

## 8-Ch/Dual 4-Ch High-Performance CMOS Analog Multiplexers

### DESCRIPTION

The DG408 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 DG409 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 protects against momentary crosstalk between adjacent channels.

An on channel conducts current 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. All control inputs, address ( $A_x$ ) and enable (EN) are TTL compatible over the full specified operating temperature range.

Applications for the DG408, DG409 include high speed data acquisition, audio signal switching and routing, ATE systems, and avionics. High performance and low power dissipation make them ideal for battery operated and remote instrumentation applications.

Designed in the 44 V silicon-gate CMOS process, the absolute maximum voltage rating is extended to 44 V. Additionally, single supply operation is also allowed. An epitaxial layer prevents latchup.

For additional information please see Technical Article TA201.

### FEATURES

- Low on-resistance -  $R_{DS(on)}$ : 100  $\Omega$
- Low charge injection - Q: 20 pC
- Fast transition time -  $t_{TRANS}$ : 160 ns
- Low power -  $I_{SUPPLY}$ : 10  $\mu A$
- Single supply capability
- 44 V supply max. rating
- TTL compatible logic

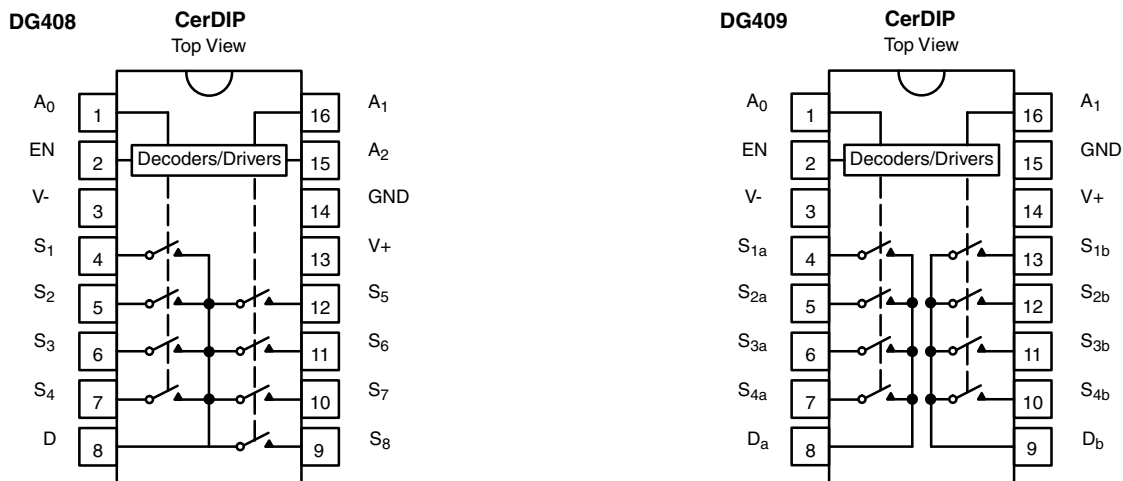
### BENEFITS

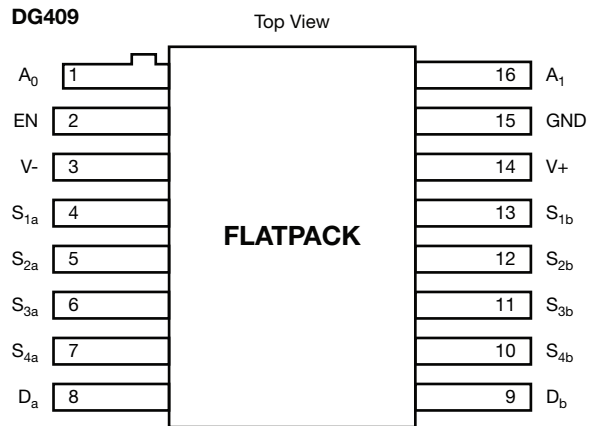
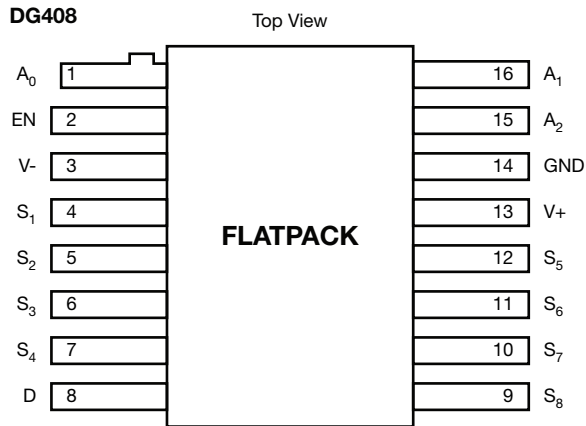
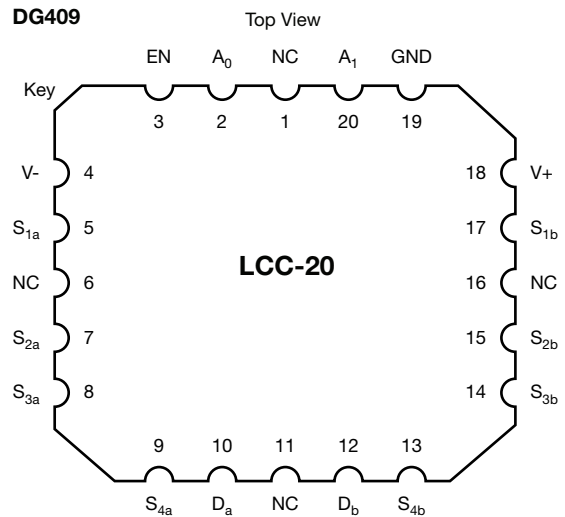
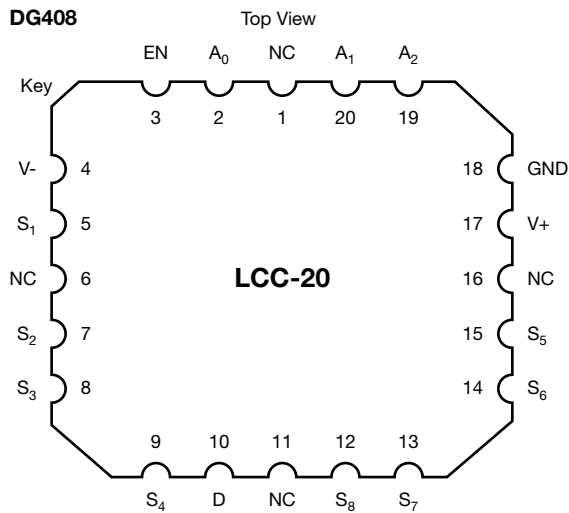
- Reduced switching errors
- Reduced glitching
- Improved data throughput
- Reduced power consumption
- Increased ruggedness
- Wide supply ranges ( $\pm 5$  V to  $\pm 20$  V)

### APPLICATIONS

- Data acquisition systems
- Audio signal routing
- ATE systems
- Battery powered systems
- High rel systems
- Single supply systems
- Medical instrumentation

