Precision Monolithic Quad SPST CMOS Analog Switches

DESCRIPTION

The DG411HS series of monolithic quad analog switches was designed to provide high speed, low error switching of precision analog signals. Combining low power (0.35 µW) with high speed (t_{on}: 68 ns), the DG411HS family is ideally suited for portable and battery powered industrial and military applications.

To achieve high-voltage ratings and superior switching performance, the DG411HS series was 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 up to the supply levels when off.

The DG411HS and DG412HS respond to opposite control logic as shown in the Truth Table. The DG413HS has two normally open and two normally closed switches.

BENEFITS

- Widest dynamic range
- Low signal errors and distortion
- Break-before-make switching action
- Simple interfacing

FEATURES

- 44 V supply max. rating
- ± 15 V analog signal range
- On-resistance - $R_{DS(on)}$: 25 Ω
- Fast switching - t_{on}: 68 ns
- Ultra low power - P_D: 0.35 µW
- TTL, CMOS compatible
- Single supply capability
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free Available

RoHS* Available

Note

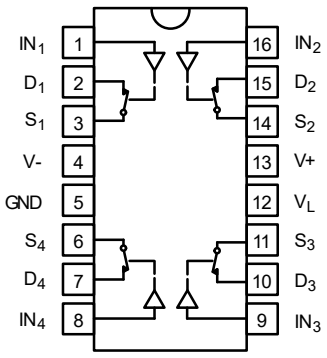
* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

APPLICATIONS

- Precision automatic test equipment
- Precision data acquisition
- Communication systems
- Battery powered systems
- Computer peripherals

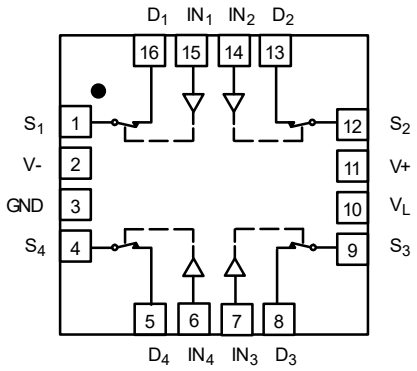
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG411HS, DG412HS
Dual-In-Line and SOIC



Top View

DG411HS, DG412HS
QFN16



Top View

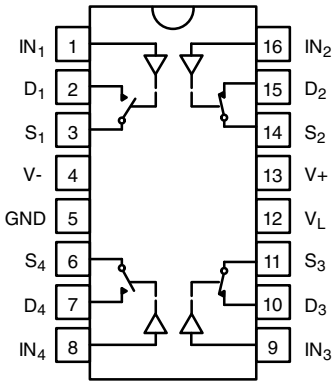
TRUTH TABLE		
LOGIC	**DG411HS**	**DG412HS**
0	On	Off
1	Off	On

For technical questions, contact: analogswitchtechsupport@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

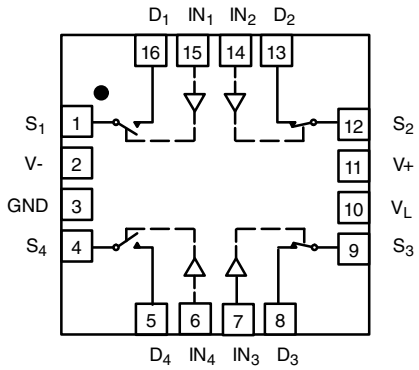
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG413HS
SOIC



Top View

DG413HS
QFN16



Top View

TRUTH TABLE		
LOGIC	**SW1, SW4**	**SW2, SW3**
0	Off	On
1	On	Off

ORDERING INFORMATION		
TEMP. RANGE	**PACKAGE**	**PART NUMBER**
DG411HS, DG412HS		
-40 °C to +85 °C	16-pin plastic DIP	DG411HSDJ-E3
		DG412HSDJ-E3
	16-pin narrow SOIC	DG411HSDY-E3 DG411HSDY-T1-E3
		DG412HSDY-E3 DG412HSDY-T1-E3
	16-pin QFN 4 x 4 mm (variation 1)	DG411HSDN-T1-E4
		DG412HSDN-T1-E4
DG413HS		
-40 °C to +85 °C	16-pin narrow SOIC	DG413HSDY-E3 DG413HSDY-T1-E3
	16-pin QFN 4 x 4 mm (variation 1)	DG413HSDN-T1-E4

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

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
Peak current, S or D (pulsed at 1 ms, 10 % duty cycle max.)		100	
Storage temperature	(AK, AZ suffix)	-65 to +150	°C
	(DJ, DY, DN suffix)	-65 to +125	
Power dissipation (package) [b]	16-pin plastic DIP [c]	470	mW
	16-pin narrow SOIC [d]	600	
	16-pin (4 x 4 mm) QFN [f]	1880	

Notes
a. Signals on SX, DX, or INX 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 25 °C
d. Derate 7.6 mW/°C above 75 °C
e. Derate 12 mW/°C above 75 °C
f. Derate 23.5 mW/°C above 70 °C

SPECIFICATIONS [a]

PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS SPECIFIED V+ = 15 V, V- = -15 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]**	**TEMP. [b]**	**TYP. [c]**	**A SUFFIX -55 °C TO +125 °C**		**D SUFFIX - 40 °C TO +85 °C**		**UNIT**
					MIN. [d]	**MAX. [d]**	**MIN. [d]**	**MAX. [d]**	
Analog Switch									
Analog signal range [e]	V_{ANALOG}		Full	-	-15	15	-15	15	V
Drain-source on-resistance	$R_{DS(on)}$	V+ = 13.5 V, V- = - 13.5 V , I_S = -10 mA, V_D = ± 8.5 V	Room	25	-	35	-	35	Ω
			Full	-	-	45	-	45	
Switch off leakage current	$I_{S(off)}$	V+ = 16.5 V, V- = -16.5 V , V_D = ± 15.5 mA, V_S = ± 15.5 V	Room	± 0.1	-0.25	0.25	-0.25	0.25	nA
			Full	-	-20	20	-5	5	
	$I_{D(off)}$		Room	± 0.1	-0.25	0.25	-0.25	0.25	
			Full	-	-20	20	-5	5	
Channel on leakage current	$I_{D(on)}$	V+ = 16.5 V, V- = -16.5 V , V_D = V_S = ± 15.5 V	Room	± 0.1	-0.4	0.4	-0.4	0.4	
			Full	-	-40	40	-10	40	
Digital Control									
Input current, V_{IN} low	I_{IL}	V_{IN} under test = 0.8 V	Full	0.005	-0.5	0.5	-0.5	0.5	µA
Input current, V_{IN} high	I_{IH}	V_{IN} under test = 2.4 V	Full	0.005	-0.5	0.5	-0.5	0.5	
Input capacitance [e]	C_{IN}	f = 1 MHz	Room	5	-	-	-	-	pF
Dynamic Characteristics									
Turn-on time	t_{on}	R_L = 300 Ω, C_L = 35 pF V_S = ± 10 V, see Fig. 2	Room	68	-	105	-	105	ns
			Full	-	-	127	-	116	
Turn-off time	t_{off}		Room	42	-	80	-	80	
			Full	-	-	94	-	90	
Break-before-make time delay	t_D	DG413HS only, V_S = 10 V, R_L = 300 Ω, C_L = 35 pF	Room	20	-	-	-	-	
Charge injection [e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 10 nF	Room	22	-	-	-	-	pC
Off Isolation [e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room	- 91	-	-	-	-	dB
Channel-to-channel crosstalk [e]	X_{TALK}		Room	- 88	-	-	-	-	
Source off capacitance [e]	$C_{S(off)}$	f = 1 MHz	Room	12	-	-	-	-	pF
Drain off capacitance [e]	$C_{D(off)}$		Room	12	-	-	-	-	
Channel on capacitance [e]	$C_{D(on)}$		Room	30	-	-	-	-	
Power Supplies									

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

SPECIFICATIONS [a]									
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS SPECIFIED V+ = 15 V, V- = -15 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]	TEMP.[b]	TYP.[c]	A SUFFIX -55 °C TO +125 °C		D SUFFIX - 40 °C TO +85 °C		UNIT
					MIN.[d]	MAX.[d]	MIN.[d]	MAX.[d]	
Positive supply current	I+	V+ = 16.5 V, V- = -16.5 V, V_{IN} = 0 V or 5 V	Room	0.0001	-	1	-	1	µA
			Full	-	-	5	-	5	
Negative supply current	I-		Room	-0.0001	-1	-	-1	-	
			Full	-	-5	-	-5	-	
Logic supply current	I_L		Room	0.0001	-	1	-	1	
			Full	-	-	5	-	5	
Ground current	I_{GND}		Room	-0.0001	-1	-	-1	-	
			Full	-	-5	-	-5	-	

SPECIFICATIONS [a] (for unipolar supplies)									
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS SPECIFIED V+ = 12 V, V- = 0 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]	TEMP.[b]	TYP.[c]	A SUFFIX -55 °C TO +125 °C		D SUFFIX - 40 °C TO +85 °C		UNIT
					MIN.[d]	MAX.[d]	MIN.[d]	MAX.[d]	
Analog Switch									
Analog signal range [e]	V_{ANALOG}		Full	-	-	12	-	12	V
Drain-source on-resistance	$R_{DS(on)}$	V+ = 10.8 V, I_S = -10 mA, V_D = 3 V, 8 V	Room	49	-	80	-	80	Ω
			Full	-	-	100	-	100	
Dynamic Characteristics									
Turn-on time	t_{on}	R_L = 300 Ω, C_L = 35 pF, VS = 8 V, see Fig. 2	Room	95	-	140	-	140	ns
			Hot	-	-	180	-	160	
Turn-off time	t_{off}		Room	36	-	70	-	70	
			Hot	-	-	79	-	74	
Break-before-make time delay	t_D	DG413HS only, VS = 8 V, R_L = 300 Ω, C_L = 35 pF	Room	60	-	-	-	-	
Charge injection	Q	V_g = 6 V, R_g = 0 Ω, C_L = 1 nF	Room	60	-	-	-	-	pC
Power Supplies									
Positive supply current	I+	V+ = 13.2 V, V_{IN} = 0 V or 5 V	Room	0.0001	-	1	-	1	µA
			Hot	-	-	5	-	5	
Negative supply current	I-		Room	-0.0001	-1	-	-1	-	
			Hot	-	-5	-	-5	-	
Logic supply current	I_L		Room	0.0001	-	1	-	1	
			Hot	-	-	5	-	5	
Ground current	I_{GND}		Room	-0.0001	-1	-	-1	-	
			Hot	-	-5	-	-5	-	

