

## Quad SPST CMOS Analog Switches

### APPLICATIONS

- Audio switching
- Battery powered systems
- Data acquisition
- Sample-and-hold circuits
- Telecommunication systems
- Automatic test equipment
- Single supply circuits
- Hard disk drives

### DESCRIPTION

The DG444, DG445 monolithic quad analog switches are designed to provide high speed, low error switching of analog signals. The DG444 has a normally closed function. The DG445 has a normally open function. Combining low power (22 nW, typ) with high speed ( $t_{ON}$ : 120 ns, typ.), the DG444, DG445 are ideally suited for upgrading DG211, DG212 sockets. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

To achieve high-voltage ratings and superior switching performance, the DG444, DG445 are built on Vishay Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks input voltages to the supply levels when off.

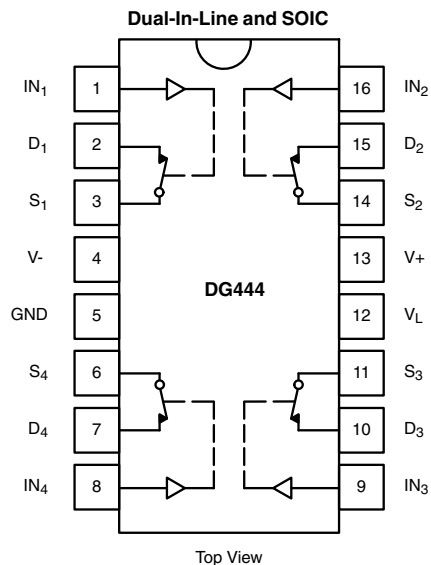
### FEATURES

- Low on-resistance: 50  $\Omega$
- Low leakage: 80 pA
- Low power consumption: 22 nW
- Fast switching action -  $t_{ON}$ : 120 ns
- Low charge injection
- DG211, DG212 upgrades
- TTL/CMOS logic compatible

### BENEFITS

- Low signal errors and distortion
- Reduced power supply requirements
- Faster throughput
- Improved reliability
- Reduced pedestal errors
- Simple interfacing

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
Logic	DG444	DG445
0	On	Off
1	Off	On

Logic "0"  $\leq 0.8$  V  
 Logic "1"  $\geq 2.4$  V

ORDERING INFORMATION		
Temp. Range	Package	Part Number
- 40 °C to 85 °C	16-pin plastic DIP	DG444DJ
		DG445DJ
	16-pin narrow SOIC	DG444DY
		DG445DY



<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)			
Parameter		Limit	Unit
V+ to V-		44	V
GND to V-		25	
$V_L$		(GND - 0.3) to (V+) + 0.3	
Digital Inputs <sup>a</sup> , $V_S$ , $V_D$		(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first	
Continuous Current (Any Terminal)		30	mA
Current, S or D (Pulsed at 1 ms, 10 % Duty Cycle)		100	
Storage Temperature		- 65 to 125	$^\circ\text{C}$
Power Dissipation (Package) <sup>b</sup>	16-Pin Plastic DIP <sup>c</sup>	450	mW
	16-Pin Narrow Body SOIC <sup>d</sup>	640	

Notes:

- a. Signals on  $S_X$ ,  $D_X$ , or  $IN_X$  exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads welded or soldered to PC board.
- c. Derate 6 mW/ $^\circ\text{C}$  above 75 $^\circ\text{C}$ .
- d. Derate 8 mW/ $^\circ\text{C}$  above 75 $^\circ\text{C}$ .