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION





TRUTH TABLE (DG408)				
A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	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 (DG409)			
A <sub>1</sub>	A <sub>0</sub>	EN	ON SWITCH
X	X	0	None
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

**Notes**

- Logic "0" =  $V_{AL} \leq 0.8\text{ V}$
- Logic "1" =  $V_{AH} \geq 2.4\text{ V}$
- X = Do not care



ORDERING INFORMATION (Hi-Rel)						
PART	CONFIGURATION	TEMP. RANGE	PACKAGE	ORDERING PART	GENERIC	DSCC NUMBER
DG408	8:1 x 1	- 55 °C to 125 °C	16-pin CerDIP	DG408AK	DG408AK	-
				DG408AK-E3	DG408AK-E3	-
				9204201EA	DG408AK/883	5962-9204201MEA
			LCC-20	92042012A	DG408AZ/883	5962-9204201M2A
				92042012C		5962-9204201M2C
			Flat-pack 16	9204201XA	DG408AL/883	5962-9204201MXA
				9204201XC		5962-9204201MXC
			DG409	4:1 x 2	- 55 °C to 125 °C	16-pin CerDIP
DG409AK-E3	DG409AK-E3	-				
9204202EA	DG409AK/883	5962-9204202MEA				
LCC-20	92042022A	DG409AZ/883				5962-9204202M2A
	92042022C					5962-9204202M2C
Flat-pack 16	9204202XA	DG409AL/883				5962-9204202MXA
	9204202XC					5962-9204202MXC

**Note**

- Block diagram and pin configuration for Flat-pack 16 not shown.

ABSOLUTE MAXIMUM RATINGS			
PARAMETER		LIMIT	UNIT
Voltages Referenced to V-	V+	44	V
	GND	25	
Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>		(V-) - 2 to (V+) + 2 or 20 mA, whichever occurs first	
Current (any terminal)		30	mA
Peak Current, S or D (pulsed at 1 ms, 10 % duty cycle max.)		100	
Storage Temperature	(A suffix)	- 65 to 150	°C
Power Dissipation (Package) <sup>b</sup>	16-pin CerDIP <sup>c</sup>	900	mW
	LCC-20 <sup>d</sup>	750	

**Notes**

- Signals on S<sub>x</sub>, D<sub>x</sub> or IN<sub>x</sub> exceeding V<sub>+</sub> or V<sub>-</sub> will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- All leads soldered or welded to PC board.
- Derate 12 mW/°C above 75 °C.
- Derate 10 mW/°C above 75 °C.

SPECIFICATIONS <sup>a</sup>							
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED	TEMP. <sup>b</sup>	TYP. <sup>c</sup>	A SUFFIX - 55 °C to 125 °C		UNIT
		V <sub>+</sub> = 15 V, V <sub>-</sub> = - 15 V			MIN. <sup>d</sup>	MAX. <sup>d</sup>	
		V <sub>AL</sub> = 0.8 V, V <sub>AH</sub> = 2.4 V <sup>F</sup>					
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	V <sub>ANALOG</sub>		Full	-	- 15	15	V
Drain-Source On-Resistance	R <sub>DS(on)</sub>	V <sub>D</sub> = ± 10 V, I <sub>S</sub> = - 10 mA	Room	40	-	100	Ω
			Full	-	-	125	
R <sub>DS(on)</sub> Matching Between Channels <sup>g</sup>	ΔR <sub>DS(on)</sub>	V <sub>D</sub> = ± 10 V	Room	-	-	15	
Source Off Leakage Current	I <sub>S(off)</sub>	V <sub>S</sub> = ± 10 V, V <sub>D</sub> = ± 10 V, V <sub>EN</sub> = 0 V	Room	-	- 0.5	0.5	
			Full	-	- 50	50	
Drain Off Leakage Current	DG408	V <sub>D</sub> = ± 10 V, V <sub>S</sub> = ± 10 V, V <sub>EN</sub> = 0 V	Room	-	- 1	1	nA
	DG408		Full	-	- 100	100	
	DG409		Room	-	- 1	1	
	DG409		Full	-	- 50	50	
Drain On Leakage Current	DG408	V <sub>S</sub> = V <sub>D</sub> = ± 10 V sequence each switch on	Room	-	- 1	1	
	DG408		Full	-	- 100	100	
	DG409		Room	-	- 1	1	
	DG409		Full	-	- 50	50	
<b>Digital Control</b>							
Logic High Input Voltage	V <sub>INH</sub>		Full	-	2.4	-	V
Logic Low Input Voltage	V <sub>INL</sub>		Full	-	-	0.8	
Logic High Input Current	I <sub>AH</sub>	V <sub>A</sub> = 2.4 V, 15 V	Full	-	- 10	10	μA
Logic Low Input Current	I <sub>AL</sub>	V <sub>EN</sub> = 0 V, 2.4 V, V <sub>A</sub> = 0 V	Full	-	- 10	10	
Logic Input Capacitance	C <sub>in</sub>	f = 1 MHz	Room	8	-	-	pF
<b>Dynamic Characteristics</b>							
Transition Time	t <sub>TRANS</sub>	see figure 2	Full	160	-	250	ns
Break-Before-Make Interval	t <sub>OPEN</sub>	see figure 4	Room	-	10	-	
			Room	115	-	150	
Enable Turn-On Time	t <sub>ON(EN)</sub>	see figure 3	Full	-	-	225	
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		Room	105	-	150	
Charge Injection	Q	C <sub>L</sub> = 10 nF, V <sub>S</sub> = 0 V	Room	20	-	-	pC
Off Isolation <sup>h</sup>	OIRR	V <sub>EN</sub> = 0 V, R <sub>L</sub> = 1 kΩ, f = 1 MHz	Room	- 75	-	-	pF
Source Off Capacitance	C <sub>S(off)</sub>	V <sub>EN</sub> = 0 V, V <sub>S</sub> = 0 V, f = 1 MHz	Room	3	-	-	
Drain Off Capacitance	DG408	V <sub>EN</sub> = 0 V, V <sub>D</sub> = 0 V, f = 1 MHz	Room	26	-	-	
	DG409		Room	14	-	-	
Drain On Capacitance	DG408		Room	37	-	-	
	DG409		Room	25	-	-	
<b>Power Supplies</b>							
Positive Supply Current	I <sub>+</sub>	V <sub>EN</sub> = V <sub>A</sub> = 0 V or 5 V	Full	10	-	75	μA
Negative Supply Current	I <sub>-</sub>		Full	1	- 75	-	
Positive Supply Current	I <sub>+</sub>	V <sub>EN</sub> = V <sub>A</sub> = 0 V or 5 V	Room	0.2	-	0.5	mA
Negative Supply Current	I <sub>-</sub>		Full	-	-	2	
			Full	-	- 500	-	μA



