

## Low-Voltage Single SPDT Analog Switch

### DESCRIPTION

The DG9431 is a single-pole/double-throw monolithic CMOS analog device designed for high performance switching of analog signals. Combining low power, high speed ( $t_{ON}$ : 35 ns,  $t_{OFF}$ : 20 ns), low on-resistance ( $r_{DS(on)}$ : 20  $\Omega$ ) and small physical size (TSOP-6), the DG9431 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG9431 is built on Vishay Siliconix's low voltage BCD-15 process. Minimum ESD protection, per Method 3015.7, is 2000 V. An epitaxial layer prevents latchup. Break-before -make is guaranteed for DG9431.

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

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the lead (Pb)-free device terminations. For analog switching products manufactured with 100 % matte tin device terminations, the lead (Pb)-free "-E3" suffix is being used as a designator.

### FEATURES

- Low Voltage Operation (+ 2.7 to + 5 V)
- Low On-Resistance -  $r_{DS(on)}$ : 20  $\Omega$
- Fast Switching -  $t_{ON}$ : 35 ns,  $t_{OFF}$ : 20 ns
- Low Leakage -  $I_{COM(on)}$ : 200-pA max
- Low Charge Injection -  $Q_{INJ}$ : 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- ESD Protection > 2000 V (Method 3015.7)
- Available in TSOP-6 and SOIC-8
- Lead (Pb)-Free Version is RoHS Compliant



**RoHS\***  
COMPLIANT

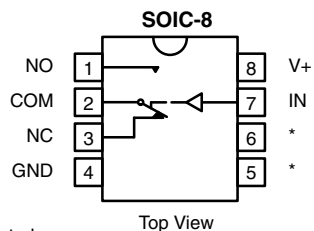
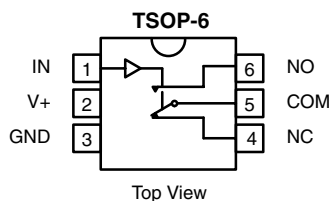
### BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space (TSOP-6)

### APPLICATIONS

- Battery Operated Systems
- Portable Test Equipment
- Sample and Hold Circuits
- Cellular Phones
- Communication Systems
- Military Radio
- PBX, PABX Guidance and Control Systems

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



\*Not Connected

TRUTH TABLE		
Logic	NC	NO
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 to 85 $^{\circ}$ C	TSOP-6	DG9431DV-T1
		DG9431DV-T1-E3 (Lead (Pb)-free)
	SOIC-8	DG9431DY-T1
		DG9431DY-T1-E3 (Lead (Pb)-free)

\* Pb containing terminations are not RoHS compliant, exemptions may apply



ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Reference V+ to GND		- 0.3 to + 13	V
IN, COM, NC, NO <sup>a</sup>		- 0.3 to (V+ + 0.3)	
Continuous Current (Any Terminal)		± 20	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		± 40	
ESD (Method 3015.7)		> 2000	V
Storage Temperature (D Suffix)		- 65 to 125	°C
Power Dissipation (Packages) <sup>b</sup>	8-Pin Narrow Body SOIC <sup>c</sup>	400	mW

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or IN<sub>X</sub> 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 6.5 mW/°C above 75 °C.

SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	D Suffix - 40 to 85 °C			Unit
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	0		3	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, V+ = 2.7 V I <sub>COM</sub> = 5 mA	Room Full		30	50 80	Ω
r <sub>DS(on)</sub> Match <sup>d</sup>	Δr <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V	Room		0.4	2	
r <sub>DS(on)</sub> Flatness <sup>f</sup>	r <sub>DS(on)</sub> Flatness	V <sub>NO</sub> or V <sub>NC</sub> = 1 and 2 V	Room		4	8	
NO or NC Off Leakage Current <sup>g</sup>	I <sub>NO/NC(off)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1 V/2 V, V <sub>COM</sub> = 2 V/1 V	Room Full	- 100 - 5000	5	100 5000	pA
COM Off Leakage Current <sup>g</sup>	I <sub>COM(off)</sub>	V <sub>COM</sub> = 1 V/2 V, V <sub>NO</sub> or V <sub>NC</sub> = 2 V/1 V	Room Full	- 100 - 5000	5	100 5000	
Channel-On Leakage Current <sup>g</sup>	I <sub>COM(on)</sub>	V <sub>COM</sub> = V <sub>NO</sub> or V <sub>NC</sub> = 1 V/2 V	Room Full	- 200 - 10000	10	200 10000	
<b>Digital Control</b>							
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full		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	Room Full		50	120 200	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		20	50 120	
Break-Before-Make Time	t <sub>d</sub>		Room	3	20		
Charge Injection	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω	Room		1	5	pC
Off-Isolation	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 74		dB
Source Off Capacitance	C <sub>S(off)</sub>	f = 1 MHz	Room		7		pF
Channel-On Capacitance	C <sub>D(on)</sub>		Room		32		
<b>Power Supply</b>							
Power Supply Range	V+			2.7		12	V
Power Supply Current	I+	V+ = 3.3 V, V <sub>IN</sub> = 0 or 3.3 V				1	μA



