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 °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 × 4 mm packages
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free

RoHS COMPLIANT

HALOGEN FREE

BENEFITS

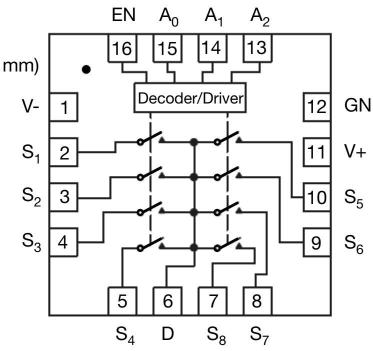
- Low insertion loss
- Low distortion
- Low power consumption
- Compact solution
- Low charge injection over the full signal range

APPLICATIONS

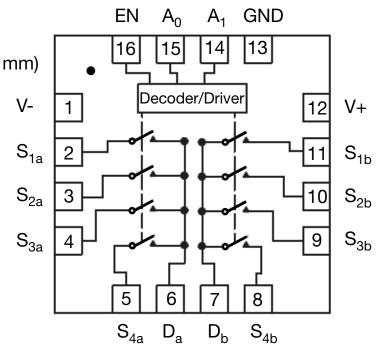
- Medical and healthcare equipment
- Data acquisition system
- Industrial control and automation
- Test and measurement equipment
- Communication systems
- Battery powered systems
- Sample and hold circuits
- Audio and video signal switching
- Relay replacement

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG1408
QFN16 (4 mm x 4 mm)



DG1409
QFN16 (4 mm x 4 mm)



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

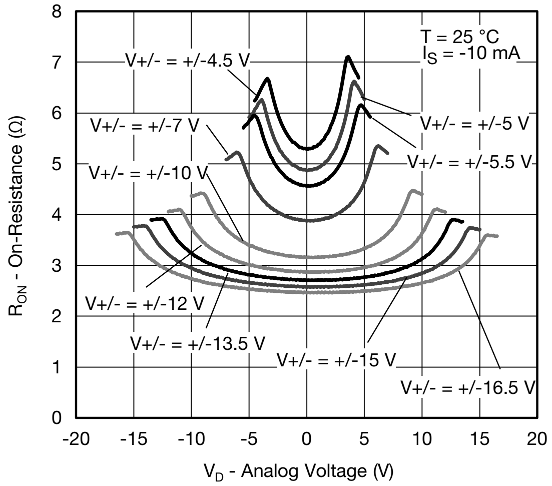
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 15 V, V- = -15 V V_{AX}, V_{EN} = 2 V, 0.8 V		+25 °C	-40 °C to +85 °C	-40 °C to +125 °C	MIN. / TYP. / MAX.	UNIT
Analog Switch								
Analog Signal Range	V_{ANALOG}			V- to V+			-	V
Drain-Source On-Resistance	$R_{DS(on)}$	V_S = ± 10 V, 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	$\Delta R_{DS(on)}$			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	$\Delta R_{DS(on)}$			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.	

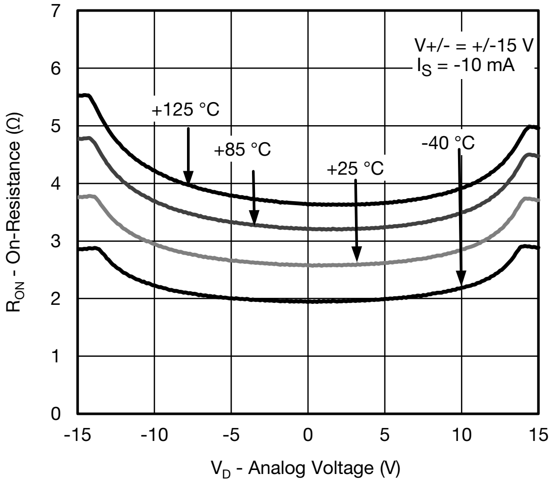
ELECTRICAL CHARACTERISTICS

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	$\Delta R_{DS(on)}$			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.	

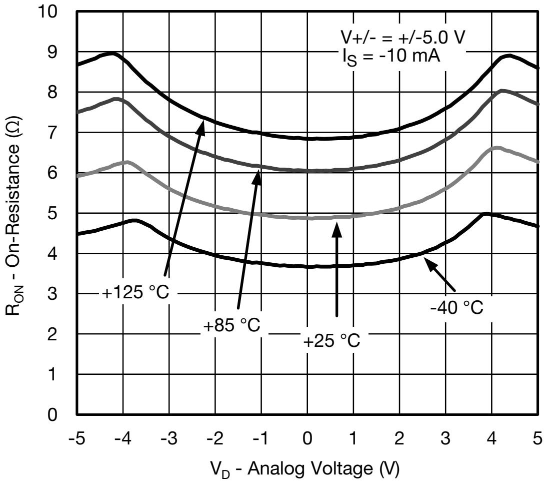
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



