Quad SPST CMOS Analog Switches

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.

BENEFITS

- Low signal errors and distortion
- Reduced power supply requirements
- Faster throughput
- Improved reliability
- Reduced pedestal errors
- Simple interfacing
- Wide supply ranges
  - Single supply: +5 V to 36 V
  - Dual supplies: ± 5 V to ± 20 V

FEATURES

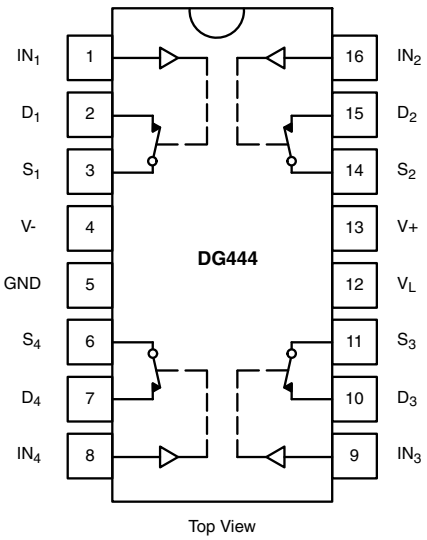
- Low on-resistance: 50 Ω
- Low leakage: 80 pA
- Low power consumption: 22 nW
- Fast switching action - t_{on}: 120 ns
- Low charge injection
- DG211, DG212 upgrades
- TTL/CMOS logic compatible

APPLICATIONS

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

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

Dual-In-Line and SOIC



Top View

TRUTH TABLE		
LOGIC	DG444	DG445
0	On	Off
1	Off	On

Note

- Logic "0" ≤ 0.8 V
  Logic "1" ≥ 2.4 V

ORDERING INFORMATION		
TEMP. RANGE	PACKAGE	PART NUMBER
-40 °C to +85 °C	16-pin narrow SOIC	DG444DY-E3
		DG445DY-E3
		DG444DY-T1-E3
		DG445DY-T1-E3

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ABSOLUTE MAXIMUM RATINGS (T_A = 25 °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 [a], 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	°C
Power dissipation (package) [b]	16-pin narrow body SOIC [d]	640	mW

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/°C above 75 °C
d. Derate 8 mW/°C above 75 °C

SPECIFICATIONS (dual supplies)							
PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** V+ = 15 V, V- = -15 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [e]	**TEMP.** [a]	**D SUFFIX** -40 °C TO +85 °C			**UNIT**
				MIN. [b]	**TYP.** [c]	**MAX.** [b]	
Analog Switch							
Analog signal range [d]	V_{ANALOG}		Full	-15	-	15	V
Drain-source on-resistance	$R_{DS(on)}$	I_S = -10 mA, V_D = ± 8.5 V, V+ = 13.5 V, V- = -13.5 V	Room	-	50	85	Ω
			Full	-	-	100	
Switch off leakage current	$I_{S(off)}$	V+ = 16.5, V- = -16.5 V, V_D = ± 15.5 V, V_S = ± 15.5 V	Room	-0.5	± 0.01	0.5	nA
			Full	-5	± 0.01	5	
	$I_{D(off)}$		Room	-0.5	± 0.01	0.5	
			Full	-5	± 0.01	5	
Channel on leakage current	$I_{D(on)}$	V+ = 16.5 V, V- = -16.5 V, V_S = V_D = ± 15.5 V	Room	-0.5	± 0.08	0.5	
			Full	-10	± 0.08	10	
Digital Control							
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	
Dynamic Characteristics							
Turn-on time	t_{ON}	R_L = 1 kΩ, C_L = 35 pF, V_S = ± 10 V, See Figure 2	Room	-	120	250	ns
Turn-off time	t_{OFF}	DG444	Room	-	110	140	
		DG445	Room	-	160	210	
Charge injection [e]	Q	C_L = 1 nF, V_S = 0 V, V_{gen} = 0 V, R_{gen} = 0 Ω	Room	-	-1	-	pC
Off isolation [e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f =1 MHz	Room	-	60	-	dB
Crosstalk (channel-to-channel) [d]	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 V	Room	-	16	-	

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SPECIFICATIONS (dual supplies)							
PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** V+ = 15 V, V- = -15 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [e]	**TEMP.** [a]	**D SUFFIX** -40 °C TO +85 °C			**UNIT**
				MIN. [b]	**TYP.** [c]	**MAX.** [b]	
Power Supplies							
Positive supply current	I+	V+ = 16.5 V, V- = -16.5 V, V_{IN} = 0 V or 5 V	Room	-	0.001	1	µA
			Full	-	-	5	
Negative supply current	I-		Room	-1	-0.0001	-	
			Full	-5	-	-	
Logic supply current	I_L		Room	-	0.001	1	
			Full	-	0.001	5	
Ground current	I_{GND}		Room	-1	-0.001	-	
			Full	-5	-0.001	-	

