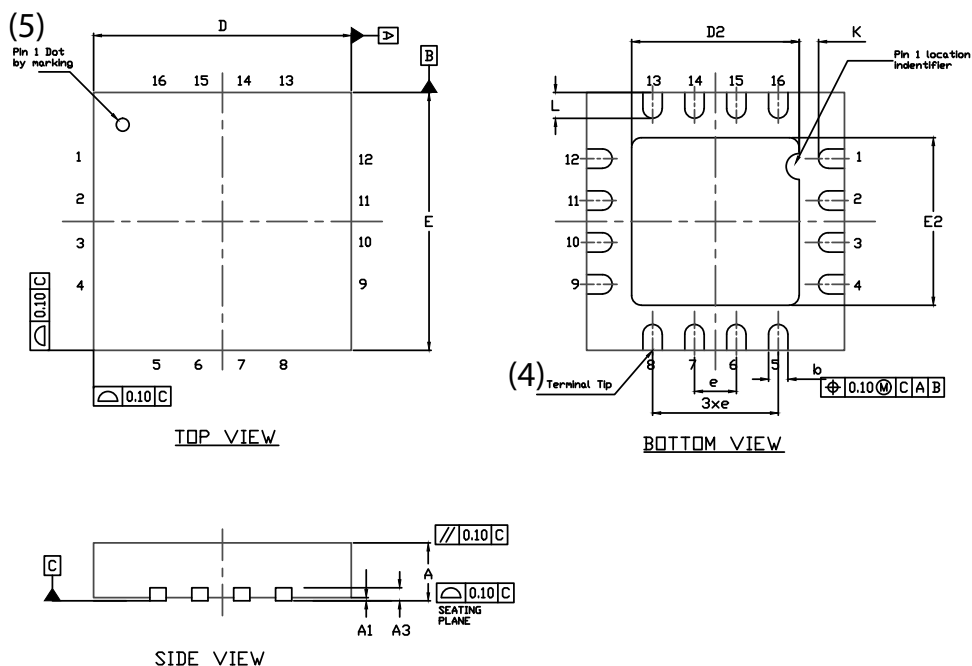
TEST CIRCUITS

Fig. 1 - Transition Time

Fig. 2 - Enable Switching Time


Fig. 3 - Break-Before-Make Internal

Fig. 4 - Charge Injection

Fig. 5 - Off-Isolation

Fig. 6 - Crosstalk


Fig. 7 - Insertion Loss

Fig. 8 - Source Drain Capacitance

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QFN 4x4-16L Case Outline



DIM	VARIATION 1						VARIATION 2					
	MILLIMETERS ⁽¹⁾			INCHES			MILLIMETERS ⁽¹⁾			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.75	0.85	0.95	0.029	0.033	0.037	0.75	0.85	0.95	0.029	0.033	0.037
A1	0	-	0.05	0	-	0.002	0	-	0.05	0	-	0.002
A3	0.20 ref.			0.008 ref.			0.20 ref.			0.008 ref.		
b	0.25	0.30	0.35	0.010	0.012	0.014	0.25	0.30	0.35	0.010	0.012	0.014
D	4.00 BSC			0.157 BSC			4.00 BSC			0.157 BSC		
D2	2.0	2.1	2.2	0.079	0.083	0.087	2.5	2.6	2.7	0.098	0.102	0.106
e	0.65 BSC			0.026 BSC			0.65 BSC			0.026 BSC		
E	4.00 BSC			0.157 BSC			4.00 BSC			0.157 BSC		
E2	2.0	2.1	2.2	0.079	0.083	0.087	2.5	2.6	2.7	0.098	0.102	0.106
K	0.20 min.			0.008 min.			0.20 min.			0.008 min.		
L	0.5	0.6	0.7	0.020	0.024	0.028	0.3	0.4	0.5	0.012	0.016	0.020
N ⁽³⁾	16			16			16			16		
Nd ⁽³⁾	4			4			4			4		
Ne ⁽³⁾	4			4			4			4		

Notes

- (1) Use millimeters as the primary measurement.
- (2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
- (3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
- (4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.
- (5) The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.
- (6) Package warpage max. 0.05 mm.

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