

## Low Voltage, Dual DPDT and Quad SPDT Analog Switches

### DESCRIPTION

The DG2018 and DG2019 are low voltage, single supply analog switches. The DG2018 is a dual double-pole/double-throw (DPDT) with two control inputs that each controls a pair of single-pole/double-throw (SPDT). The DG2019 uses one control pin to operate four independent SPDT switches.

When operated on a + 3 V supply, the DG2018's control pins are compatible with 1.8 V digital logic. The DG2019 has an available feature of a  $V_L$  pin that allows a 1.0 V threshold for the control pin when  $V_L$  is powered with 1.5 V.

Built on Vishay Siliconix's low voltage submicron CMOS process, the DG2018 and DG2019 are ideal for high performance switching of analog signals; providing low on-resistance ( $6 \Omega$  at + 2.7 V), fast speed ( $T_{on}$ ,  $T_{off}$  at 42 ns and 16 ns), and a bandwidth that exceeds 180 MHz.

The DG2018 and DG2019 were designed to offer solutions that extend beyond audio/video functions, to providing the performance required for today's demanding mixed-signal switching in portable applications.

An epitaxial layer prevents latch-up. Brake-before-make is guaranteed for all SPDT's. All switches conduct 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
  - $R_{DS(on)}$ :  $6 \Omega$  at 2.7 V
- Low voltage logic compatible
  - DG2019:  $V_{INH} = 1 V$
- High bandwidth: 180 MHz
- QFN-16 package

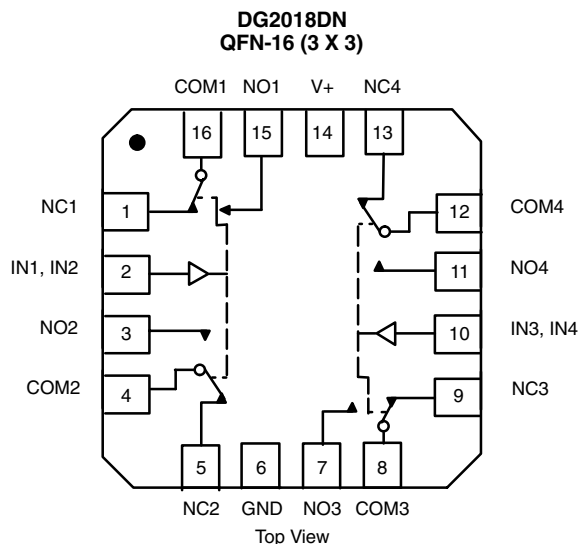
### BENEFITS

- Ideal for both analog and digital signal switching
- Reduced power consumption
- High accuracy
- Reduced PCB space
- Fast switching
- Low leakage

### APPLICATIONS

- Cellular phones
- Audio and video signal routing
- PCMCIA cards
- Battery operated systems
- Portable instrumentation

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



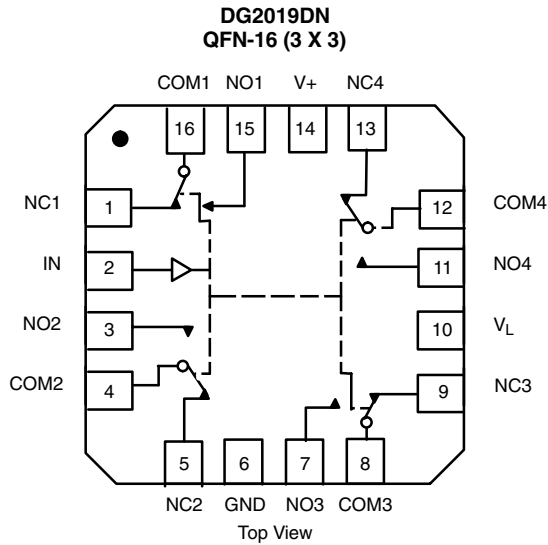
### TRUTH TABLE

IN1, IN2		
Logic	NC1 and NC2	NO1 and NO2
0	ON	OFF
1	OFF	ON
IN3, IN4		
Logic	NC3 and NC4	NO3 and NO4
0	ON	OFF
1	OFF	ON

### ORDERING INFORMATION

Temp. Range	Package	Part Number
- 40 °C to 85 °C	QFN-16 (3 x 3 mm)	DG2018DN

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
Logic	NC1, 2, 3 and 4	NO1, 2, 3 and 4
0	ON	OFF
1	OFF	ON