SPECIFICATIONS for Unipolar Supplies							
PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** V+ = 12 V, V- = 0 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [e]	**TEMP.** [a]	**LIMITS** -40 °C TO 85 °C			**UNIT**
				MIN. [b]	**TYP.** [c]	**MAX.** [b]	
Analog Switch							
Analog signal range [d]	V_{ANALOG}		Full	0	-	12	V
Drain-source on-resistance [d]	$R_{DS(on)}$	I_S = -10 mA, V_D = 3 V, 8 V, V+ = 10.8 V, V_L = 5.25 V	Room	-	100	160	Ω
			Full	-	-	200	
Dynamic Characteristics							
Turn-on time	t_{ON}	R_L = 1 kΩ, C_L = 35 pF, V_S = 8 V, see Fig. 2	Room	-	300	450	ns
Turn-off time	t_{OFF}		Room	-	60	200	
Charge injection	Q	C_L = 1 nF, V_{gen} = 6 V, R_{gen} = 0 Ω	Room	-	2	-	pC
Power Supplies							
Positive supply current	I+	V+ = 13.2 V, V_{IN} = 0 V or 5 V	Room	-	0.001	1	µA
			Full	-	-	5	
Negative supply current	I-	V_{IN} = 0 V or 5 V	Room	-1	-0.0001	-	
			Full	-5	-	-	
Logic supply current	I_L	V_L = 5.25 V, V_{IN} = 0 V or 5 V	Room	-	0.001	1	
			Full	-	-	5	
Ground current	I_{GND}	V_{IN} = 0 V or 5 V	Room	-1	-0.001	-	
			Full	-5	-	-	

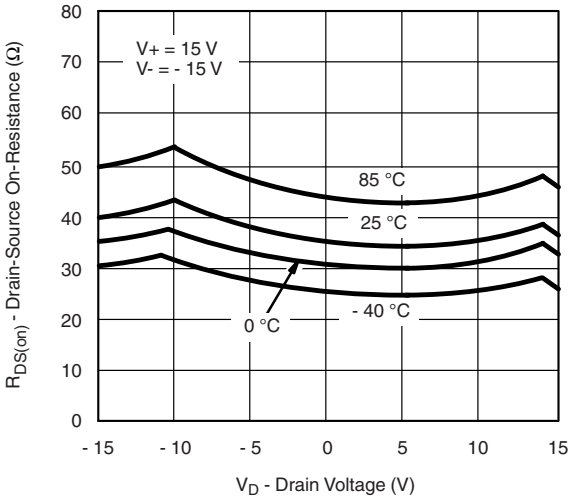
Notes

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_{IN} = input voltage to perform proper function

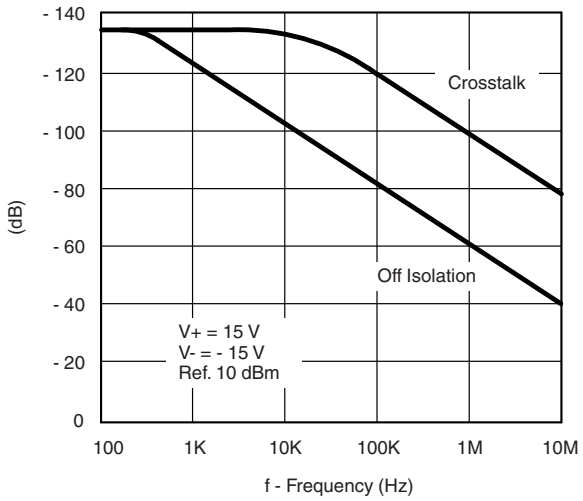
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

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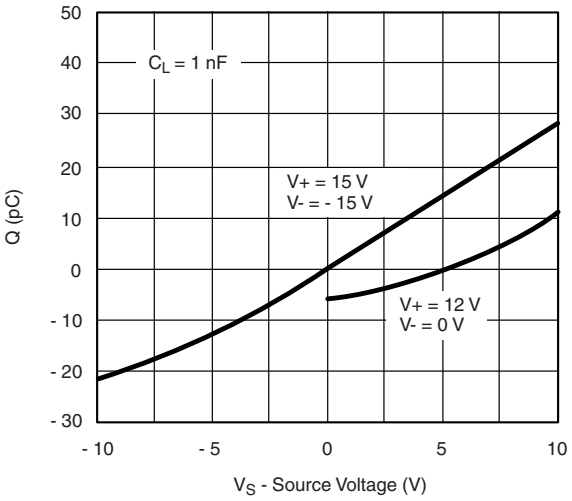
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