<b>SPECIFICATIONS</b> for Dual Supplies									
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , 0.8 V <sup>e</sup>	Temp. <sup>a</sup>	D Suffix - 40 $^\circ\text{C}$ to 85 $^\circ\text{C}$			Unit		
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>			
<b>Analog Switch</b>									
Analog Signal Range <sup>d</sup>	$V_{ANALOG}$		Full	- 15		15	V		
Drain-Source On-Resistance	$R_{DS(on)}$	$I_S = -10\text{ mA}$ , $V_D = \pm 8.5\text{ V}$ $V_+ = 13.5\text{ V}$ $V_- = -13.5\text{ V}$	Room Full		50	85 100	$\Omega$		
Switch Off Leakage Current	$I_{S(off)}$	$V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$ $V_D = \pm 15.5\text{ V}$ , $V_S = \pm 15.5\text{ V}$	Room Full	- 0.5 - 5	$\pm 0.01$	0.5 5	nA		
	$I_{D(off)}$		Room Full	- 0.5 - 5	$\pm 0.01$	0.5 5			
Channel On Leakage Current	$I_{D(on)}$	$V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$ $V_S = V_D = \pm 15.5\text{ V}$	Room Full	- 0.5 - 10	$\pm 0.08$	0.5 10			
<b>Digital Control</b>									
Input Current $V_{IN}$ Low	$I_{IL}$	$V_{IN}$ under test = 0.8 V All Other = 2.4 V	Full	- 500	- 0.01	500	nA		
Input Current $V_{IN}$ High	$I_{IH}$	$V_{IN}$ under test = 2.4 V All Other = 0.8 V	Full	- 500	0.01	500			
<b>Dynamic Characteristics</b>									
Turn-On Time	$t_{ON}$	$R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ $V_S = \pm 10\text{ V}$ , See Figure 2	Room			120	250	ns	
Turn-Off Time	$t_{OFF}$		DG444	Room			110		140
			DG445	Room			160		210
Charge Injection <sup>e</sup>	Q	$C_L = 1\text{ nF}$ , $V_S = 0\text{ V}$ $V_{gen} = 0\text{ V}$ , $R_{gen} = 0\text{ }\Omega$	Room		- 1		pC		
Off Isolation <sup>e</sup>	OIRR	$R_L = 50\text{ }\Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$	Room			60		dB	
Crosstalk (Channel-to-Channel) <sup>d</sup>	$X_{TALK}$		Room			100			
Source Off Capacitance	$C_{S(off)}$	f = 1 MHz	Room			4		pF	
Drain Off Capacitance	$C_{D(off)}$		Room			4			
Channel On Capacitance	$C_{D(on)}$	$V_{ANALOG} = 0\text{ V}$	Room			16			



SPECIFICATIONS for Dual Supplies							
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 15\text{ V}, V_- = -15\text{ V}$ $V_L = 5\text{ V}, V_{IN} = 2.4\text{ V}, 0.8\text{ V}^e$	Temp. <sup>a</sup>	D Suffix - 40 °C °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
<b>Power Supplies</b>							
Positive Supply Current	I+	$V_+ = 16.5\text{ V}, V_- = -16.5\text{ V}$ $V_{IN} = 0\text{ or }5\text{ V}$	Room Full		0.001	1 5	$\mu\text{A}$
Negative Supply Current	I-		Room Full	- 1 - 5	- 0.0001		
Logic Supply Current	I <sub>L</sub>		Room Full		0.001	1 5	
Ground Current	I <sub>GND</sub>		Room Full	- 1 - 5	- 0.001		

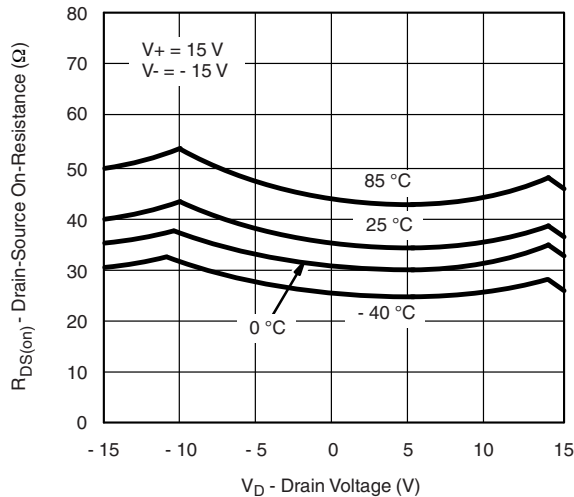
SPECIFICATIONS for Unipolar Supplies							
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 12\text{ V}, V_- = 0\text{ V}$ $V_L = 5\text{ V}, V_{IN} = 2.4\text{ V}, 0.8\text{ V}^e$	Temp. <sup>a</sup>	Limits - 40 °C °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	0		12	V
Drain-Source On-Resistance <sup>d</sup>	R <sub>DS(on)</sub>	$I_S = -10\text{ mA}, V_D = 3\text{ V}, 8\text{ V}$ $V_+ = 10.8\text{ V}, V_L = 5.25\text{ V}$	Room Full		100	160 200	$\Omega$
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	$R_L = 1\text{ k}\Omega, C_L = 35\text{ pF}, V_S = 8\text{ V}$ See Figure 2	Room		300	450	ns
Turn-Off Time	t <sub>OFF</sub>		Room		60	200	
Charge Injection	Q	$C_L = 1\text{ nF}, V_{gen} = 6\text{ V}, R_{gen} = 0\ \Omega$	Room		2		pC
<b>Power Supplies</b>							
Positive Supply Current	I+	$V_+ = 13.2\text{ V}, V_{IN} = 0\text{ or }5\text{ V}$	Room Full		0.001	1 5	$\mu\text{A}$
Negative Supply Current	I-	$V_{IN} = 0\text{ or }5\text{ V}$	Room Full	- 1 - 5	- 0.0001		
Logic Supply Current	I <sub>L</sub>	$V_L = 5.25\text{ V}, V_{IN} = 0\text{ or }5\text{ V}$	Room Full		0.001	1 5	
Ground Current	I <sub>GND</sub>	$V_{IN} = 0\text{ or }5\text{ V}$	Full	- 1 - 5	- 0.001		

