

Low-Voltage, Low R_{ON} , Dual DPDT Analog Switch

DESCRIPTION

The DG2017 is a dual DPDT (double-pole/double-throw), optimized for high performance analog switching, and specifically designed to benefit portable audio applications.

One pair of double-throw switches is sub $1\ \Omega$ for low impedance speaker performance while the second pair of double-throw switches is suitable for microphone applications.

With the DPDT configuration, the DG2017 provides the flexibility for stereo-single-end or differential BTL output structures with a fully integrated differential microphone switching solution.

The DG2017 is an integrated monolithic device in a QFN-16 (4 mm x 4 mm) package that provides a space saving solution over the use of multiple single SPDT devices as well as providing the advantage of on-resistance flatness and matching that single SPDT devices cannot offer.

The DG2017 provides low charge injection (2 pC), fast switching time (t_{ON} and t_{OFF} less than 100 ns), excellent Off-Isolation and Crosstalk (-70 dB at 100 kHz). During operation, continuous current through any or all switches is rated at $\pm 200\text{ mA}$, ideal for portable audio applications.

Built on Vishay Siliconix's low voltage CMOS process, the DG2017 contains an epitaxial layer that prevents latchup. Break-before-make is guaranteed. When on, each switch conducts equally well in both directions, and block up to the power supply level when off.

FEATURES

- Low voltage operation (2 V to 5.5 V)
- Low on-resistance at 2.7 V - R_{ON} :
 $SW_1, SW_2 - 3.2\ \Omega$
 $SW_3, SW_4 - 0.64\ \Omega$
- Fast switching: $t_{ON} = 46\text{ ns}$
 $t_{OFF} = 21\text{ ns}$
- QFN-16 (4 mm x 4 mm) package
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912



RoHS
COMPLIANT
HALOGEN
FREE

BENEFITS

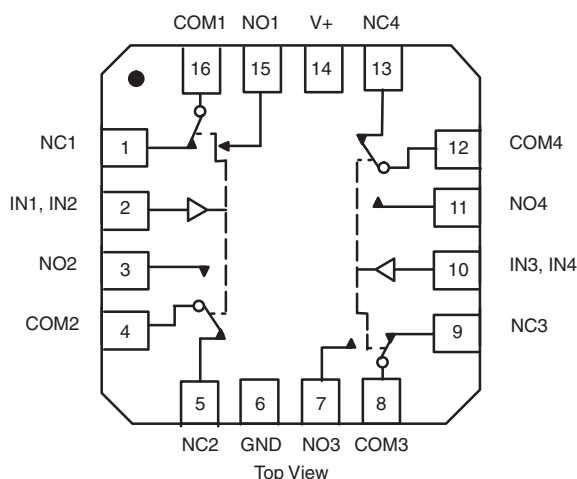
- Space saving solution
- Low power consumption
- Guaranteed low voltage operation
- Low voltage logic compatible

APPLICATIONS

- Cellular Phones
- Integrated Speaker Switching
- Audio and Video Signal Routing
- PCMCIA Cards
- Battery Operated Systems

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

QFN-16 (4 x 4)



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	16-pin QFN (4 x 4 mm) (Variation 1)	DG2017DN-T1-E4

ABSOLUTE MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Parameter	Limit	Unit
Reference V_+ to GND	- 0.3 to + 6	V
IN, COM, NC, NO^a	- 0.3 to ($V_+ + 0.3$)	
Current (Any terminal except NO, NC or COM)	30	mA
Continuous Current (NO, NC, or COM)	± 200	
Peak Current (Pulsed at 1 ms, 10 % duty cycle)	± 300	
Storage Temperature (D Suffix)	- 65 to 150	$^\circ\text{C}$
Package Solder Reflow Conditions ^d	16-pin QFN (4 mm x 4 mm)	
Power Dissipation (Packages) ^b	QFN-16 (4 mm x 4 mm)	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 23.5 mW/ $^\circ\text{C}$ above 70°C .
d. Manual soldering with 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 ($V_+ = 3\text{ V}$)

