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

DESCRIPTION

The DG1408E is a precision analog multiplexer comprising eight single-ended channels. The DG1409E is a dual four single-ended channels analog multiplexer. Built on a new CMOS process, the Vishay Siliconix DG1408E and DG1409E offer low on-resistance of 3.9 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 DG1408E and DG1409E 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 DG1408E connects one of eight inputs to a common output as determined by a 3-bit binary address (A0, A1, A2). The DG1409E 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 DG1408E and DG1409E 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.

DG1408E and DG1409E are available in RoHS-compliant, halogen-free QFN16, 4 mm x 4 mm package.

FEATURES

Pb-free

RoHS COMPLIANT

HALOGEN FREE

- 35 V supply max. rating
- 3.9 Ω typical and 4.2 Ω max. on-resistance at 25 °C
- 0.59 Ω on-resistance flatness
- Channel to channel on-resistance match: 0.27 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:
  DG1408E, $C_{S(off)}$ = 13 pF, $C_{D(on)}$ = 104 pF
  DG1409E, $C_{S(off)}$ = 13 pF, $C_{D(on)}$ = 70 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

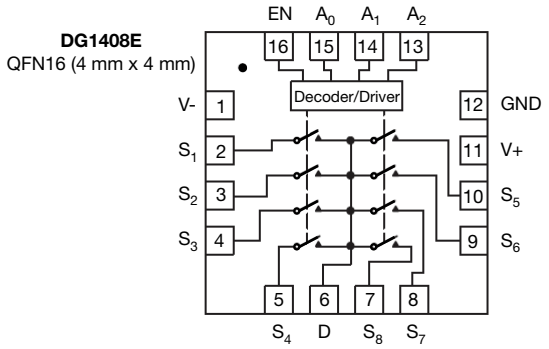
BENEFITS

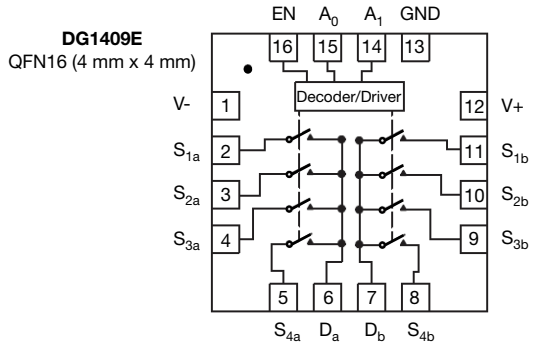
- Low insertion loss
- Low distortion
- Low power consumption
- Compact solution
- Low charge injection over the full signal range

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 - DG1408E				
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 - DG1409E			
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**
DG1408E	8:1 MUX	-40 °C to +125 °C	QFN (4 mm x 4 mm) 16L (variation 2)	DG1408EEN-T1-GE4
DG1409E	Dual 4:1 MUX			DG1409EEN-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
ESD human body model (HBM); per ANSI / ESDA / JEDEC® JS-001		6000	V
Latch up current, per JESD78D		200	mA
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		3.9	-	-	Typ.	Ω
				4.2	5.1	6.1	Max.	
On-resistance flatness	$R_{flat(on)}$			0.59	-	-	Typ.	
				0.7	0.9	1.1	Max.	
On-resistance matching	$\Delta R_{DS(on)}$			0.27	-	-	Typ.	
				0.4	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		± 0.027	-	-	Typ.	nA
				± 0.55	± 1	± 10	Max.	
Drain off leakage current	$I_{D(off)}$			± 0.018	-	-	Typ.	
				± 0.45	± 2	± 20	Max.	
Drain on leakage current	$I_{D(on)}$	V+ = +16.5 V, V- = -16.5 V, V_S = V_D = ± 10 V		± 0.05	-	-	Typ.	
				± 1.5	± 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+		0.016	-	-	Typ.	µA
				-	-	± 0.1	Max.	
Digital input capacitance	C_{IN}			3.1	-	-	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		133	-	-	Typ.	ns
				180	214	245	Max.	
Break-before-make time	t_{OPEN}	V_{S1}= V_{S8} = 10 V, R_L= 100 Ω, C_L = 35 pF		29	-	-	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		100	-	-	Typ.	
				130	160	185	Max.	
Enable turn-off time	t_{OFF}(EN)			75	-	-	Typ.	
				105	120	140	Max.	
Charge injection	Q_{INJ}	C_{INJ} = 1 nF, R_{GEN} = 0 Ω, V_S = 0 V	DG1408E	-31	-	-	Typ.	pC
			DG1409E	-103	-	-		
Off isolation	OIRR	C_L = 5 pF, R_L = 50 Ω, 1 MHz		-58	-	-	Typ.	dB
Cross talk	X_{TALK}			-64	-	-		
Total harmonic distortion + N	THD + N	R_L = 100 Ω, 15 V_{p-p}, f = 20 Hz to 20 kHz		0.025	-	-	Typ.	%
-3dB, bandwidth	BW	R_L = 50 Ω	DG1408E	55	-	-	Typ.	MHz
			DG1409E	90	-	-		
Source off capacitance	$C_{S(off)}$	f = 1 MHz, V_S = 0 V		13	-	-	Typ.	pF
Drain off capacitance	$C_{D(off)}$		DG1408E	85	-	-	Typ.	
			DG1409E	43	-	-		
Drain on capacitance	$C_{D(on)}$		DG1408E	104	-	-	Typ.	
			DG1409E	70	-	-		
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, 5 V, V+, V+ = +16.5 V, V- = -16.5 V		3.4	3.8	4	Typ.	µA
				-	-	10	Max.	
Negative supply current	I-	V_{AX}, V_{EN} = 0 V, V+, V+ = +16.5 V, V- = -16.5 V		0.0002	0.0085	0.33	Typ.	
				-	-	1	Max.	

