

# Low-Voltage Single SPDT Analog Switch

## DESCRIPTION

The DG2001 is a single-pole/double-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, high speed, low on-resistance and small physical size, the DG2001 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2001 is built on Vishay Siliconix's low voltage J12 process. The DG2001 has a minimum 2000 V, ESD protection, per Method 3015.7. 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.

## FEATURES

- **Halogen-free according to IEC 61249-2-21 Definition**
- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance -  $R_{ON}$ : 3  $\Omega$
- Fast Switching -  $t_{ON}$ : 20 ns,  $t_{OFF}$ : 10 ns
- Low Leakage -  $I_{COM}$ : 0.2 nA
- Low Charge Injection -  $Q_{INJ}$ : 5 pC
- Low Power Consumption
- TTL/CMOS Compatible
- ESD Protection > 2000 V (Method 3015.7)
- TSOP-6 Package
- **Compliant to RoHS Directive 2002/95/EC**



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

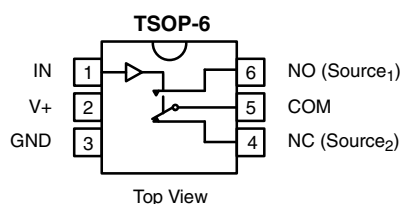
## BENEFITS

- 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



## TRUTH TABLE

Logic	NC	NO
0	ON	OFF
1	OFF	ON

## ORDERING INFORMATION

Temp Range	Package	Part Number
- 40 °C to 85 °C	TSOP-6	DG2001DV-T1
		DG2001DV-T1-E3

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

Parameter	Symbol	Limit	Unit
Referenced $V_+$ to GND		- 0.3 to + 6	V
IN, COM, NC, NO <sup>a</sup>		- 0.3 to ( $V_+ + 0.3$ )	
Continuous Current (Any Terminal)		$\pm 50$	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		$\pm 200$	
ESD (MIL-STD-883B, Method 3015.7)		> 2000	V
Storage Temperature (D Suffix)		- 65 to 125	$^\circ\text{C}$
Power Dissipation (Packages) <sup>b</sup>	TSOP-6 <sup>c</sup>	570	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 7 mW/ $^\circ\text{C}$  above  $25^\circ\text{C}$ .**SPECIFICATIONS** ( $V_+ = 2\text{ V}$ )

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 2 V, ± 10 % VIN = 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>	VNO, VNC VCOM		Full	0		V+	V
On-Resistance	RON	V+ = 1.8 V, VCOM = 1 V, INO, INC = 10 mA	Room Full		15 17	30 32	Ω
RON Flatness <sup>d</sup>	RON Flatness	V+ = 1.8 V, VCOM = 0 V to V+, INO, INC = 10 mA	Room		5		
Switch Off Leakage Current <sup>g</sup>	INO(off) INC(off)	V+ = 2.2 V VNO, VNC = 0.5 V/1.5 V, VCOM = 1.5 V/0.5 V	Room Full	- 300 - 3.5		300 3.5	pA nA
	ICOM(off)		Room Full	- 300 - 3.5		300 3.5	pA nA
Channel-On Leakage Current <sup>g</sup>	ICOM(on)	V+ = 2.2 V, VNO, VNC = VCOM = 0.5 V/1.5 V	Room Full	- 350 - 3.5		300 3.5	pA nA
Digital Control							
Input High Voltage	VINH		Full	1.6			V
Input Low Voltage	VINL		Full			0.4	
Input Capacitance	Cin		Full		4		pF
Input Current	IINL or IINH	VIN = 0 V or V+	Full	1		1	μA
Dynamic Characteristics							
Turn-On Time	tON	VNO or VNC = 1.5 V, RL = 300 Ω, CL = 35 pF	Room Full		30	50 53	ns
Turn-Off Time	tOFF		Room Full		15	30 33	
Break-Before-Make Time	td		Room	1	15		
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω	Room		1	10	pC
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 71		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 70		
NO, NC Off Capacitance <sup>d</sup>	CNO(off) CNC(off)	VIN = 0 V or V+, f = 1 MHz	Room		17		pF
Channel-On Capacitance <sup>d</sup>	CON		Room		50		
Power Supply							
Power Supply Range	V+			1.8		2.20	V
Power Supply Current	I+	VIN = 0 V or V+			0.01	1	μA
Power Consumption	PC					2.2	μW



SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Unless Otherwise 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>	
Analog Switch							
Analog Signal Range <sup>d</sup>	VNO, VNC, VCOM		Full	0		V+	V
On-Resistance	RON	V+ = 2.7 V, VCOM = 1.5 V, INO, INC = 10 mA	Room Full		5 6	9.2 10.2	Ω
RON Flatness <sup>d</sup>	RON Flatness	V+ = 2.7 V, VCOM = 0 V to V+, INO, INC = 10 mA	Room		3		
Switch Off Leakage Current <sup>g</sup>	INO(off), INC(off)	V+ = 3.3 V VNO, VNC = 1 V/3 V, VCOM = 3 V/1 V	Room Full	- 400 - 4.5		400 4.5	pA nA
	ICOM(off)		Room Full	- 400 - 4.5		400 4.5	pA nA
Channel-On Leakage Current <sup>g</sup>	ICOM(on)	V+ = 3.3 V, VNO, VNC = VCOM = 1 V/3 V	Room Full	- 450 - 4.5		400 4.5	pA nA
Digital Control							
Input High Voltage	VINH		Full	2			V
Input Low Voltage	VINL		Full			0.4	
Input Capacitance	Cin		Full		4		pF
Input Current	IINL or IINH	VIN = 0 V or V+	Full	1		1	μA
Dynamic Characteristics							
Turn-On Time	tON	VNO or VNC = 2 V, RL = 300 Ω, CL = 35 pF	Room Full		24	45 48	ns
Turn-Off Time	tOFF		Room Full		12	30 33	
Break-Before-Make Time	td		Room	1	13		
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω	Room		3	10	pC
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 71		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 70		
NO, NC Off Capacitance <sup>d</sup>	CNO(off), CNC(off)	VIN = 0 V or V+, f = 1 MHz	Room		17		pF
Channel-On Capacitance <sup>d</sup>	CON		Room		50		
Power Supply							
Power Supply Range	V+			2.7		3.3	V
Power Supply Current	I+	VIN = 0 V or V+			0.01	1	μA
Power Consumption	PC						3.3

SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Unless Otherwise 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 = 3 V, INO, INC = 10 mA	Room Full		3 4	7 8	Ω
RON Flatness <sup>d</sup>	RON Flatness	V+ = 4.5 V, VCOM = 0 V to V+, INO, INC = 10 mA	Room		2		
Switch Off Leakage Current <sup>g</sup>	INO(off) INC(off)	V+ = 5.5 V VNO, VNC = 1 V/4.5 V, VCOM = 4.5 V/1 V	Room Full	- 900 - 5.5		900 5.5	pA nA
	ICOM(off)		Room Full	- 900 - 5.5		900 5.5	pA nA
Channel-On Leakage Current <sup>g</sup>	ICOM(on)	V+ = 5.5 V, V+ = 5.5 V VNO, VNC = VCOM = 1 V/4.5 V	Room Full	- 1000 - 5.5		1000 5.5	pA nA
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
Dynamic Characteristics							
Turn-On Time	tON	VNO or VNC = 3 V, RL = 300 Ω, CL = 35 pF	Room Full		20	37 40	ns
Turn-Off Time	tOFF		Room Full		10	27 30	
Break-Before-Make Time	td		Room	1	10		
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω	Room		7	10	pC
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 71		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 70		
Source-Off Capacitance <sup>d</sup>	CNO(off) CNC(off)	VIN = 0 V or V+, f = 1 MHz	Room		17		pF
Channel-On Capacitance <sup>d</sup>	CON		Room		50		
Power Supply							
Power Supply Range	V+			4.5		5.5	V
Power Supply Current	I+	VIN = 0 V or V+			0.01	1	μA
Power Consumption	PC					5.5	μW