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, VIN = 0.4 V or 1.6 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
DC Characteristics							
On-Resistance	R _{ON} (SW ₁ , SW ₂)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 10 mA	Room Full		3.2	3.7 4.3	Ω
	R _{ON} (SW ₃ , SW ₄)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 100 mA	Room Full		0.67	1.1 1.2	
R _{ON} Flatness ^d	R _{ON} (SW ₁ , SW ₂)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 10 mA	Room Full		1.4	2	
	R _{ON} (SW ₃ , SW ₄)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 100 mA	Room Full		0.12	0.3	
R _{ON} Match ^d	ΔR _{ON} (SW ₁ , SW ₂)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 10 mA	Room Full			0.3	
	ΔR _{ON} (SW ₃ , SW ₄)	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} , I _{NC} = 100 mA	Room Full			0.3	
Switch Off Leakage Current	I _{NO(off)} I _{NC(off)}	V+ = 3.3 V V _{NO} , V _{NC} = 0.3 V/3 V, V _{COM} = 0.3 V/3 V	Room Full	- 0.5 5		0.5 5	nA
	I _{COM(off)}		Room Full	- 0.5 5		0.5 5	
Channel-On Leakage Current	I _{COM(on)}	V+ = 3.3 V, V _{NO} = V _{NC} , V _{COM} = 0.3 V/3 V	Room Full	- 0.5 5		0.5 5	
Digital Control							
Input High Voltage	V _{INH}		Full	1.6			V
Input Low Voltage	V _{INL}		Full			0.4	
Input Capacitance	C _{in}		Full		6		pF
Input Current	I _{INL} or I _{INH}	V _{IN} = 0 V or V+	Full	- 1		1	μA



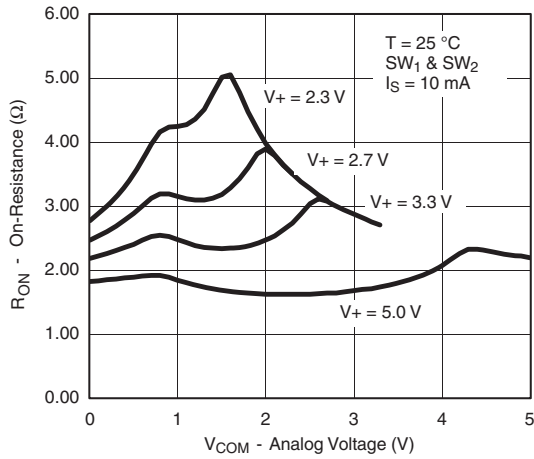
SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, VIN = 0.4 V or 1.6 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Dynamic Characteristics							
Turn-On Time	t _{ON} (SW ₁ , SW ₂)	V _{NO} or V _{NC} = 2 V, R _L = 300 Ω, C _L = 35 pF (fig. 1, 2)	Room Full		62	85 91	ns
	t _{ON} (SW ₃ , SW ₄)		Room Full		46	74 79	
Turn-Off Time	t _{ON} (SW ₁ , SW ₂)		Room Full		12	35 36	
	t _{ON} (SW ₃ , SW ₄)		Room Full		21	46 48	
Break-Before-Make Time	t _d (SW ₁ , SW ₂)		Full	5	45		
	t _d (SW ₃ , SW ₄)		Full	5	26		
Charge Injection ^d	Q _{INJ} (SW ₁ , SW ₂)	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω (fig. 3)	Room		2		pC
	Q _{INJ} (SW ₃ , SW ₄)				1		
Off-Isolation ^d	OIRR (SW ₁ , SW ₂)	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz (fig. 4)	Room		- 68		dB
	OIRR (SW ₃ , SW ₄)				- 51		
Crosstalk ^d	X _{TALK} (SW ₁ , SW ₂)				- 69		
	X _{TALK} (SW ₃ , SW ₄)				- 51		
N _O , N _C Off Capacitance ^d	C _{OFF} (SW ₁ , SW ₂)	V _{IN} = 0 V or V+, f = 1 MHz	Room		12		pF
	C _{OFF} (SW ₃ , SW ₄)				43		
Channel-On Capacitance ^d	C _{ON} (SW ₁ , SW ₂)				86		
	C _{ON} (SW ₃ , SW ₄)				283		
Power Supply							
Power Supply Range	V+			2		5.5	V
Power Supply Current	I+	V _{OE} = 0 V or V+				1	μA