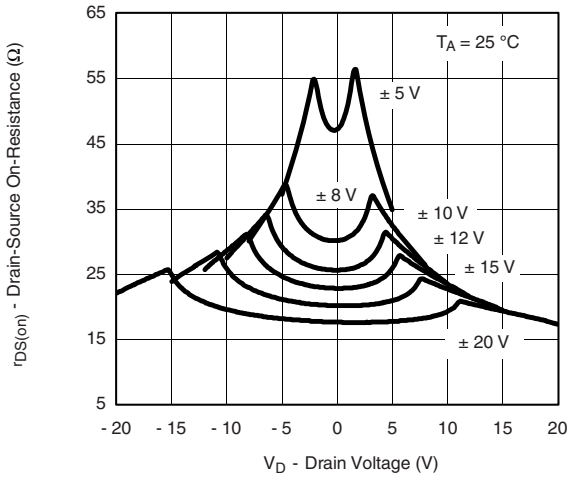
Notes

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_{IN} = input voltage to perform proper function

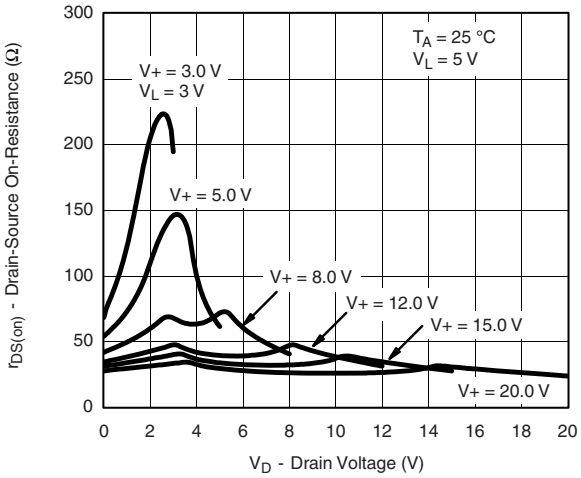
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

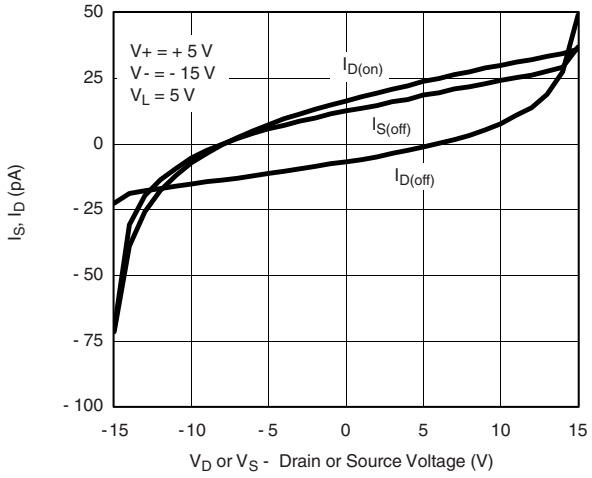
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



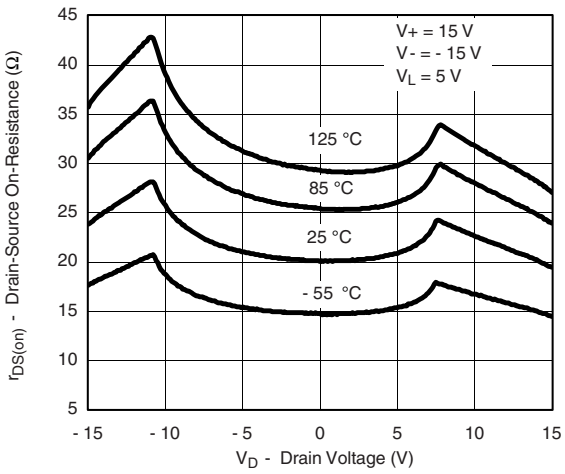
On-Resistance vs. V_D and Dual Supply Voltage



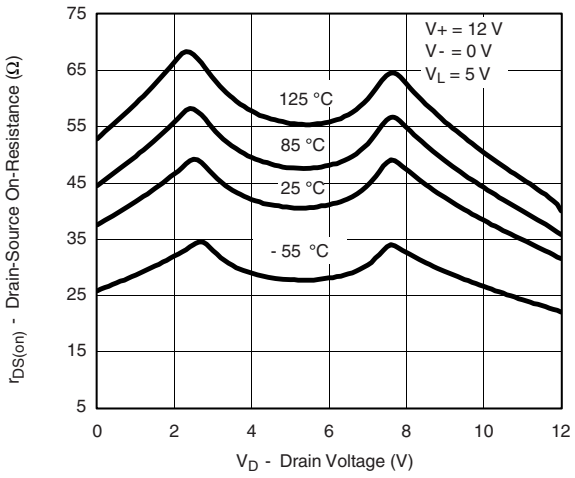
On-Resistance vs. V_D and Unipolar Supply Voltage