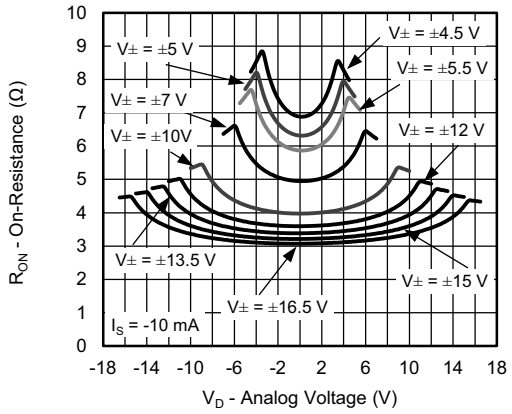
ELECTRICAL CHARACTERISTICS

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		7.5	-	-	Typ.	Ω
				8	10	12	Max.	
On-resistance flatness	$R_{flat(on)}$			2	-	-	Typ.	
				2.2	2.5	3	Max.	
On-resistance matching	$\Delta R_{DS(on)}$			0.3	-	-	Typ.	
				0.5	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		± 0.01	-	-	Typ.	nA
				± 0.55	± 1	± 8	Max.	
Drain off leakage current	$I_{D(off)}$			± 0.01	-	-	Typ.	
				± 0.3	± 2	± 20	Max.	
Drain on leakage current	$I_{D(on)}$	V+ = +13.2 V, V- = 0 V, V_S = V_D = 1 V / 10 V		± 0.01	-	-	Typ.	
				± 1.5	± 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+		0.018	-	-	Typ.	µA
				-	-	± 0.1	Max.	
Digital input capacitance	C_{IN}			3.1	-	-	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		134	-	-	Typ.	ns
				190	235	280	Max.	
Break-before-make time	t_{OPEN}	V_{S1}= V_{S8} = 8 V, R_L= 100 Ω, C_L = 35 pF		64	-	-	Typ.	
				-	-	14	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		117	-	-	Typ.	
				151	180	215	Max.	
Enable turn-off time	$t_{OFF(EN)}$			79	-	-	Typ.	
				105	125	145	Max.	
Charge injection	Q_{INj}	C_{INJ} = 1 nF, R_{GEN} = 0 Ω, V_S = 6 V	DG1408E	5	-	-	Typ.	pC
			DG1409E	-22	-	-		
Off isolation	OIRR	C_L = 5 pF, R_L = 50 Ω, 1 MHz		-58	-	-	Typ.	dB
Cross talk	X_{TALK}			-64	-	-		
Total harmonic distortion + N	THD + N	R_L = 100 Ω, 6 V_{p-p}, f = 20 Hz to 20 kHz		0.055	-	-	Typ.	%
-3dB, bandwidth	BW	R_L = 50 Ω	DG1408E	50	-	-	Typ.	MHz
			DG1409E	78	-	-		
Source off capacitance	$C_{S(off)}$	f = 1 MHz, V_S = 6 V		16	-	-	Typ.	pF
Drain off capacitance	$C_{D(off)}$		DG1408E	100	-	-	Typ.	
			DG1409E	53	-	-		
Drain on capacitance	$C_{D(on)}$		DG1408E	122	-	-	Typ.	
			DG1409E	81	-	-		
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		2.8	4.8	5.5	Typ.	µA
				-	-	8	Max.	
		V_{AX}, V_{EN} = 5 V, V+ = 13.2 V, V- = 0 V		2.8	3.1	3.6	Typ.	
				-	-	8	Max.	

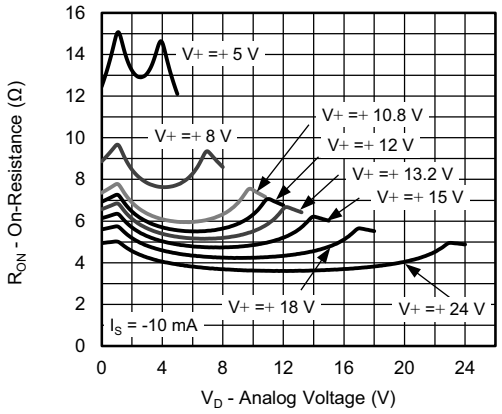
ELECTRICAL CHARACTERISTICS

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		8.8	-	-	Typ.	Ω
				10	12	14	Max.	
On-resistance flatness	$R_{flat(on)}$			2	-	-	Typ.	
				2.5	3	3.2	Max.	
On-resistance matching	$\Delta R_{DS(on)}$			0.36	-	-	Typ.	
				0.55	1	1.5	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		± 0.04	-	-	Typ.	nA
				± 0.55	± 1	± 10	Max.	
Drain off leakage current	$I_{D(off)}$			± 0.04	-	-	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.	
				± 1.5	± 4	± 30	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+		0.017	-	-	Typ.	µA
				-	-	± 0.1	Max.	
Digital input capacitance	C_{IN}			3.1	-	-	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		160	-	-	Typ.	ns
				210	260	280	Max.	
Break-before-make time	t_{OPEN}	V_{S1}= V_{S8} = 3 V, R_L= 100 Ω, C_L = 35 pF		73	-	-	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		120	-	-	Typ.	
				160	200	230	Max.	
Enable turn-off time	$t_{OFF(EN)}$			86	-	-	Typ.	
				110	132	155	Max.	
Charge injection	Q_{INJ}	C_{INJ} = 1 nF, R_{GEN} = 0 Ω, V_S = 0 V	DG1408E	7	-	-	Typ.	pC
			DG1409E	-15	-	-		
Off isolation	OIRR	C_L = 5 pF, R_L = 50 Ω, 1 MHz		-58	-	-	Typ.	dB
Cross talk	X_{TALK}			-64	-	-		
Total harmonic distortion + N	THD + N	R_L = 100 Ω, 5 V_{p-p}, f = 20 Hz to 20 kHz		0.07	-	-	Typ.	%
-3dB, bandwidth	BW	R_L = 50 Ω	DG1408E	46	-	-	Typ.	MHz
			DG1409E	78	-	-		
Source off capacitance	$C_{S(off)}$	f = 1 MHz, V_S = 0 V		17	-	-	Typ.	pF
Drain off capacitance	$C_{D(off)}$		DG1408E	109	-	-	Typ.	
			DG1409E	55	-	-		
Drain on capacitance	$C_{D(on)}$		DG1408E	126	-	-	Typ.	
			DG1409E	83	-	-		
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, 3 V, V+, V+ = +5.5 V, V- = -5.5 V		1.7	2.2	2.4	Typ.	µA
				-	-	5	Max.	
Negative supply current	I-	V_{AX}, V_{EN} = 0 V, V+, V+ = +5.5 V, V- = -5.5 V		0.08	0.12	0.14	Typ.	
				-	-	1	Max.	

