



# Low Voltage, Low On-Resistance, Dual DPDT/Quad SPDT Analog Switch

## DESCRIPTION

The DG2788, DG2789 are monolithic CMOS analog switching products designed for high performance switching of analog signals. Combining low power, high speed, low on-resistance and small physical size, the DG2788, DG2789 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2788, DG2789 are built on Vishay Siliconix's low voltage process. An epitaxial layer prevents latchup. Break-before-make is guaranteed.

The switch conducts equally well in both directions when on, and blocks up to the power supply level when off. The DG2788 is configured as a dual Double Pole Double Throw switches while the DG2789 is configured as a Quad Single Pole Double Throw. The DG2789 has one control pin for all four SPDT switches and also has an enable pin that can turn all switches off.

The DG2788 and DG2789 comes in a small miniQFN-16 lead package (2.6 mm x 1.8 mm x 0.75 mm).

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the lead (Pb)-free device terminations and is 100 % RoHS compliant.

## FEATURES

- Wide operation voltage range: 1.65 V to 4.3 V
- Low on-resistance -  $R_{ON}$ : 0.4  $\Omega$  typ. at 2.7 V
- Fast switching:  $t_{ON}$  = 47 ns  
 $t_{OFF}$  = 15 ns
- miniQFN-16 package
- Latch-up current > 300 mA (JESD78)
- Material categorization: For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



RoHS COMPLIANT

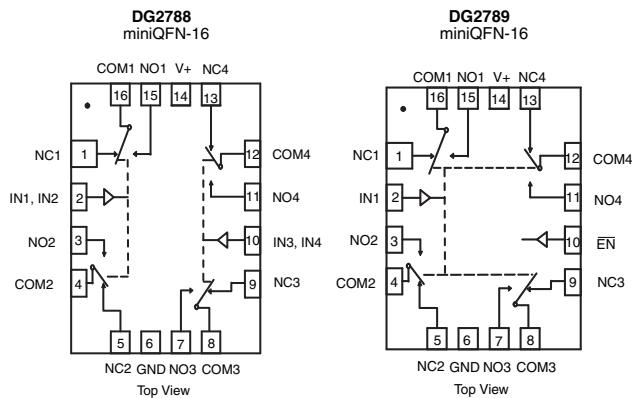
## BENEFITS

- Reduced power consumption
- High accuracy
- Reduce board space
- Low voltage logic compatible
- High bandwidth

## APPLICATIONS

- Cellular phones
- Speaker headset switching
- Audio and video signal routing
- PCMCIA cards
- Battery operated systems

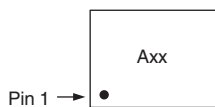
## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE (DG2788)		
LOGIC	NC1, 2, 3 and 4	NO1, 2, 3 and 4
0	ON	OFF
1	OFF	ON

TRUTH TABLE (DG2789)			
EN LOGIC	IN LOGIC	NC1, 2, 3 and 4	NO1, 2, 3 and 4
0	0	ON	OFF
0	1	OFF	ON
1	x	OFF	OFF

ORDERING INFORMATION		
TEMP. RANGE	PACKAGE	PART NUMBER
-40 °C to 85 °C	miniQFN-16	DG2788DN-T1-E4 DG2789DN-T1-E4



Device Marking: Axx for DG2788  
Bxx for DG2789  
xx = Date/Lot Traceability Code  
Note: Pin 1 has long lead



<b>ABSOLUTE MAXIMUM RATINGS</b> ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)				
PARAMETER		SYMBOL	LIMIT	UNIT
Reference to GND	V+		-0.3 to 5	V
	IN, COM, NC, NO <sup>a</sup>		-0.3 to (V+ + 0.3)	
Current (Any terminal except NO, NC, or COM)			30	mA
Continuous Current (NO, NC, or COM)			$\pm 300$	
Peak Current (Pulsed at 1 ms, 10 % duty cycle)			$\pm 500$	
Storage Temperature (D suffix)			-65 to 150	$^\circ\text{C}$
Package Solder Reflow Conditions <sup>d</sup>	miniQFN-16		250	
Power Dissipation (Packages) <sup>b</sup>	miniQFN-16 <sup>c</sup>		525	mW