## 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.

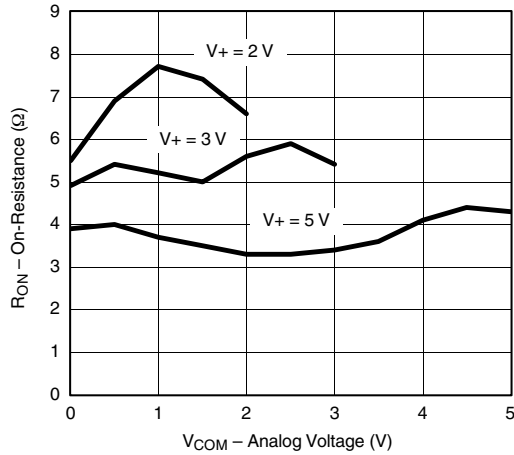
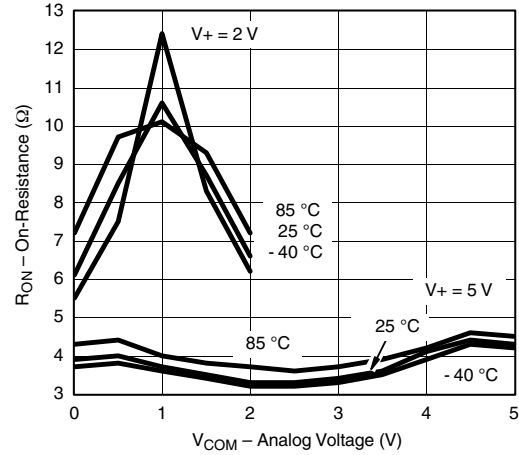
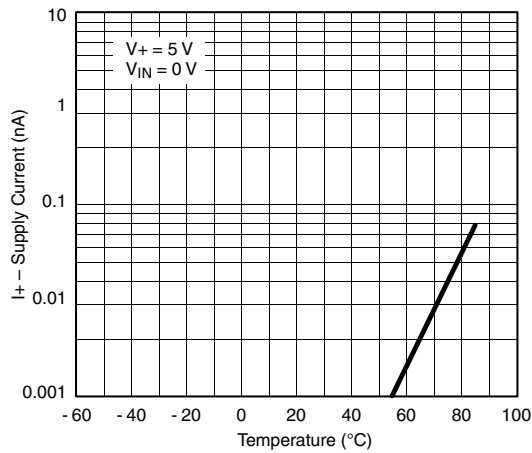
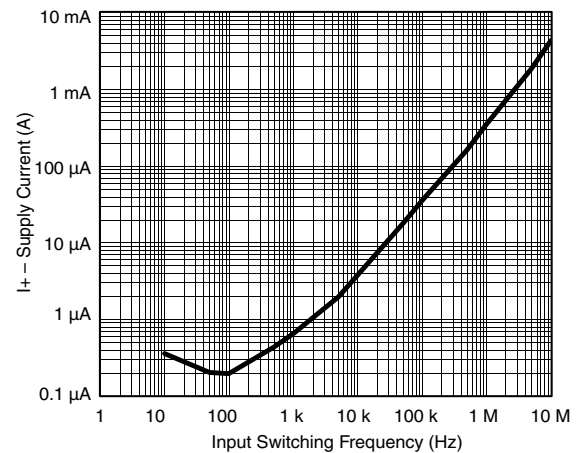
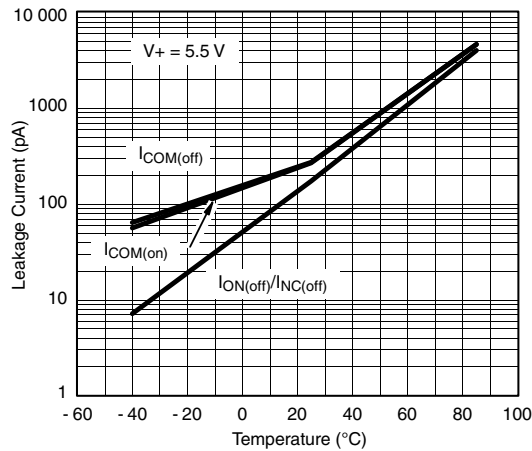
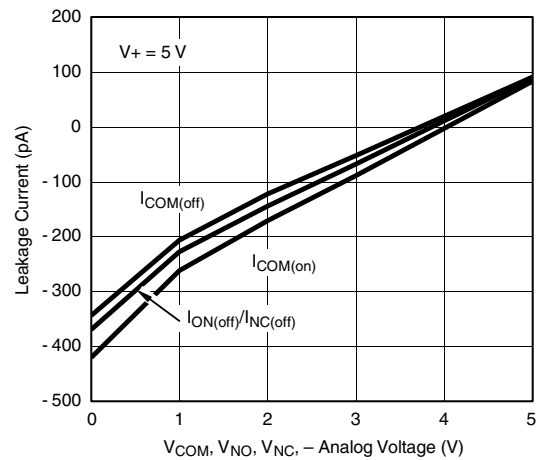
c. Typical values are for design aid only, not guaranteed nor subject to production testing.