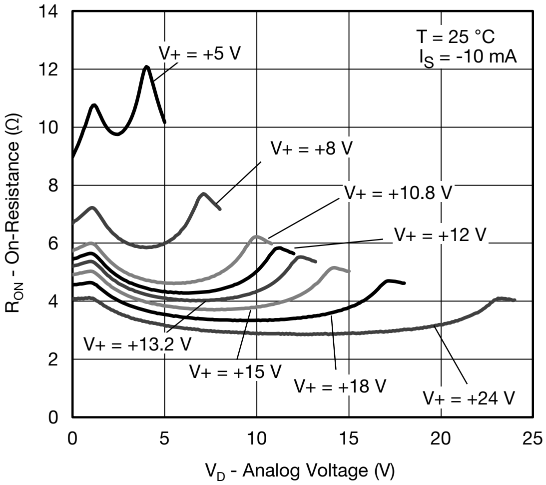
On-Resistance vs. Analog Voltage



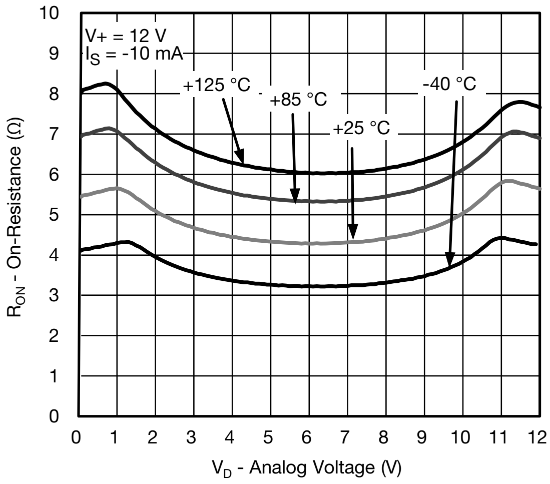
On-Resistance vs. Analog Voltage



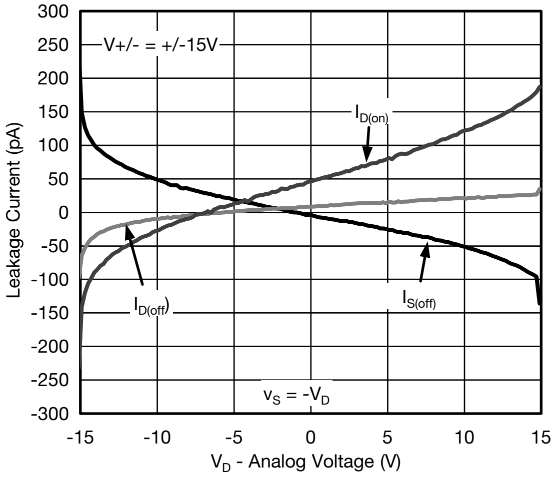
On-Resistance vs. Analog Voltage



On-Resistance vs. Analog Voltage

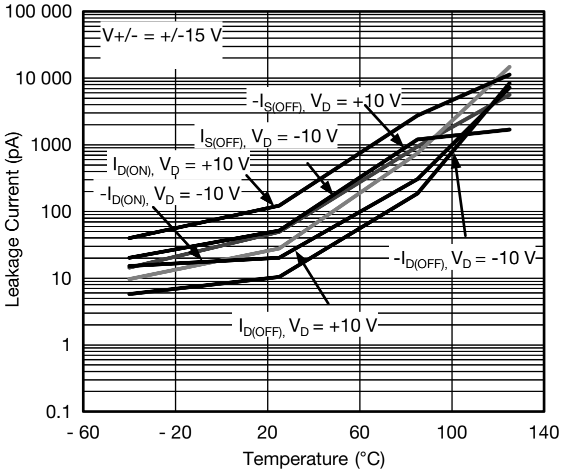


On-Resistance vs. Analog Voltage

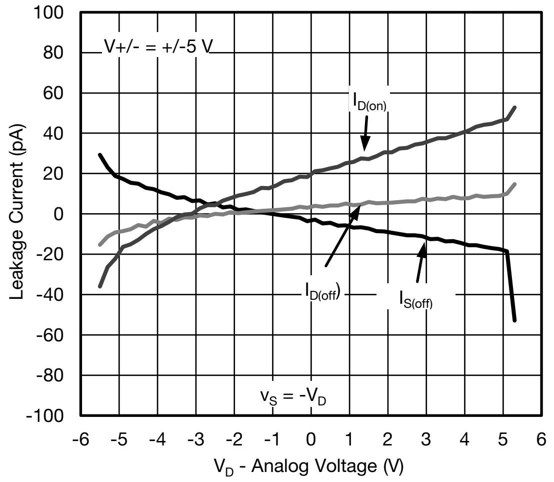


Leakage Current vs. Analog Voltage

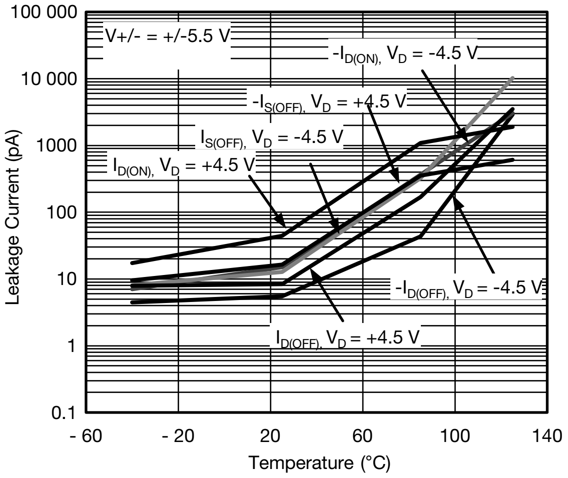
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