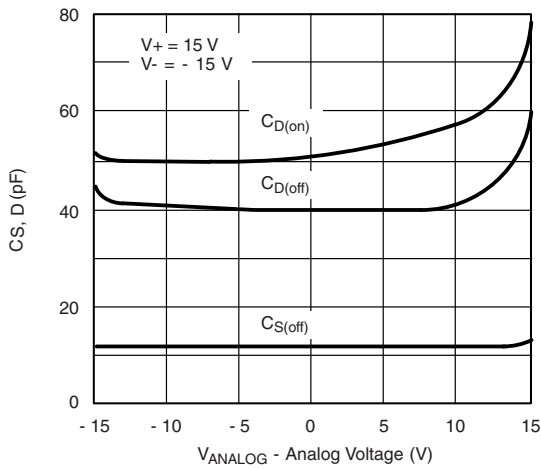
SPECIFICATIONS <sup>a</sup> (Single Supply)							
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED	TEMP. <sup>b</sup>	TYP. <sup>c</sup>	A SUFFIX - 55 °C to 125 °C		UNIT
		V <sub>+</sub> = 12 V, V <sub>-</sub> = 0 V			MIN. <sup>d</sup>	MAX. <sup>d</sup>	
		V <sub>AL</sub> = 0.8 V, V <sub>AH</sub> = 2.4 V <sup>f</sup>					
<b>Analog Switch</b>							
Drain-Source On-Resistance <sup>e, f</sup>	R <sub>DS(on)</sub>	V <sub>D</sub> = 3 V, 10 V, I <sub>S</sub> = - 1 mA	Room	90	-	-	Ω
<b>Dynamic Characteristics</b>							
Switching Time of Multiplexer <sup>e</sup>	t <sub>TRANS</sub>	V <sub>S1</sub> = 8 V, V <sub>S8</sub> = 0 V, V <sub>IN</sub> = 2.4 V	Room	180	-	-	ns
Enable Turn-On Time <sup>e</sup>	t <sub>ON(EN)</sub>	V <sub>INH</sub> = 2.4 V, V <sub>INL</sub> = 0 V, V <sub>S1</sub> = 5 V	Room	180	-	-	
Enable Turn-Off Time <sup>e</sup>	t <sub>OFF(EN)</sub>		Room	120	-	-	
Charge Injection <sup>e</sup>	Q	C <sub>L</sub> = 1 nF, V <sub>S</sub> = 0 V, R <sub>S</sub> = 0	Room	5	-	-	pC

**Notes**

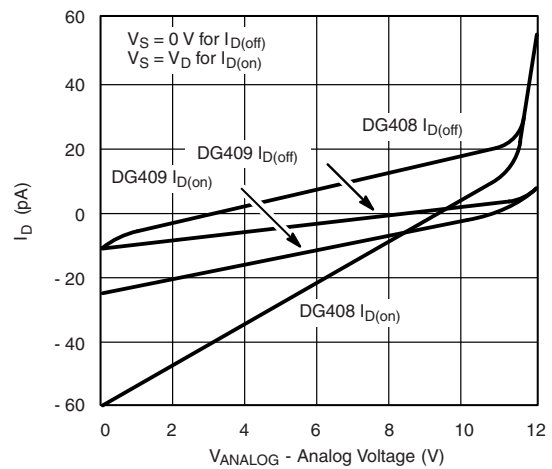
- a. Refer to PROCESS OPTION FLOWCHART.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.
- g. ΔR<sub>DS(on)</sub> = R<sub>DS(on)</sub> max. - R<sub>DS(on)</sub> min.
- h. Worst case isolation occurs on channel 4 due to proximity to the drain pin.

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.

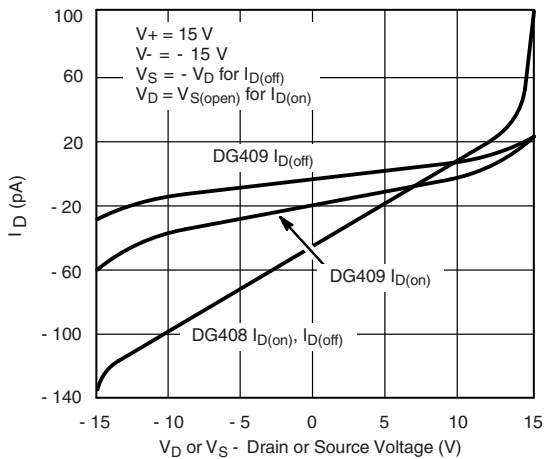
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



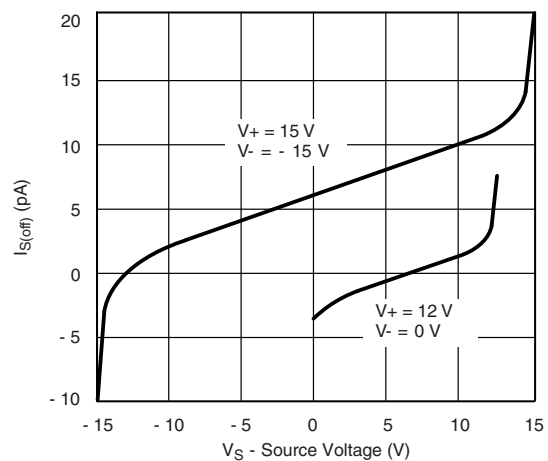
Source/Drain Capacitance vs. Analog Voltage



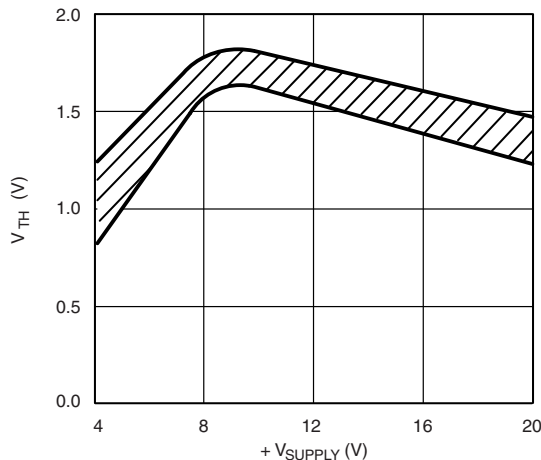
Drain Leakage Current vs. Source/Drain Voltage (Single 12 V Supply)



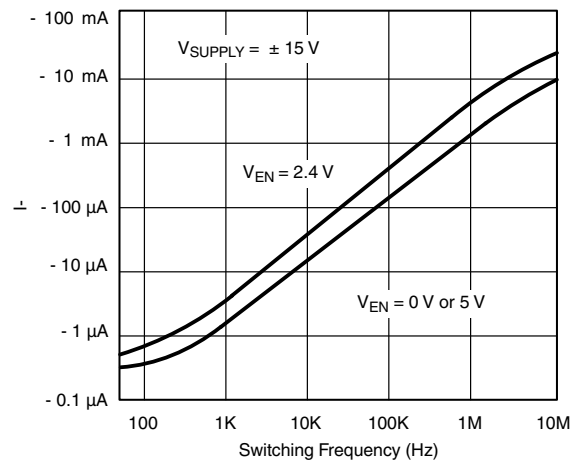
Drain Leakage Current vs. Source/Drain Voltage