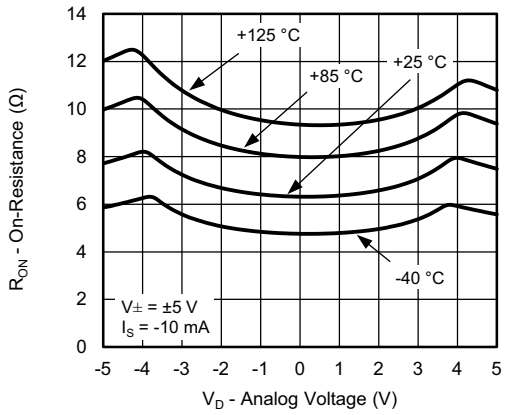
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



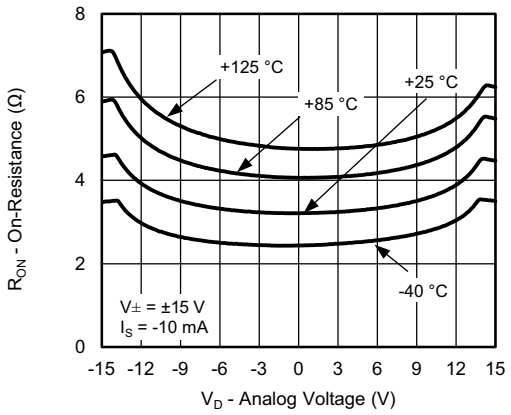
On-Resistance vs. Analog Voltage



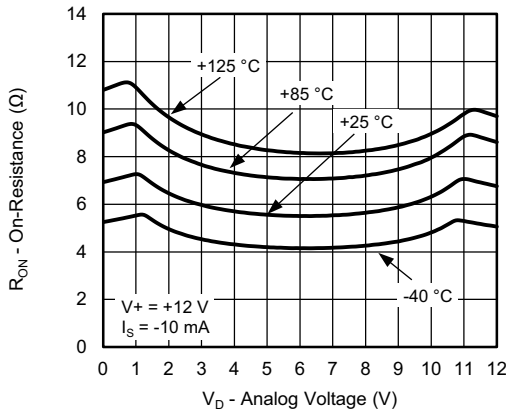
On-Resistance vs. Analog Voltage



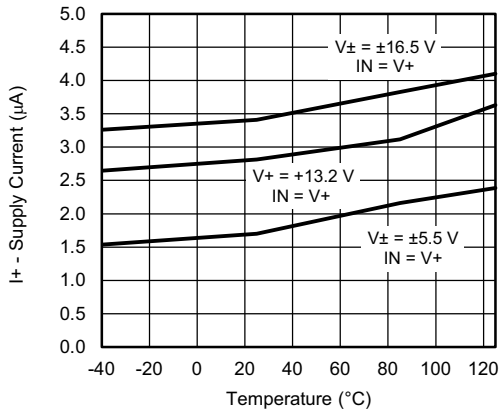
On-Resistance vs. Analog Voltage



On-Resistance vs. Analog Voltage

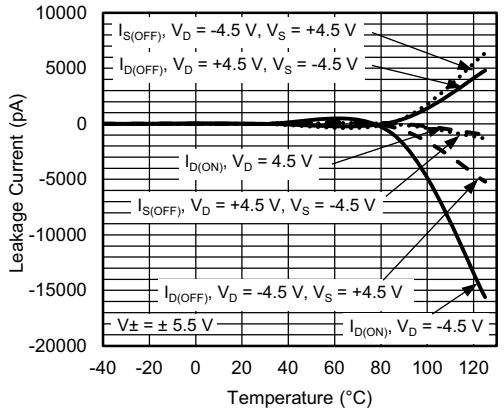


On-Resistance vs. Analog Voltage

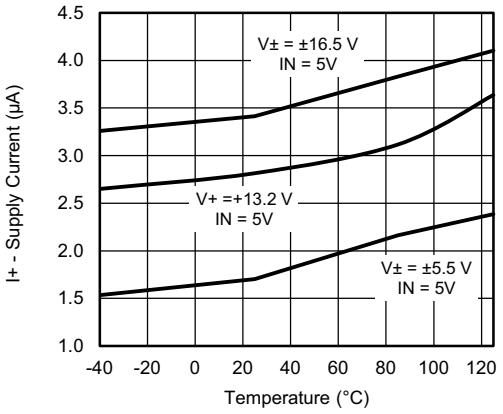


Supply Current vs. Temperature

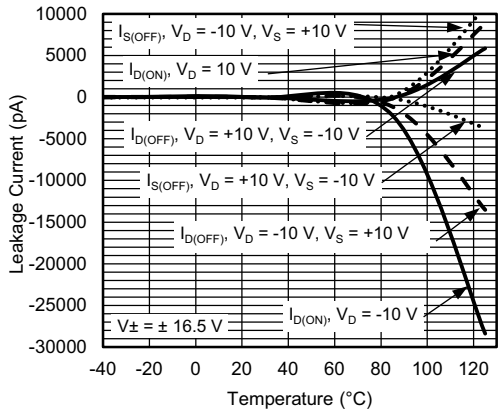
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