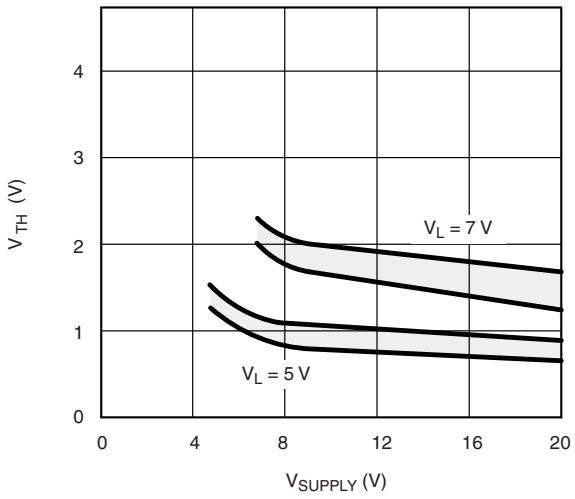
$R_{DS(on)}$ vs. V_D and Temperature



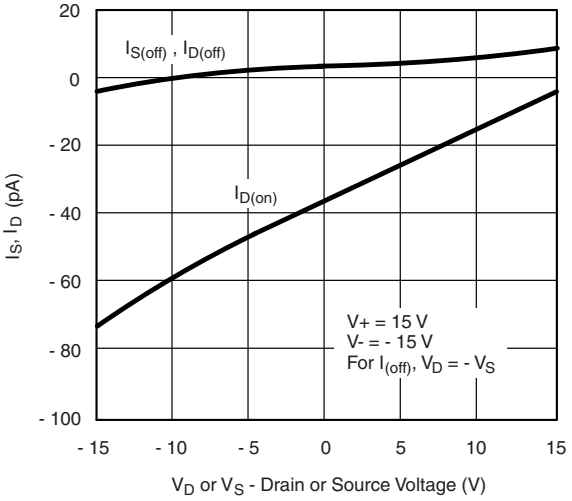
Crosstalk and Off Isolation vs. Frequency



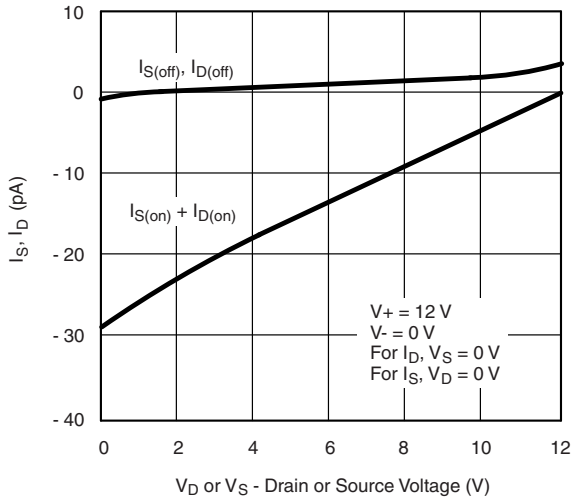
Charge Injection vs. Source Voltage



Switching Threshold vs. Supply Voltage



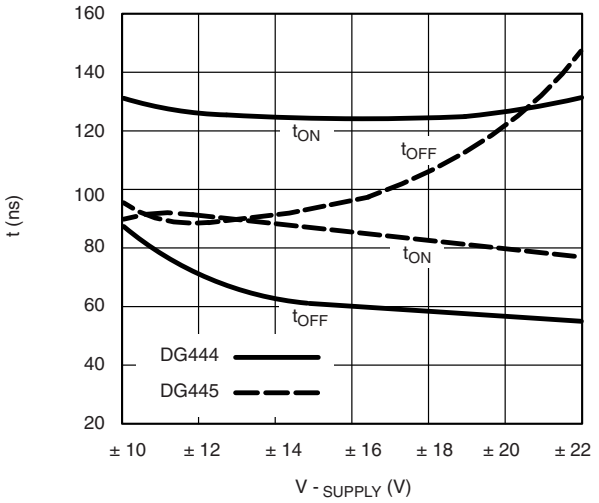
Source/Drain Leakage Currents



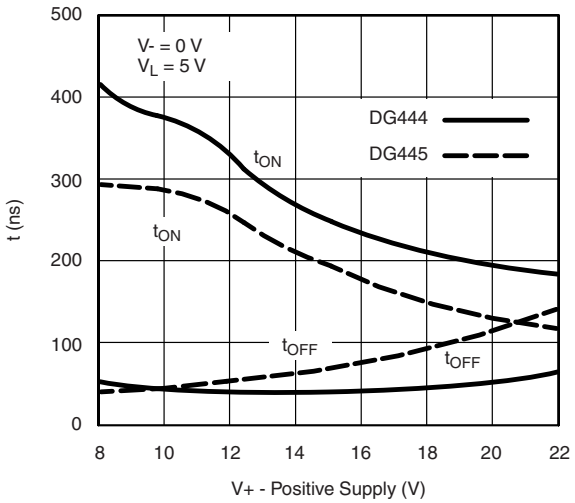
Source/Drain Leakage Currents (Single 12-V Supply)

