

## Low-Voltage, Low $R_{ON}$ Quad SPST Analog Switch

### DESCRIPTION

The DG2041/2042/2043 are quad single-pole/single-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, fast switching, low on-resistance ( $R_{DS(on)}$ :  $1\ \Omega$  at 2.7 V) and small physical size, the DG2041/2042/2043 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2041/2042/2043 are built on Vishay Siliconix's new high density low voltage process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

### FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance -  $R_{DS(on)}$ :  $1\ \Omega$
- Fast Switching - 14 ns  $t_{ON}$
- Low Charge Injection -  $Q_{INJ}$ : 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- TSSOP-16 and QFN-16 Packages
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

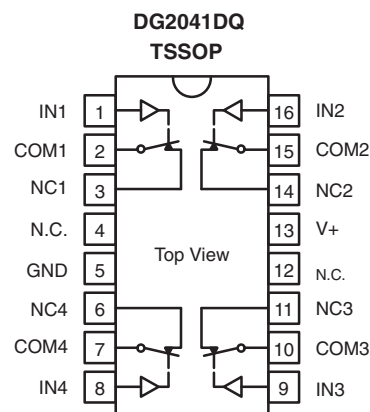
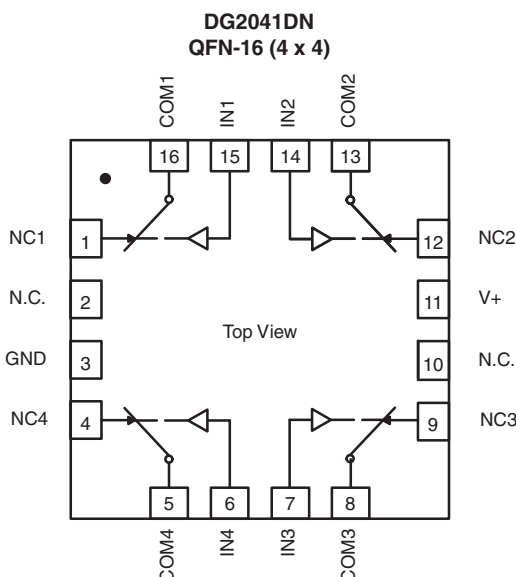
### BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space

### APPLICATIONS

- Cellular Phones
- Communication Systems
- Portable Test Equipment
- Battery Operated Systems
- Sample and Hold Circuits

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION - DG2041

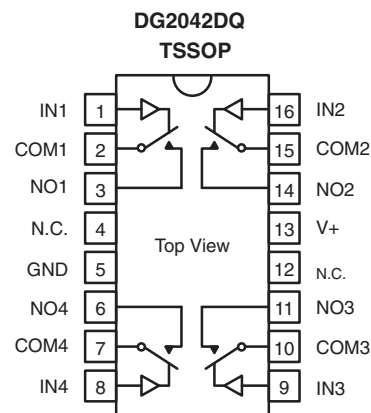
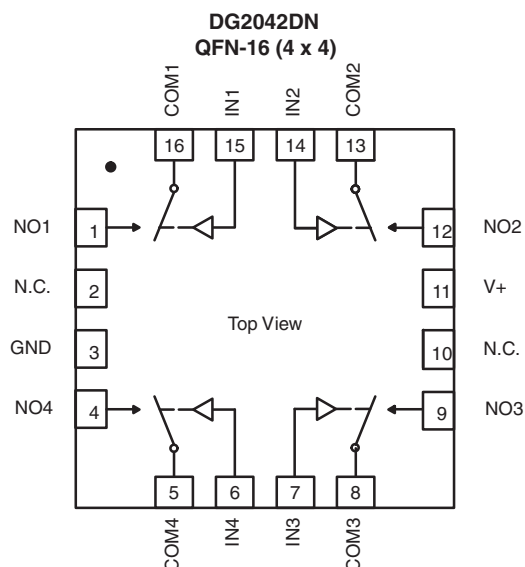