d. Guarantee by design, nor subjected to production test.

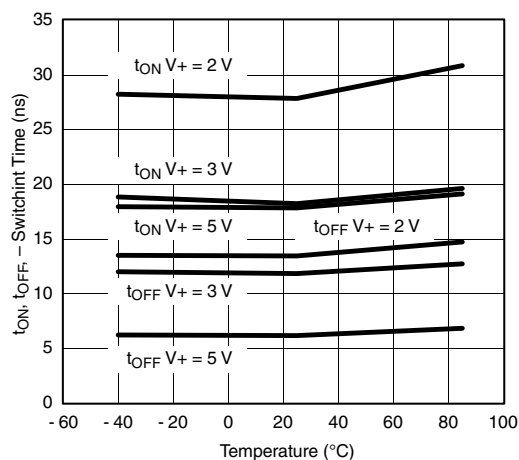
e.  $V_{IN}$  = input voltage to perform proper function.

f. Guaranteed by 5 V leakage testing, not production tested.

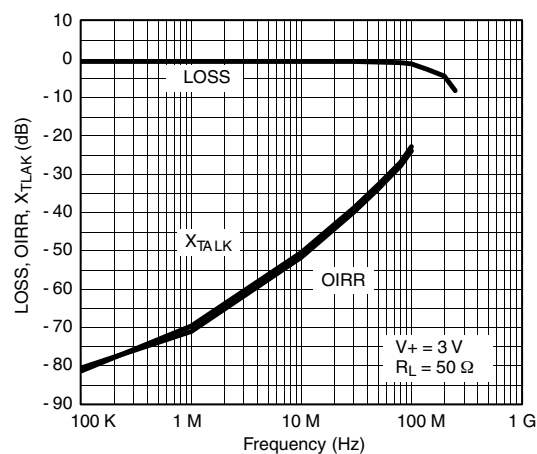
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

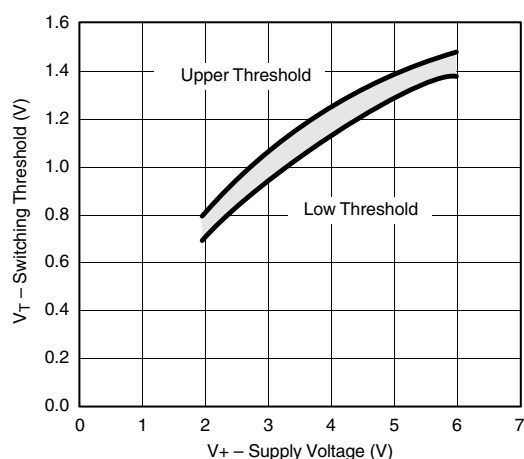
### TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