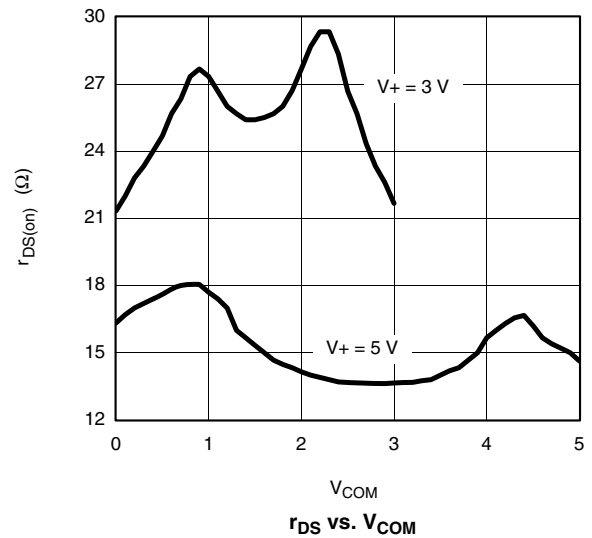
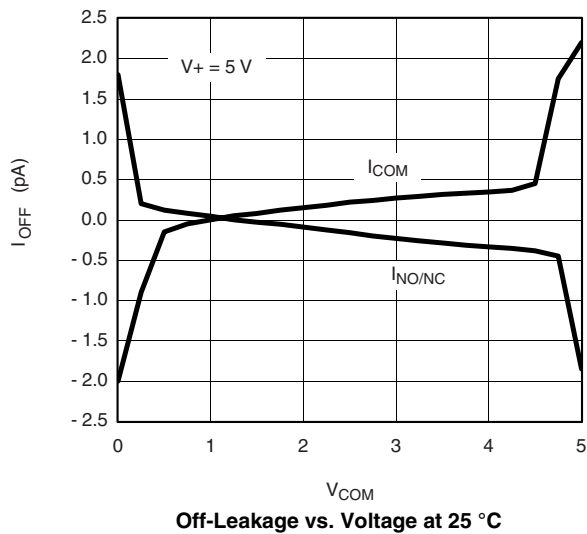
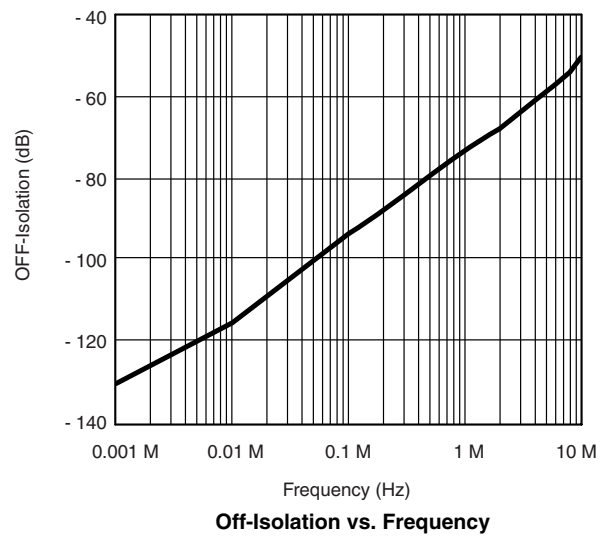
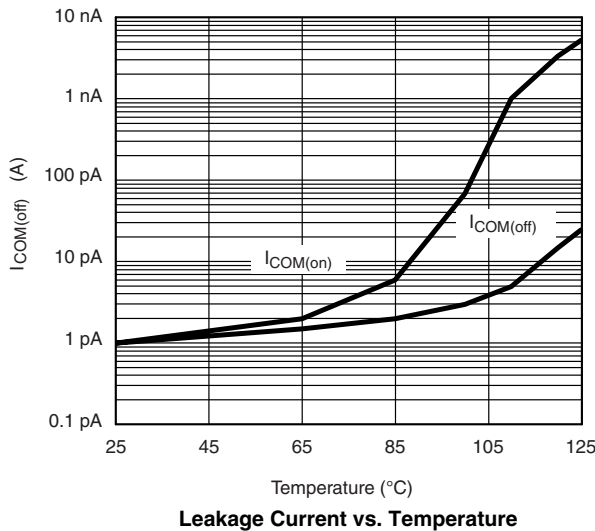
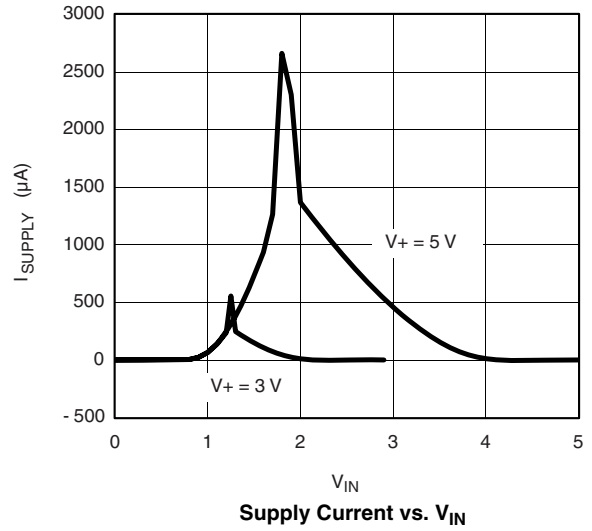
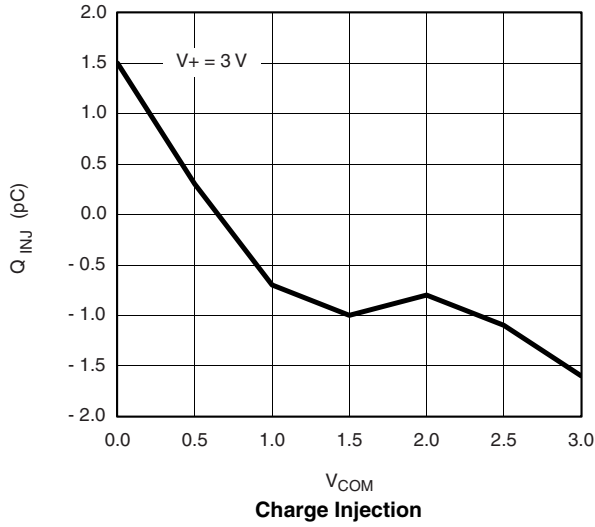
SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 5 V, ± 10 %, VIN = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	D Suffix - 40 to 85 °C			Unit
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	0		5	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3.5 V, V+ = 4.5 V I <sub>COM</sub> = 5 mA	Room Full		20	30 50	Ω
r <sub>DS(on)</sub> Match <sup>d</sup>	Δr <sub>DS(on)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V	Room		0.4	2	
r <sub>DS(on)</sub> Flatness <sup>f</sup>	r <sub>DS(on)</sub> Flatness	V <sub>NO</sub> or V <sub>NC</sub> = 1, 2 and 3 V	Room		2	6	
NO or NC Off Leakage Current	I <sub>NO/NC(off)</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1 V/4 V, V <sub>COM</sub> = 4 V/1 V	Room Full	- 100 - 5000	10	100 5000	pA
COM Off Leakage Current	I <sub>COM(off)</sub>	V <sub>COM</sub> = 1 V/4 V, V <sub>NO</sub> or V <sub>NC</sub> = 4 V/1 V	Room Full	- 100 - 5000	10	100 5000	
Channel-On Leakage Current	I <sub>COM(on)</sub>	V <sub>COM</sub> = V <sub>NO</sub> or V <sub>NC</sub> = 1 V/4 V	Room Full	- 200 - 10000		200 10000	
<b>Digital Control</b>							
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full		1		μA
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3.0 V	Room Full		35	75 150	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		20	50 100	
Break-Before-Make Time	t <sub>d</sub>		Room	3	10		
Charge Injection	Q <sub>INJ</sub>	C <sub>L</sub> = 1 nF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω	Room		2	5	pC
Off-Isolation	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 74		dB
NC and NO Capacitance	C <sub>(off)</sub>	f = 1 MHz	Room		- 7		pF
Channel-On Capacitance	C <sub>D(on)</sub>		Room		32		
<b>Power Supply</b>							
Power Supply Range	V+			2.7		12	V
Power Supply Current	I+	V+ = 5.5 V, VIN = 0 or 5.5 V				1	μA