**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 6.6 mW/ $^\circ\text{C}$  above 70  $^\circ\text{C}$ .
- d. Manual soldering with iron is not recommended for leadless components. The miniQFN-16 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+ = 3 V)									
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 3 V, ± 10 %, VIN = 0.5 or 1.4 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>			
<b>Analog Switch</b>									
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> = 0.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA	Room	-	0.4	0.5	Ω		
		V+ = 2.7 V, V <sub>COM</sub> = 1.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA		-	0.33				
			Full	-	-	0.56			
R <sub>ON</sub> Flatness <sup>d</sup>	R <sub>ON</sub> Flatness	V+ = 2.7 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA	Room	-	0.1	0.15			
R <sub>ON</sub> Match <sup>d</sup>	ΔR <sub>ON</sub>		Room	-	0.05	-			
Switch Off Leakage Current	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	-1	-	1		nA	
			Full	-10	-	10			
	Room		-1	-	1				
	Full		-10	-	10				
Channel-On Leakage Current	I <sub>COM(on)</sub>	Room	-1	-	1				
		Full	-10	-	10				
<b>Digital Control</b>									
Input High Voltage	V <sub>INH</sub>		Full	1.4	-	-	V		
Input Low Voltage	V <sub>INL</sub>		Full	-	-	0.5			
Input Capacitance	C <sub>IN</sub>		Full	-	6	-	pF		
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 or V+	Full	-1	-	1	μA		
<b>Dynamic Characteristics</b>									
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Room	-	47	72	ns		
			Full	-	-	75			
Turn-Off Time	t <sub>OFF</sub>		Room	-	15	43			
			Full	-	-	45			
Break-Before-Make Time	t <sub>d</sub>			Full	1	-		-	
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	Room	-	87		-	pC
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 100 kHz	Room	-	-69	-	dB		
		R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz		-	-49	-			
Crosstalk <sup>d, f</sup>	X <sub>TALK</sub>	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 100 kHz		-	-106	-			
		R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz		-	-96	-			
NO, NC Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub>	f = 1 MHz	Room	-	81	-	pF		
	C <sub>NC(off)</sub>		Room	-	81	-			
Channel-On Capacitance <sup>d</sup>	C <sub>NO(on)</sub>		Room	-	186	-			
	C <sub>NC(on)</sub>		Room	-	186	-			
<b>Power Supply</b>									
Power Supply Range	V+				1.65	-		4.3	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+	Full	-	-	1	μA		



SPECIFICATIONS (V+ = 3 V)							
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 3 V, ± 10 %, VIN = 0.5 or 1.4 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>	
<b>Analog Switch</b>							
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+ = 4.3 V, V <sub>COM</sub> = 0.9 V, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA	Room	-	0.32	0.45	Ω
		V+ = 4.3 V, V <sub>COM</sub> = 2.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA		-	0.27		
			Full	-	-	0.5	
R <sub>ON</sub> Flatness <sup>d</sup>	R <sub>ON</sub> Flatness	V+ = 4.3 V, V <sub>COM</sub> = 0 to V+, I <sub>NO</sub> , I <sub>NC</sub> = 100 mA	Room	-	0.1	0.15	
R <sub>ON</sub> Match <sup>d</sup>	ΔR <sub>ON</sub>		Room	-	0.03	-	
Switch-Off Leakage Current <sup>d</sup>	I <sub>NO(off)</sub> , I <sub>NC(off)</sub>	V+ = 4.3 V, V <sub>NO</sub> , V <sub>NC</sub> = 0.3 V/4 V, V <sub>COM</sub> = 4 V/0.3 V	Room	-10	-	10	nA
			Full	-100	-	100	
	Room		-10	-	10		
	Full		-100	-	100		
Channel-On Leakage Current <sup>d</sup>	I <sub>COM(on)</sub>	V+ = 4.3 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 3 V/4 V	Room	-10	-	10	
			Full	-100	-	100	
<b>Digital Control</b>							
Input High Voltage	V <sub>INH</sub>		Full	1.6	-	-	V
Input Low Voltage	V <sub>INL</sub>		Full	-	-	0.5	
Input Capacitance	C <sub>IN</sub>		Full	-	6	-	pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 or V+	Full	-1	-	1	μA
<b>Dynamic Characteristics</b>							
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	Room	-	105	-	pC
N <sub>O</sub> , N <sub>C</sub> Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub>	f = 1 MHz	Room	-	79	-	pF
	C <sub>NC(off)</sub>		Room	-	79	-	
Channel-On Capacitance <sup>d</sup>	C <sub>NO(on)</sub>		Room	-	183	-	
	C <sub>NC(on)</sub>		Room	-	183	-	
<b>Power Supply</b>							
Power Supply Range	V+			1.65	-	4.3	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+	Full	-	-	1	μA