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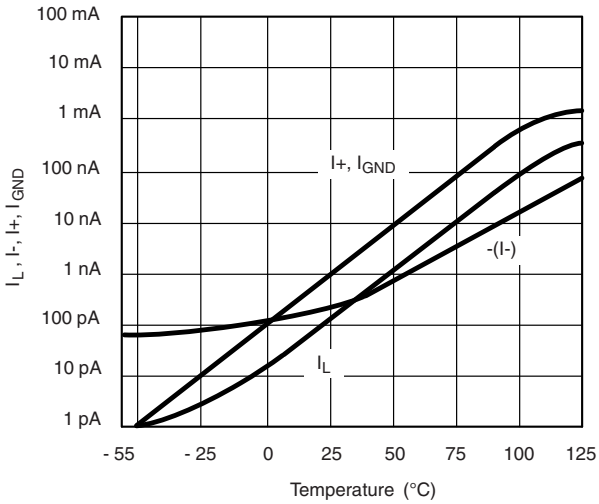
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



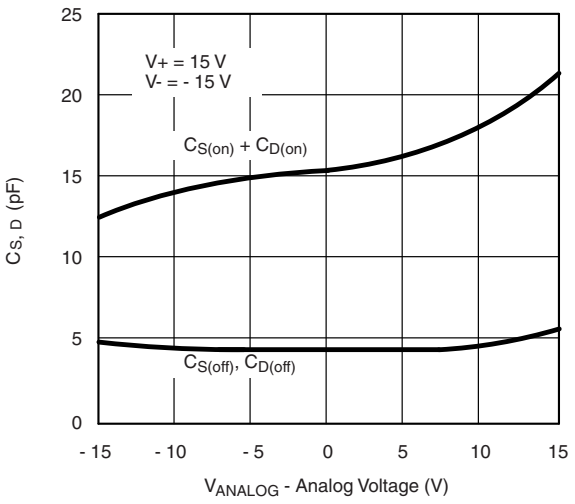
Switching Time vs. Power Supply Voltage



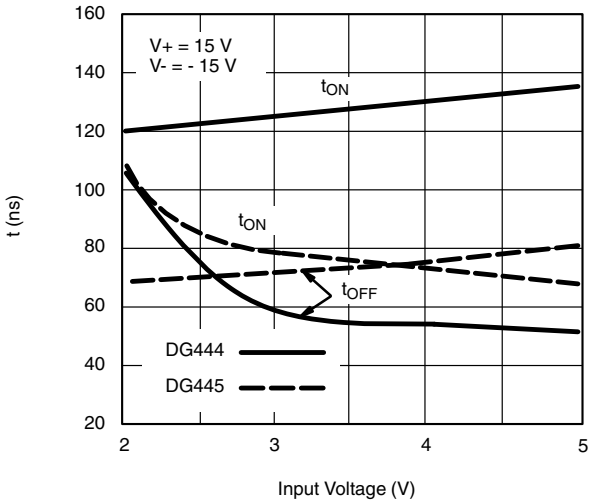
Switching Times vs. Power Supply Voltage



Supply Current vs. Temperature



Source/Drain Capacitance vs. Analog Voltage



Switching Time vs. Input Voltage

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SCHEMATIC DIAGRAM TYPICAL CHANNEL

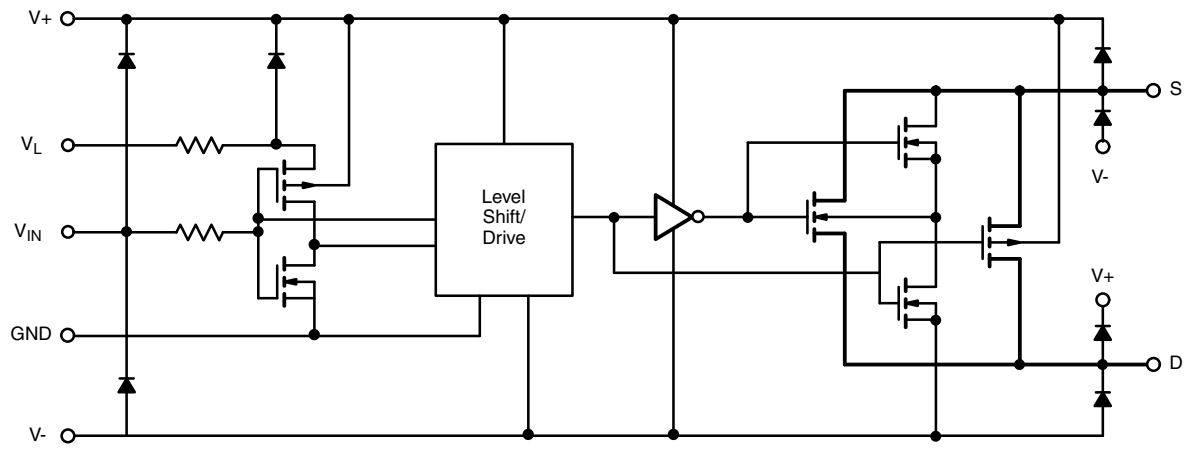
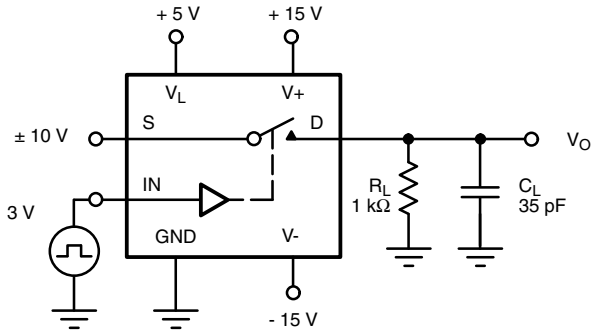
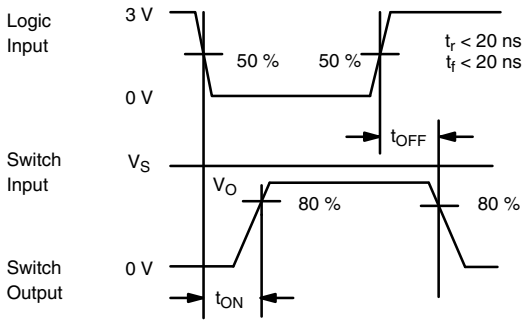