Notes:

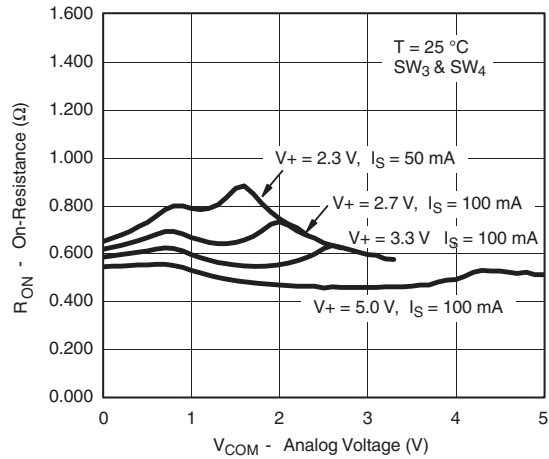
- Room = 25 °C, full = as determined by the operating suffix.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guarantee by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

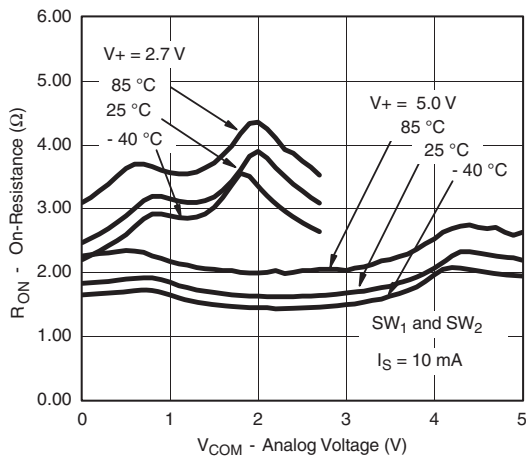
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



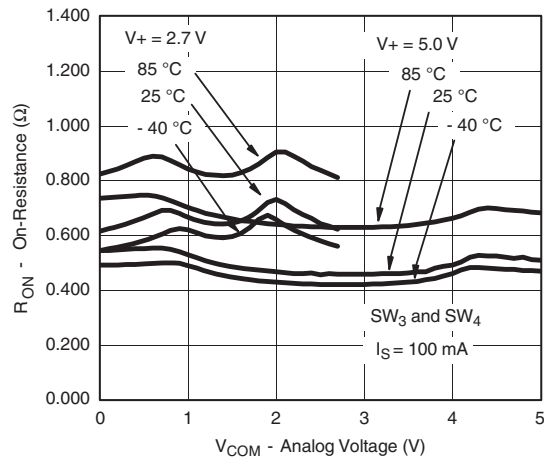
R_{ON} vs. V_{COM} and Single Supply Voltage



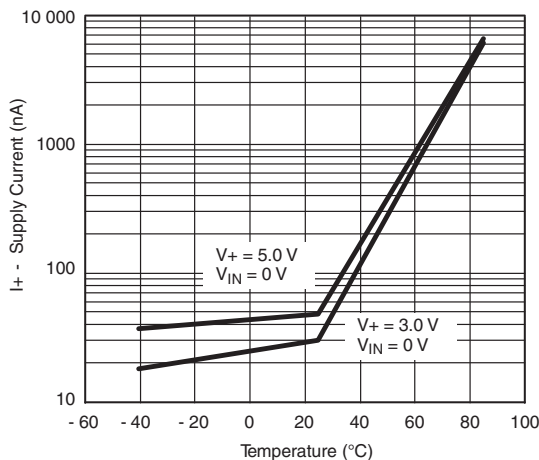
R_{ON} vs. V_{COM} and Single Supply Voltage