### TRUTH TABLE - DG2041

Logic	Switch
0	On
1	Off

Switches Shown for Logic "0" Input

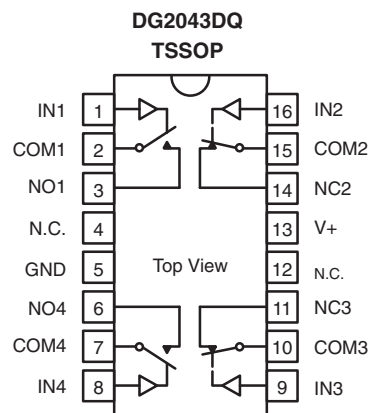
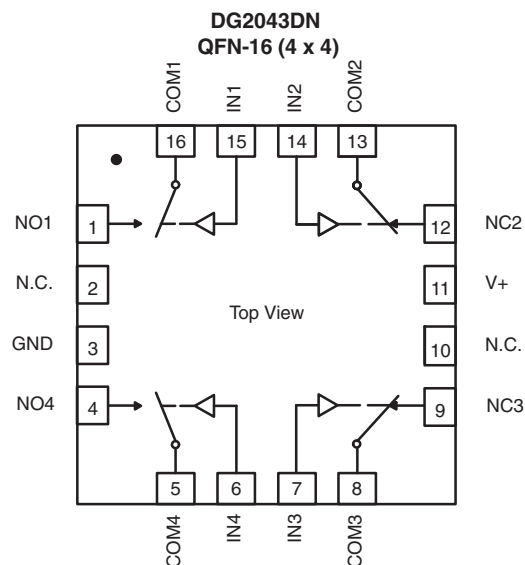
## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION - DG2042, DG2043



**TRUTH TABLE - DG2042**

Logic	Switch
0	Off
1	On

Switches Shown for Logic "0" Input



**TRUTH TABLE - DG2043**

Logic	Switches 1, 4	Switches 2, 3
0	Off	On
1	On	Off

Switches Shown for Logic "0" Input

**ORDERING INFORMATION**

Temp Range	Package	Part Number
- 40 °C to 85 °C	TSSOP-16	DG2041DQ-T1
		DG2041DQ-T1-E3
		DG2042DQ-T1
		DG2042DQ-T1-E3
		DG2043DQ-T1
		DG2043DQ-T1-E3
	QFN-16 (4 mm x 4 mm) (Variation 1)	DG2041DN-T1-E4
		DG2042DN-T1-E4
		DG2043DN-T1-E4

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Limit	Unit
Reference V+ to GND		- 0.3 to + 6	V
IN, COM, NC, NO <sup>a</sup>		- 0.3 to (V+ + 0.3)	
Continuous Current (Any terminal)		± 50	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		± 200	
Storage Temperature (D Suffix)		- 65 to 150	°C
Power Dissipation (Packages) <sup>b</sup>	TSSOP-16 <sup>c</sup>	450	mW
	QFN-16 (4 mm x 4 mm) <sup>d</sup>	1880	

Notes:

- a. Signals on NC, NO, or COM or IN exceeding 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 5.6 mW/°C above 70 °C  
d. Derate 23.5 mW/°C above 70 °C  
e. Manual soldering with soldering iron is not recommended for leadless components. The QFN is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper lip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.

**SPECIFICATIONS (V+ = 2 V)**

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2 V, V <sub>IN</sub> = 0.4 V or 1.6 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Analog Switch							
Analog Signal Range <sup>d</sup>	V <sub>NO</sub> , V <sub>NC</sub> V <sub>COM</sub>		Full	0		V+	V
On- Resistance	R <sub>ON</sub>	V+ = 2 V, V <sub>COM</sub> = 0.2 V/1.2 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full		3	6.3 6.3	Ω
R <sub>ON</sub> Flatness <sup>d</sup>	R <sub>ON</sub> Flatness	V+ = 2 V, V <sub>COM</sub> = 0 V to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room			4.2	
R <sub>ON</sub> Match Between Channels	ΔR <sub>ON</sub>		Room			0.4	
Switch Off Leakage Current <sup>f</sup>	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = 2.2 V V <sub>NO</sub> , V <sub>NC</sub> = 0.2 V/2 V, V <sub>COM</sub> = 2 V/0.2 V	Room Full <sup>d</sup>	- 1 - 10		1 10	nA
	I <sub>COM(off)</sub>		Room Full <sup>d</sup>	- 1 - 10		1 10	
Channel-On Leakage Current <sup>f</sup>	I <sub>COM(on)</sub>	V+ = 2.2 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.2 V/2 V	Room Full <sup>d</sup>	- 1 - 10		1 10	

SPECIFICATIONS (V+ = 2 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2 V, V <sub>IN</sub> = 0.4 V or 1.6 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Digital Control							
Input High Voltage	V <sub>INH</sub>		Full	1.6			V
Input Low Voltage	V <sub>INL</sub>		Full			0.4	
Input Capacitance <sup>d</sup>	C <sub>in</sub>		Full		4		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 V or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF fig. 1 and 2	Room Full <sup>d</sup>		30	81 82	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full <sup>d</sup>		22	41 42	
Break-Before-Make Time Delay	t <sub>D</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF (DG2043 Only)	Room	5			
Charge Injection <sup>d</sup>	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω, fig. 2	Room		1		pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 95		
NO, NC Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub> C <sub>NC(off)</sub>	V <sub>IN</sub> = 0 V or V+, f = 1 MHz	Room		24		pF
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		48		
Power Supply							
Power Supply Current <sup>d</sup>	I+	V <sub>IN</sub> = 0 V or V+			0.001	1	μA

SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.4 V or 2 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Analog Switch							
Analog Signal Range <sup>d</sup>	V <sub>NO</sub> , V <sub>NC</sub> V <sub>COM</sub>		Full	0		V+	V
On-Resistance	R <sub>ON</sub>	V+ = 2.7 V, V <sub>COM</sub> = 0.7 V/1.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full		1.6	2.1 2.2	Ω
R <sub>ON</sub> Flatness <sup>d</sup>	R <sub>ON</sub> Flatness	V+ = 2.7 V, V <sub>COM</sub> = 0 V to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room			0.7	
R <sub>ON</sub> Match Between Channels	ΔR <sub>ON</sub>		Room			0.3	
Switch Off Leakage Current <sup>f</sup>	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = 3.3 V V <sub>NO</sub> , V <sub>NC</sub> = 0.3 V/3 V, V <sub>COM</sub> = 3 V/0.3 V	Room Full	- 1 - 10		1 10	nA
	I <sub>COM(off)</sub>		Room Full	- 1 - 10		1 10	
Channel-On Leakage Current <sup>f</sup>	I <sub>COM(on)</sub>	V+ = 3.3 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.3 V/3 V	Room Full	- 1 - 10		1 10	
Digital Control							
Input High Voltage <sup>d</sup>	V <sub>INH</sub>		Full	1.6			V
Input Low Voltage	V <sub>INL</sub>		Full			0.4	
Input Capacitance <sup>d</sup>	C <sub>in</sub>		Full		4		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 V or V+	Full	- 1		1	μA



SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, VIN = 0.4 V or 2 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Dynamic Characteristics							
Turn-On Time <sup>d</sup>	tON	VNO or VNC = 2 V, RL = 300 Ω, CL = 35 pF fig. 1 and 2	Room Full		19	51 52	ns
Turn-Off Time <sup>d</sup>	tOFF		Room Full		17	36 37	
Break-Before-Make Time Delay	tD	VNO or VNC = 2 V, RL = 300 Ω, CL = 35 pF (DG2043 Only)	Room	2			
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω, fig. 2	Room		3		pC
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 94		
NO, NC Off Capacitance <sup>d</sup>	CNO(off) CNC(off)	VIN = 0 V or V+, f = 1 MHz	Room		25		pF
Channel-On Capacitance <sup>d</sup>	CON		Room		49		
Power Supply							
Power Supply Current	I+	VIN = 0 V or V+			0.001	1	μA