Notes:

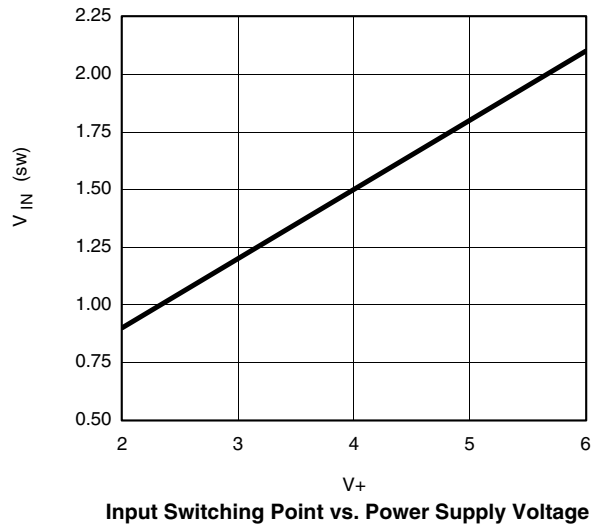
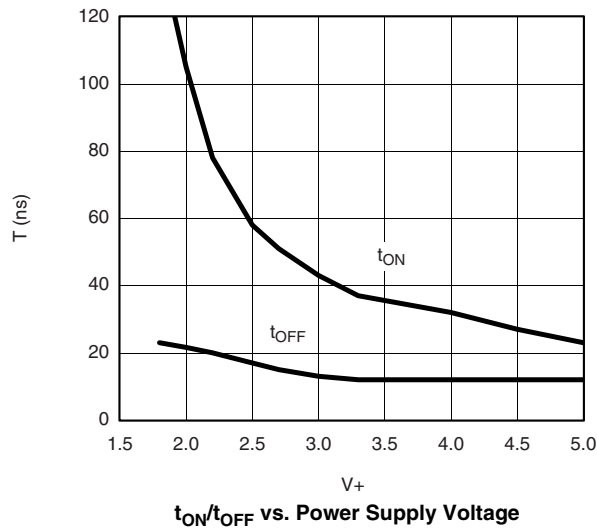
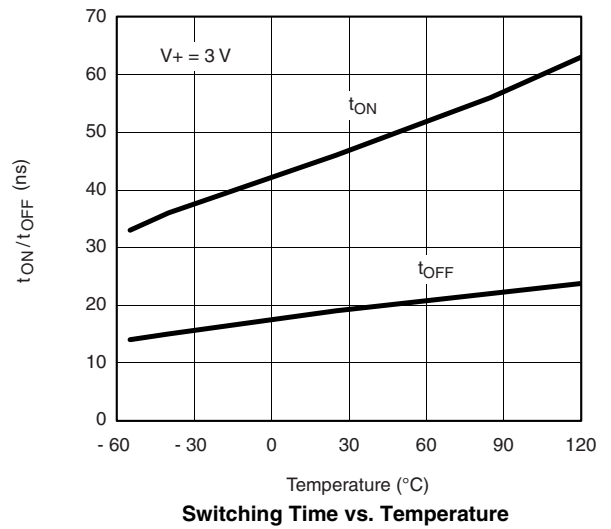
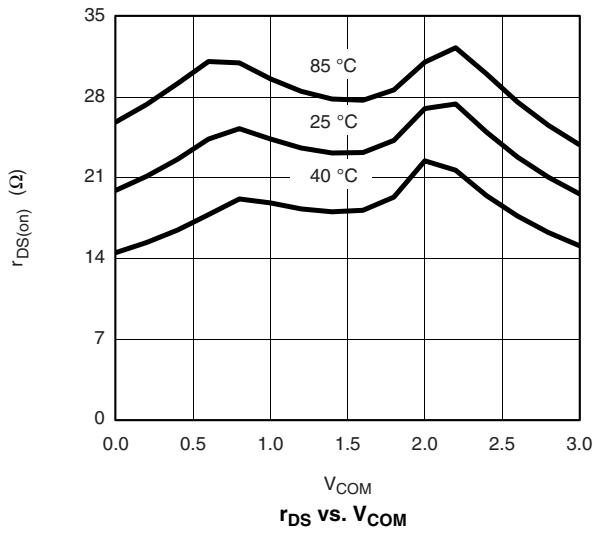
- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. Typical values are for design aid only, not guaranteed nor subject to production testing.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Guarantee by design, nor subjected to production test.
- e. VIN = input voltage to perform proper function.
- f. Difference of min and max values.
- g. Guraranteed 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.