Notes:

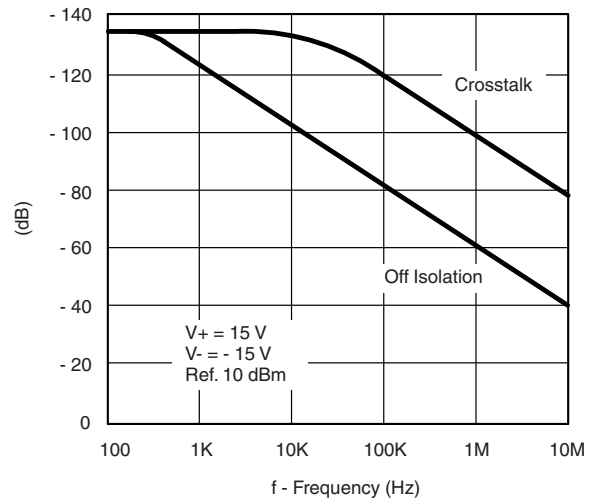
- a. Room = 25 °C, Full = as determined by the operating temperature suffix.
- b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. Guaranteed by design, not subject to production test.
- e. V<sub>IN</sub> = input voltage to perform proper function.

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.

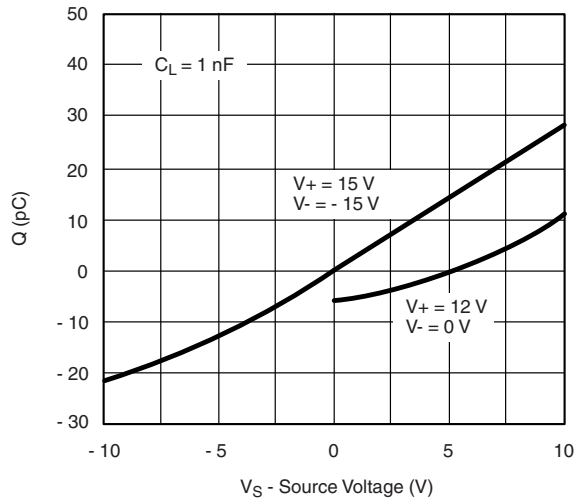
## TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



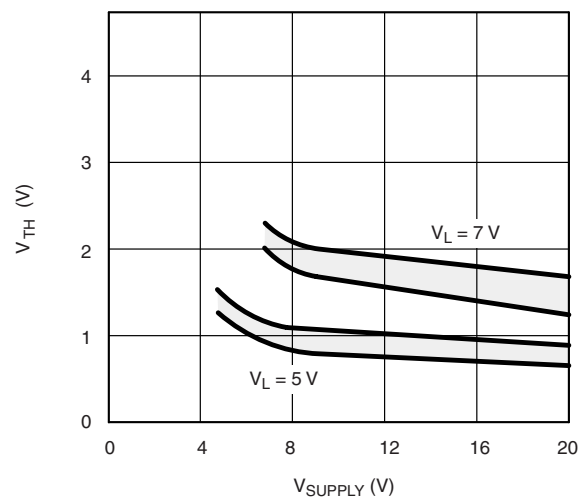
**R<sub>DS(on)</sub> vs. V<sub>D</sub> and Temperature**



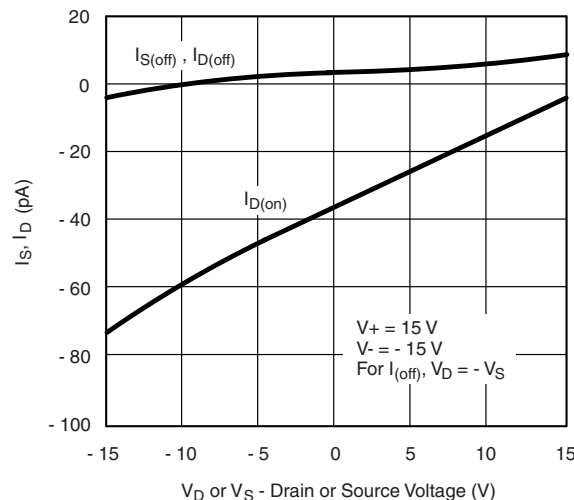
**Crosstalk and Off Isolation vs. Frequency**