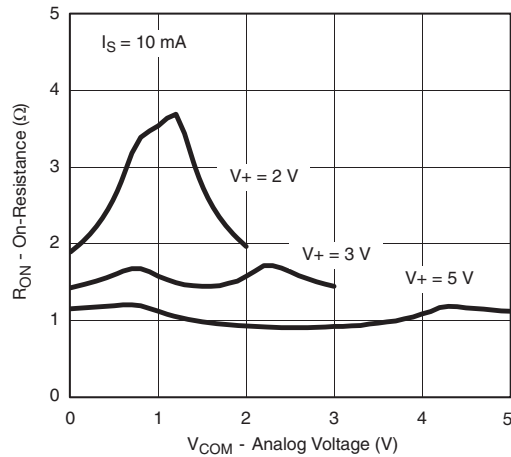
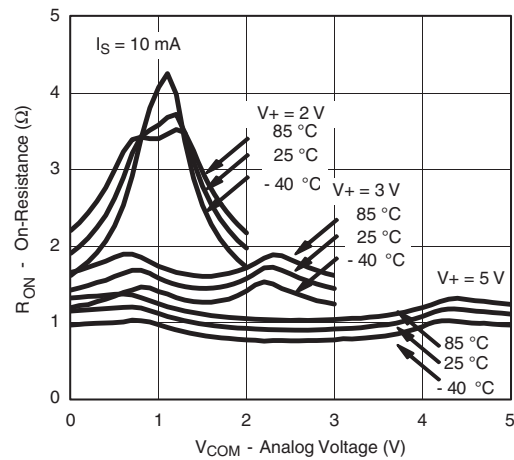
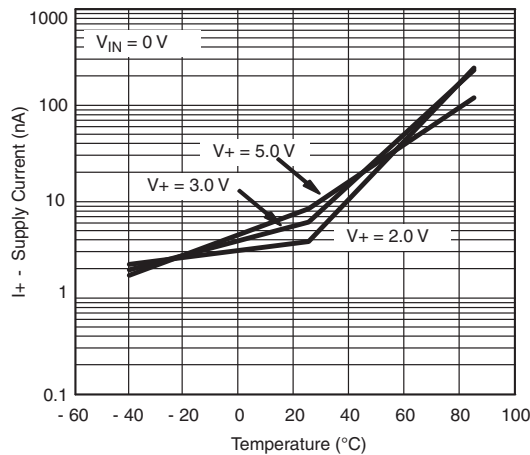
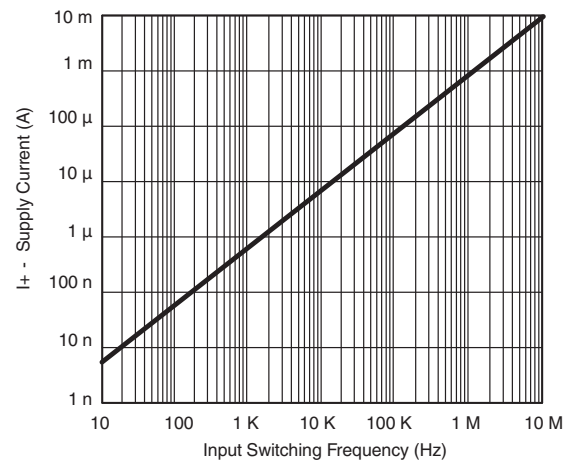
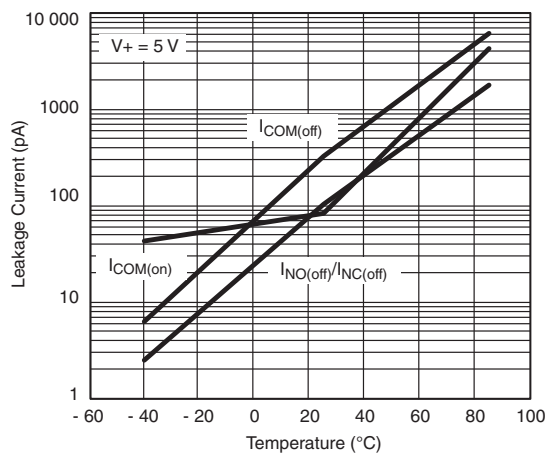
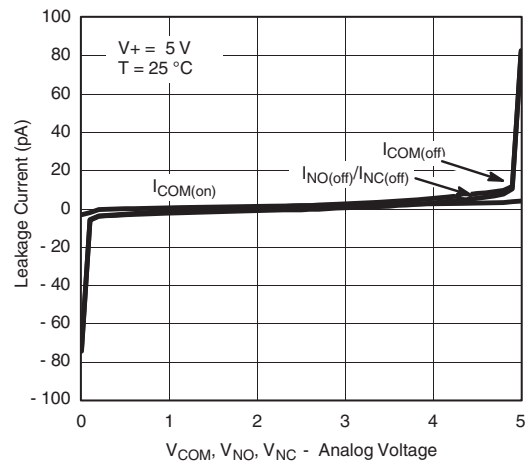
SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, VIN = 0.8 V or 2.4 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Analog Switch							
Analog Signal Range <sup>d</sup>	VNO, VNC VCOM		Full	0		V+	V
On-Resistance	RON	V+ = 4.5 V, VCOM = 0.7 V/2.5 V, INO, INC = 10 mA	Room Full		1	1.5 1.6	Ω
RON Flatness <sup>d</sup>	RON Flatness	V+ = 4.5 V, VCOM = 0 V to V+, INO, INC = 10 mA	Room			0.7	
RON Match Between Channels	ΔRON		Room			0.3	
Switch Off Leakage Current	INO(off) INC(off)	V+ = 5.5 V VNO, VNC = 1 V/4.5 V, VCOM = 4.5 V/1 V	Room Full	- 1 - 10		1 10	nA
	ICOM(off)		Room Full	- 1 - 10		1 10	
Channel-On Leakage Current	ICOM(on)	V+ = 5.5 V, VNO, VNC = VCOM = 1 V/4.5 V	Room Full	- 1 - 10		1 10	
Digital Control							
Input High Voltage	VINH		Full	2.4			V
Input Low Voltage	VINL		Full			0.8	
Input Capacitance	Cin		Full		4		pF
Input Current	IINL or IINH	VIN = 0 V or V+	Full	- 1		1	μA

SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, VIN = 0.8 V or 2.4 V <sup>e</sup>	Temp. <sup>a</sup>	Limits - 40 °C to 85 °C			Unit
				Min. <sup>b</sup>	Typ. <sup>c</sup>	Max. <sup>b</sup>	
Dynamic Characteristics							
Turn-On Time <sup>d</sup>	tON	VNO or VNC = 3 V, RL = 300 Ω, CL = 35 pF fig. 1 and 2	Room Full		13	42 43	ns
Turn-Off Time <sup>d</sup>	tOFF		Room Full		19	32 33	
Break-Before-Make Time Delay	tD	VNO or VNC = 3 V, RL = 300 Ω, CL = 35 pF (DG2043 Only)	Room	1			
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω, fig. 2	Room		3		pC
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 93		
Source-Off Capacitance <sup>d</sup>	CNO(off) CNC(off)	VIN = 0 V or V+, f = 1 MHz	Room		26		pF
Channel-On Capacitance <sup>d</sup>	CON		Room		49		
Power Supply							
Power Supply Current	I+	VIN = 0 V or V+			0.001	1	μA