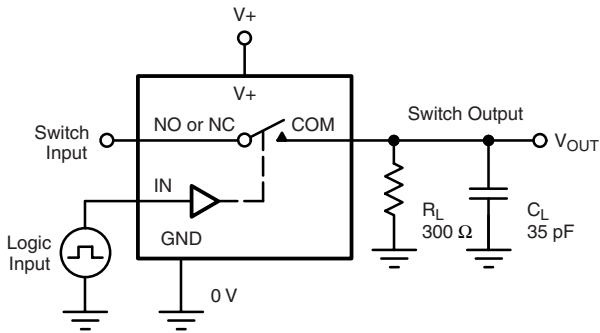
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

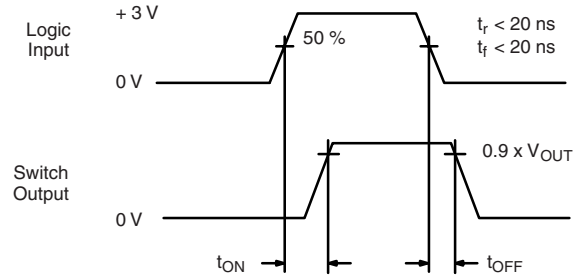


TEST CIRCUITS



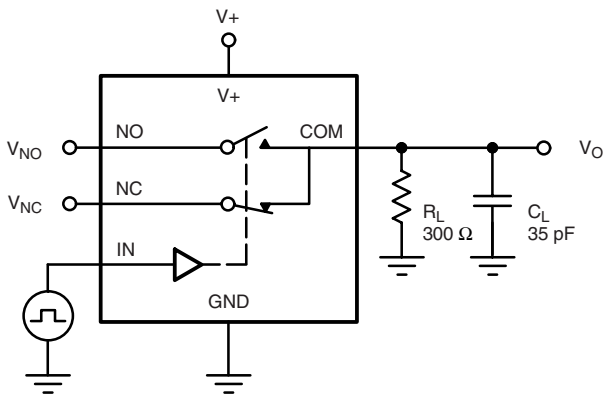
$C_L$  (includes fixture and stray capacitance)

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



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

Figure 1. Switching Time



$C_L$  (includes fixture and stray capacitance)