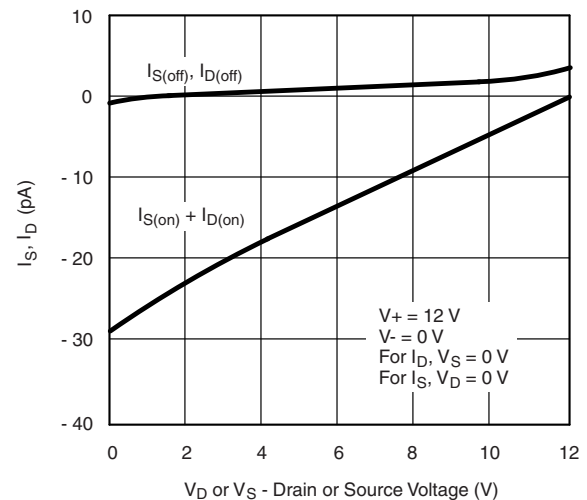
**Charge Injection vs. Source Voltage**



**Switching Threshold vs. Supply Voltage**

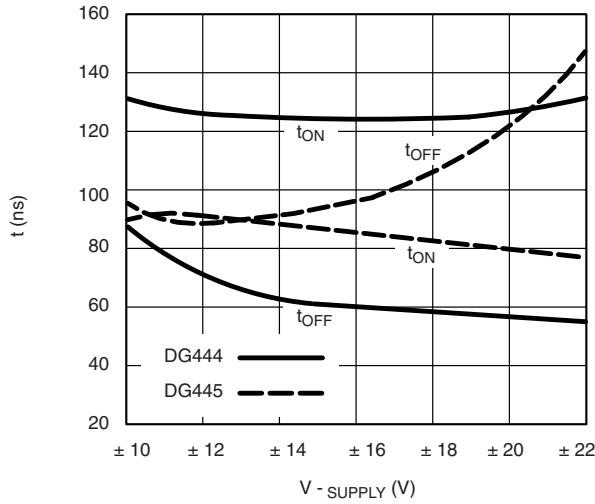


**Source/Drain Leakage Currents**

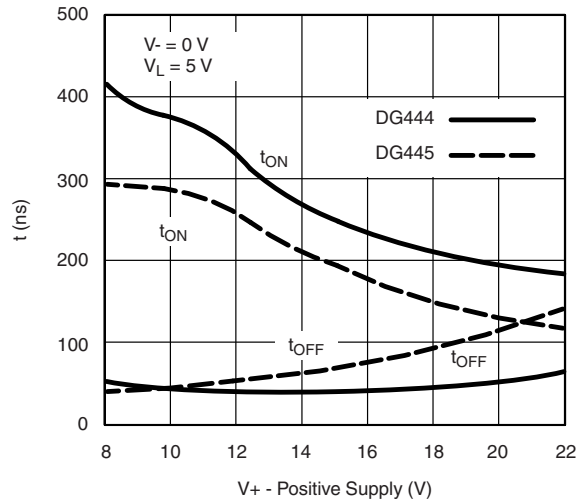


**Source/Drain Leakage Currents (Single 12-V Supply)**

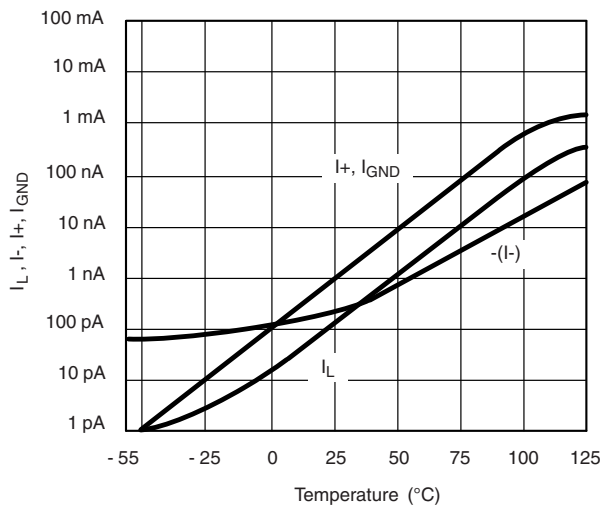
## TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