Fig. 1

TEST CIRCUITS

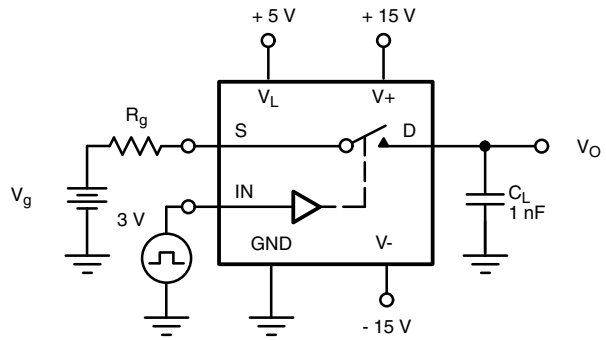


C_L (includes fixture and stray capacitance)



Note: Logic input waveform is inverted for DG445.

Fig. 2 - Switching Time



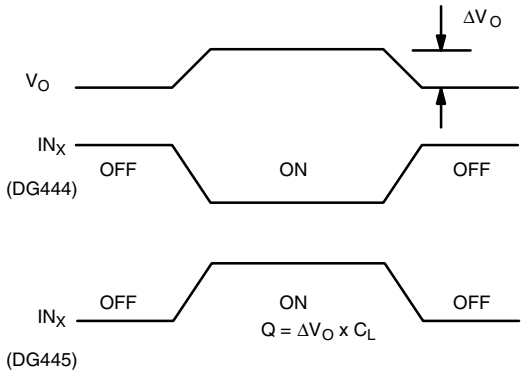


Fig. 3 - Charge Injection

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TEST CIRCUITS

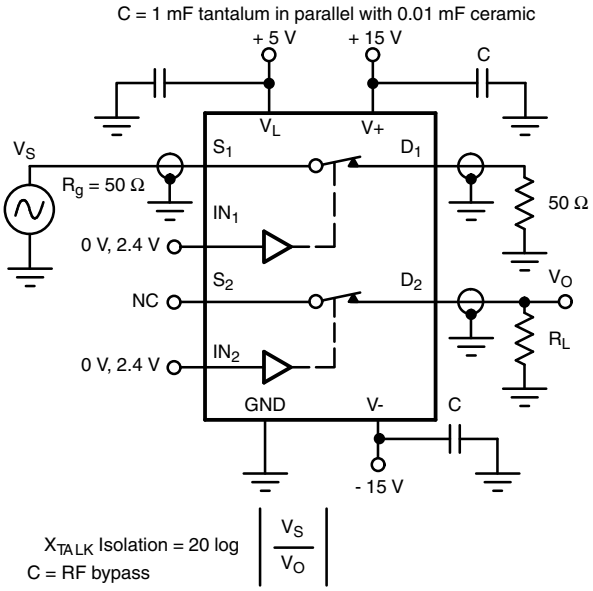


Fig. 4 - Crosstalk

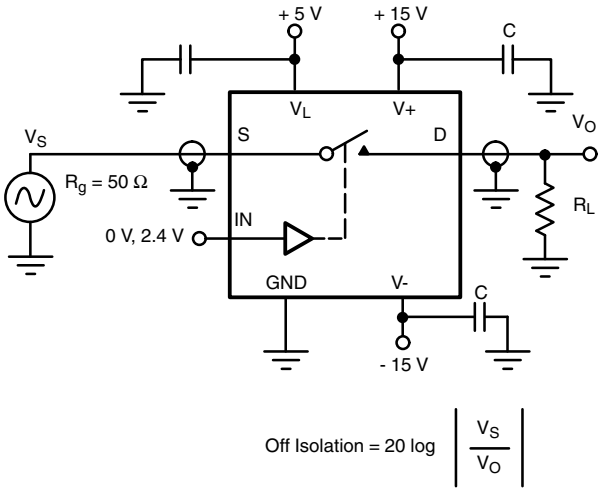


Fig. 5 - Off Isolation

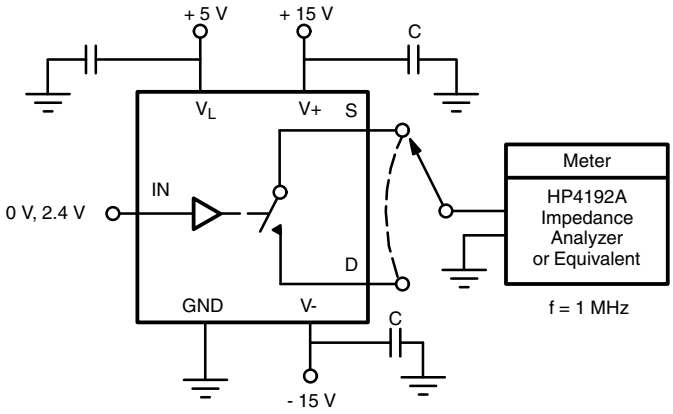


Fig. 6 - Source/Drain Capacitances

APPLICATIONS

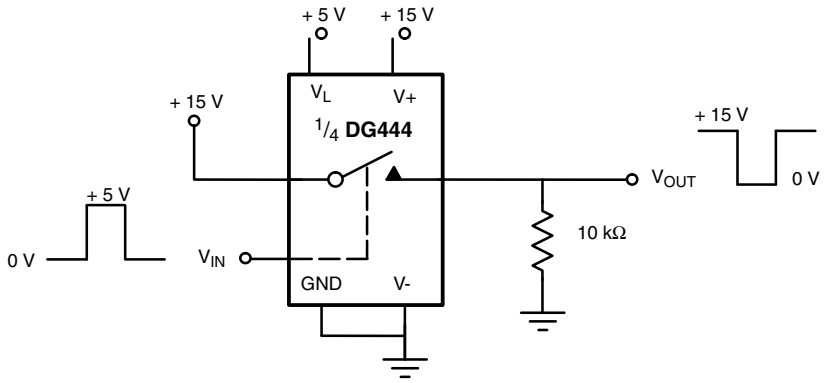


Fig. 7 - Level Shifter