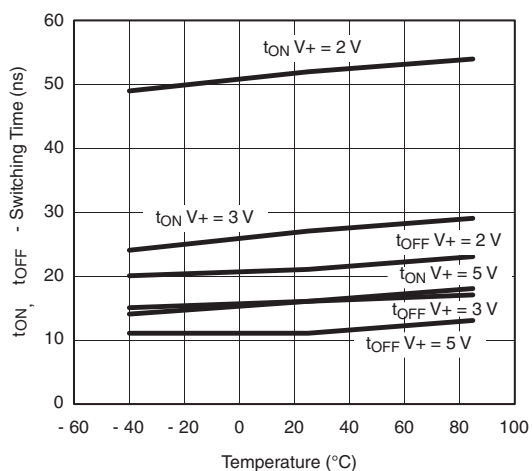
### Notes:

- Room = 25 °C, full = as determined by the operating suffix.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- Guarantee by design, nor subjected to production test.
- V<sub>IN</sub> = input voltage to perform proper function.
- Guaranteed by 5 V leakage testing, not production tested.

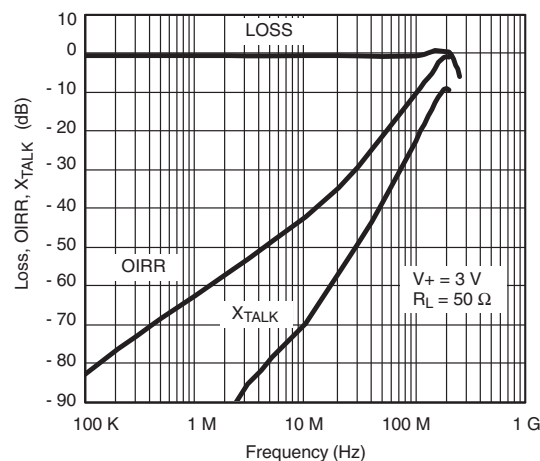
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

**TYPICAL CHARACTERISTICS** (25 °C unless noted)

 **$R_{ON}$  vs.  $V_{COM}$  and Supply Voltage**

 **$R_{ON}$  vs. Analog Voltage and Temperature**

**Supply Current vs. Temperature**

**Supply Current vs. Input Switching Frequency**

**Leakage Current vs. Temperature**

**Leakage vs. Analog Voltage**

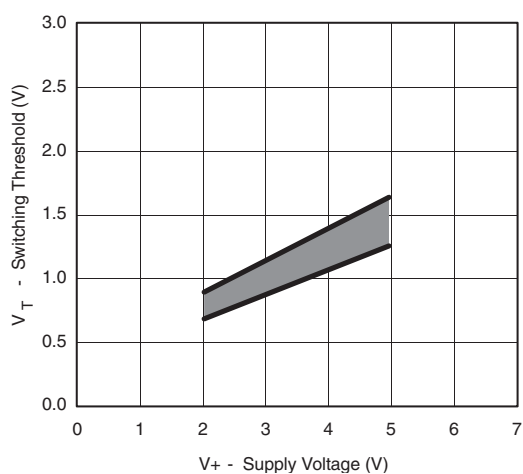
## TYPICAL CHARACTERISTICS (25 °C unless noted)



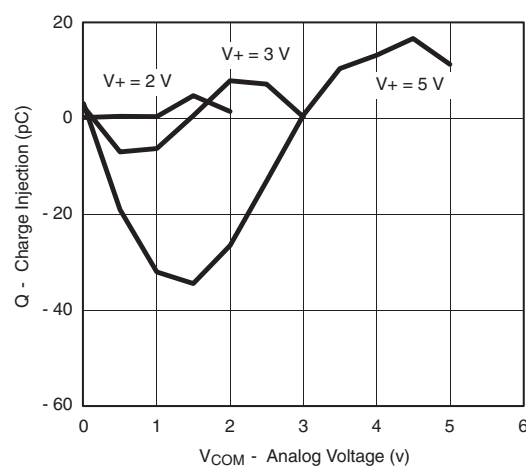
Switching Time vs. Temperature and Supply Voltage