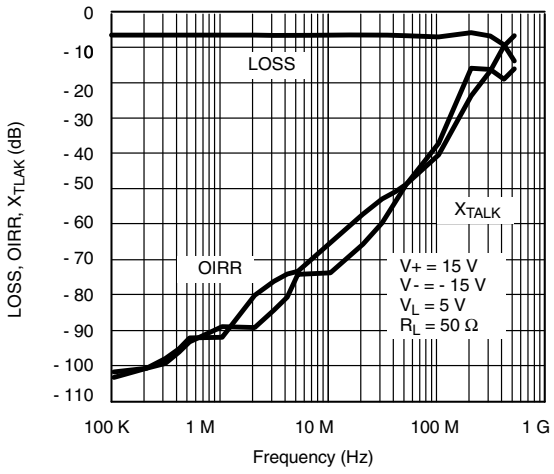
Leakage Current vs. Analog Voltage



On-Resistance vs. V_D and Temperature



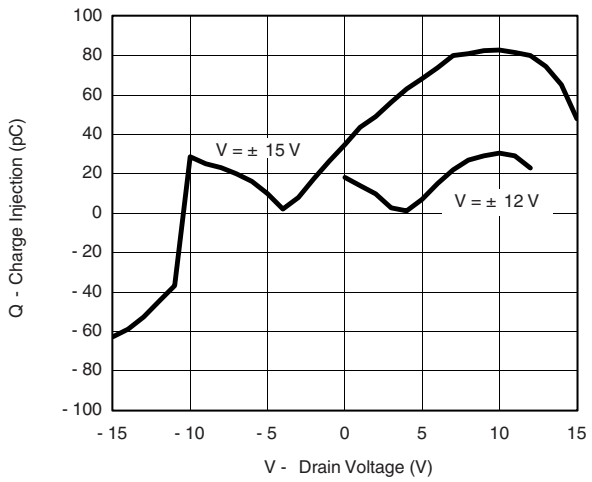
On-Resistance vs. V_D and Temperature



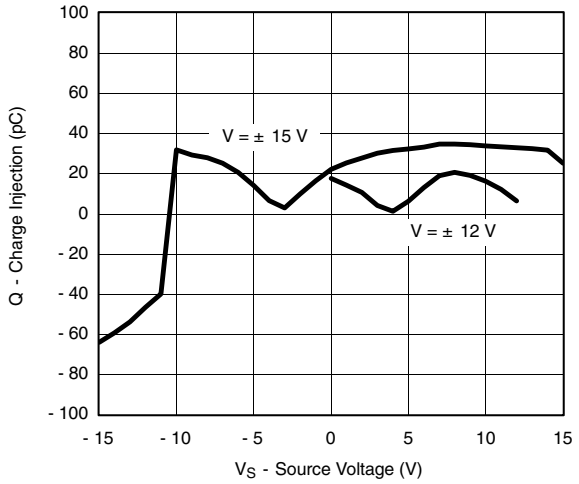
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

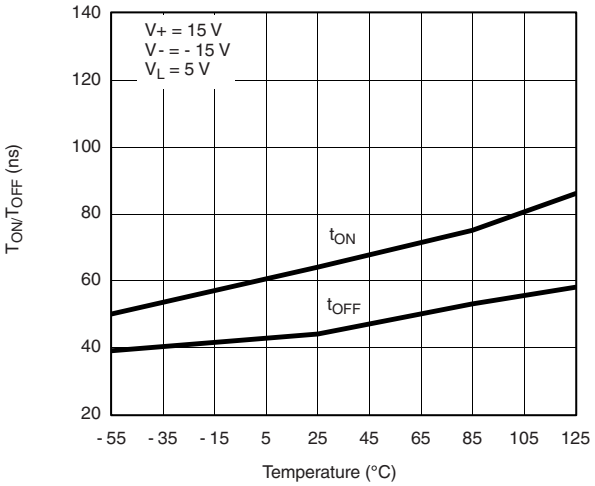
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



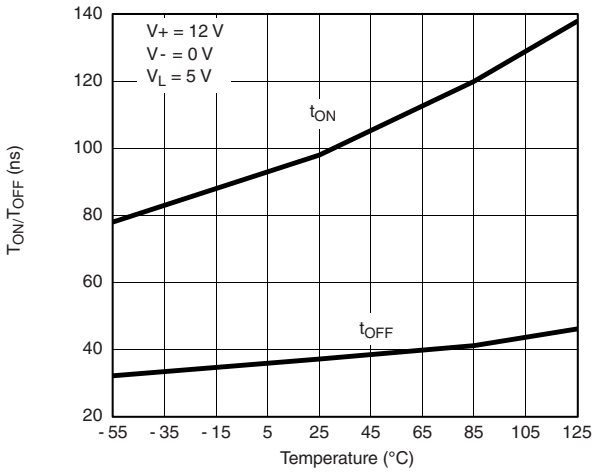
Charge Injection vs. Analog Voltage



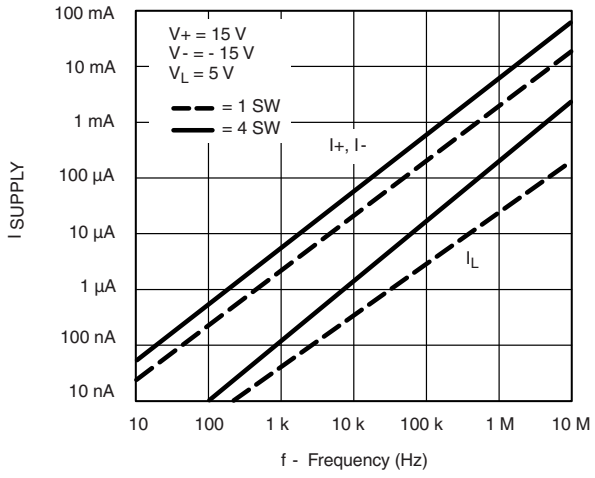
Charge Injection vs. Analog Voltage



Switching Time vs. Temperature



Switching Time vs. Temperature



Supply Current vs. Input Switching Frequency

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

SCHEMATIC DIAGRAM (typical channel)