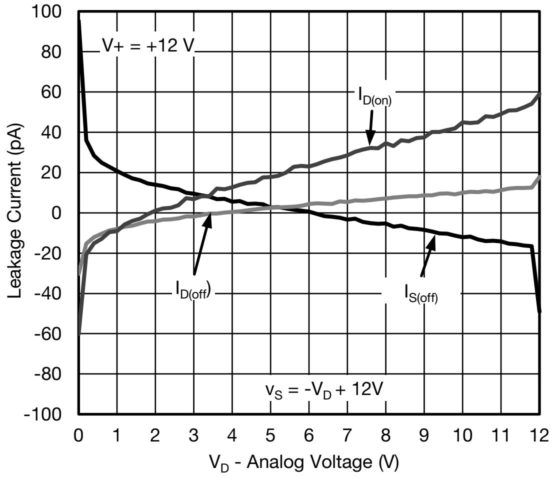
Leakage Current vs. Temperature



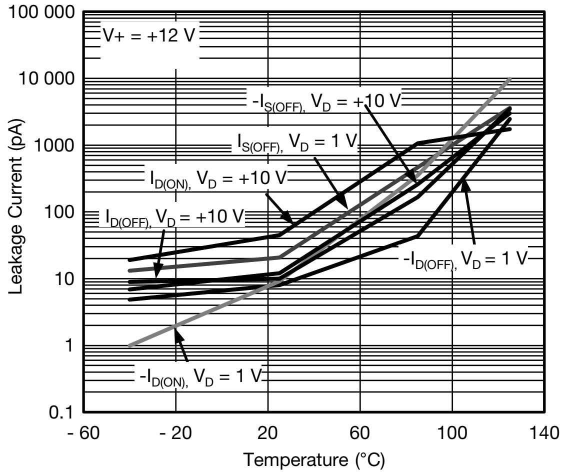
Leakage Current vs. Temperature



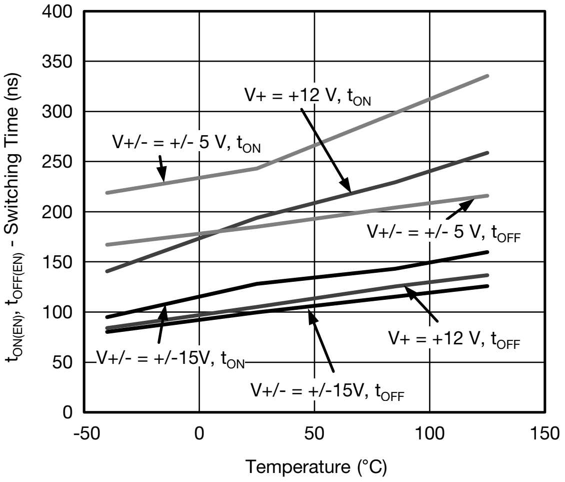
Leakage Current vs. Temperature



Leakage Current vs. Analog Voltage

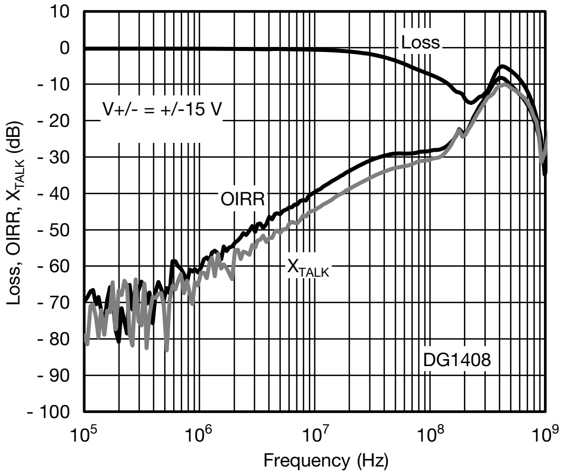


Leakage Current vs. Analog Voltage

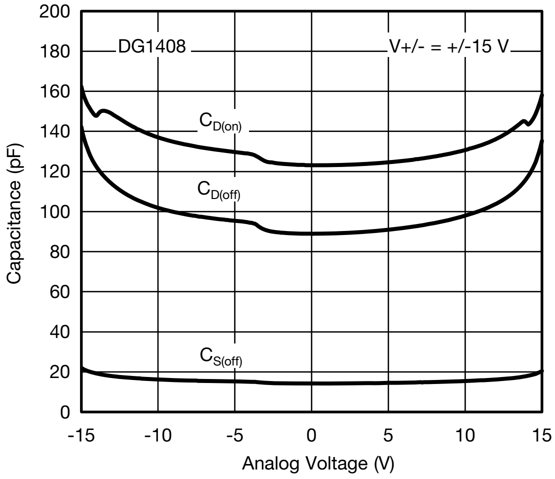


Switching Time vs. Temperature

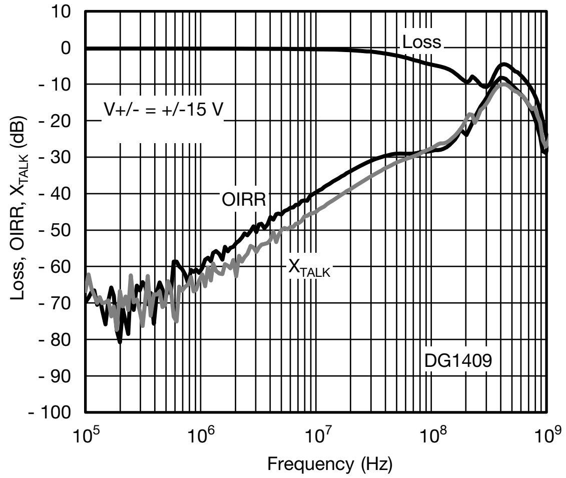
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