ORDERING INFORMATION		
Temp. Range	Package	Part Number
- 40 °C to 85 °C	QFN-16 (3 x 3 mm)	DG2019DN

ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Reference V+ to GND		- 0.3 to + 6	V
IN, COM, NC, NO		- 0.3 to (V+ + 0.3)	
Continuous Current (Any terminal)		± 50	mA
Peak Current (Pulsed at 1 ms, 10 % Duty Cycle)		± 100	
Storage Temperature (D Suffix)		- 65 to 150	°C
Power Dissipation (Packages) <sup>b</sup>	QFN-16 (3 x 3 mm) <sup>c</sup>	850	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 4.0 mW/°C above 70 °C.



SPECIFICATIONS $V_+ = 3\text{ V}$							
Parameter	Symbol	Test Conditions Otherwise Unless Specified $V_+ = 3\text{ V}, \pm 10\%$ , (DG2018 Only) $V_{IN} = 0.5\text{ or }1.4\text{ V}^e$ (DG2019 Only) $V_L = 1.5\text{ V}, V_{IN} = 0.4\text{ or }1.0\text{ V}^e$	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>	$V_{NO}, V_{NC}, V_{COM}$		Full	0		$V_+$	V
On-Resistance	$R_{ON}$	$V_+ = 2.7\text{ V}, V_{COM} = 0.2\text{ V}/1.5\text{ V}$ $I_{NO}, I_{NC} = 10\text{ mA}$	Room Full		6	12 15	Ω
$R_{ON}$ Flatness	$R_{ON}$ Flatness	$V_+ = 2.7\text{ V}$ $V_{COM} = 0\text{ to }V_+, I_{NO}, I_{NC} = 10\text{ mA}$	Room		0.5	2	
$R_{ON}$ Match Between Channels	$\Delta R_{ON}$		Room		0.6	3	
Switch Off Leakage Current	$I_{NO(off)}$ $I_{NC(off)}$	$V_+ = 3.3\text{ V}, V_{NO}, V_{NC} = 0.3\text{ V}/3\text{ V}$ $V_{COM} = 3\text{ V}/0.3\text{ V}$	Room Full	- 1 - 10	0.3	1 10	nA
	$I_{COM(off)}$		Room Full	- 1 - 10	0.3	1 10	
Channel-On Leakage Current	$I_{COM(on)}$	$V_+ = 3.3\text{ V}, V_{NO}, V_{NC} = V_{COM} = 0.3\text{ V}/3\text{ V}$	Room Full	- 1 10	0.3	1 10	
<b>Digital Control</b>							
Input High Voltage	$V_{INH}$		DG2018	Full	1.4		V
		$V_L = 1.5\text{ V}$	DG2019	Full	1.0		
Input Low Voltage	$V_{INL}$		DG2018	Full		0.5	V
		$V_L = 1.5\text{ V}$	DG2019	Full		0.4	
Input Capacitance	$C_{in}$	$f = 1\text{ MHz}$	Full		9		pF
Input Current	$I_{INL}$ or $I_{INH}$	$V_{IN} = 0\text{ or }V_+$	Full	- 1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time	$t_{ON}$	$V_{NO}$ or $V_{NC} = 2.0\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$	Room Full		42	55 65	ns
Turn-Off Time	$t_{OFF}$		Room Full		16	25 35	
Break-Before-Make Time	$t_d$	$V_{NO}$ or $V_{NC} = 2.0\text{ V}, R_L = 50\ \Omega, C_L = 35\text{ pF}$	Full	1			
Charge Injection <sup>d</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\ \Omega$	Room		- 1.46		pC
Off-Isolation <sup>d</sup>	OIRR	$R_L = 50\ \Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$	Room		- 67		dB
Crosstalk <sup>d</sup>	$X_{TALK}$		Room		- 72		
Bandwidth <sup>d</sup>	BW		Room		180		MHz
$N_O, N_C$ Off Capacitance <sup>d</sup>	$C_{NO(off)}$	$V_{IN} = 0\text{ or }V_+, f = 1\text{ MHz}$	Room		9		pF
	$C_{NC(off)}$		Room		9		
Channel-On Capacitance <sup>d</sup>	$C_{NO(on)}$		Room		30		
	$C_{NC(on)}$		Room		30		
<b>Power Supply</b>							
Power Supply Current	$I_+$	$V_{IN} = 0\text{ or }V_+$	Full		0.01	1.0	μA