Insertion Loss, Off-Isolation Crosstalk vs. Frequency



Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage



## TEST CIRCUITS

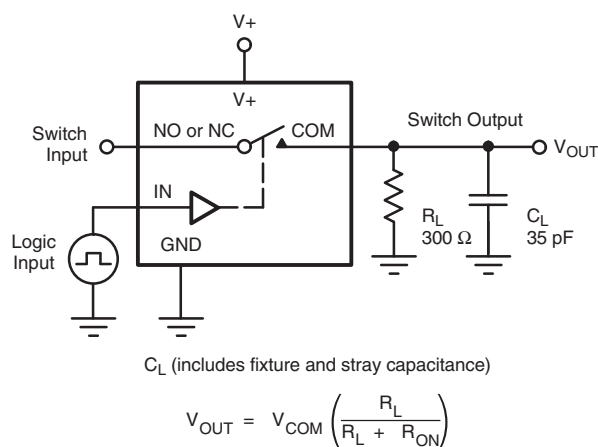
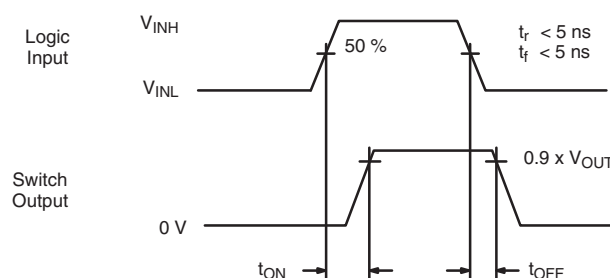
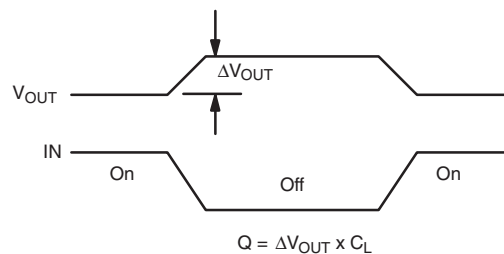
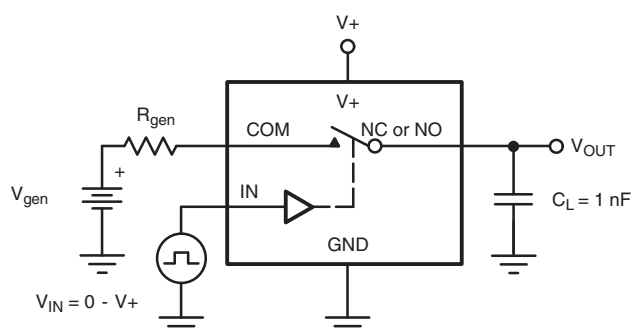


Figure 1. Switching Time



Logic "1" = Switch On  
Logic input waveforms inverted for switches that have the opposite logic sense.



IN depends on switch configuration: input polarity determined by sense of switch.