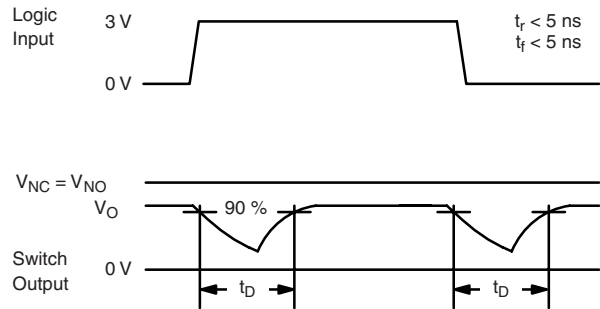
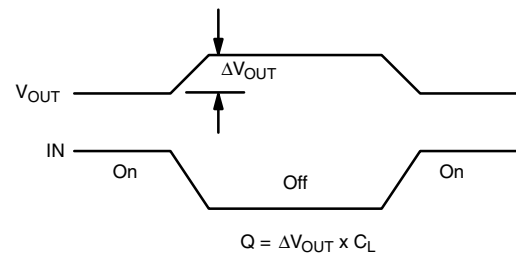
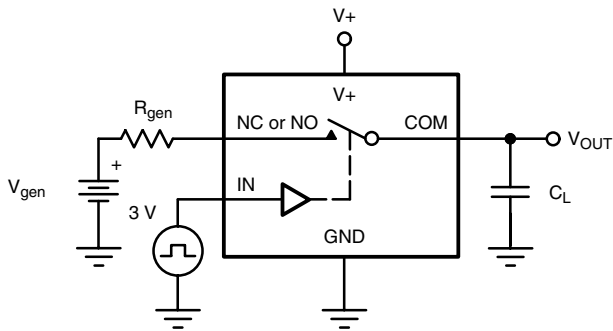


Figure 2. Break-Before-Make Interval



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

Figure 3. Charge Injection

TEST CIRCUITS

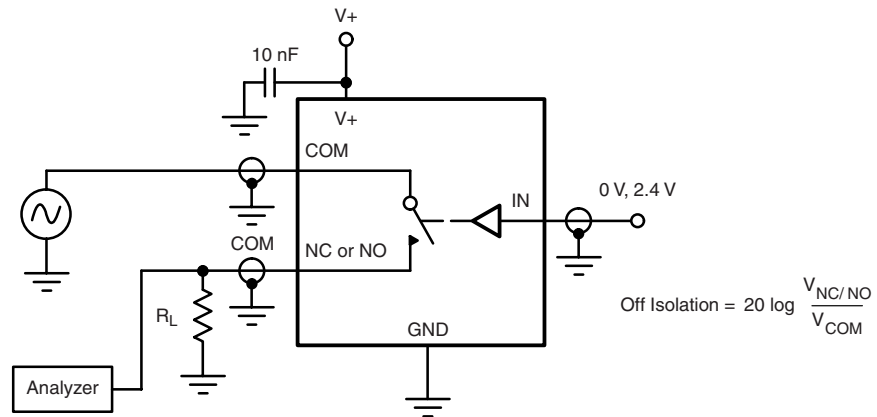


Figure 4. Off-Isolation

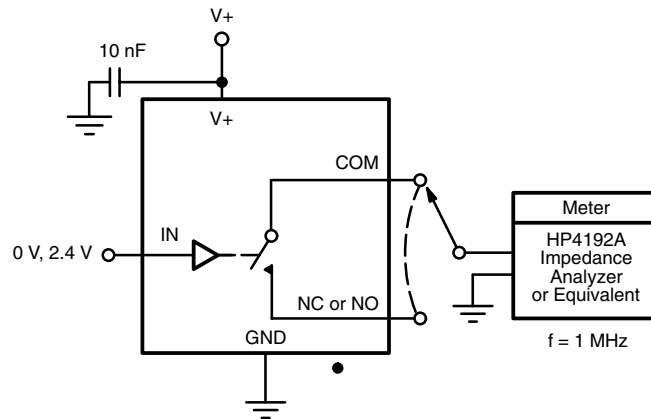


Figure 5. Channel Off/On Capacitance

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 <http://www.vishay.com/ppg?70831>.



## Disclaimer

All product specifications and data are subject to change without notice.

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 herein or in any other disclosure relating to any product.

Vishay disclaims any and all liability arising out of the use or application of any product described herein or of any information provided herein to the maximum extent permitted by law. The product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein, which apply to these products.

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.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications unless otherwise expressly indicated. Customers using or selling Vishay products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify Vishay for any damages arising or resulting from such use or sale. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.