Notes:

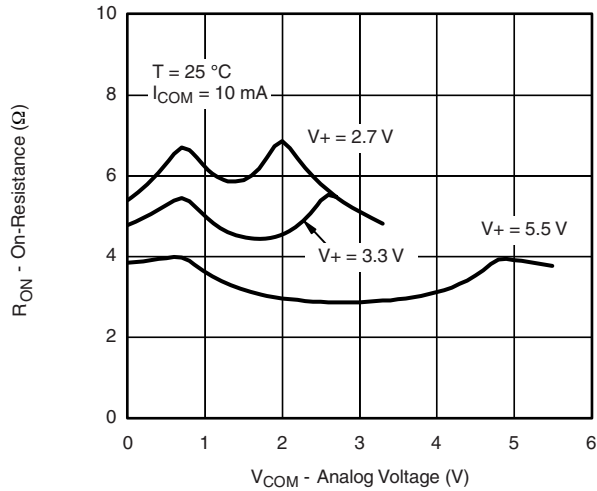
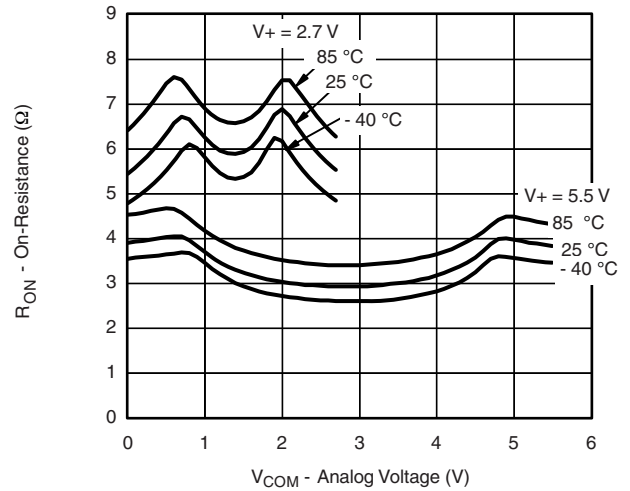
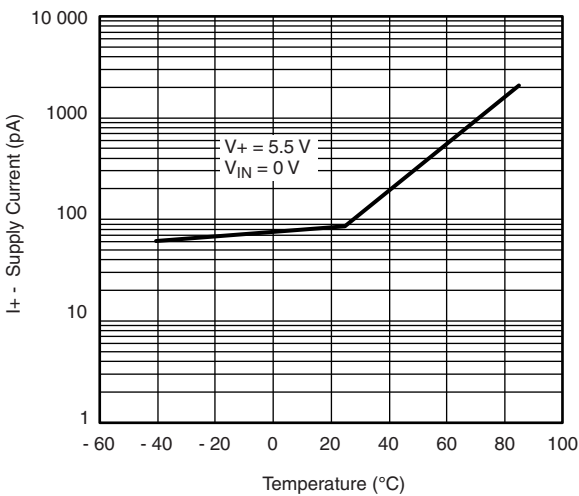
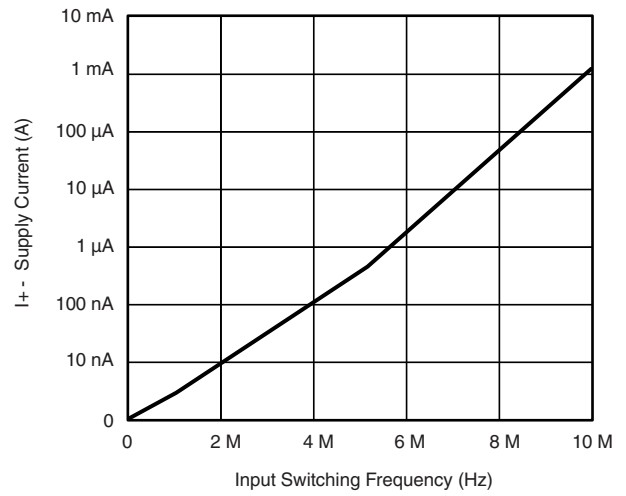
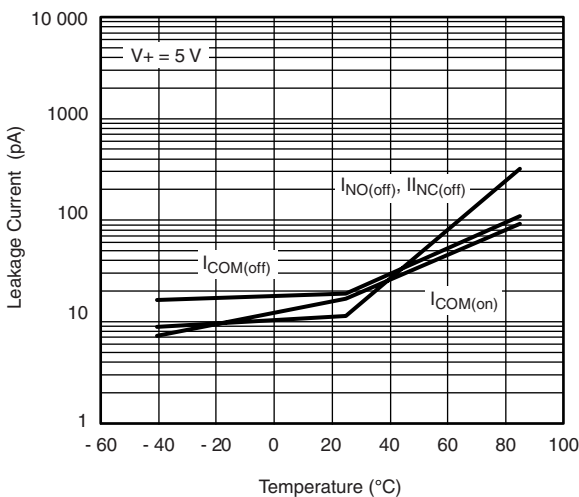
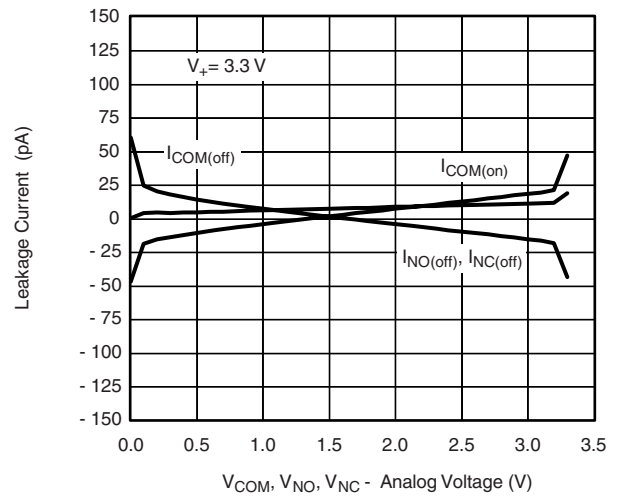
- a. Room = 25 °C, Full = as determined by the operating suffix.
- b. Typical values are for design aid only, not guaranteed nor subject to production testing.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d.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