Source Leakage Current vs. Source Voltage

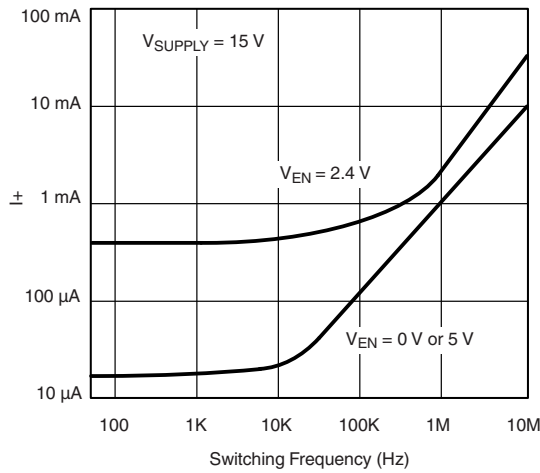


Input Switching Threshold vs. Supply Voltage

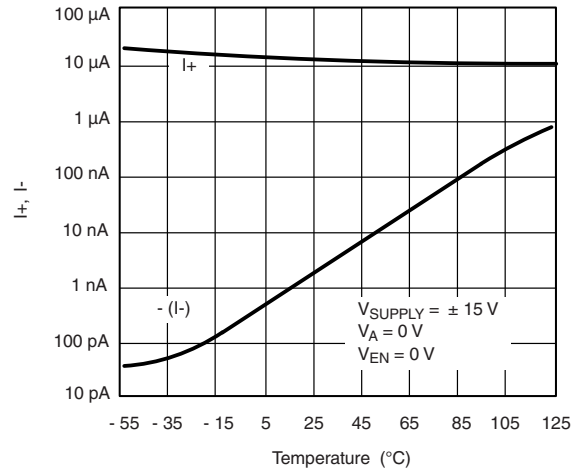


Negative Supply Current vs. Switching Frequency

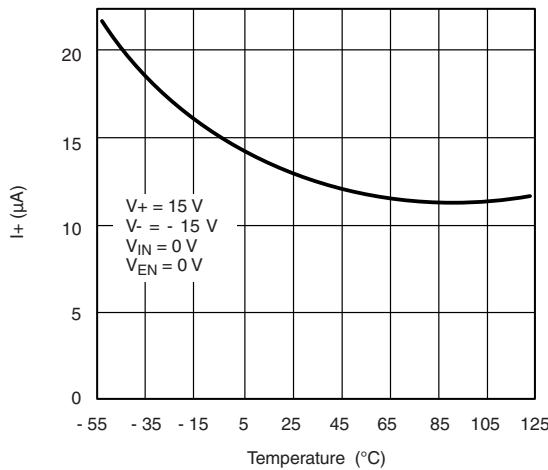
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



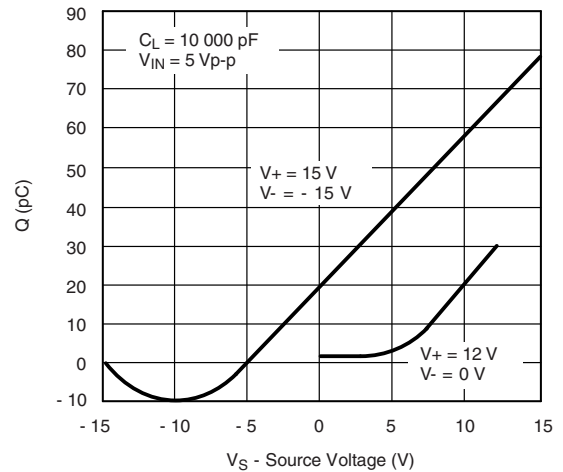
**Positive Supply Current vs. Switching Frequency**



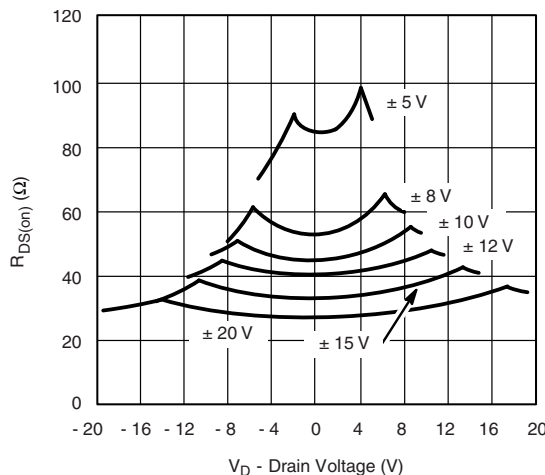
**$I_{SUPPLY}$  vs. Temperature**



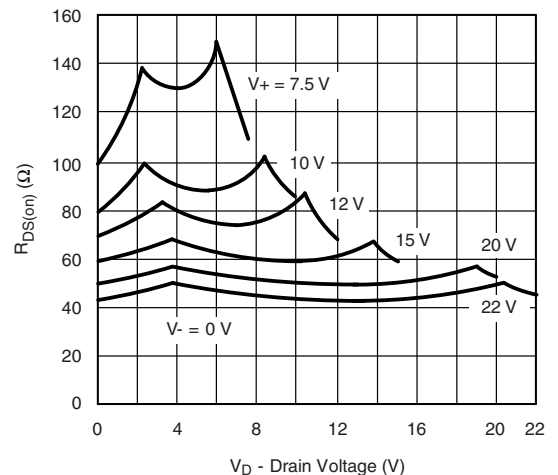
**Positive Supply Current vs. Temperature (DG408)**