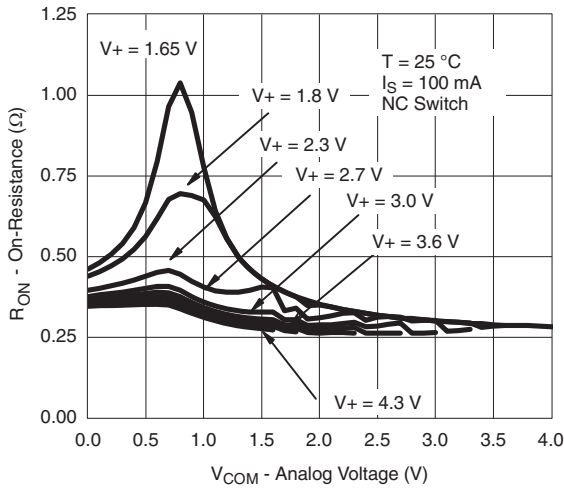
**Notes**

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

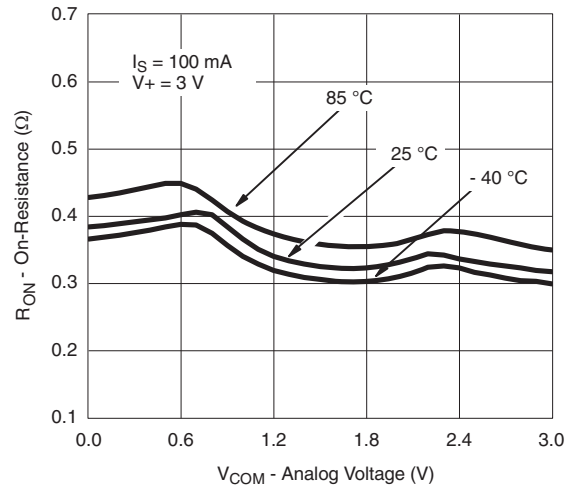
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



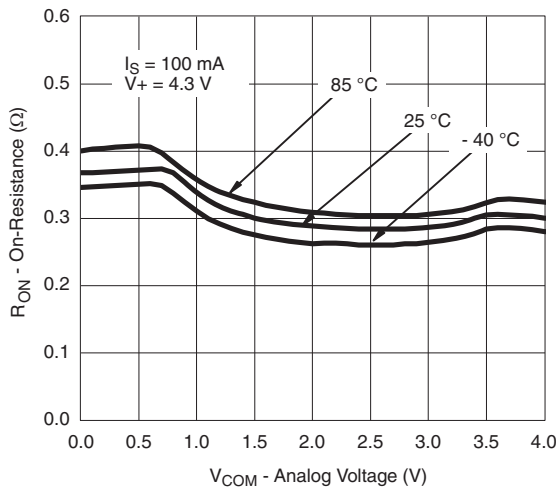
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



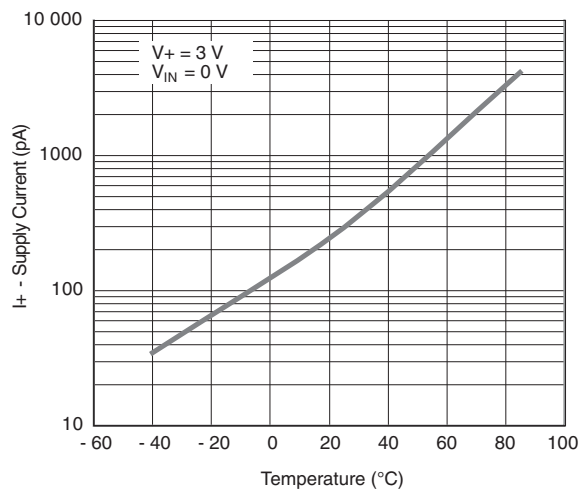
R<sub>ON</sub> vs. V<sub>COM</sub> and Supply Voltage