SPECIFICATIONS $V_+ = 5\text{ V}$							
Parameter	Symbol	Test Conditions Otherwise Unless Specified $V_+ = 5\text{ V}, \pm 10\%$ , (DG2018 Only) $V_{IN} = 0.8$ or $1.8\text{ V}^e$ (DG2019 Only) $V_L = 1.5\text{ V}, V_{IN} = 0.4$ or $1.0\text{ V}^e$	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>	$V_{NO}, V_{NC}, V_{COM}$		Full	0		$V_+$	V
On-Resistance	$R_{ON}$	$V_+ = 4.5\text{ V}, V_{COM} = 3\text{ V}, I_{NO}, I_{NC} = 10\text{ mA}$	Room Full		4	8 10	Ω
$R_{ON}$ Flatness	$R_{ON}$ Flatness	$V_+ = 4.5\text{ V}$ $V_{COM} = 0$ to $V_+, I_{NO}, I_{NC} = 10\text{ mA}$	Room		0.6	1.2	
$R_{ON}$ Match Between Channels	$\Delta R_{ON}$		Room		0.6	1.2	
Switch Off Leakage Current <sup>f</sup>	$I_{NO(off)}$ $I_{NC(off)}$	$V_+ = 5.5\text{ V}$ $V_{NO}, V_{NC} = 1\text{ V}/4.5\text{ V}, V_{COM} = 4.5\text{ V}/1\text{ V}$	Room Full	- 1 - 10	0.03	1 10	nA
	$I_{COM(off)}$		Room Full	- 1 - 10	0.03	1 10	
Channel-On Leakage Current <sup>f</sup>	$I_{COM(on)}$	$V_+ = 5.5\text{ V}, V_{NO}, V_{NC} = V_{COM} = 1\text{ V}/4.5\text{ V}$	Room Full	- 1 - 10	0.03	1 10	
<b>Digital Control</b>							
Input High Voltage	$V_{INH}$		DG2018	Full	1.8		V
		$V_L = 1.5\text{ V}$	DG2019	Full	1.0		
Input Low Voltage	$V_{INL}$		DG2018	Full		0.8	
		$V_L = 1.5\text{ V}$	DG2019	Full		0.4	
Input Capacitance	$C_{in}$		Full		9		pF
Input Current	$I_{INL}$ or $I_{INH}$	$V_{IN} = 0$ or $V_+$	Full	1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time	$t_{ON}$	$V_{NO}$ or $V_{NC} = 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$	Room Full		44	48 52	ns
Turn-Off Time	$t_{OFF}$		Room Full		19	33 35	
Break-Before-Make Time	$t_d$	$V_{NO}$ or $V_{NC} = 3\text{ V}, R_L = 50\ \Omega, C_L = 35\text{ pF}$	Full	1			
Charge Injection <sup>d</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\ \Omega$	Room		- 2.46		pC
Off-Isolation <sup>d</sup>	OIRR	$R_L = 50\ \Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$	Room		- 67		dB
Crosstalk <sup>d</sup>	$X_{TALK}$		Room		- 72		
Bandwidth <sup>d</sup>	BW		Room		180		
Source-Off Capacitance <sup>d</sup>	$C_{NO(off)}$	$V_{IN} = 0$ or $V_+, f = 1\text{ MHz}$	Room		7.5		pF
	$C_{NC(off)}$		Room		7.5		
Channel-On Capacitance <sup>d</sup>	$C_{NO(on)}$		Room		30		
	$C_{NC(on)}$		Room		30		
<b>Power Supply</b>							
Power Supply Range	$V_+$			1.8		5.5	V
Power Supply Current	$I_+$	$V_{IN} = 0$ or $V_+$	Full		0.01	1.0	μA