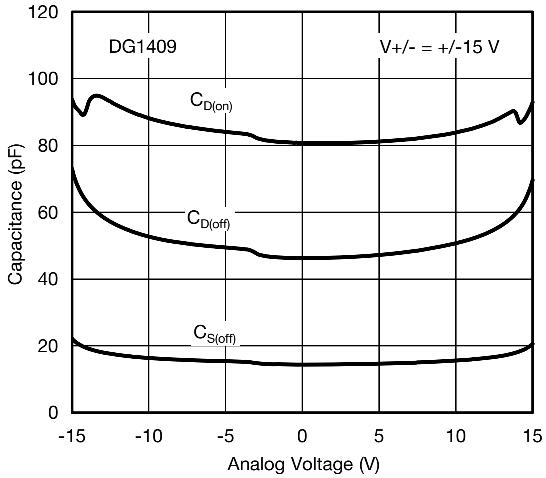
Loss, OIRR, X_{TALK} vs. Frequency



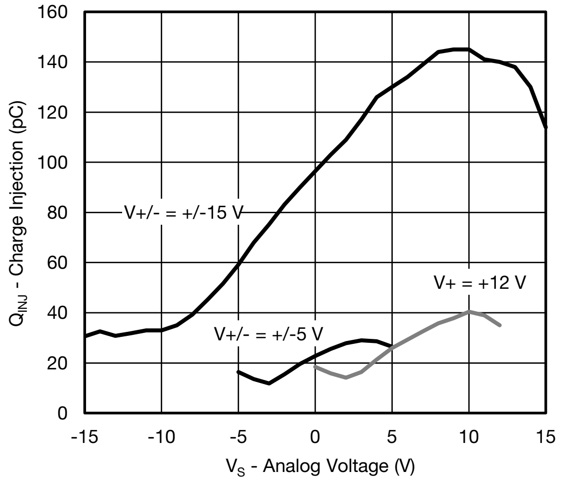
Capacitance vs. Analog Voltage



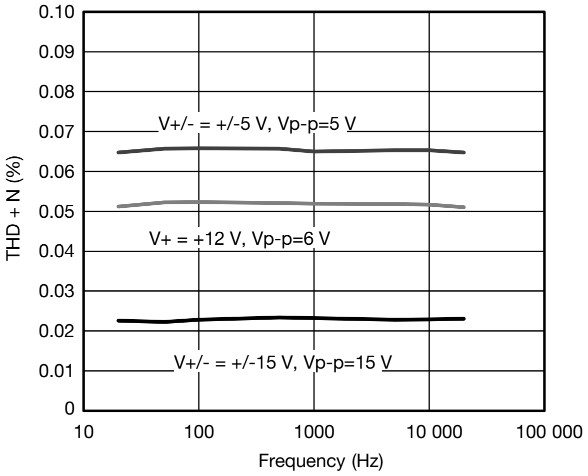
Loss, OIRR, X_{TALK} vs. Frequency



Capacitance vs. Analog Voltage

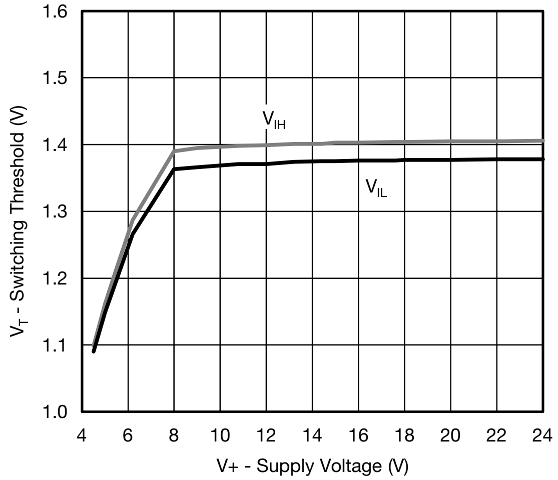


Charge Injection vs. Source Voltage