Figure 2. Charge Injection

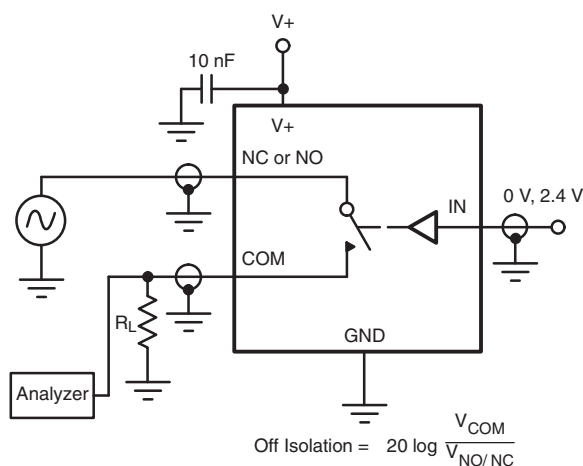


Figure 3. Off-Isolation

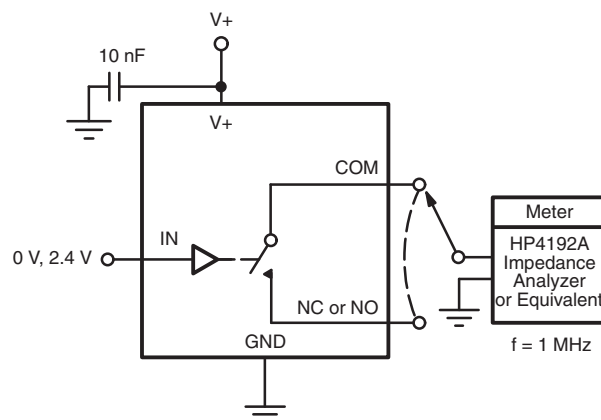
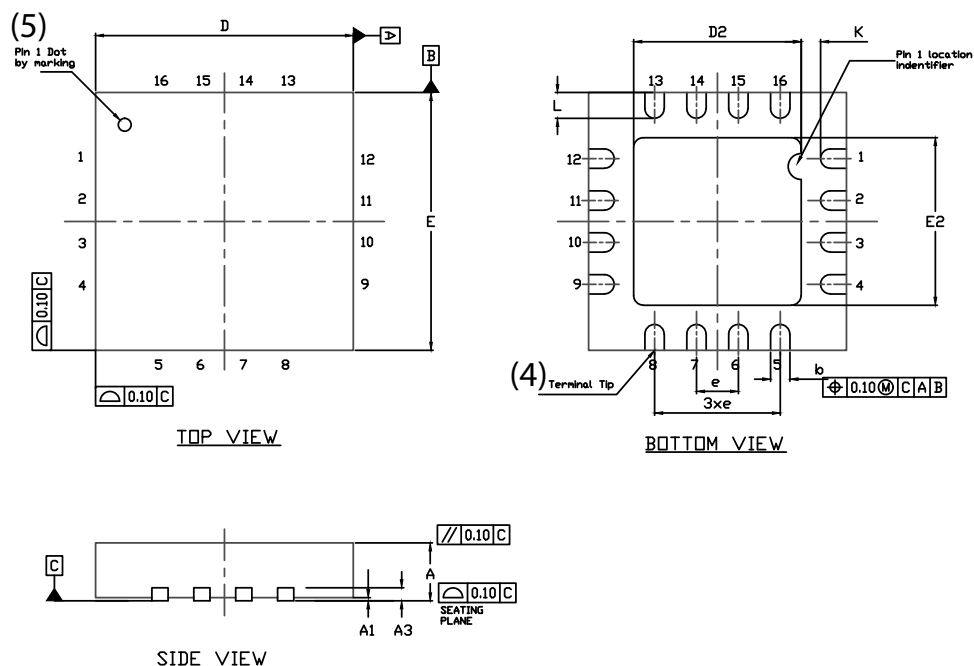


Figure 4. Channel Off/On Capacitance

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?72091](http://www.vishay.com/ppg?72091).

## QFN 4x4-16L Case Outline



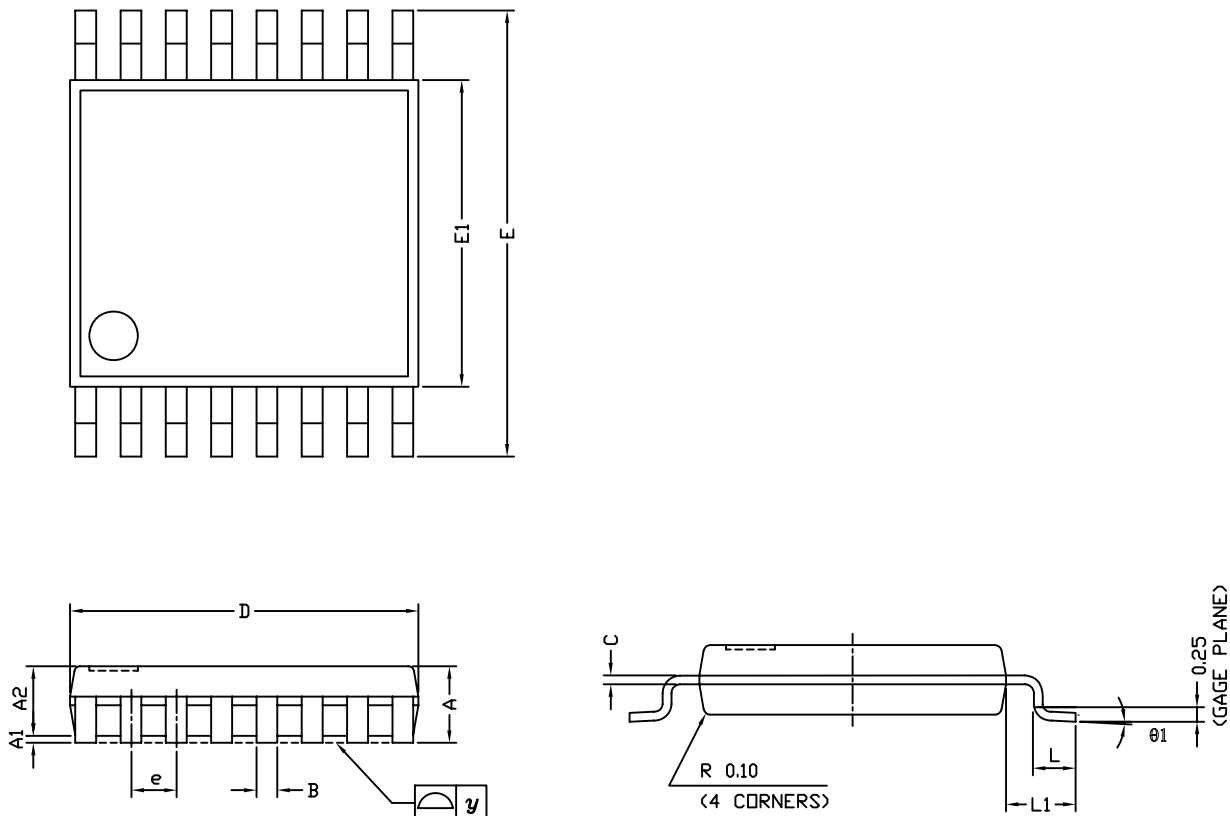
DIM	VARIATION 1						VARIATION 2					
	MILLIMETERS <sup>(1)</sup>			INCHES			MILLIMETERS <sup>(1)</sup>			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.75	0.85	0.95	0.029	0.033	0.037	0.75	0.85	0.95	0.029	0.033	0.037
A1	0	-	0.05	0	-	0.002	0	-	0.05	0	-	0.002
A3	0.20 ref.			0.008 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 <sup>(3)</sup>	16			16			16			16		
Nd <sup>(3)</sup>	4			4			4			4		
Ne <sup>(3)</sup>	4			4			4			4		