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APPLICATIONS

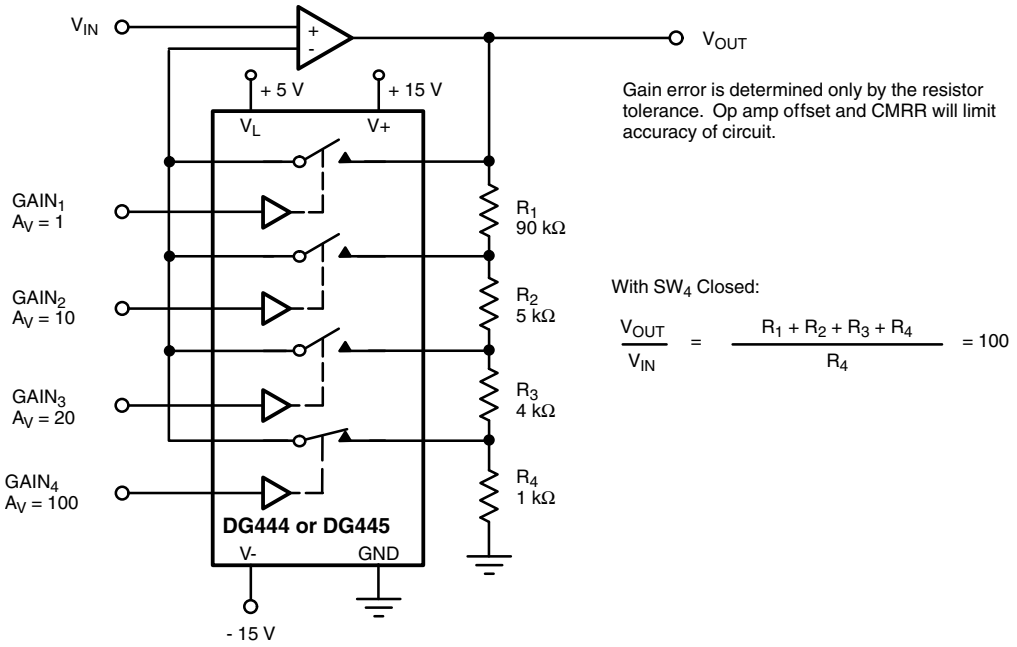


Fig. 8 - Precision-Weighted Resistor Programmable-Gain Amplifier

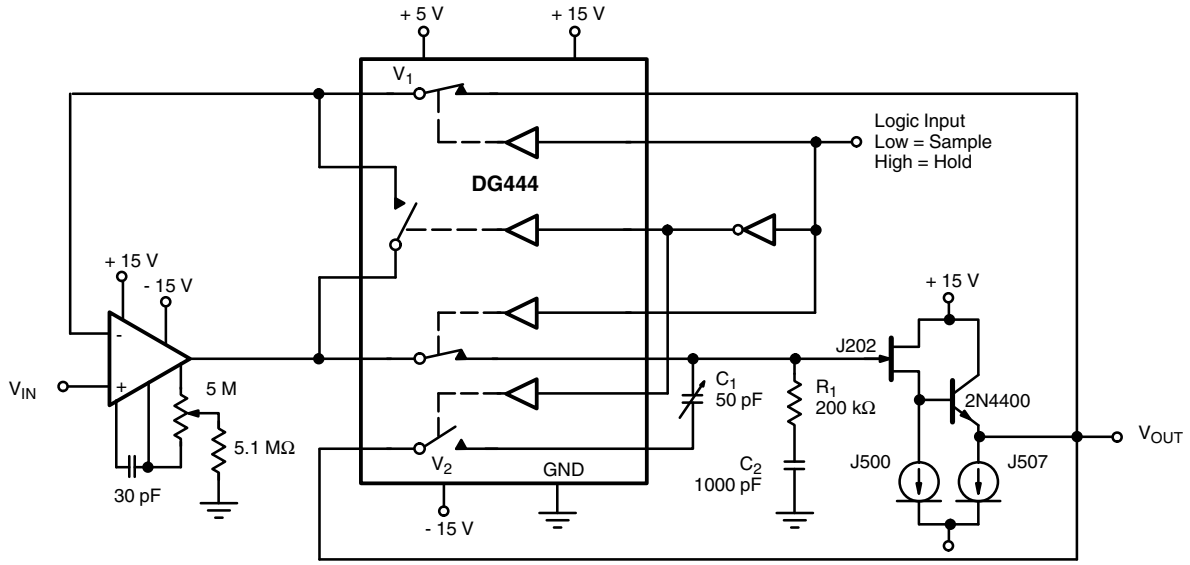


Fig. 9 - Precision Sample-and-Hold

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PRODUCT SUMMARY		
Part number	DG444	DG445
Status code	2	2
Configuration	SPST x 4, NC	SPST x 4, NO
Single supply min. (V)	5	5
Single supply max. (V)	36	36
Dual supply min. (V)	5	5
Dual supply max. (V)	20	20
On-resistance (Ω)	50	50
Charge injection (pC)	-1	-1
Source on capacitance (pF)	16	16
Source off capacitance (pF)	4	4
Leakage switch on typ. (nA)	0.08	0.08