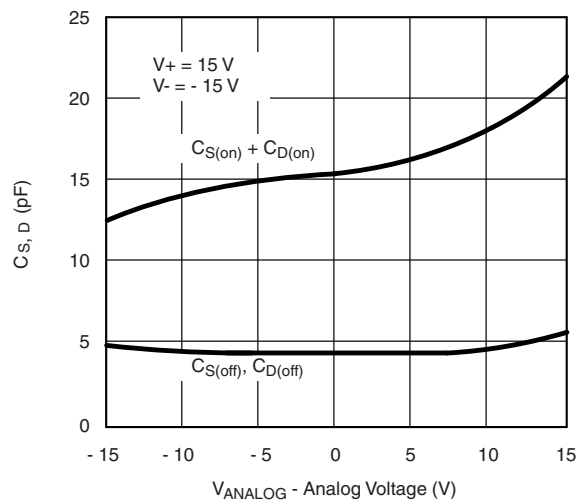
Switching Time vs. Power Supply Voltage



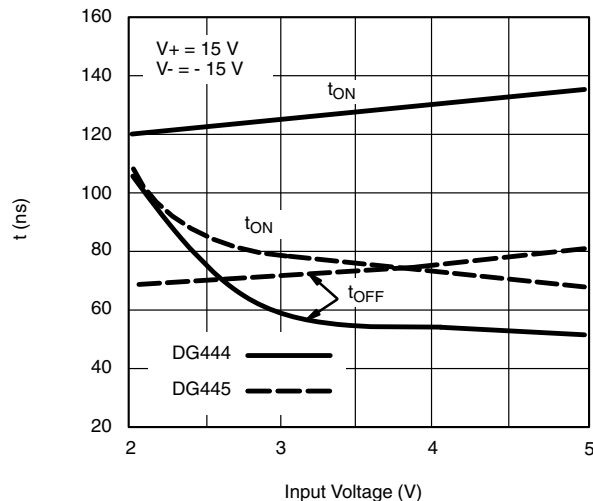
Switching Times vs. Power Supply Voltage



Supply Current vs. Temperature



Source/Drain Capacitance vs. Analog Voltage



Switching Time vs. Input Voltage

## SCHEMATIC DIAGRAM Typical Channel

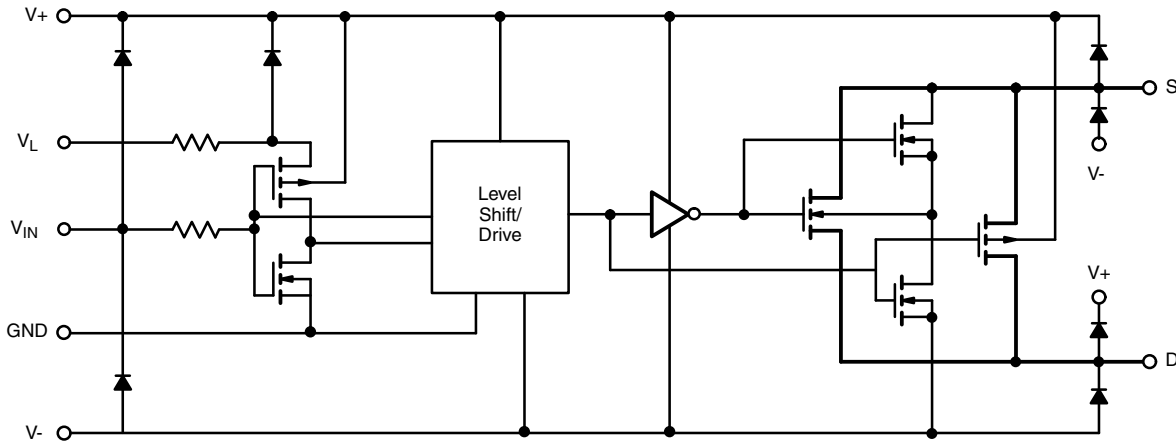
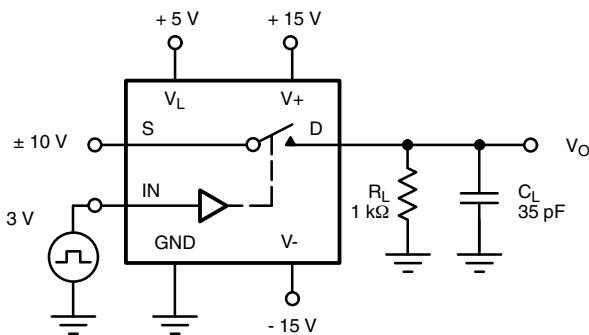
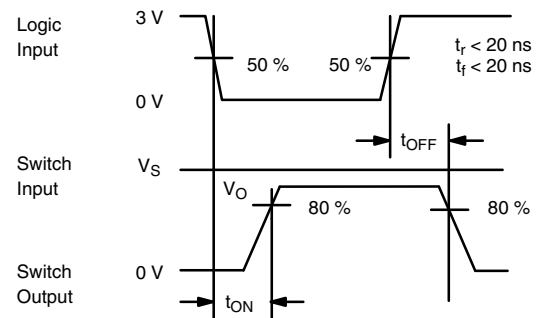


Figure 1.

## TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)



Note: Logic input waveform is inverted for DG445.