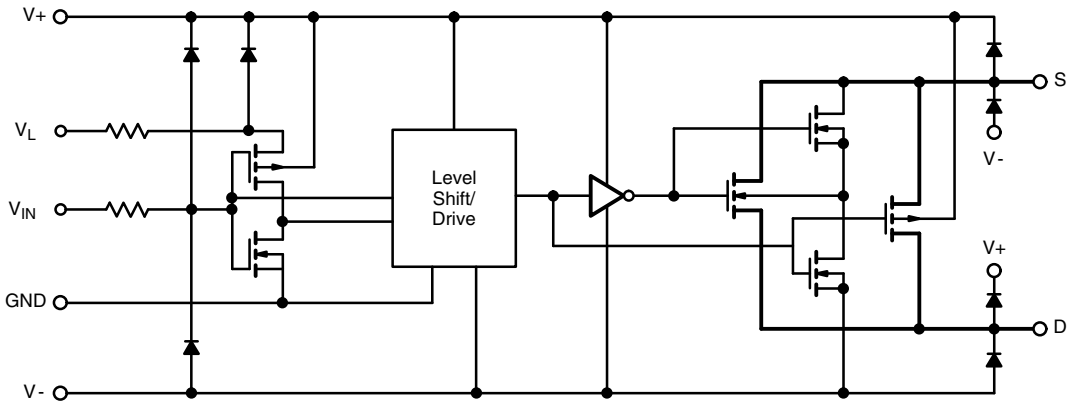
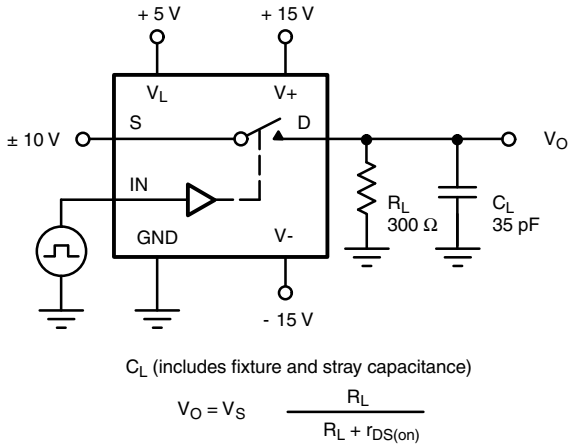


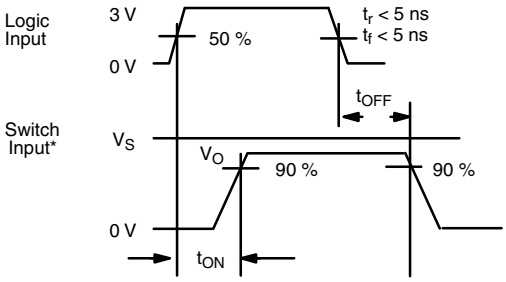
Fig. 1

TEST CIRCUITS



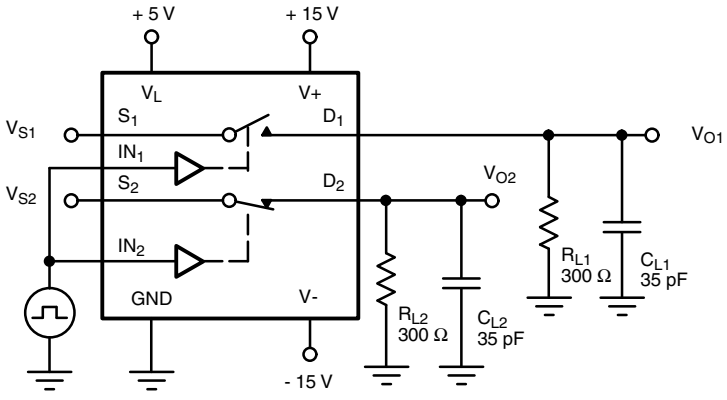
C_L (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$



Note: Logic input waveform is inverted for switches that have the opposite logic sense control

Fig. 2 - Switching Time



C_L (includes fixture and stray capacitance)

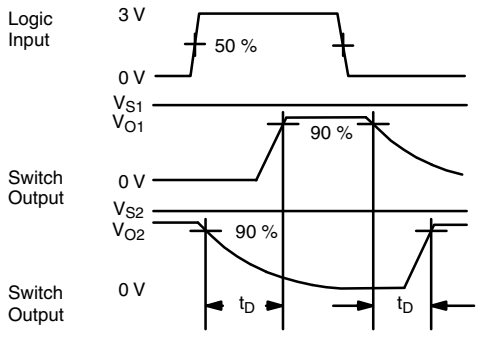


Fig. 3 - Break-Before-Make (DG413HS)