Leakage switch off max. (nA)	0.5	0.5
-3 dB bandwidth (MHz)	-	-
Package	SO-16 (narrow) AS	SO-16 (narrow) AS
Functional circuit / applications	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare
Interface	Binary	Binary
Single supply operation	Yes	Yes
Dual supply operation	Yes	Yes
Turn on time max. (ns)	250 at ± 15 V / 450 at 12 V	250 at ± 15 V / 450 at 12 V
Crosstalk and off isolation (dB)	100	100

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.

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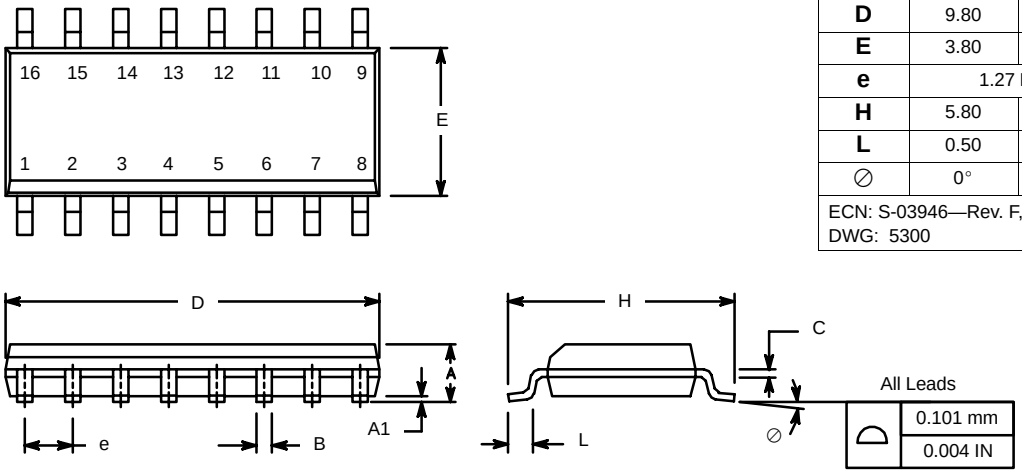
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SOIC (NARROW): 16-LEAD