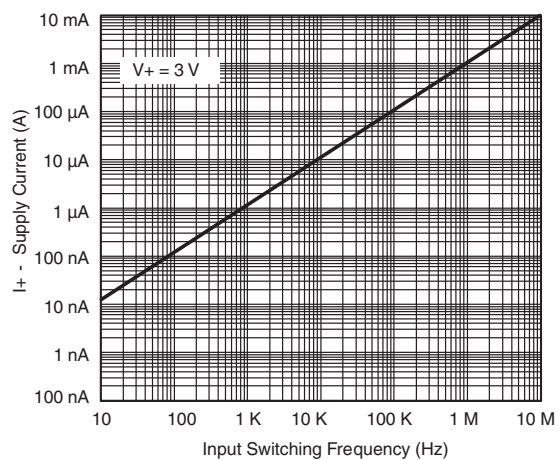
R_{ON} vs. Analog Voltage and Temperature



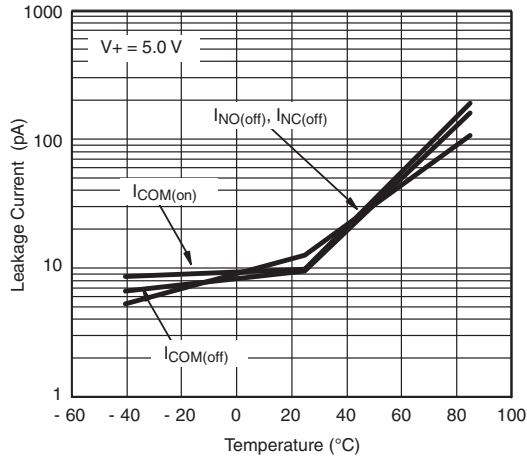
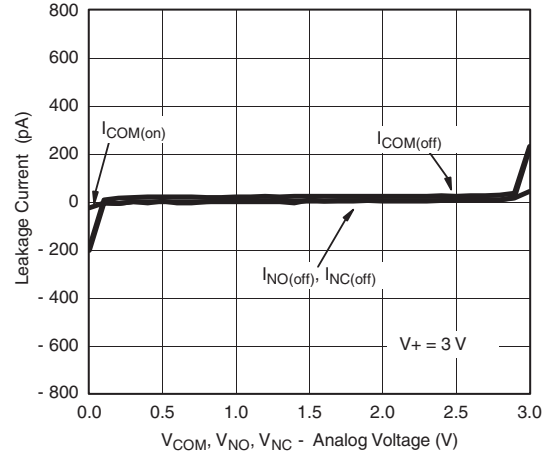
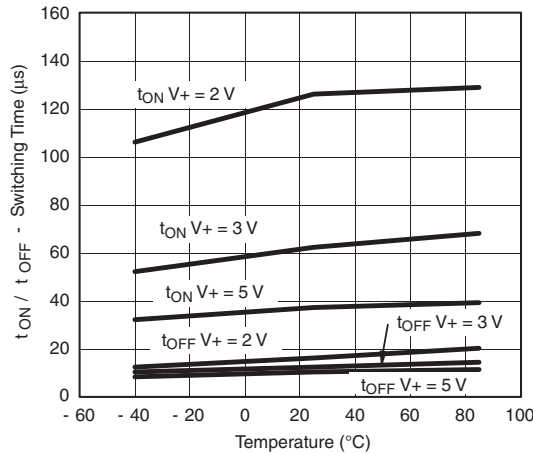
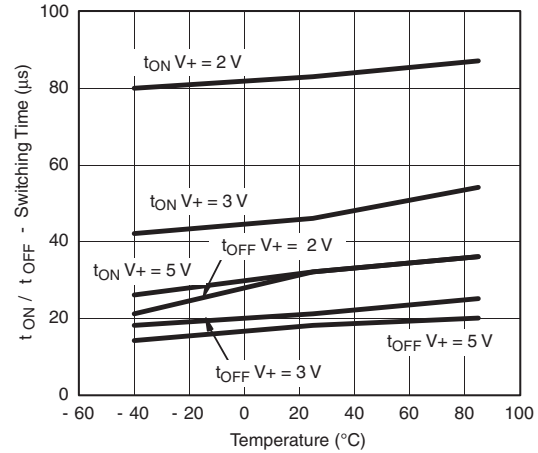
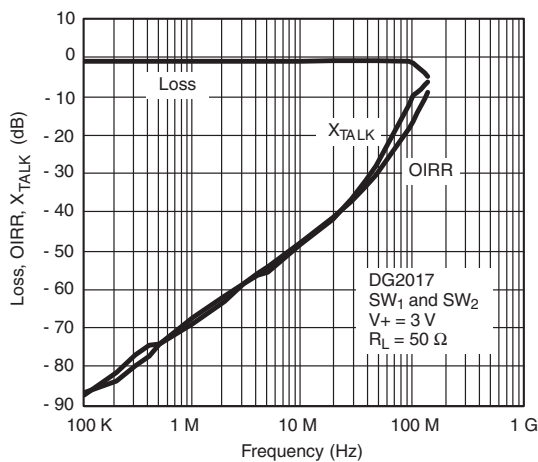
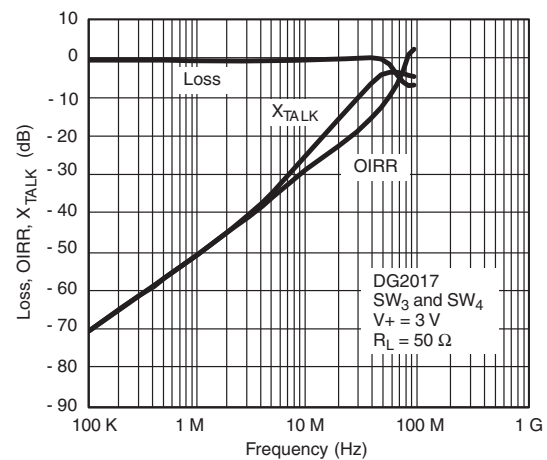
R_{ON} vs. Analog Voltage and Temperature