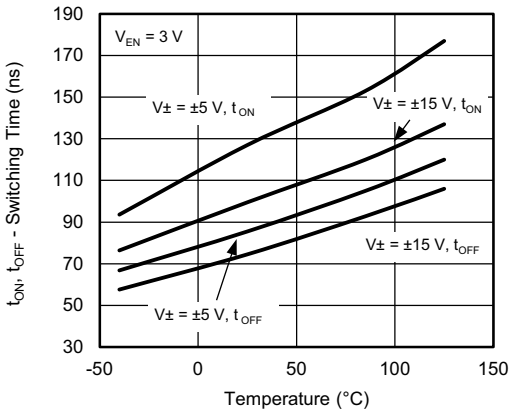
Leakage Current vs. Temperature



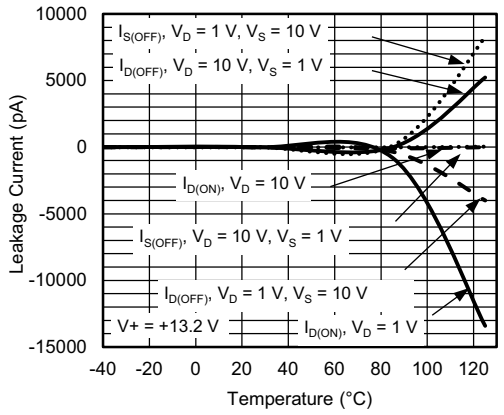
Supply Current vs. Temperature



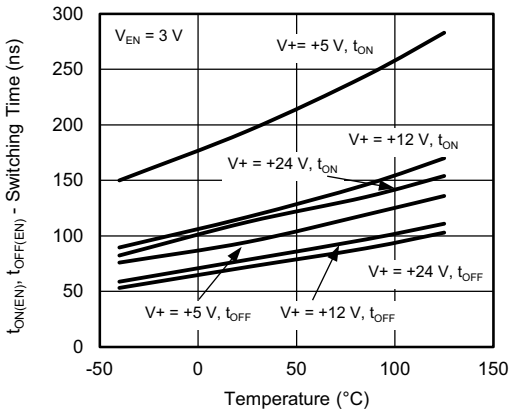
Leakage Current vs. Temperature



Switching Time vs. Temperature

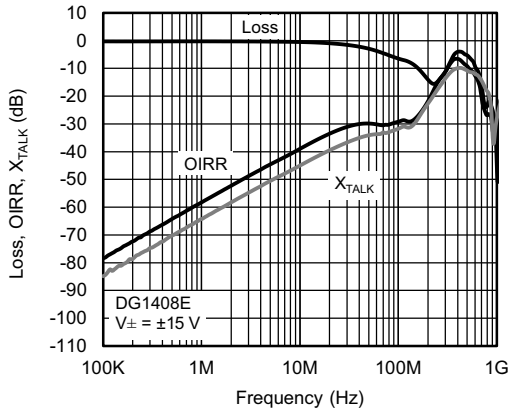


Leakage Current vs. Temperature

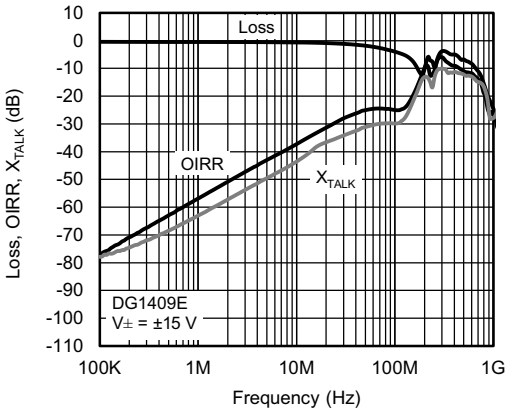


Switching Time vs. Temperature

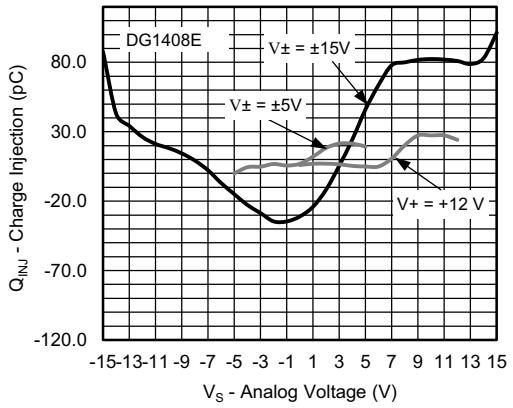
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