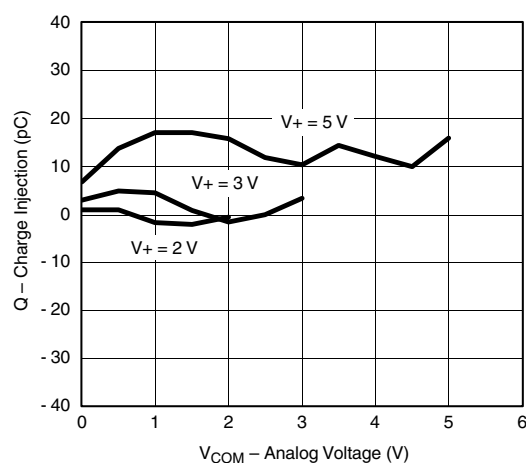
Switching Time vs. Temperature and Supply Voltage



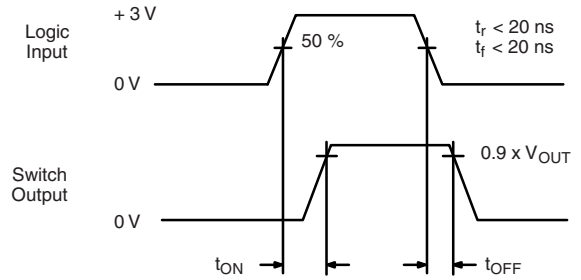
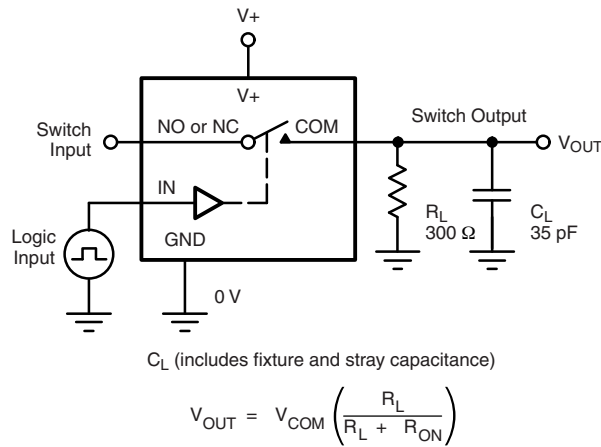
Insertion Loss, Off-Isolation Crosstalk vs. Frequency