**Charge Injection vs. Analog Voltage**

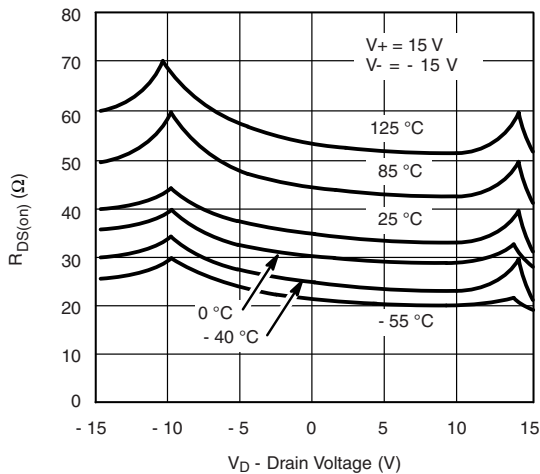


**$R_{DS(on)}$  vs.  $V_D$  and Supply**

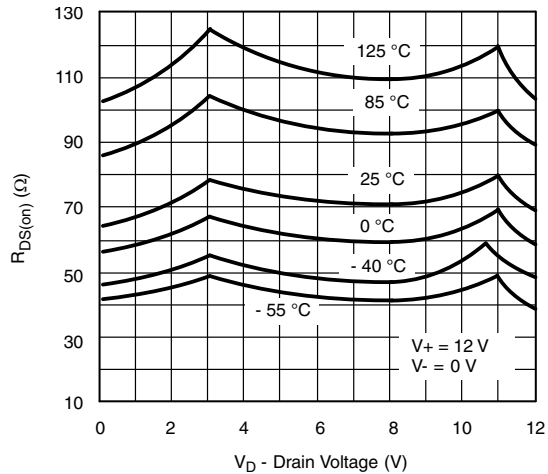


**$R_{DS(on)}$  vs.  $V_D$  and Supply (Single Supply)**

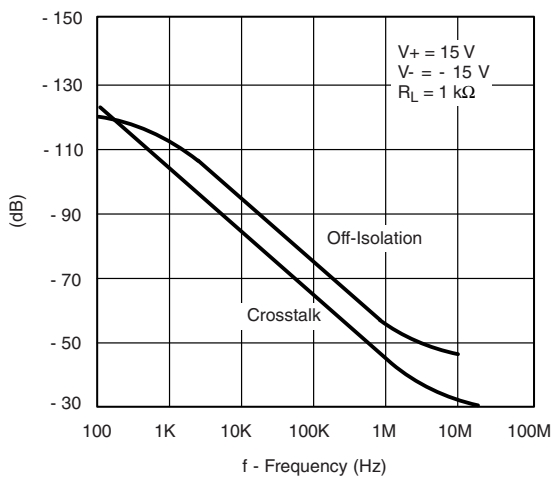
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



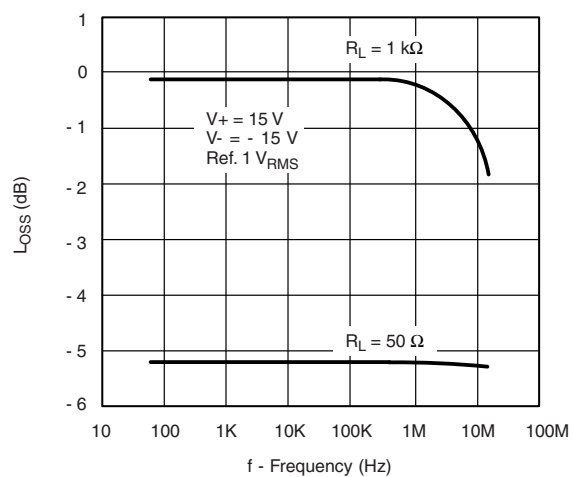
**$R_{DS(on)}$  vs.  $V_D$  and Temperature**



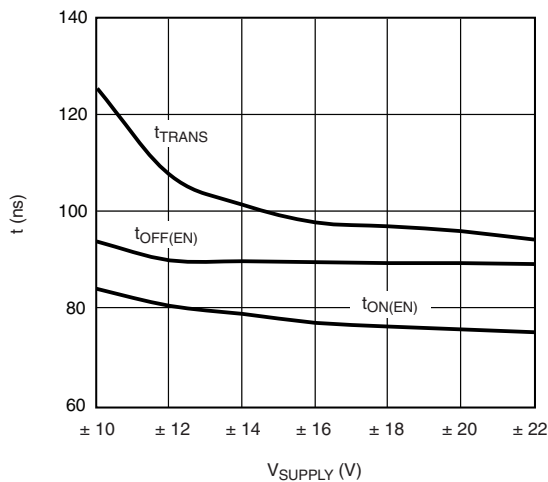
**$R_{DS(on)}$  vs.  $V_D$  and Temperature (Single Supply)**



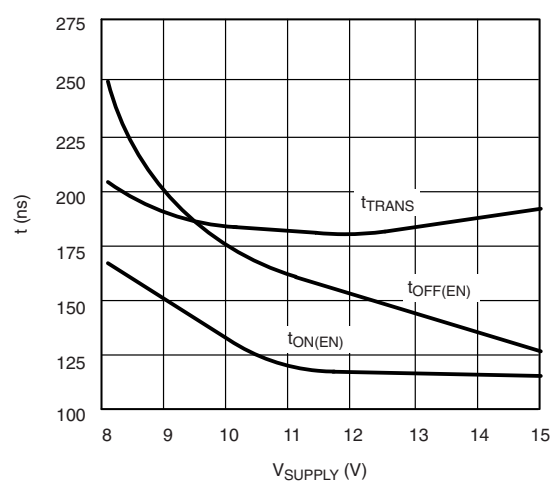
**Off Isolation and Crosstalk vs. Frequency**