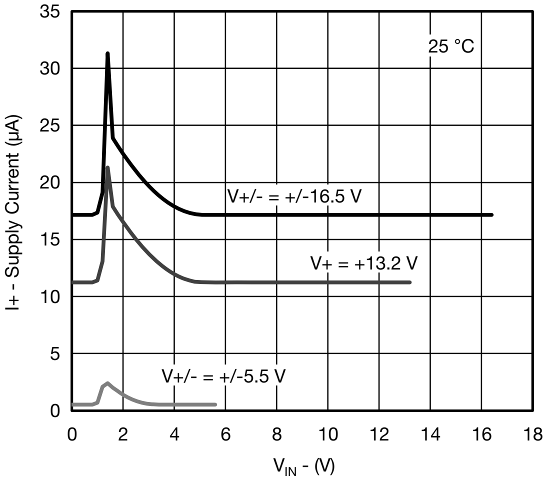


THD vs. Frequency

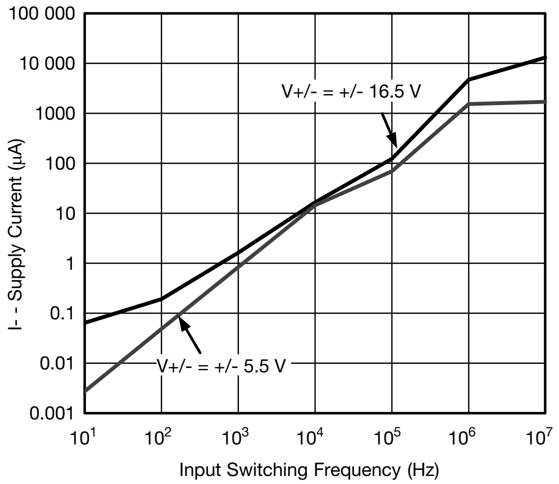
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



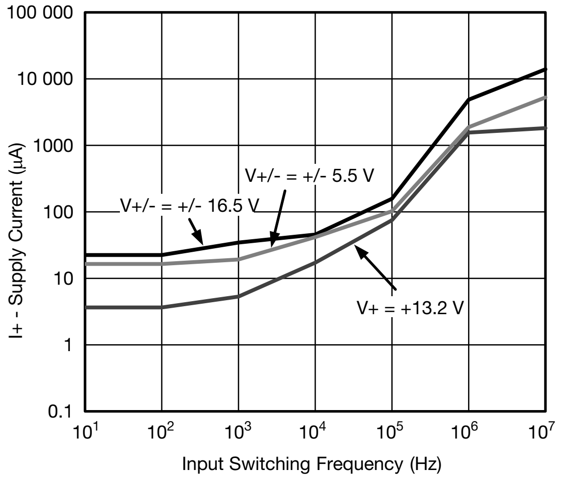
Switching Threshold vs. Supply Voltage



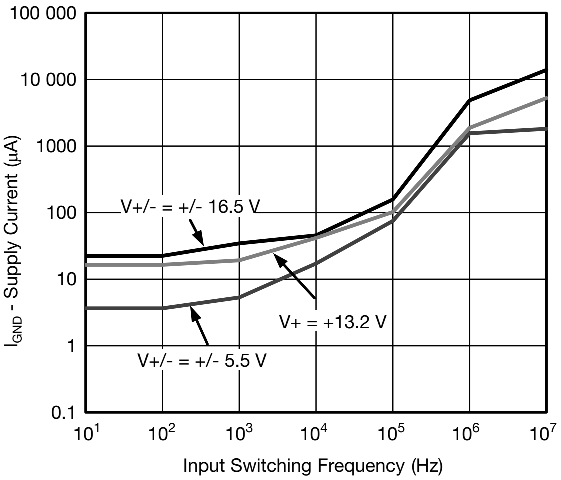
Positive Supply Current vs. Switching Frequency