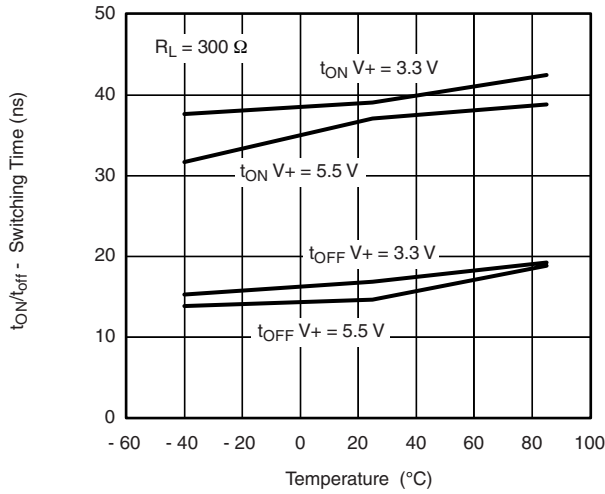
Notes:

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- e.  $V_{IN}$  = input voltage to perform proper function.
- f. Not production tested.

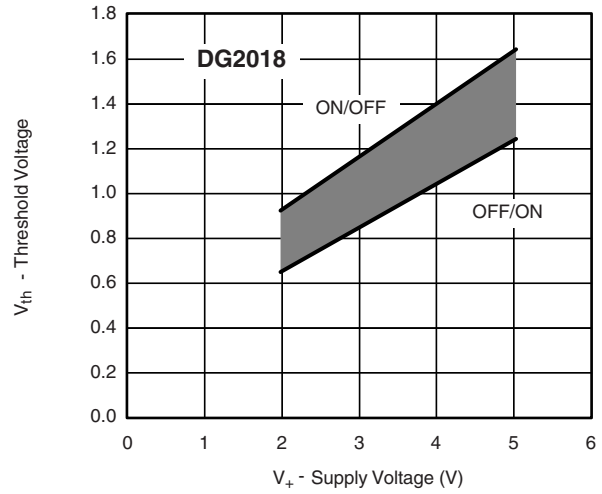
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

 **$R_{ON}$  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**

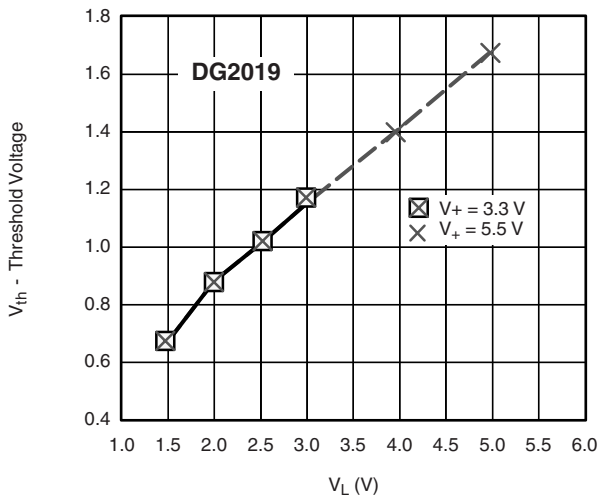
### TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