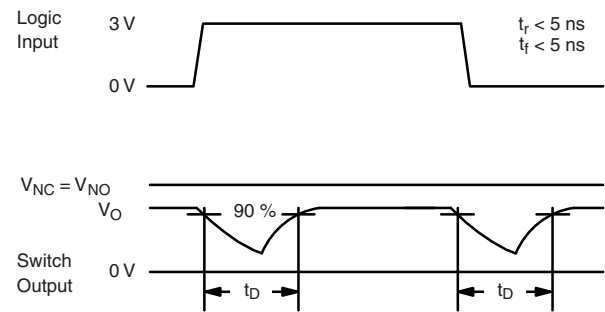
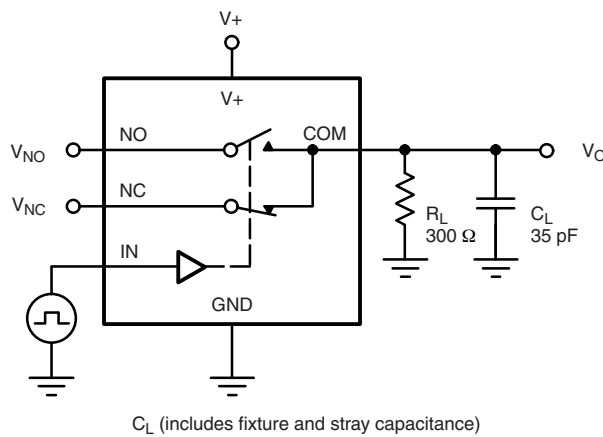
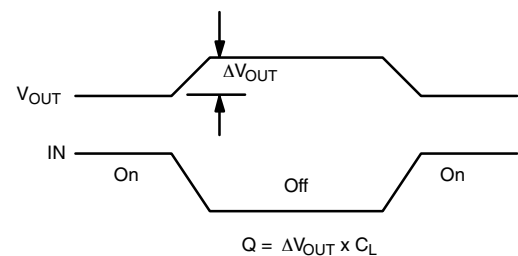
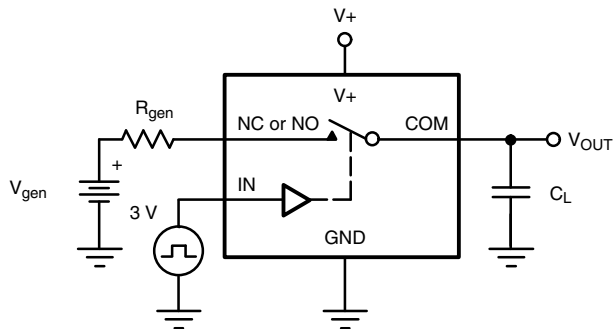
Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage

**TEST CIRCUITS**


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

**Figure 1. Switching Time**

**Figure 2. Break-Before-Make Interval**


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

**Figure 3. Charge Injection**

### TEST CIRCUITS

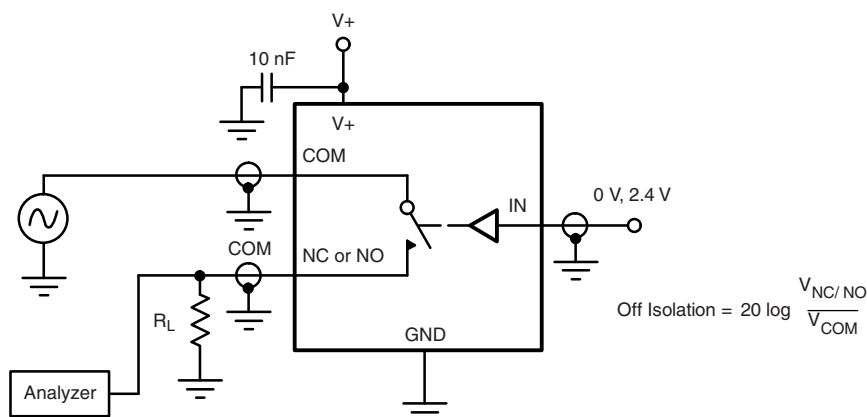


Figure 4. Off-Isolation

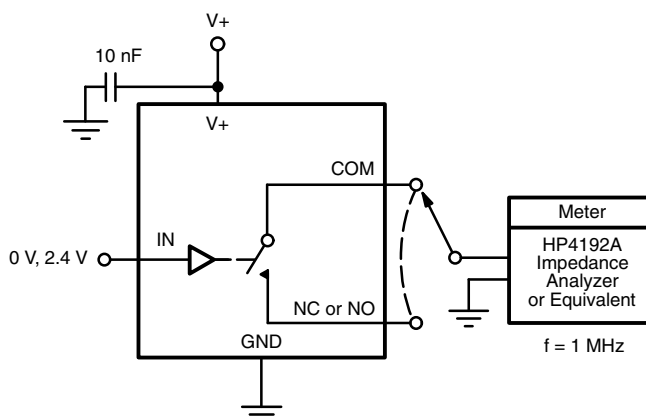


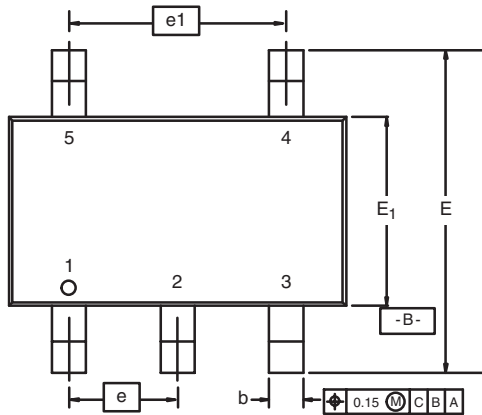
Figure 5. Channel Off/On Capacitance

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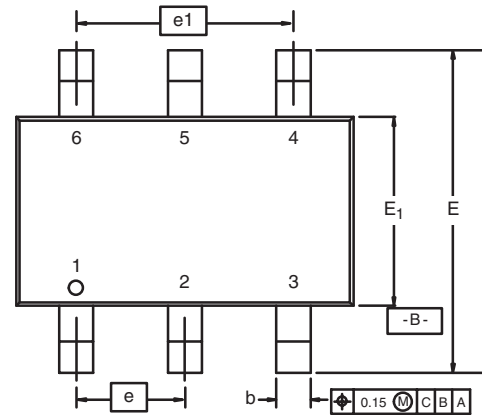


## TSOP: 5/6-LEAD

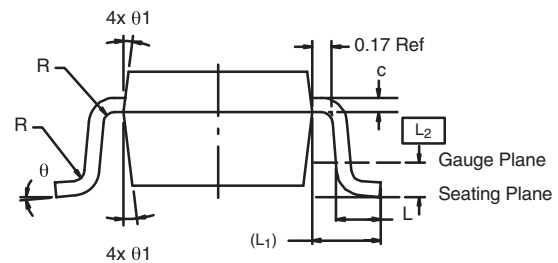
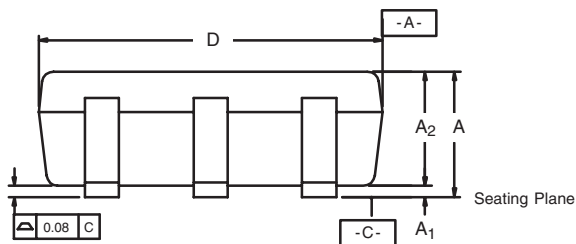
JEDEC Part Number: MO-193C



5-LEAD TSOP



6-LEAD TSOP



	MILLIMETERS			INCHES		
Dim	Min	Nom	Max	Min	Nom	Max
A	0.91	-	1.10	0.036	-	0.043
A <sub>1</sub>	0.01	-	0.10	0.0004	-	0.004
A <sub>2</sub>	0.90	-	1.00	0.035	0.038	0.039
b	0.30	0.32	0.45	0.012	0.013	0.018
c	0.10	0.15	0.20	0.004	0.006	0.008
D	2.95	3.05	3.10	0.116	0.120	0.122
E	2.70	2.85	2.98	0.106	0.112	0.117
E <sub>1</sub>	1.55	1.65	1.70	0.061	0.065	0.067
e	0.95 BSC			0.0374 BSC		
e <sub>1</sub>	1.80	1.90	2.00	0.071	0.075	0.079
L	0.32	-	0.50	0.012	-	0.020
L <sub>1</sub>	0.60 Ref			0.024 Ref		
L <sub>2</sub>	0.25 BSC			0.010 BSC		
R	0.10	-	-	0.004	-	-
θ	0°	4°	8°	0°	4°	8°
θ <sub>1</sub>	7° Nom			7° Nom		
ECN: C-06593-Rev. I, 18-Dec-06						
DWG: 5540						



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