Negative Supply Current vs. Switching Frequency



Positive Supply Current vs. Input Logic Voltage



Ground Current vs. Switching Frequency

TEST CIRCUITS

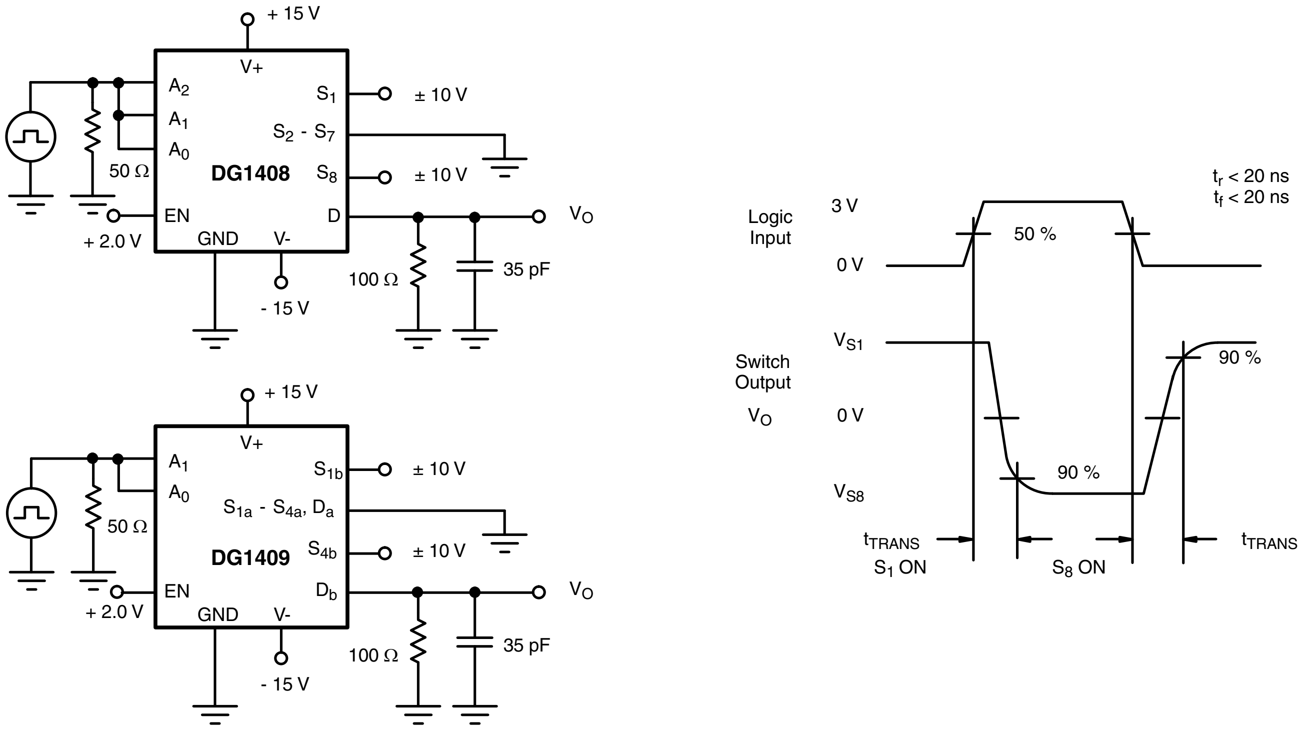


Fig. 1 - Transition Time

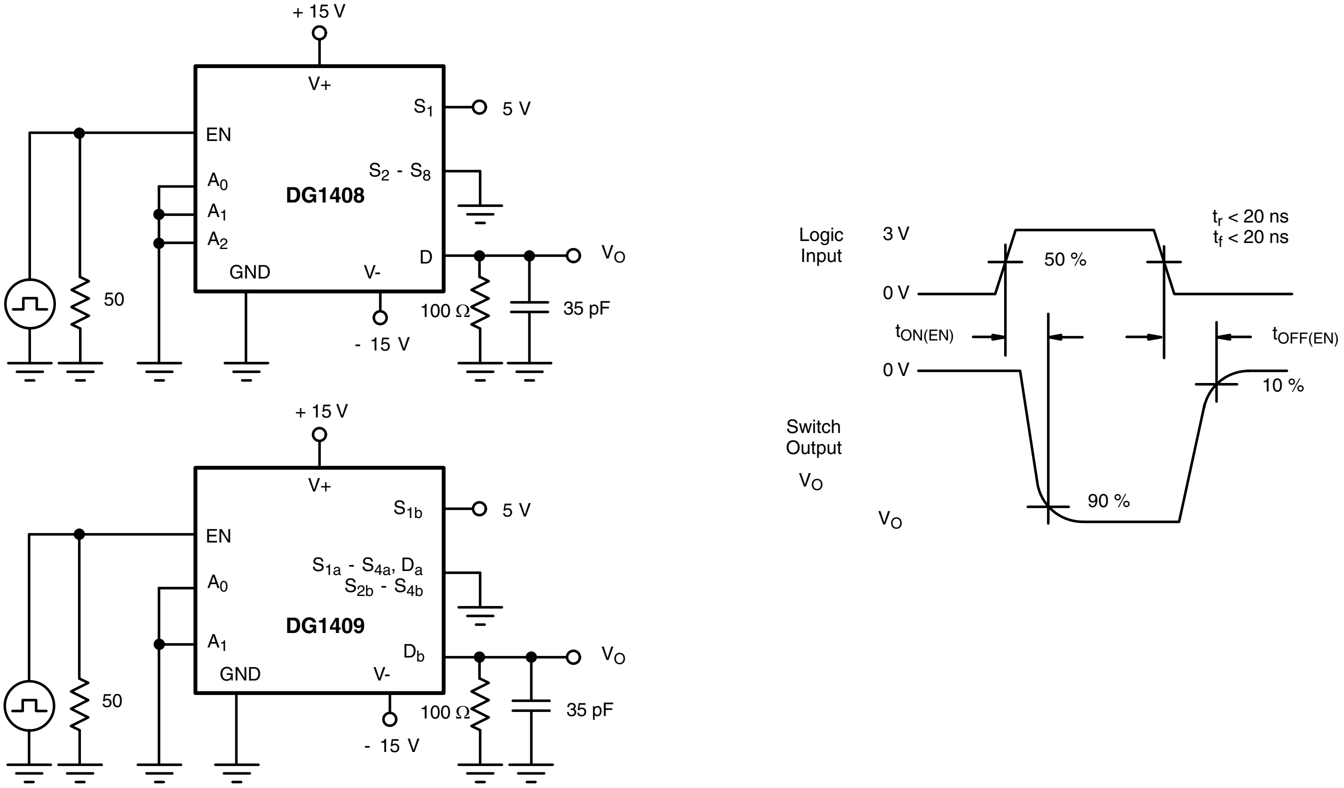