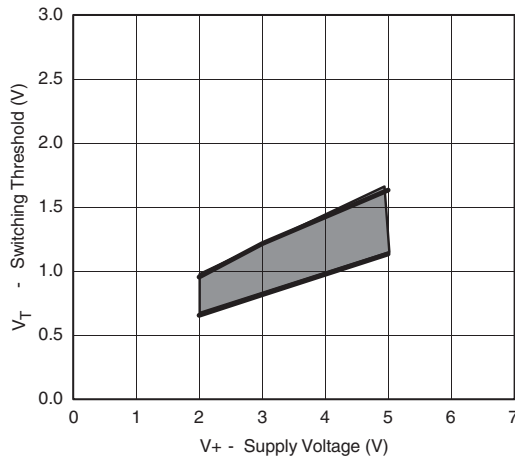
Supply Current vs. Temperature



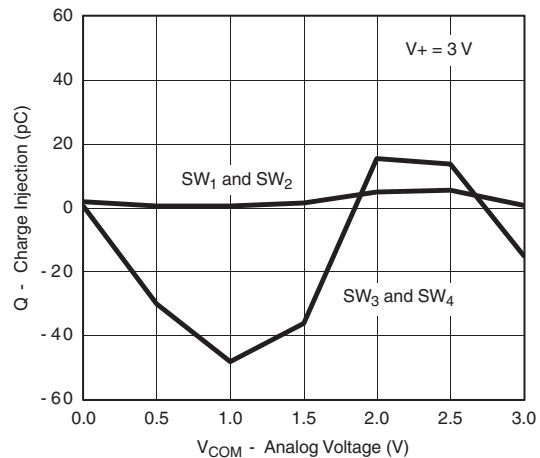
Supply Current vs. Input Switching Frequency

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

Leakage Current vs. Temperature

Leakage vs. Analog Voltage

Switching Time vs. Temperature

Switching Time vs. Temperature

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

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

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)