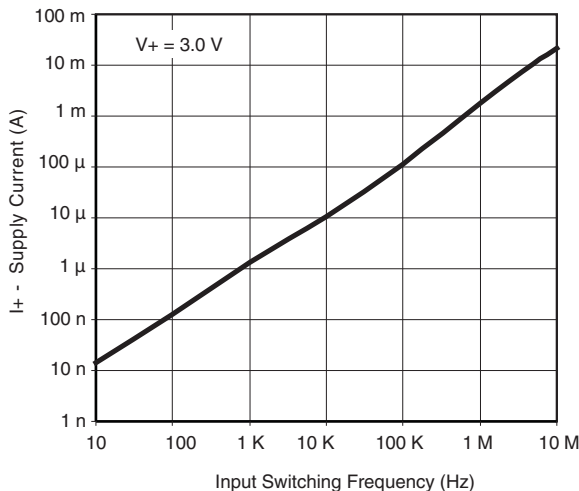
R<sub>ON</sub> vs. Analog Voltage and Temperature



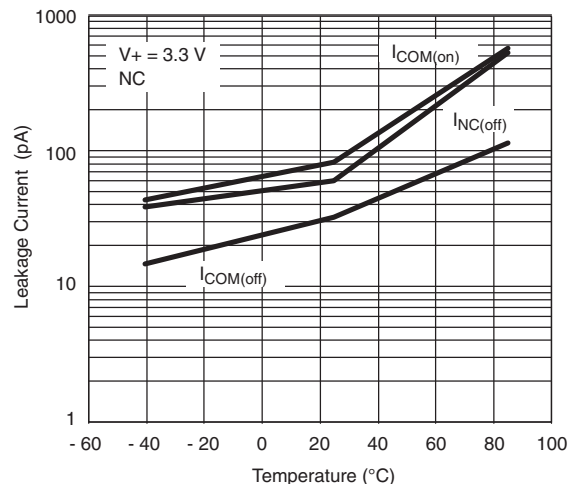
R<sub>ON</sub> vs. Analog Voltage and Temperature