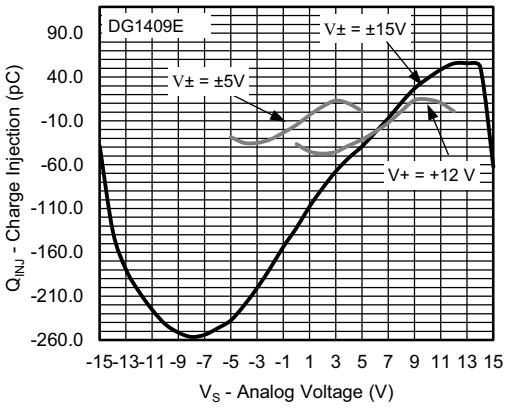
Loss, OIRR, X_{TALK} vs. Frequency



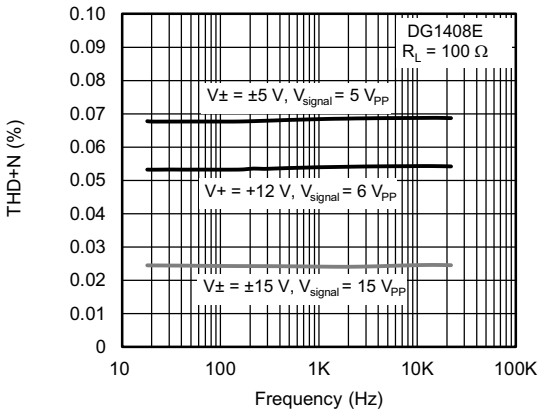
Loss, OIRR, X_{TALK} vs. Frequency



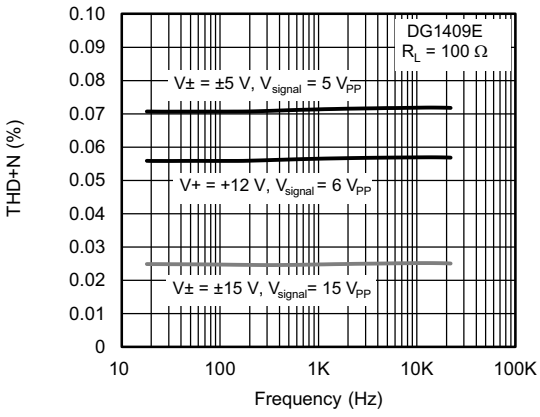
Charge Injection vs. Source Voltage



Charge Injection vs. Source Voltage

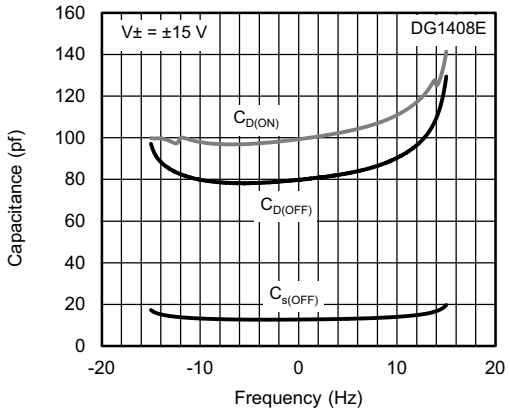


THD + N vs. Frequency

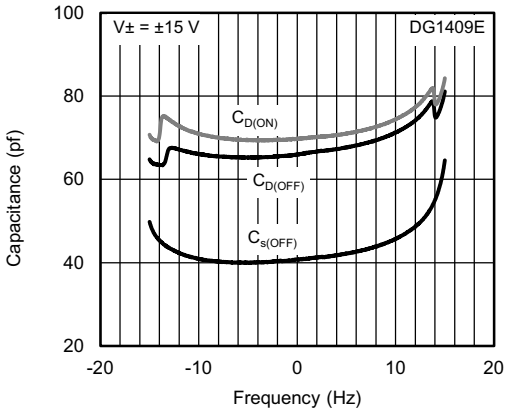


THD + N vs. Frequency

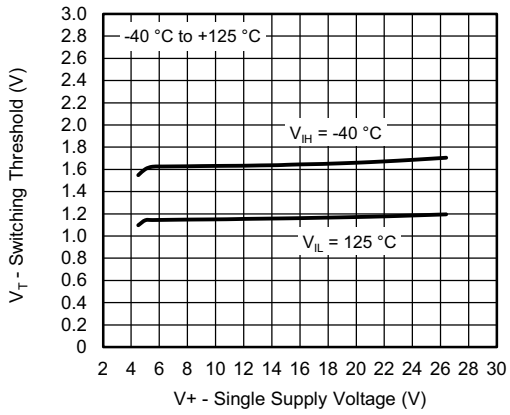
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