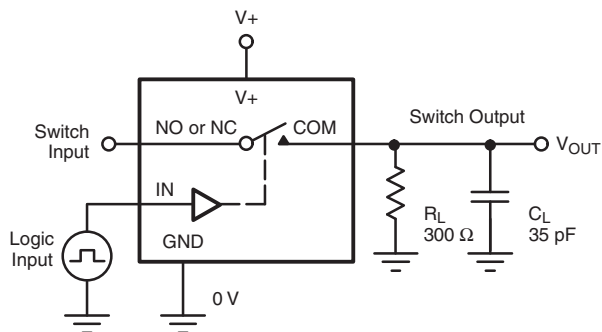


Switching Threshold vs. Supply Voltage



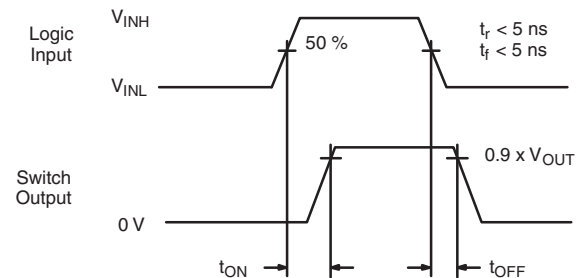
Charge Injection vs. Analog Voltage

TEST CIRCUITS



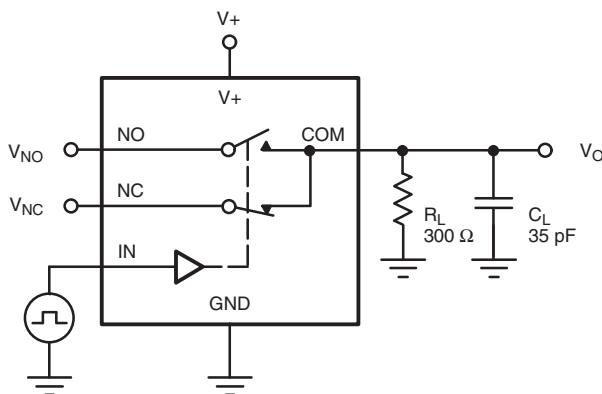
C_L (includes fixture and stray capacitance)

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



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

Figure 1. Switching Time



C_L (includes fixture and stray capacitance)