Supply Current vs. Temperature

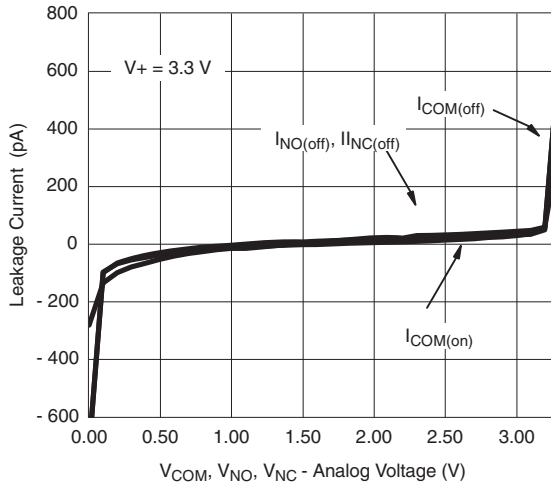


Supply Current vs. Input Switching Frequency

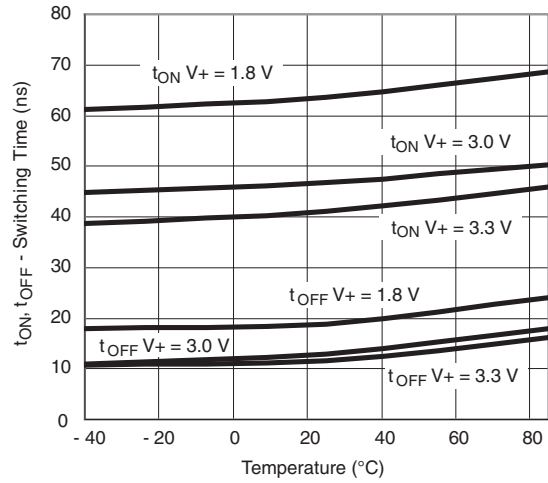


Leakage Current vs. Temperature

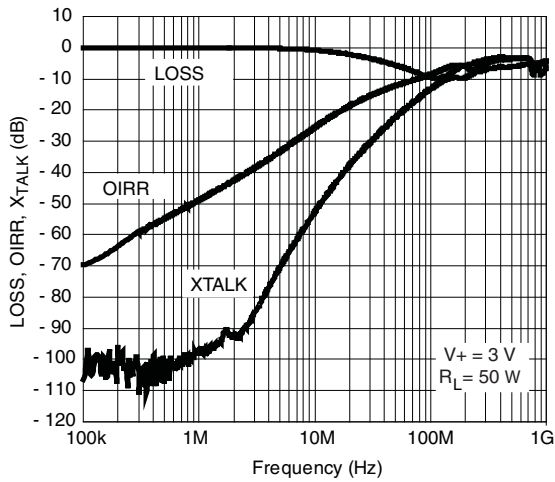
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



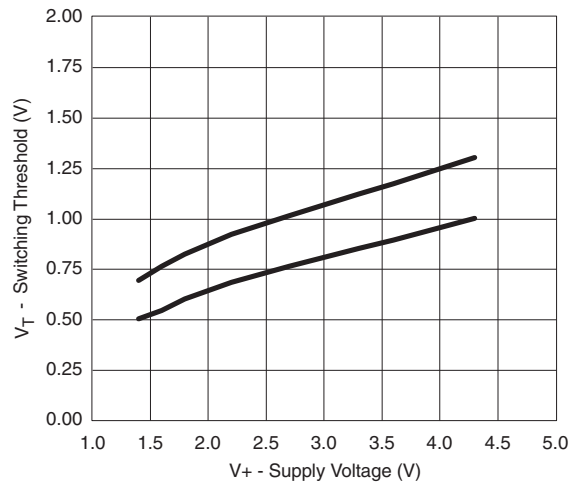
**Leakage vs. Analog Voltage**



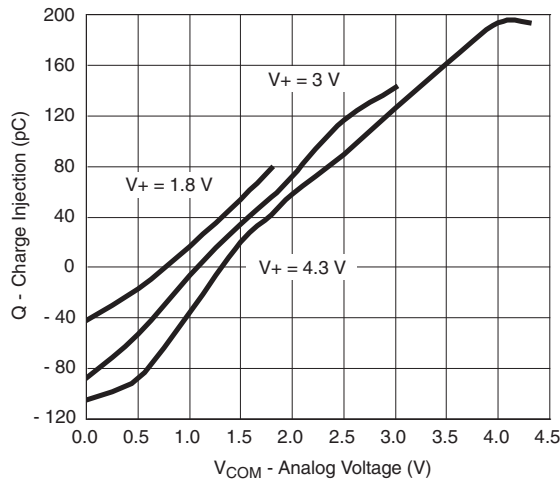
**Switching Time vs. Temperature**



**Insertion Loss, Off-Isolation Crosstalk vs. Frequency**

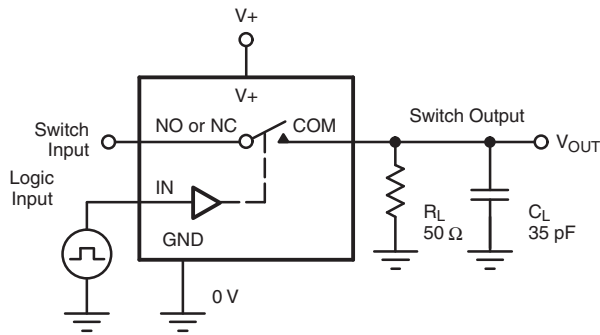


**Switching Threshold vs. Supply Voltage**



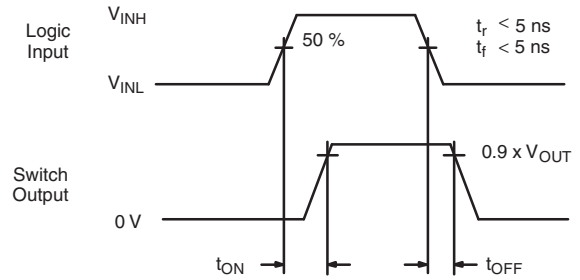
**Charge Injection vs. Analog Voltage**

TEST CIRCUITS



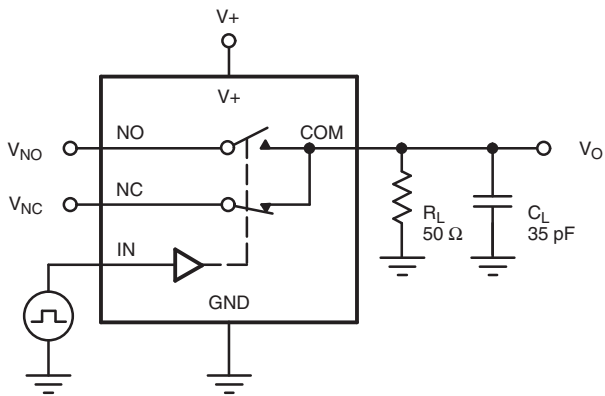
$C_L$  (includes fixture and stray capacitance)