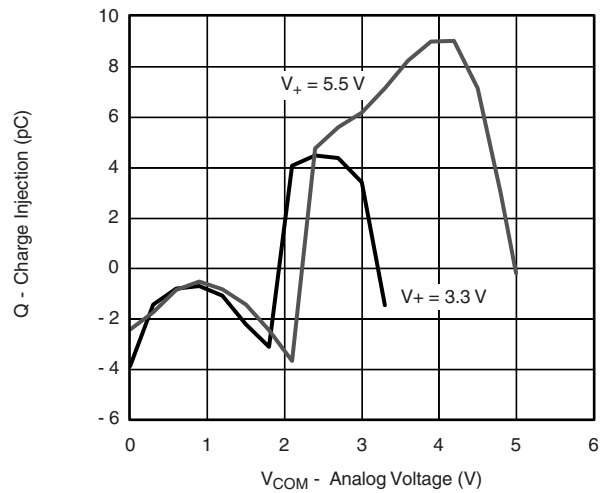
**Switching Time vs. Temperature and Supply Voltage**



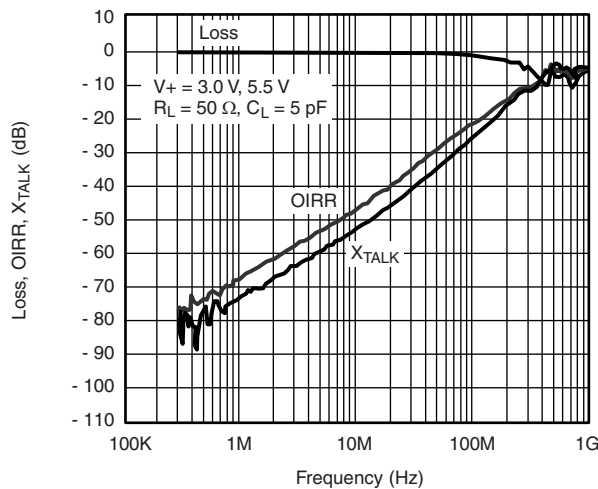
**Switching Voltage vs. Supply Voltage ( $V_+$ )**



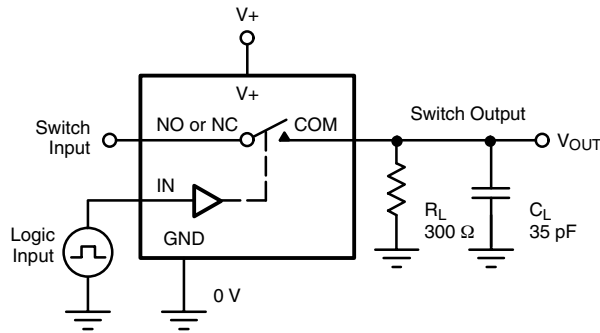
**$V_{IN}$  vs.  $V_L$  (Typ)**



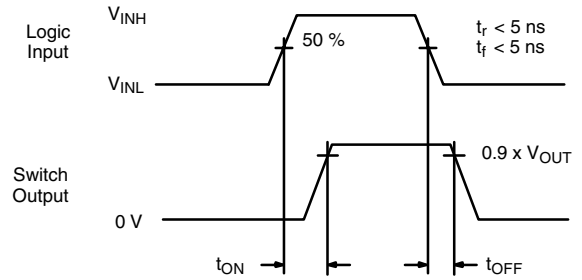
**Charge Injection at Source vs. Analog Voltage**