### Notes

- Use millimeters as the primary measurement.
- Dimensioning and tolerances conform to ASME Y14.5M. - 1994.
- N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.
- Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.
- The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.
- Package warpage max. 0.05 mm.

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

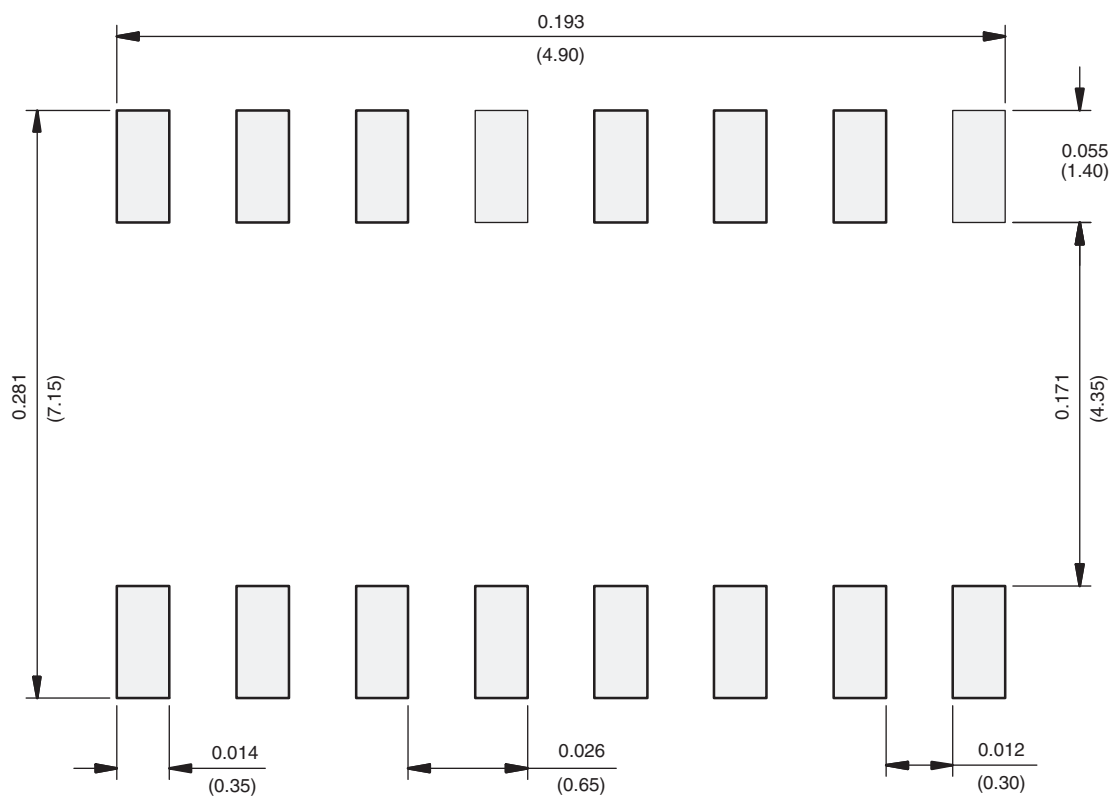
## TSSOP: 16-LEAD



Symbols	DIMENSIONS IN MILLIMETERS		
	Min	Nom	Max
A	-	1.10	1.20
A1	0.05	0.10	0.15
A2	-	1.00	1.05
B	0.22	0.28	0.38
C	-	0.127	-
D	4.90	5.00	5.10
E	6.10	6.40	6.70
E1	4.30	4.40	4.50
e	-	0.65	-
L	0.50	0.60	0.70
L1	0.90	1.00	1.10
y	-	-	0.10
θ1	0°	3°	6°
ECN: S-61920-Rev. D, 23-Oct-06			
DWG: 5624			



## RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads  
Dimensions in inches (mm)



## 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.