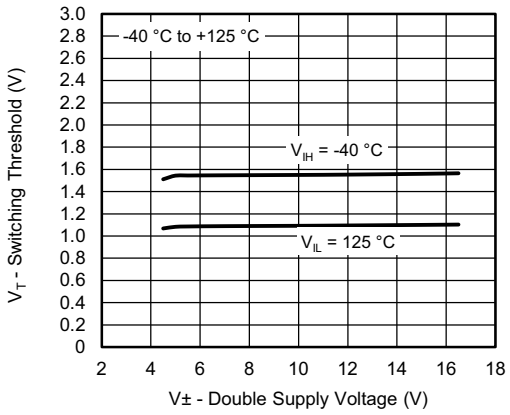
Capacitance vs. Analog Voltage



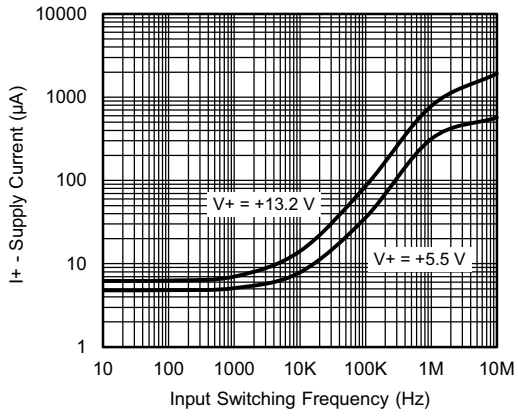
Capacitance vs. Analog Voltage



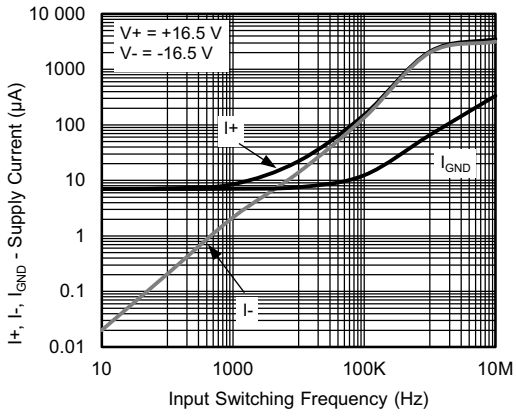
Switching Threshold vs. Supply Voltage



Switching Threshold vs. Supply Voltage



Positive Supply Current vs. Switching Frequency



Double Supply Current vs. Switching Frequency

TEST CIRCUITS

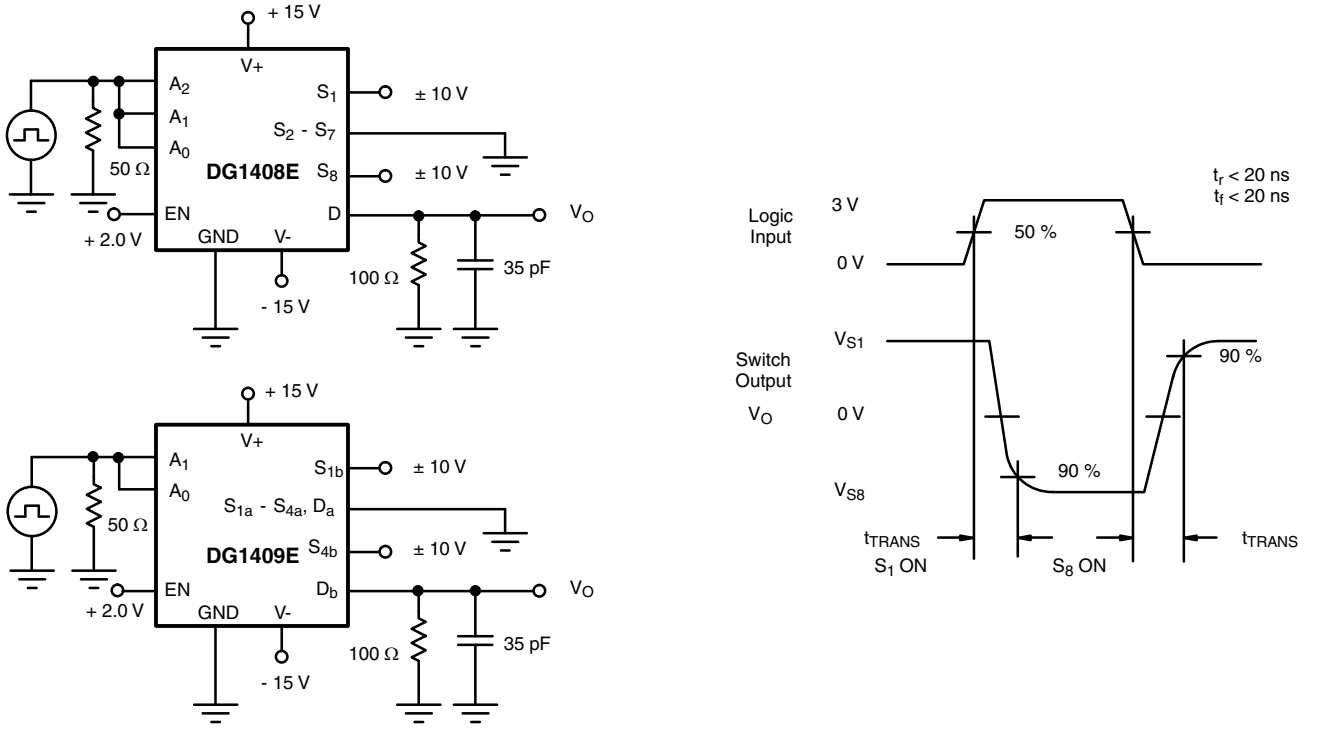