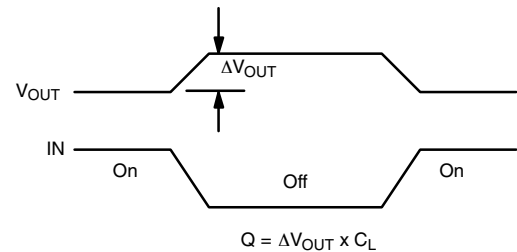
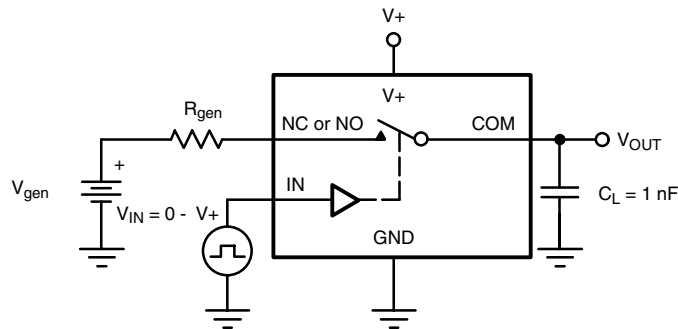
**Insertion Loss, Off Isolation and Crosstalk vs. Frequency**

**TEST CIRCUITS**

 $C_L$  (includes fixture and stray capacitance)

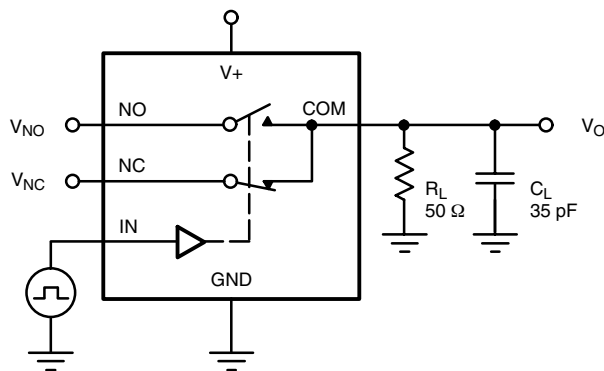
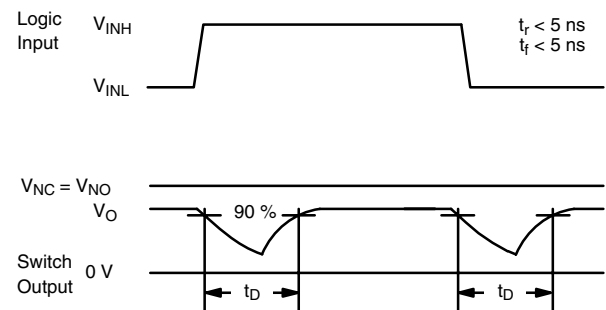
$$V_{OUT} = V_{COM} \left( \frac{R_L}{R_L + R_{ON}} \right)$$



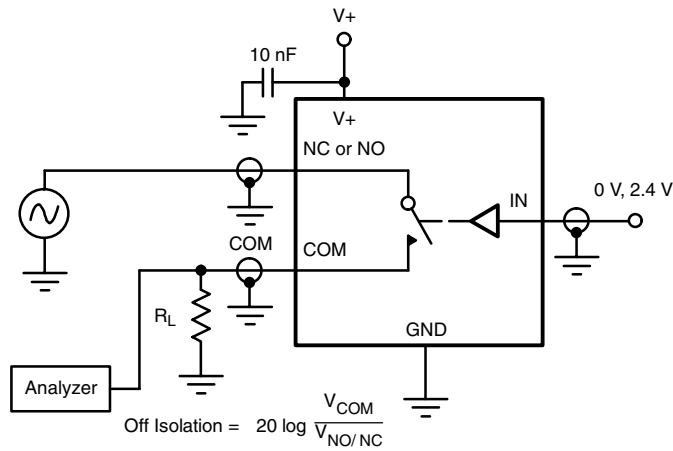
Logic "1" = Switch On  
 Logic input waveforms inverted for switches that have the opposite logic sense.

**Figure 1. Switching Time**


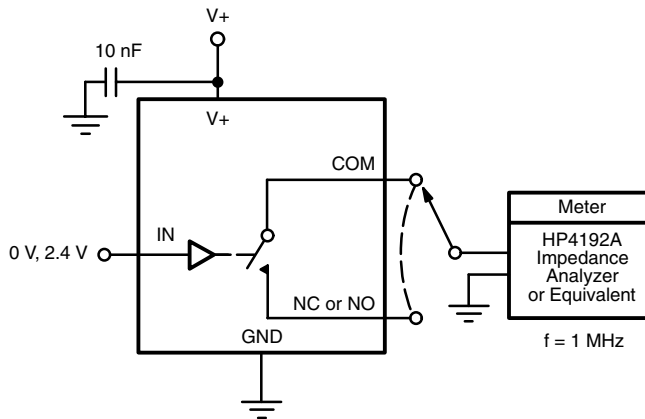
IN depends on switch configuration: input polarity determined by sense of switch.