$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



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

Fig. 1 - Switching Time



$C_L$  (includes fixture and stray capacitance)

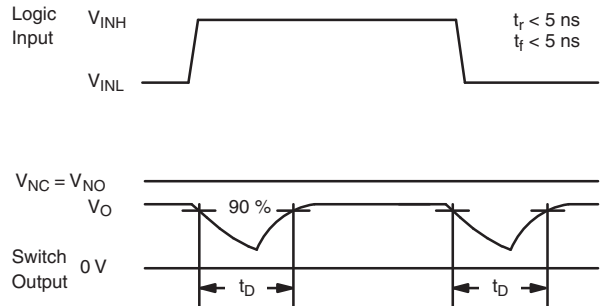
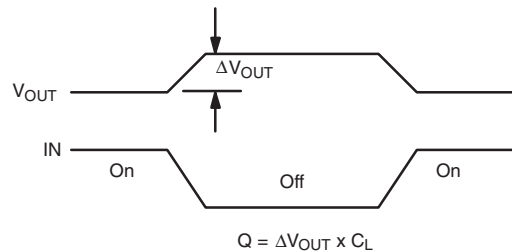
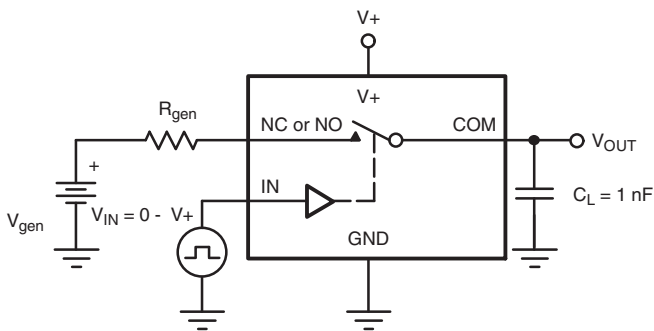
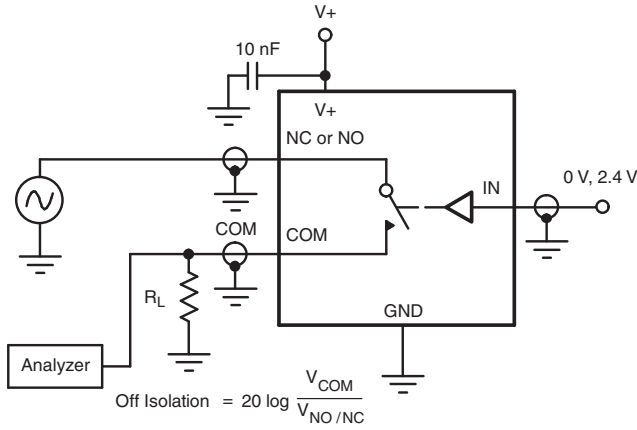
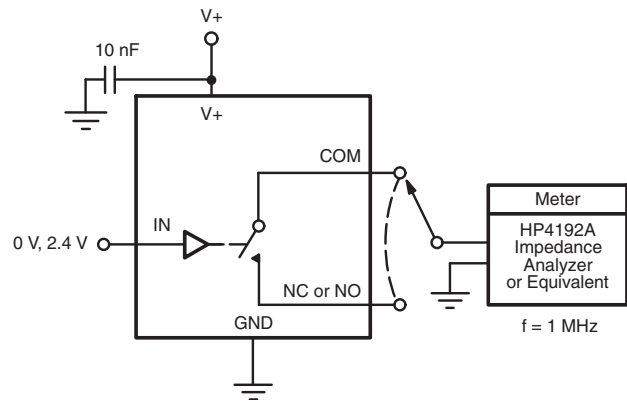