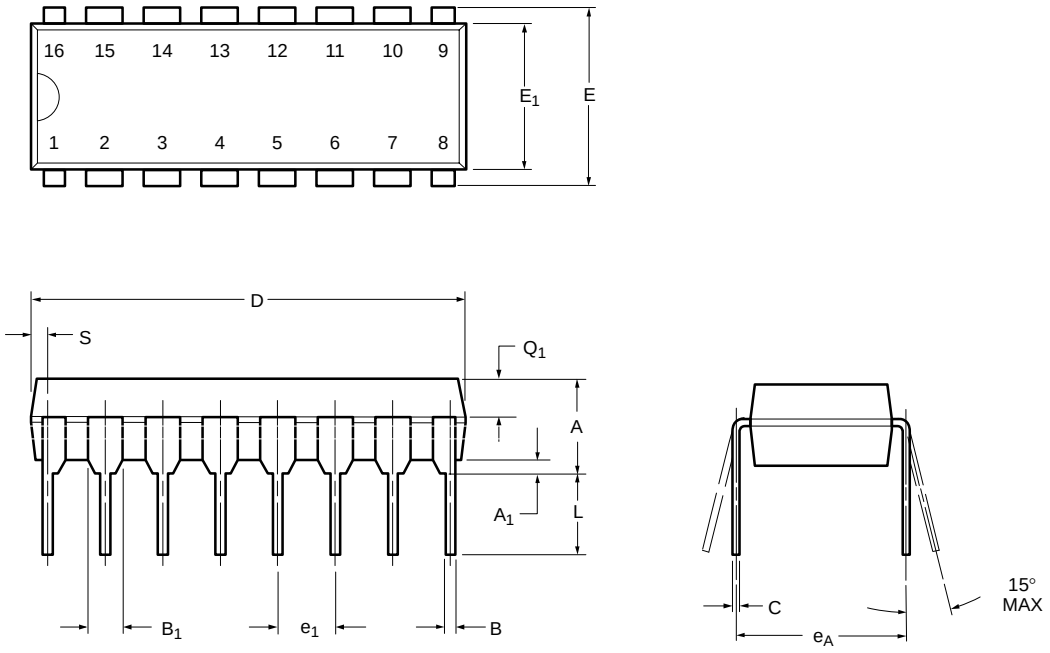
JEDEC Part Number: MS-012

Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A_1	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

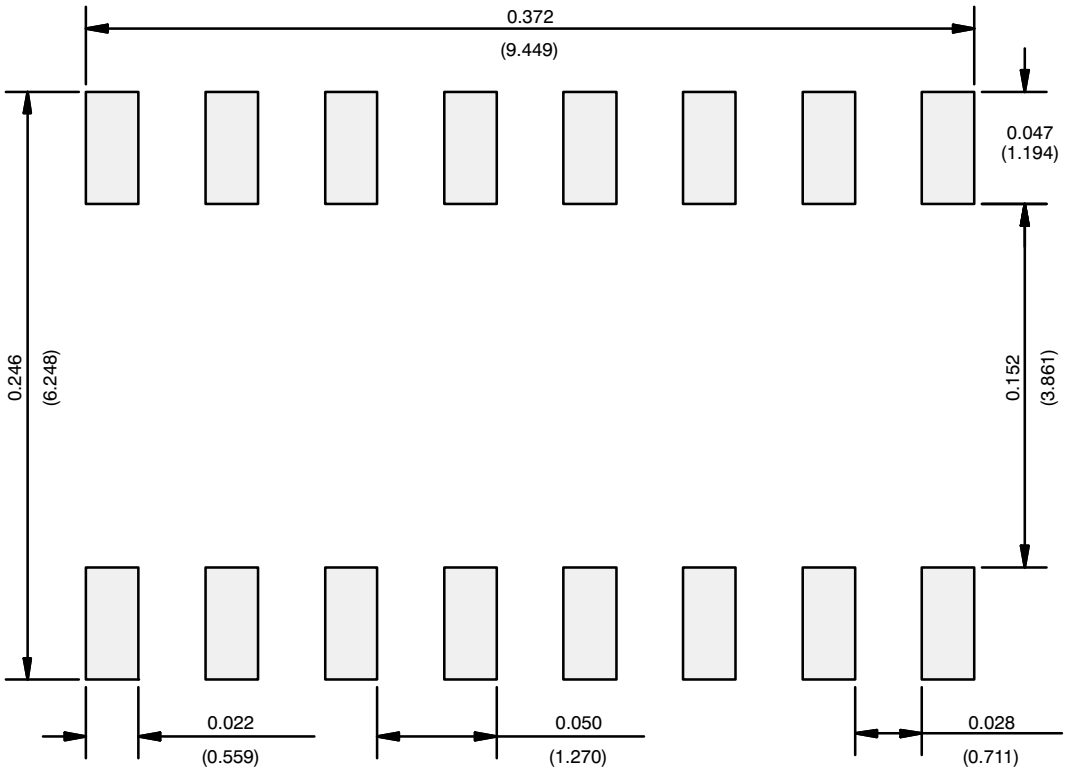


PDIP: 16-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	3.81	5.08	0.150	0.200
A_1	0.38	1.27	0.015	0.050
B	0.38	0.51	0.015	0.020
B_1	0.89	1.65	0.035	0.065
C	0.20	0.30	0.008	0.012
D	18.93	21.33	0.745	0.840
E	7.62	8.26	0.300	0.325
E_1	5.59	7.11	0.220	0.280
e_1	2.29	2.79	0.090	0.110
e_A	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
Q_1	1.27	2.03	0.050	0.080
S	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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