Figure 2. Switching Time

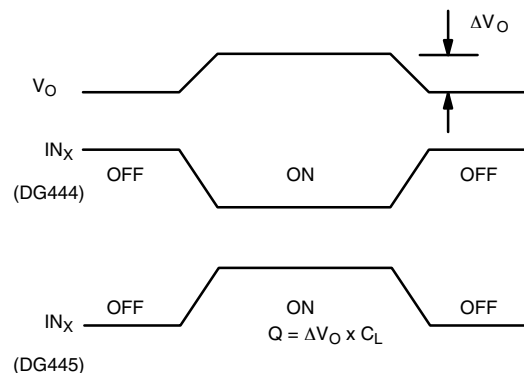
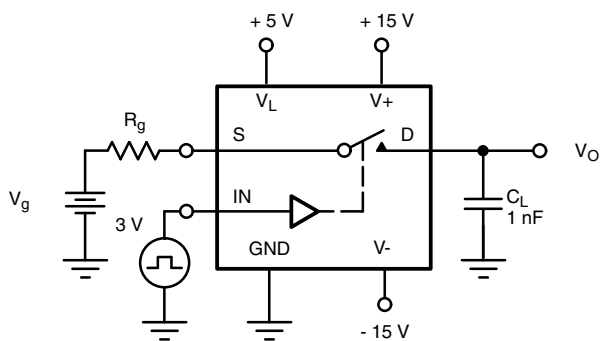
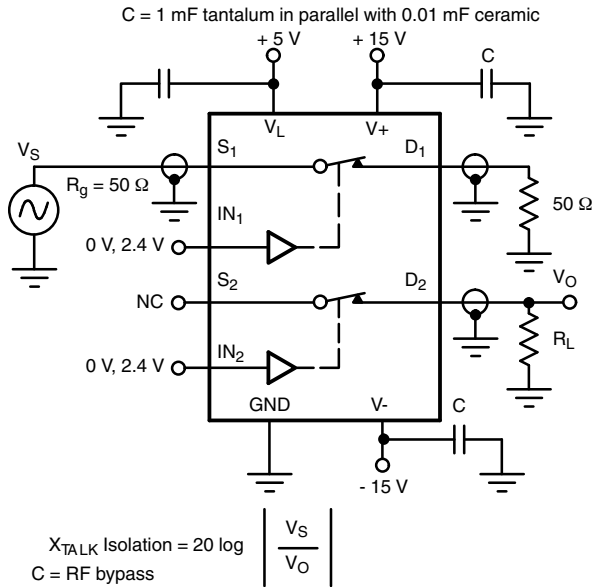
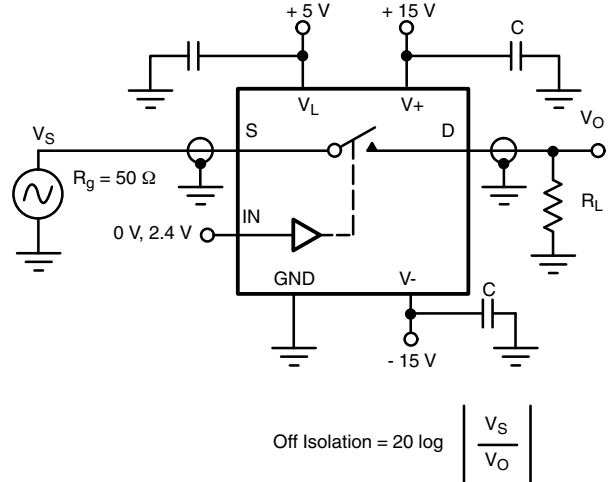