Fig. 1 - Transition Time

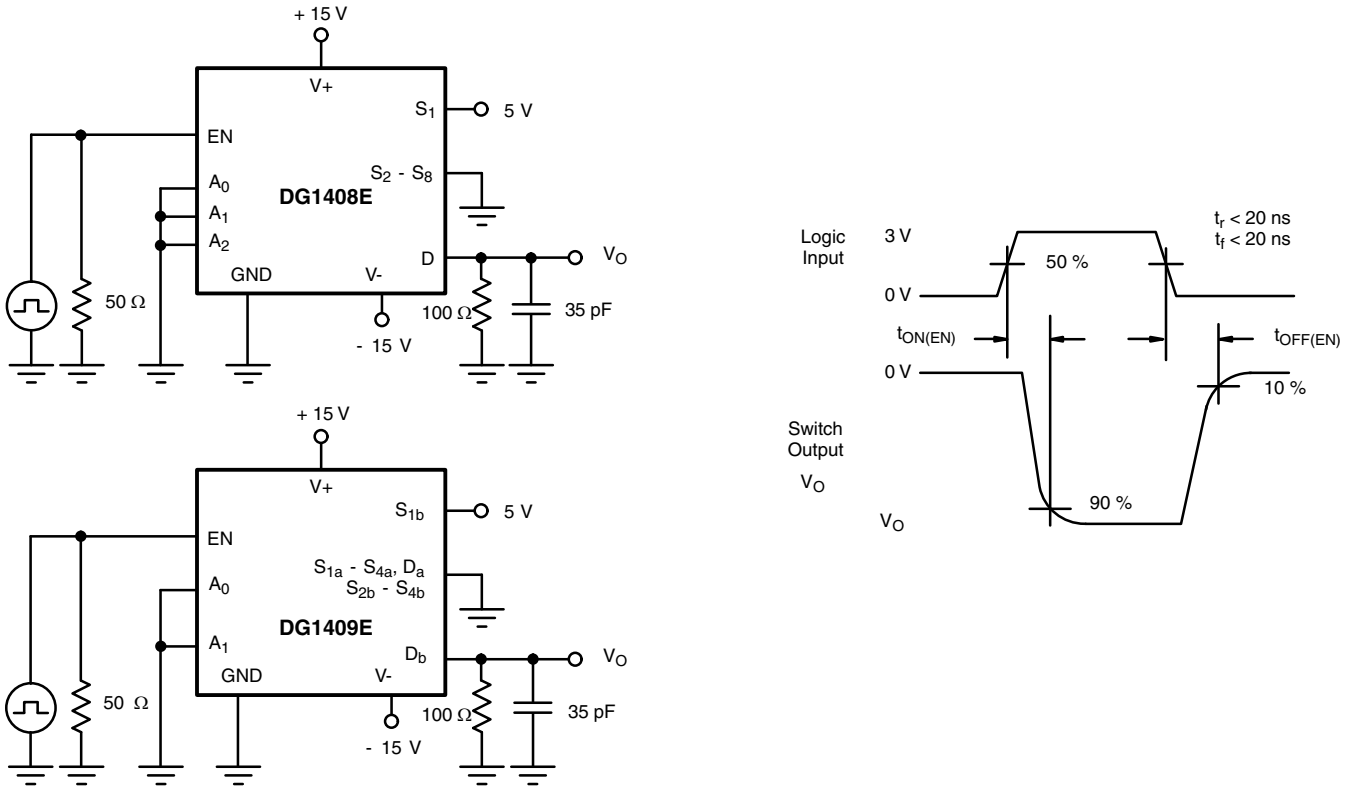


Fig. 2 - Enable Switching Time

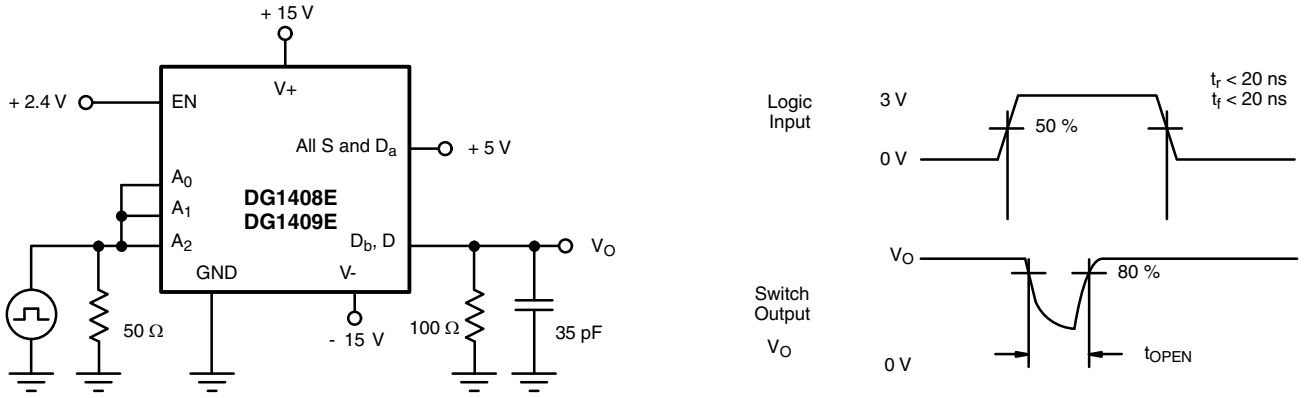


Fig. 3 - Break-Before-Make Internal

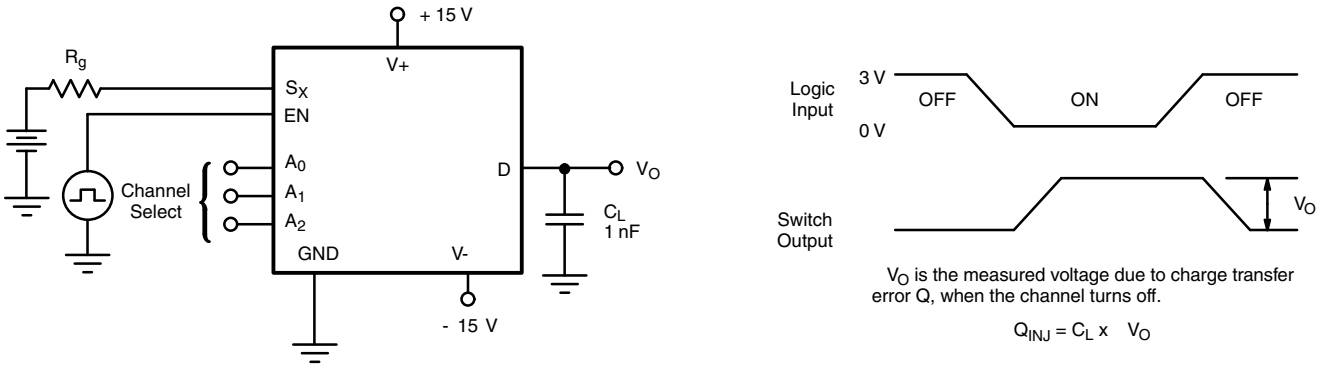


Fig. 4 - Charge Injection

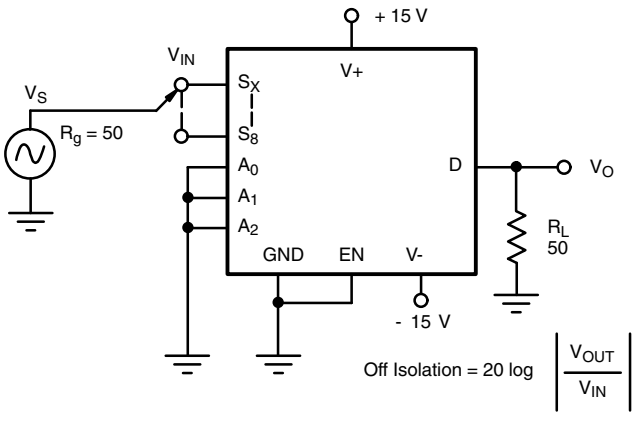


Fig. 5 - Off-Isolation

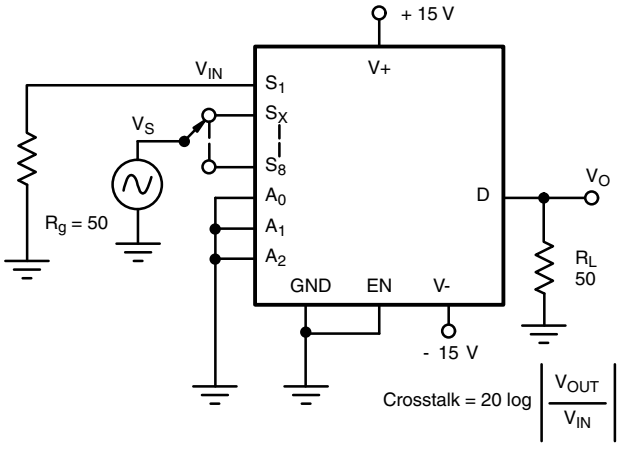


Fig. 6 - Crosstalk