**Insertion Loss vs. Frequency**



**Switching Time vs. Bipolar Supply**



**Switching Time vs. Single Supply**



## SCHEMATIC DIAGRAM (Typical Channel)

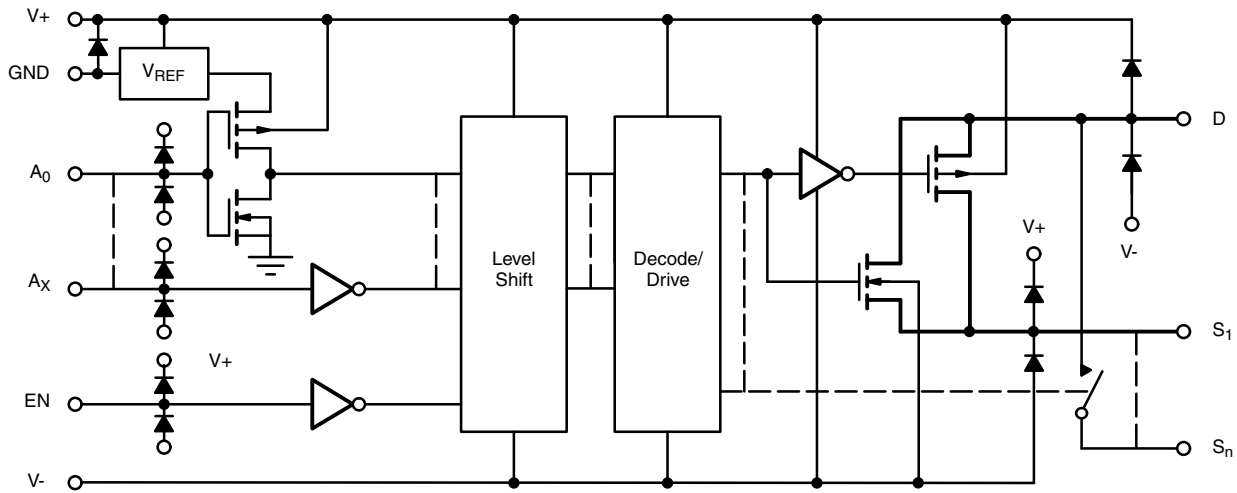


Fig. 1

## TEST CIRCUITS

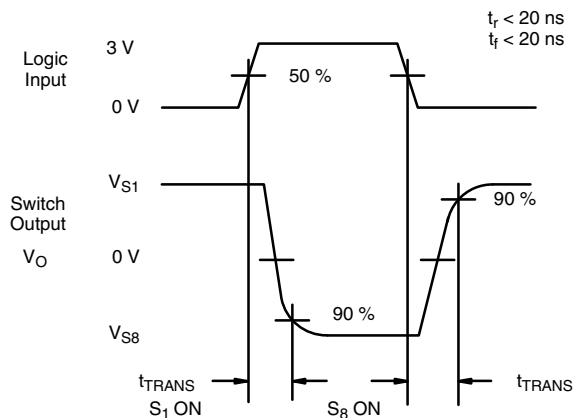
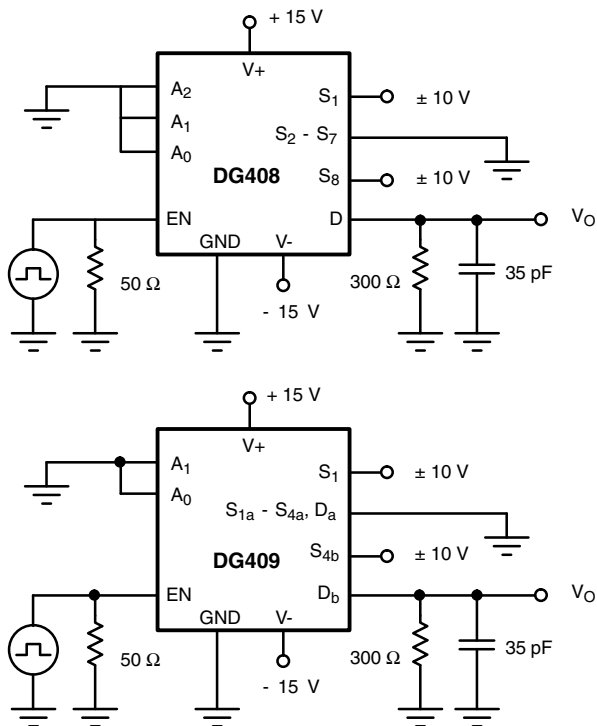


Fig. 2 - Transition Time

## TEST CIRCUITS

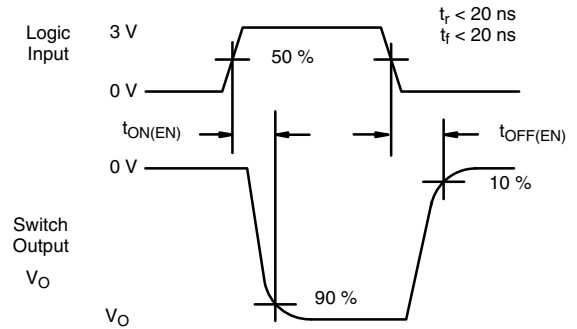
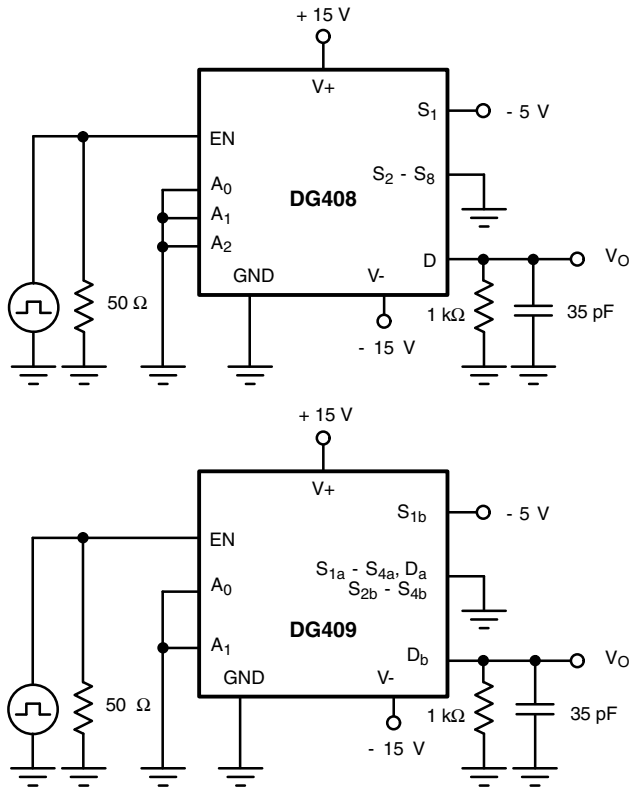


Fig. 3 - Enable Switching Time

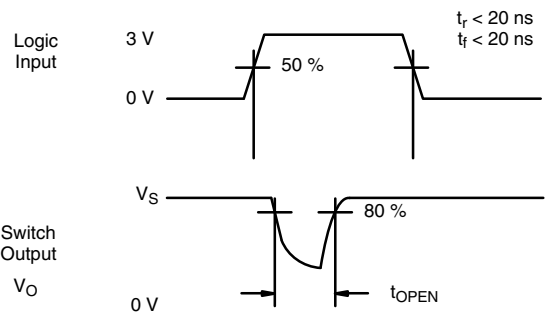
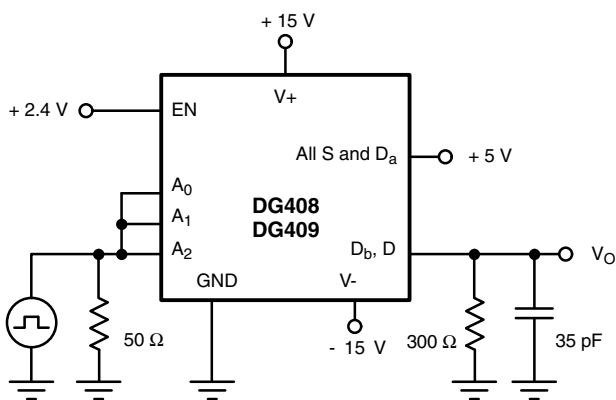


Fig. 4 - Break-Before-Make Interval

## TEST CIRCUITS

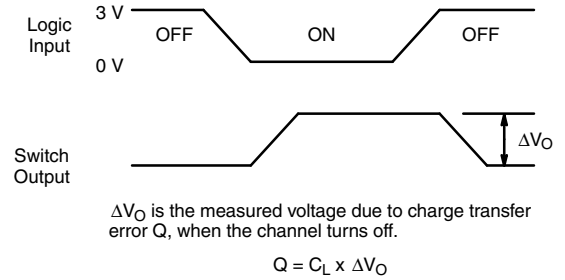
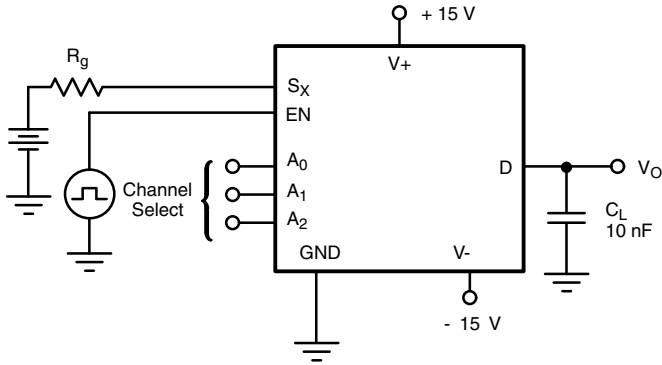