Figure 3. Charge Injection

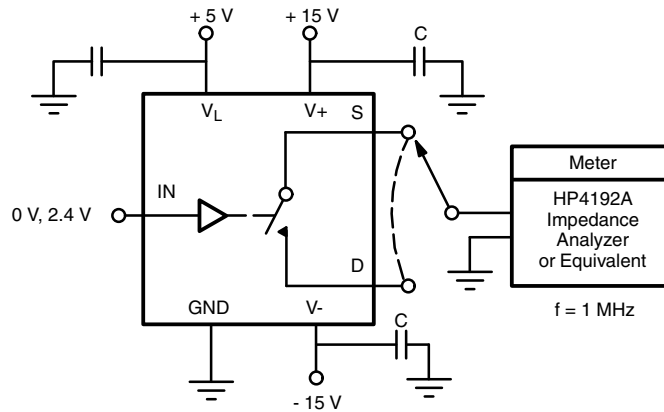
**TEST CIRCUITS**



**Figure 4. Crosstalk**

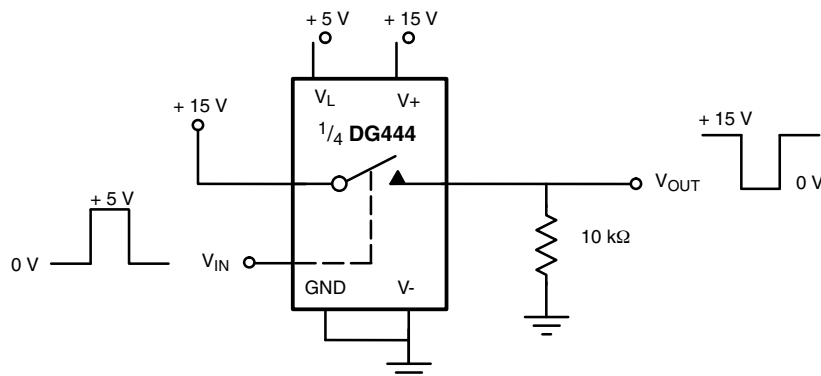


**Figure 5. Off Isolation**



**Figure 6. Source/Drain Capacitances**

**APPLICATIONS**



**Figure 7. Level Shifter**

## APPLICATIONS

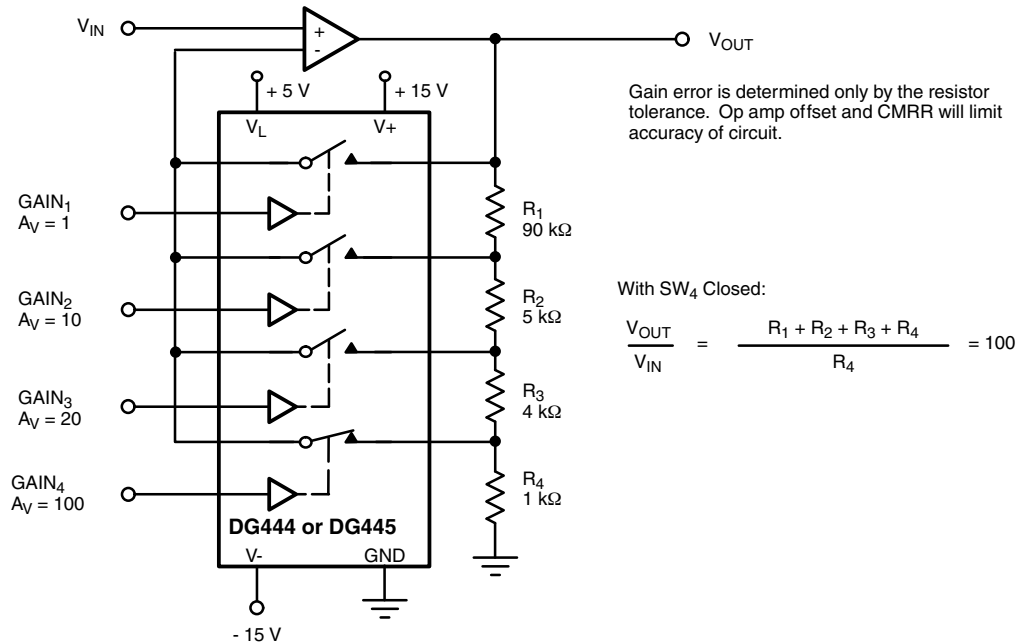


Figure 8. Precision-Weighted Resistor Programmable-Gain Amplifier

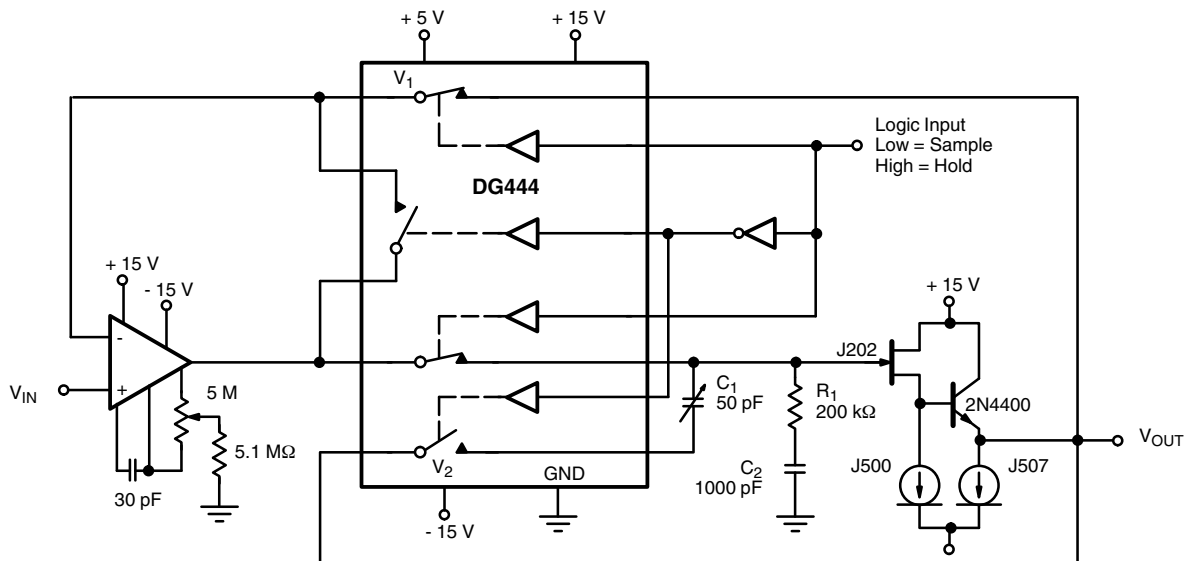


Figure 9. Precision Sample-and-Hold

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?70054](http://www.vishay.com/ppg?70054).





**SOIC (NARROW): 16-LEAD**  
JEDEC Part Number: MS-012



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A <sub>1</sub>	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
∅	0°	8°	0°	8°