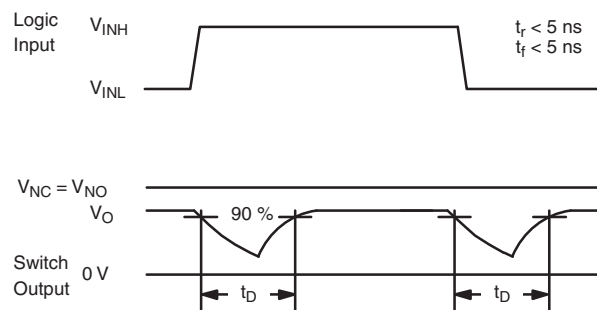
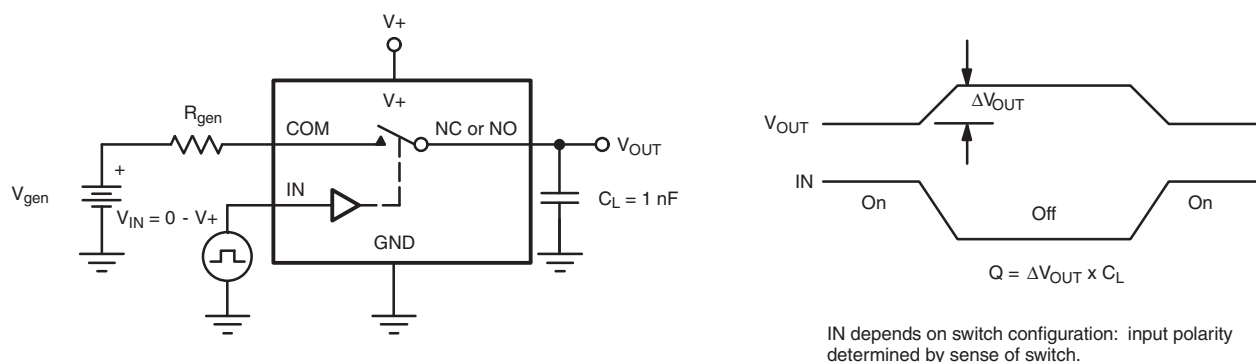
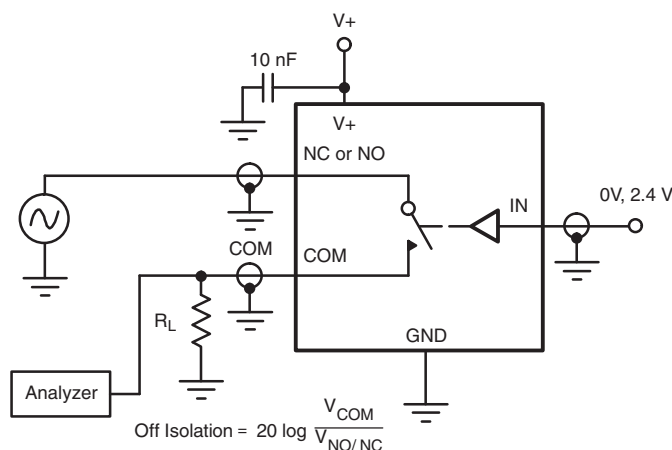
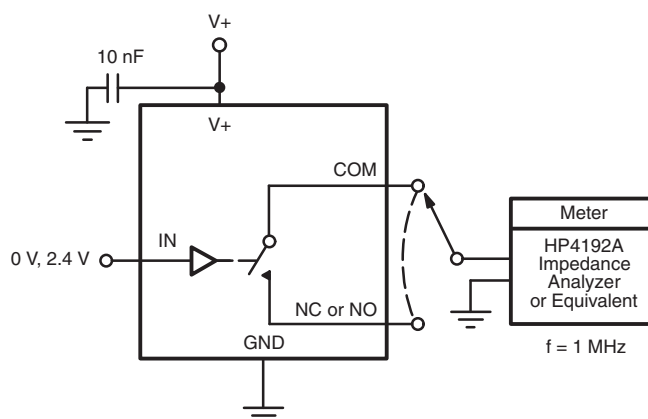
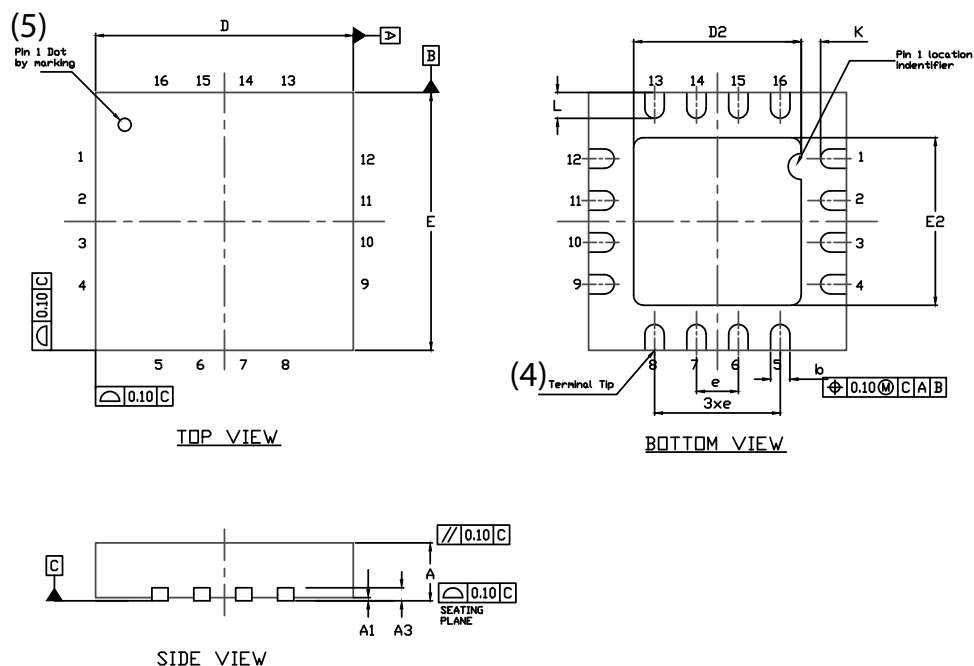


Figure 2. Break-Before-Make Interval

TEST CIRCUITS

Figure 3. Charge Injection

Figure 4. Off-Isolation

Figure 5. Channel Off/On Capacitance

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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.

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DWG: 5890



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