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

TEST CIRCUITS

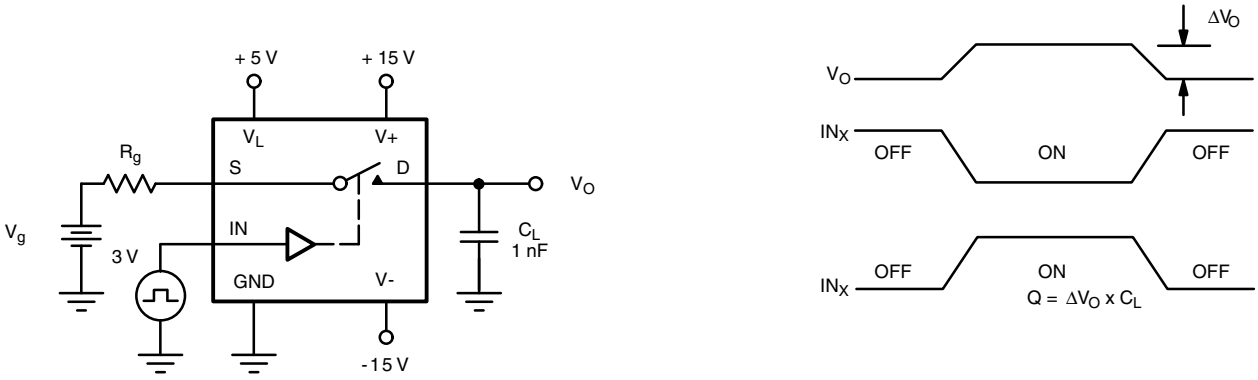


Fig. 4 - Charge Injection

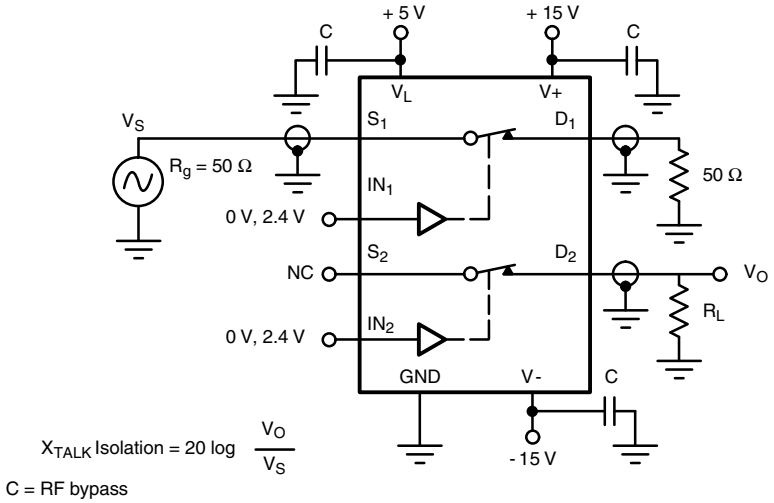


Fig. 5 - Crosstalk

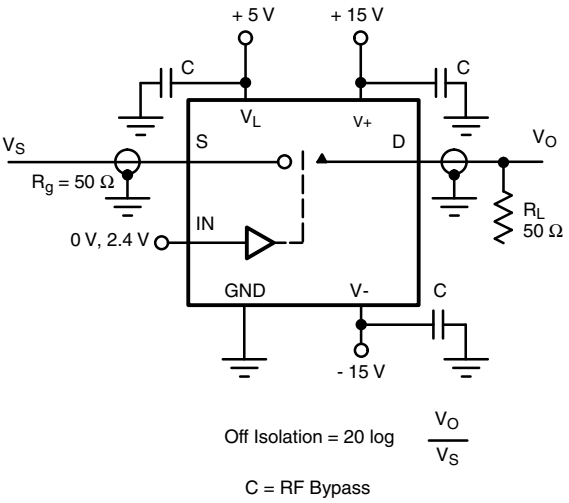


Fig. 6 - Off-Isolation

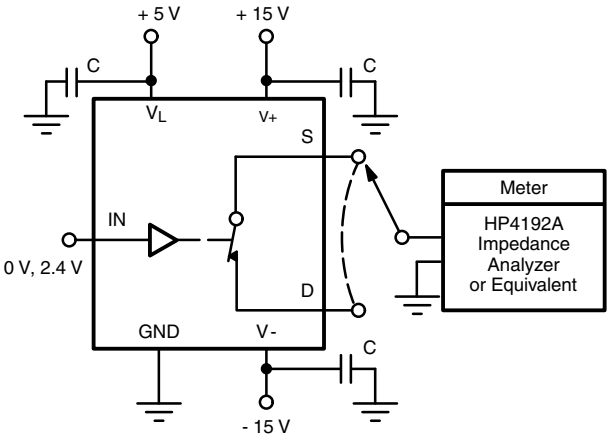


Fig. 7 - Source/Drain Capacitances

For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

PRODUCT SUMMARY							
Part number	DG411HS	DG411HS	DG411HS	DG412HS	DG412HS	DG413HS	DG413HS
Status code	2	2	2	2	2	2	2
Configuration	SPST x 4, NC	SPST x 4, NC	SPST x 4, NC	SPST x 4, NO	SPST x 4, NO	SPST x 4, comp	SPST x 4, comp
Single supply min. (V)	5	5	5	5	5	5	5
Single supply max. (V)	36	36	36	36	36	36	36
Dual supply min. (V)	5	5	5	5	5	5	5
Dual supply max. (V)	22	22	22	22	22	22	22
On-resistance (Ω)	35	35	35	35	35	35	35
Charge injection (pC)	22	22	22	22	22	22	22
Source on capacitance (pF)	30	30	30	30	30	30	30
Source off capacitance (pF)	12	12	12	12	12	12	12
Leakage switch on typ. (nA)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Leakage switch off max. (nA)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
-3 dB bandwidth (MHz)	-	-	-	-	-	-	-
Package	Plastic DIP-16	SO-16 (narrow) AS	QFN-16 4 x 4	Plastic DIP-16	SO-16 (narrow) AS	SO-16 (narrow) AS	QFN-16 4 x 4
Functional circuit / applications	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation	Multi purpose, medical and healthcare, instrumentation
Interface	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Single supply operation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dual supply operation	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Turn on time max. (ns)	105	105	105	105	105	105	105
Crosstalk and off isolation	-91	-91	-91	-91	-91	-91	-91

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?72053.

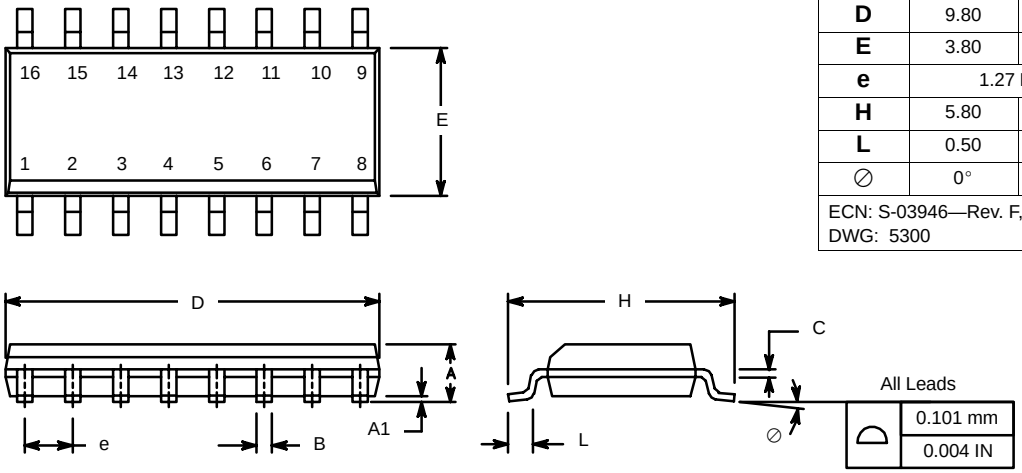
For technical questions, contact: analogswitchtechsupport@vishay.com
THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