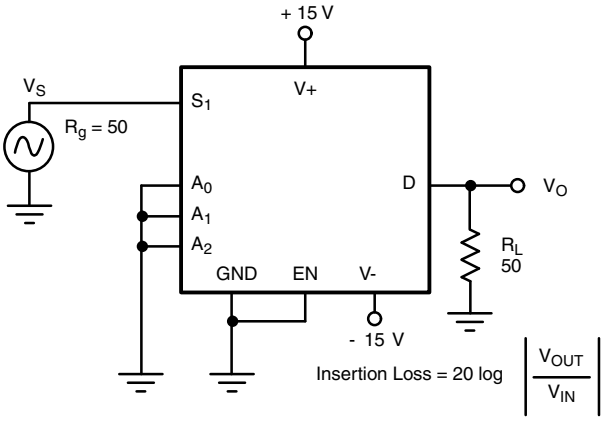


Fig. 7 - Insertion Loss

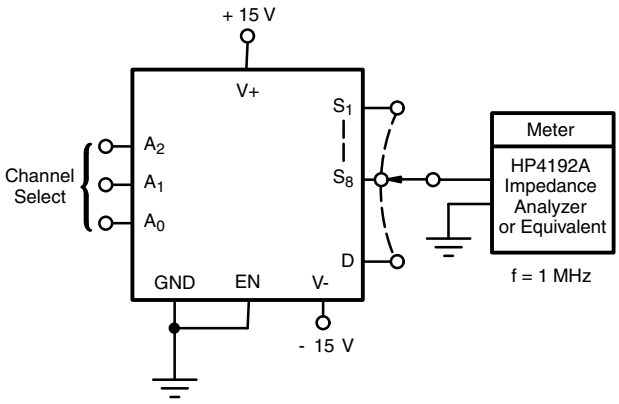


Fig. 8 - Source Drain Capacitance

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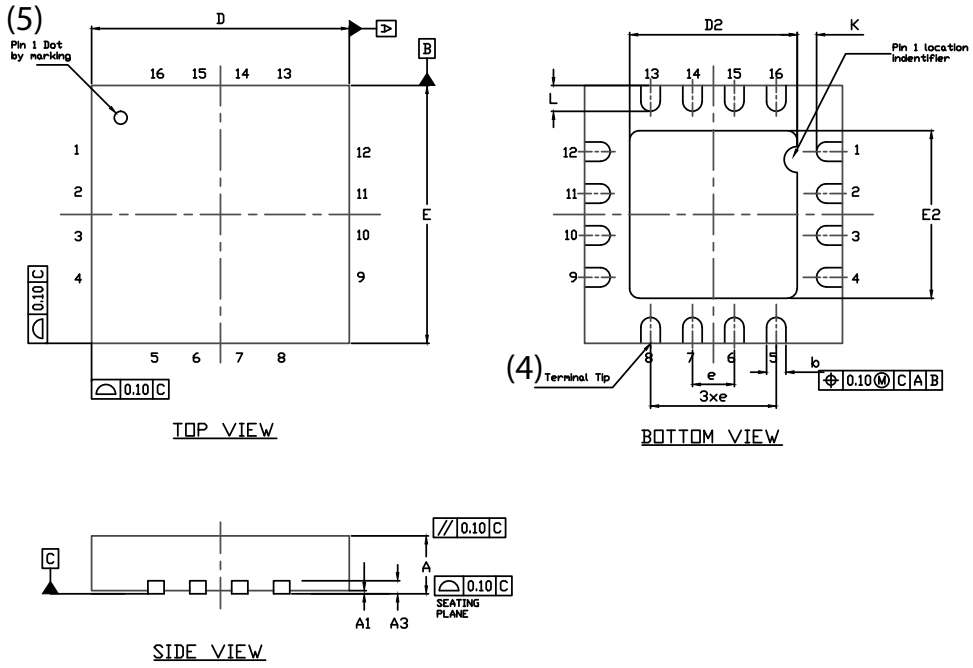
QFN 4x4-16L Case Outline



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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DWG: 5890

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