Fig. 2 - Break-Before-Make Interval



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

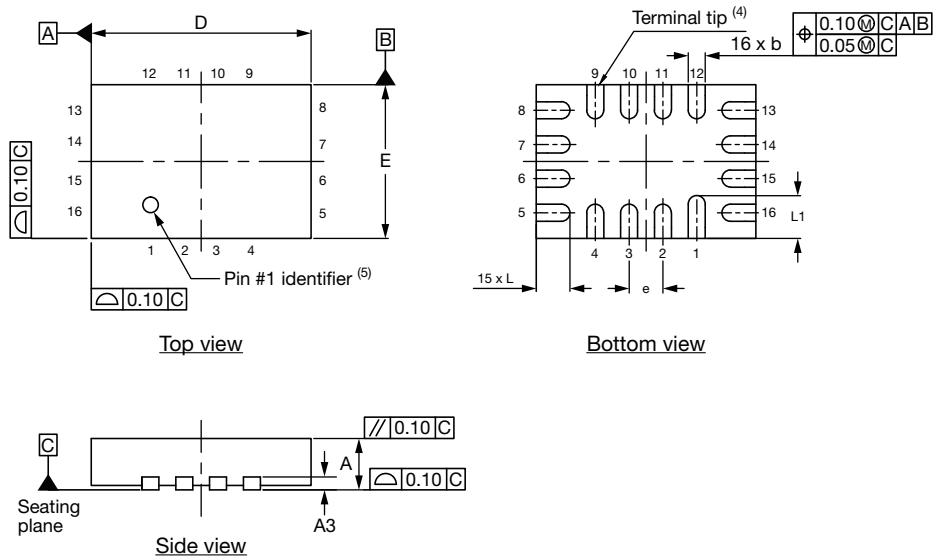
Fig. 3 - Charge Injection

**TEST CIRCUITS**

**Fig. 4 - Off-Isolation**

**Fig. 5 - 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?73863](http://www.vishay.com/ppg?73863).



### Thin miniQFN16 Case Outline



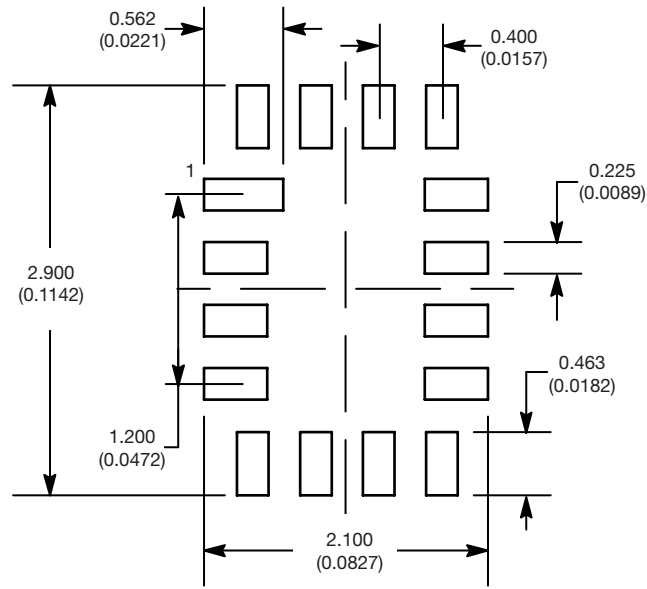
DIMENSIONS	MILLIMETERS <sup>(1)</sup>			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.50	0.55	0.60	0.020	0.022	0.024
A1	0	-	0.05	0	-	0.002
A3	0.15 ref.			0.006 ref.		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	2.50	2.60	2.70	0.098	0.102	0.106
e	0.40 BSC			0.016 BSC		
E	1.70	1.80	1.90	0.067	0.071	0.075
L	0.35	0.40	0.45	0.014	0.016	0.018
L1	0.45	0.50	0.55	0.018	0.020	0.022
N <sup>(3)</sup>	16			16		
Nd <sup>(3)</sup>	4			4		
Ne <sup>(3)</sup>	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: T16-0226-Rev. B, 09-May-16  
 DWG: 6023

**RECOMMENDED MINIMUM PADS FOR MINI QFN 16L**



Mounting Footprint  
Dimensions in mm (inch)



## **Disclaimer**

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