ECN: S-03946—Rev. F, 09-Jul-01  
DWG: 5300



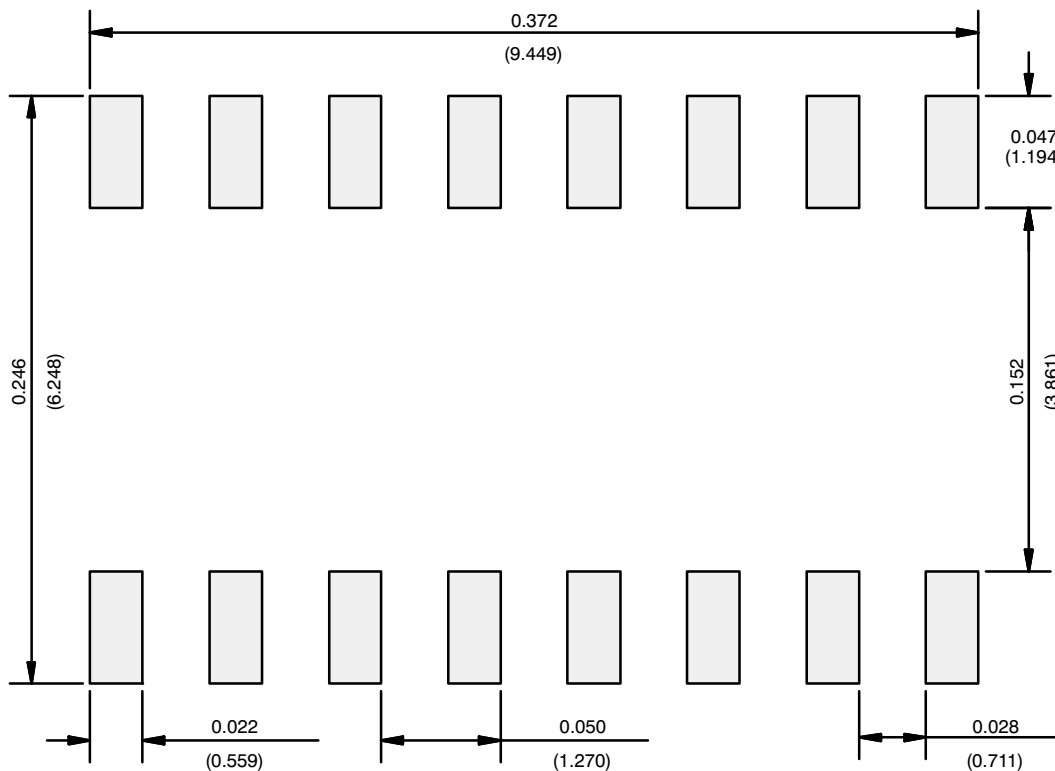
### PDIP: 16-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
<b>A</b>	3.81	5.08	0.150	0.200
<b>A<sub>1</sub></b>	0.38	1.27	0.015	0.050
<b>B</b>	0.38	0.51	0.015	0.020
<b>B<sub>1</sub></b>	0.89	1.65	0.035	0.065
<b>C</b>	0.20	0.30	0.008	0.012
<b>D</b>	18.93	21.33	0.745	0.840
<b>E</b>	7.62	8.26	0.300	0.325
<b>E<sub>1</sub></b>	5.59	7.11	0.220	0.280
<b>e<sub>1</sub></b>	2.29	2.79	0.090	0.110
<b>e<sub>A</sub></b>	7.37	7.87	0.290	0.310
<b>L</b>	2.79	3.81	0.110	0.150
<b>Q<sub>1</sub></b>	1.27	2.03	0.050	0.080
<b>S</b>	0.38	1.52	.015	0.060

ECN: S-03946—Rev. D, 09-Jul-01  
DWG: 5482

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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