Fig. 5 - Charge Injection

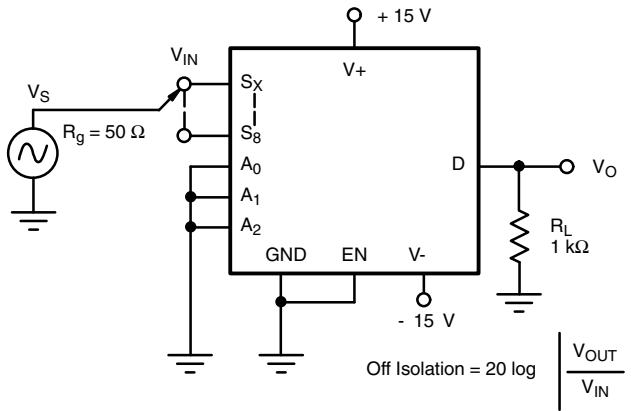


Fig. 6 - Off Isolation

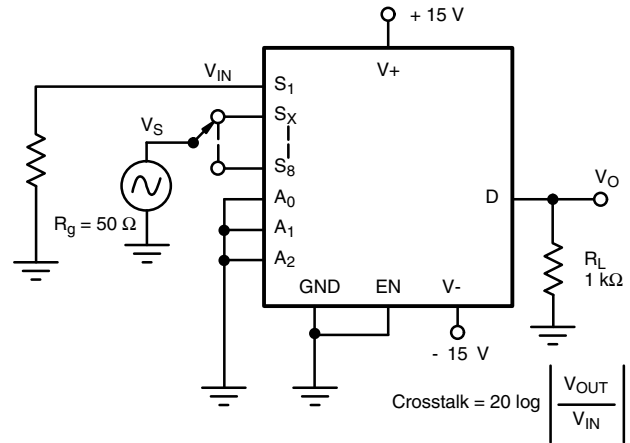


Fig. 7 - Crosstalk

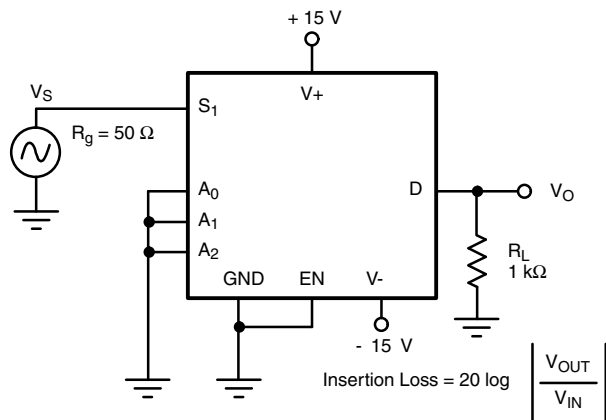


Fig. 8 - Insertion Loss

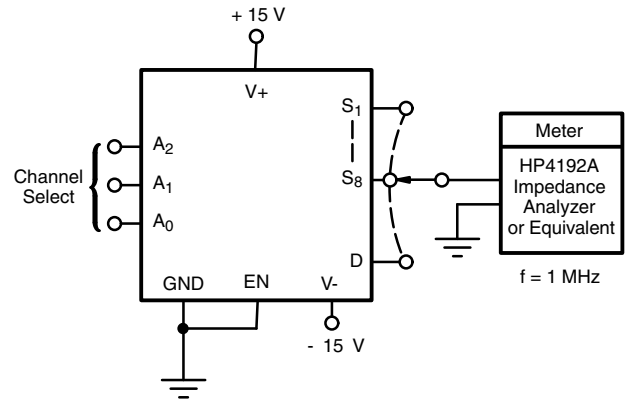


Fig. 9 - Source Drain Capacitance

## APPLICATION HINTS

### Overvoltage Protection

A very convenient form of overvoltage protection consists of adding two small signal diodes (1N4148, 1N914 type) in series with the supply pins (see figure 10). This arrangement effectively blocks the flow of reverse currents. It also floats the supply pin above or below the normal  $V+$  or  $V-$  value. In this case the overvoltage signal actually becomes the power

supply of the IC. From the point of view of the chip, nothing has changed, as long as the difference  $V_S - (V-)$  does not exceed + 44 V. The addition of these diodes will reduce the analog signal range to 1 V below  $V+$  and 1 V above  $V-$ , but it preserves the low channel resistance and low leakage characteristics.