SOIC (NARROW): 16-LEAD

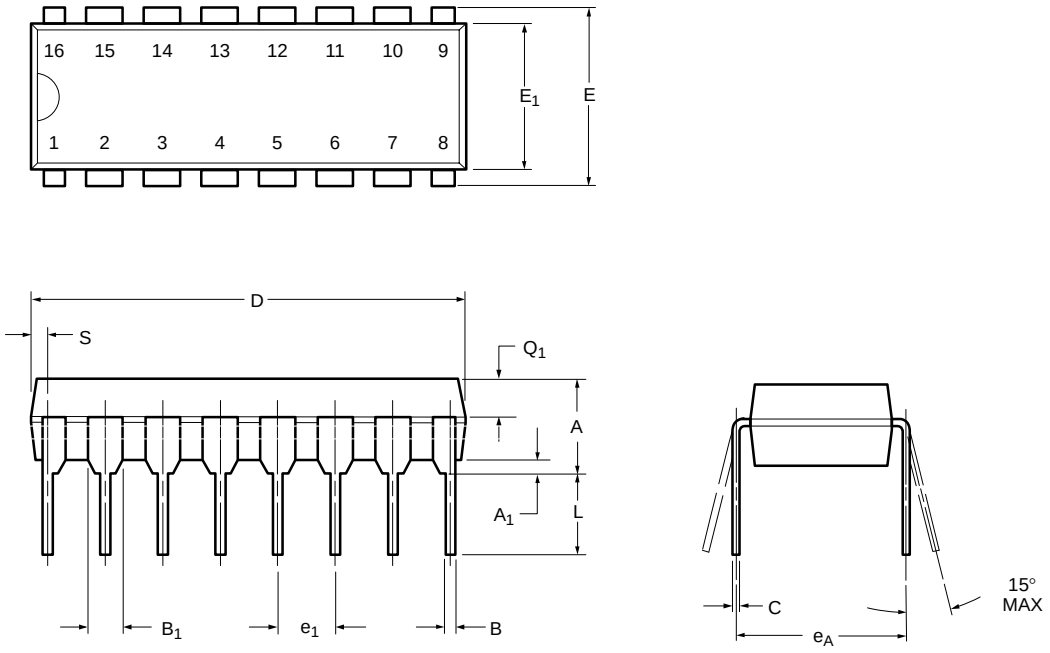
JEDEC Part Number: MS-012

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

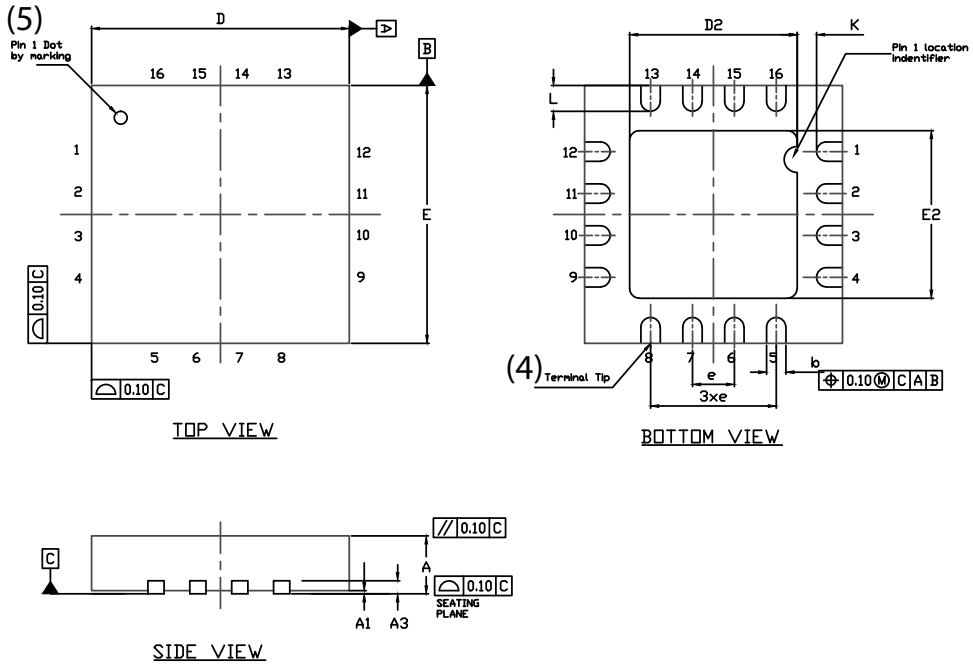


PDIP: 16-LEAD



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				

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

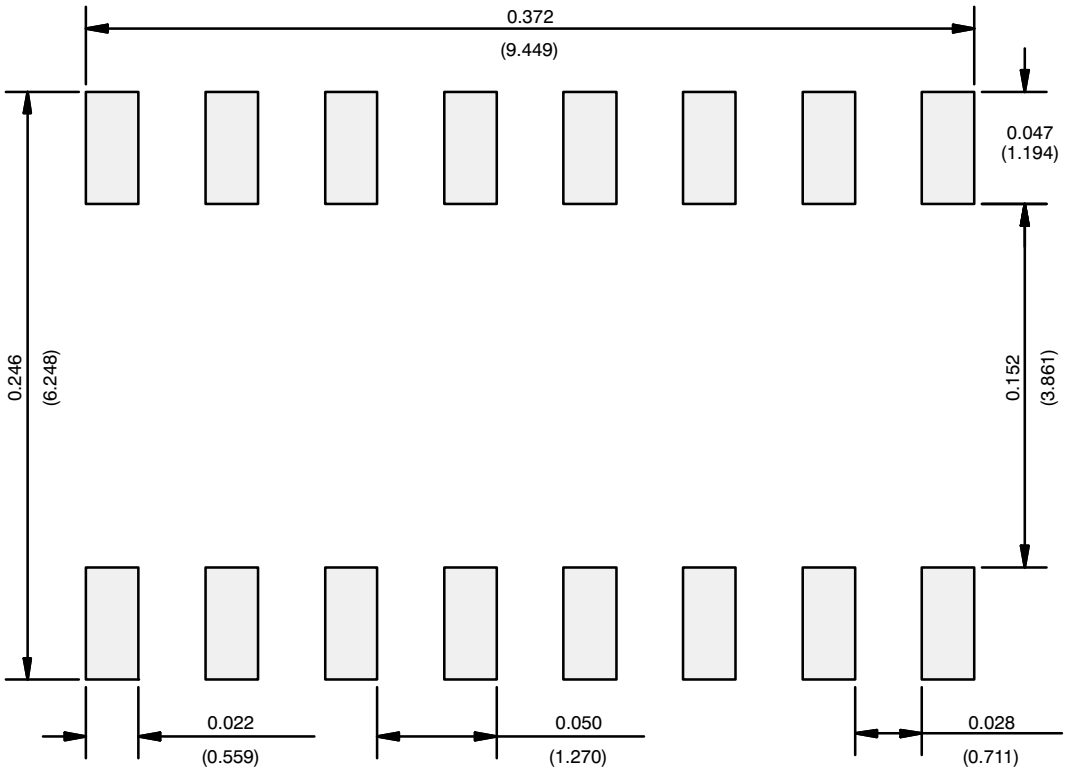
(1) Use millimeters as the primary measurement.
(2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
(3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
(4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 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.

ECN: S13-0893-Rev. B, 22-Apr-13
DWG: 5890

For technical questions, contact: powerictechsupport@vishay.com

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

Return to Index

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.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Vishay products are not designed for use in life-saving or life-sustaining applications or any application in which the failure of the Vishay product could result in personal injury or death unless specifically qualified in writing by Vishay. 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.

© 2024 VISHAY INTERTECHNOLOGY, INC. ALL RIGHTS RESERVED

THIS DOCUMENT IS SUBJECT TO CHANGE WITHOUT NOTICE. THE PRODUCTS DESCRIBED HEREIN AND THIS DOCUMENT ARE SUBJECT TO SPECIFIC DISCLAIMERS, SET FORTH AT www.vishay.com/doc?91000