Fig. 2 - Enable Switching Time

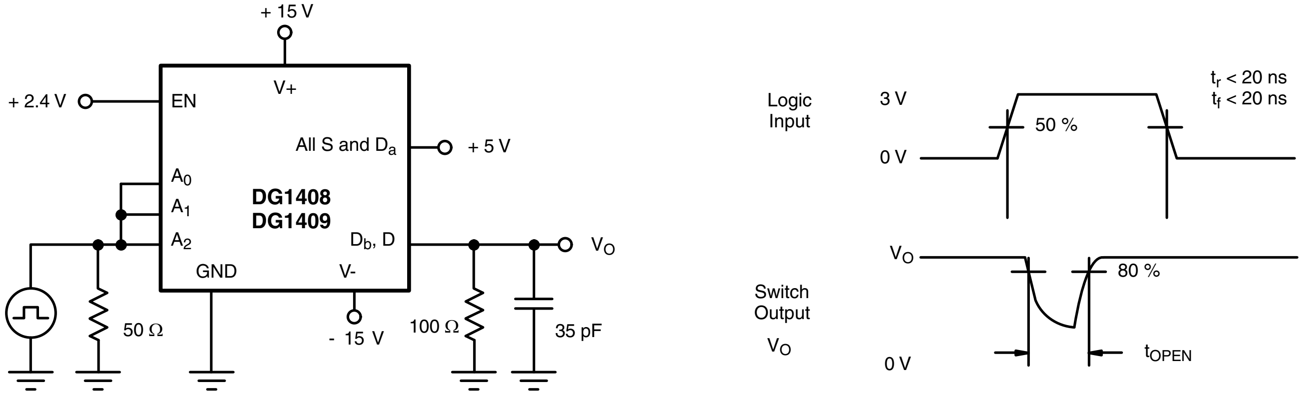
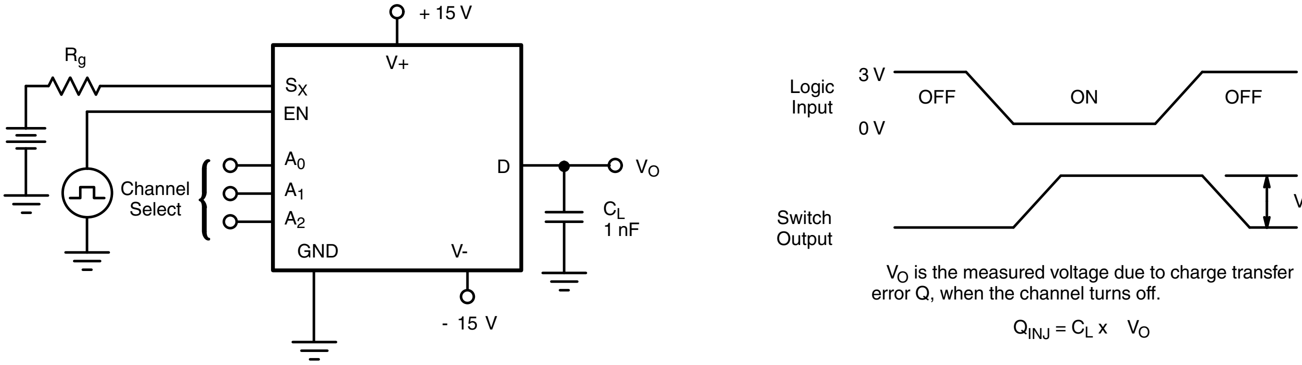


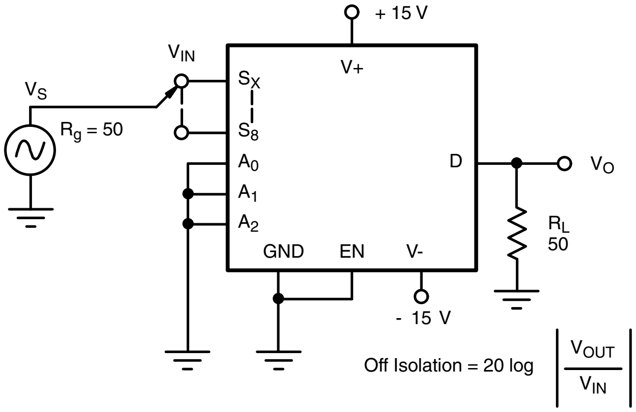
Fig. 3 - Break-Before-Make Internal



V_O is the measured voltage due to charge transfer error Q, when the channel turns off.