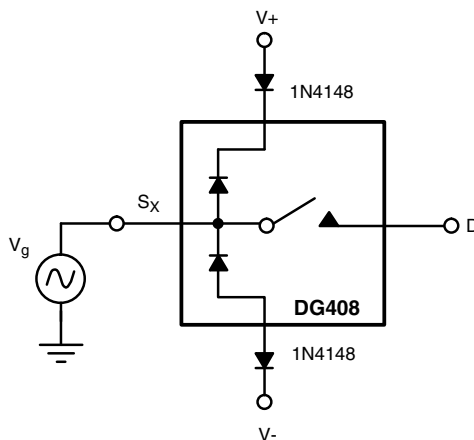


Fig. 10 - Overvoltage Protection Using Blocking Diodes

### 8-Channel Sequential Multiplexer/Demultiplexer

### Differential 4-Channel Sequential Multiplexer/Demultiplexer

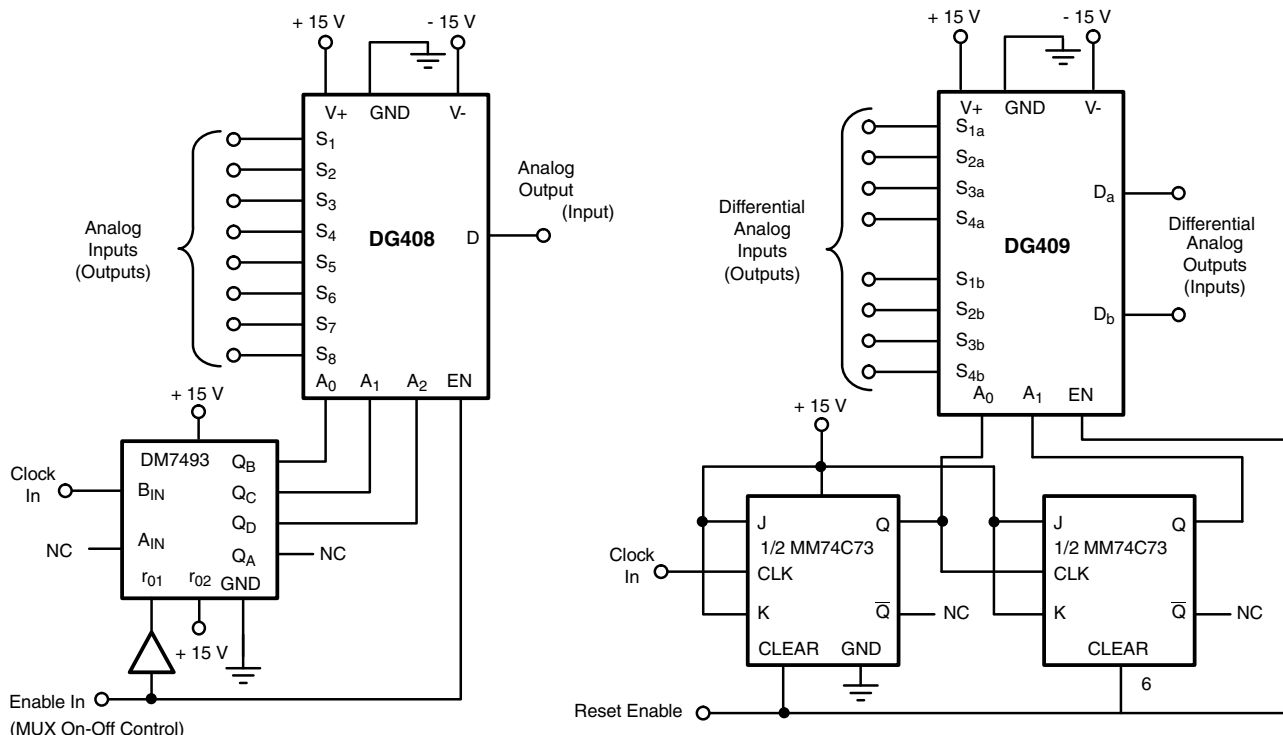
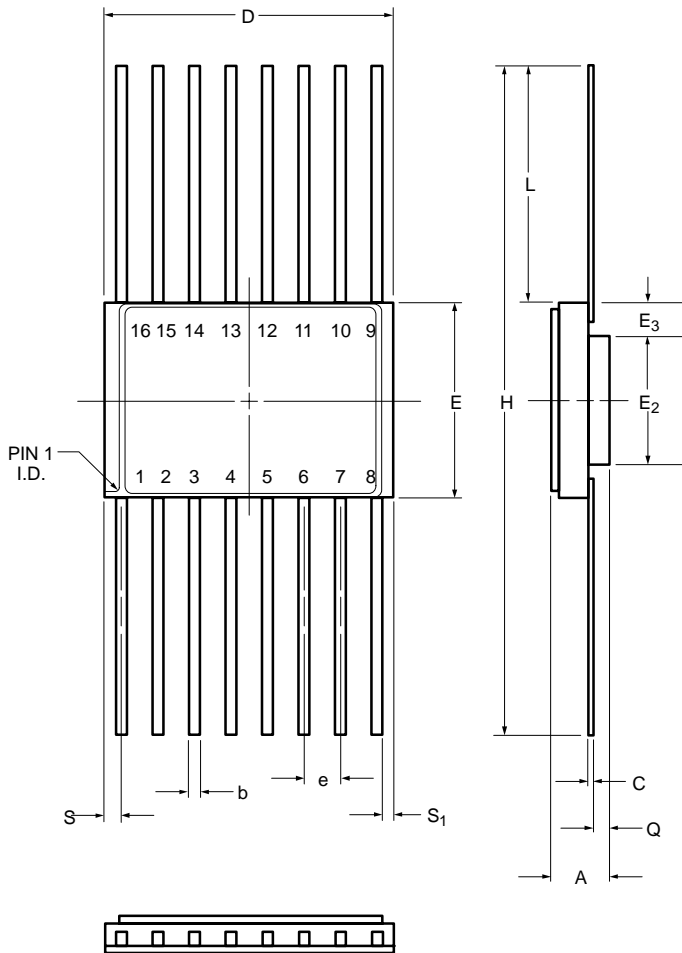


Fig. 11

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?70062](http://www.vishay.com/ppg?70062).



**FLAT PACK: 16-LEAD**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	1.78	2.29	0.070	0.090
<b>b</b>	0.38	0.48	0.015	0.019
<b>c</b>	0.10	0.18	0.004	0.007
<b>D</b>	9.91	10.41	0.390	0.410
<b>E</b>	6.60	7.11	0.260	0.280
<b>E<sub>2</sub></b>	4.57	5.08	0.180	0.200
<b>E<sub>3</sub></b>	0.76	1.27	0.030	0.050
<b>e</b>	1.27 BSC		0.050 BSC	
<b>H</b>	22.35	23.88	0.880	0.940
<b>L</b>	7.62	8.89	0.300	0.350
<b>Q</b>	0.25	0.51	0.010	0.020
<b>S</b>	–	1.02	–	0.040
<b>S<sub>1</sub></b>	0.13	–	0.005	–

ECN: S-03946—Rev. C, 09-Jul-01  
DWG: 5430



**CERDIP: 16-LEAD**

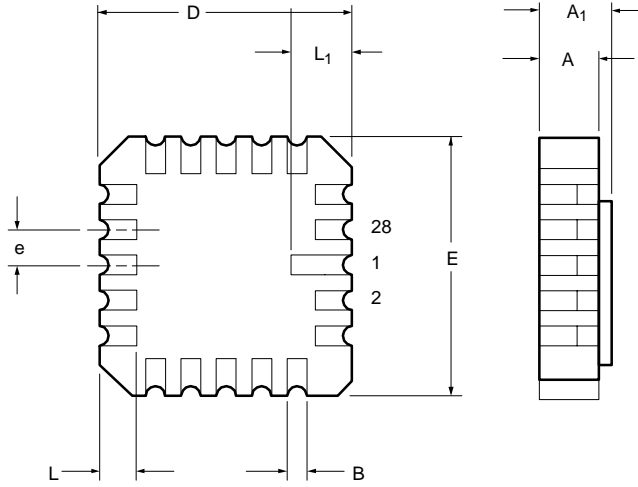


Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	4.06	5.08	0.160	0.200
A <sub>1</sub>	0.51	1.14	0.020	0.045
B	0.38	0.51	0.015	0.020
B <sub>1</sub>	1.14	1.65	0.045	0.065
C	0.20	0.30	0.008	0.012
D	19.05	19.56	0.750	0.770
E	7.62	8.26	0.300	0.325
E <sub>1</sub>	6.60	7.62	0.260	0.300
e <sub>1</sub>	2.54 BSC		0.100 BSC	
e <sub>A</sub>	7.62 BSC		0.300 BSC	
L	3.18	3.81	0.125	0.150
L <sub>1</sub>	3.81	5.08	0.150	0.200
Q <sub>1</sub>	1.27	2.16	0.050	0.085
S	0.38	1.14	0.015	0.045
∞	0°	15°	0°	15°

ECN: S-03946—Rev. G, 09-Jul-01  
DWG: 5403



**20-LEAD LCC**



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	1.37	2.24	0.054	0.088
<b>A<sub>1</sub></b>	1.63	2.54	0.064	0.100
<b>B</b>	0.56	0.71	0.022	0.028
<b>D</b>	8.69	9.09	0.342	0.358
<b>E</b>	8.69	9.09	0.442	0.358
<b>e</b>	1.27 BSC		0.050 BSC	
<b>L</b>	1.14	1.40	0.045	0.055
<b>L<sub>1</sub></b>	1.96	2.36	0.077	0.093

ECN: S-03946—Rev. B, 09-Jul-01  
DWG: 5321



## Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

## Material Category Policy

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**