**Figure 2. Charge Injection**

 $C_L$  (includes fixture and stray capacitance)

**Figure 3. Break-Before-Make Interval**

**TEST CIRCUITS**



**Figure 4. Off-Isolation**



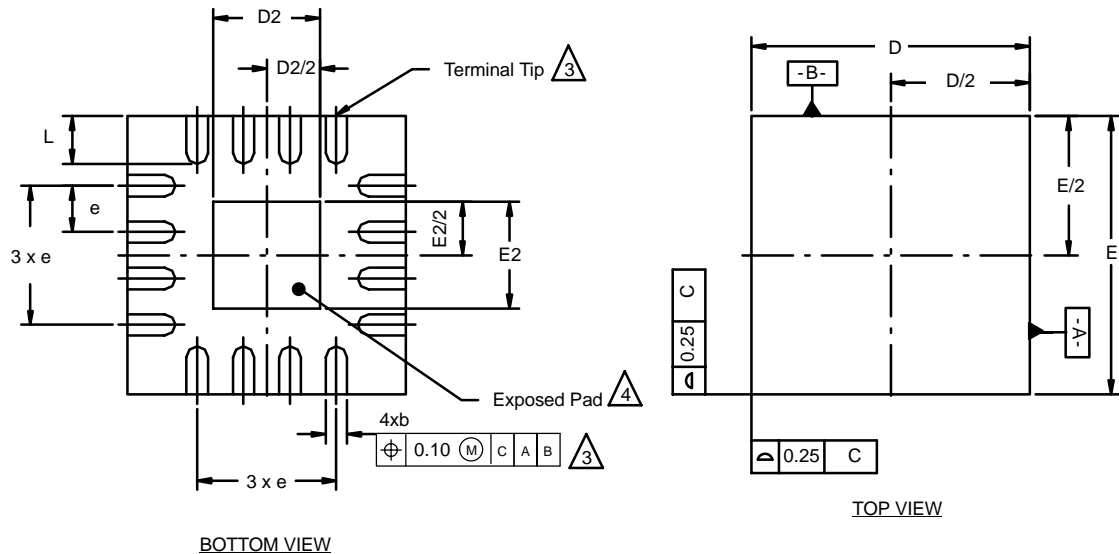
**Figure 5. Channel Off/On Capacitance**

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?72342>.





**QFN-16 LEAD (3 X 3)**



NOTES:

1. All dimensions are in millimeters.
2. N is the total number of terminals.
3. Dimension b applies to metallized terminal and is measured between 0.25 and 0.30 mm from terminal tip.
4. Coplanarity applies to the exposed heat sink slug as well as the terminal.
5. The pin #1 identifier may be either a mold or marked feature, it must be located within the zone indicated.

Dim	VARIATION 1						VARIATION 2					
	MILLIMETERS			INCHES			MILLIMETERS			INCHES		
	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
<b>A</b>	0.80	0.90	1.00	0.031	0.035	0.039	0.80	0.90	1.00	0.031	0.035	0.039
<b>b</b>	0.18	0.23	0.30	0.007	0.009	0.012	0.18	0.25	0.30	0.007	0.010	0.012
<b>D</b>	3.00 BSC			0.118 BSC			3.00 BSC			0.118 BSC		
<b>D2</b>	1.00	1.15	1.25	0.039	0.045	0.049	1.55	1.70	1.80	0.061	0.067	0.071
<b>E</b>	3.00 BSC			0.118 BSC			3.00 BSC			0.118 BSC		
<b>E2</b>	1.00	1.15	1.25	0.039	0.045	0.049	1.55	1.70	1.80	0.061	0.067	0.071
<b>e</b>	0.50 BSC			0.020 BSC			0.50 BSC			0.020 BSC		
<b>L</b>	0.30	0.40	0.50	0.012	0.016	0.020	0.30	0.40	0.50	0.012	0.016	0.020

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DWG: 5899



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**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**