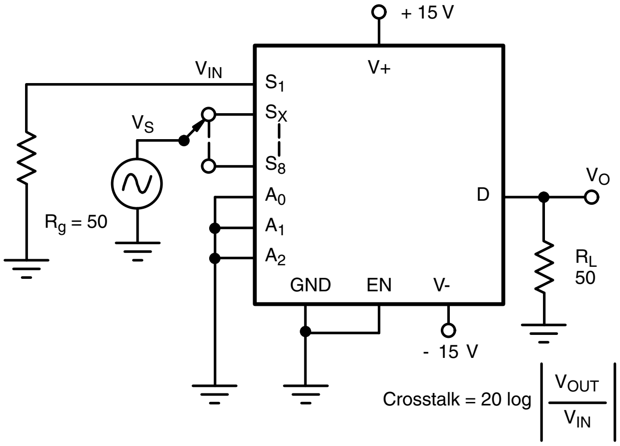
$Q_{INJ} = C_L \times V_O$

Fig. 4 - Charge Injection



$$\text{Off Isolation} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

Fig. 5 - Off-Isolation



$$\text{Crosstalk} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

Fig. 6 - Crosstalk

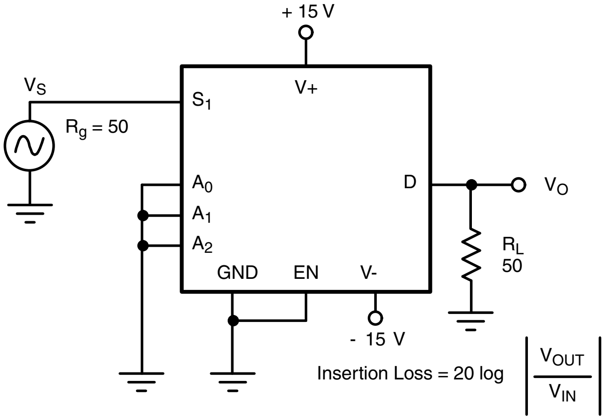


Fig. 7 - Insertion Loss

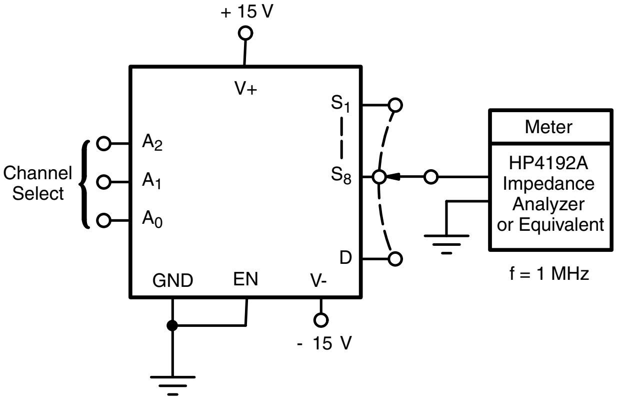
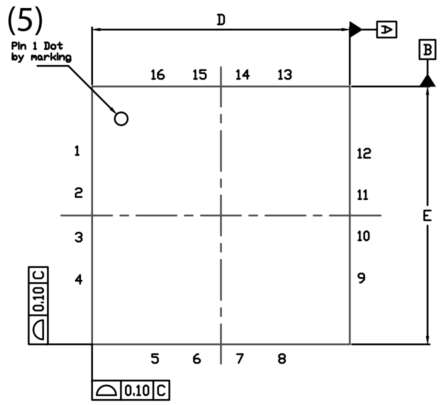
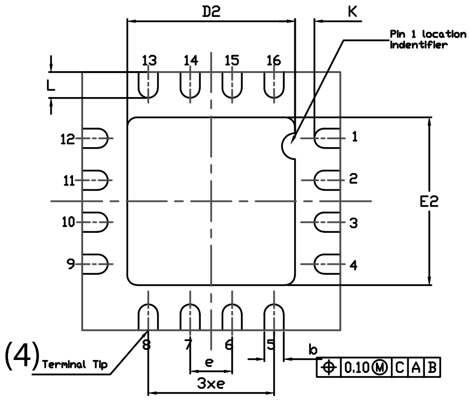


Fig. 8 - Source Drain Capacitance

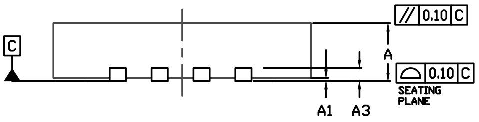
QFN 4x4-16L Case Outline



TOP VIEW



BOTTOM VIEW



SIDE VIEW

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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DWG: 5890

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