

## 4 $\Omega$ Dual SPST Switches

### DESCRIPTION

The DG2537, DG2538, and DG2539 are low voltage, precision dual SPST switches that can be operated in a single supply or in a dual supply configuration power supply with low power dissipation. The DG2537, DG2538 and DG2539 can switch both analog and digital signals within the power supply rail, and conduct well in both directions.

Fabricated with advance submicron CMOS process, these switches provide high precision low and flat ON resistance, low leakage current, low parasitic capacitance, and low charge injection.

The DG2537, DG2538 and DG2539 contain two independent Single Pole Single Throw (SPST) switches. Switch-1 and switch-2 are normally open for the DG2537 and normally closed for the DG2538. For the DG2539, switch-1 is normally open and switch-2 is normally closed with a Break-Before-Make switching timing.

The DG2537, DG2538 and DG2539 are the ideal switches for use in low voltage instruments and healthcare devices, fitting the circuits of low voltage ADC and DAC, analog front end gain control, and signal path control.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with lead (Pb)-free device termination.

As a further sign of Vishay Siliconix's commitment, the DG2537, DG2538 and D2539 are fully RoHS compliant and halogen-free.

### FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- Low and flat switch on resistance, 2.5  $\Omega$ /typ
- Low leakage and parasitic capacitance
- 366 MHz, - 3 dB bandwidth
- Latch-up current > 300 mA (JESD78)
- Over voltage tolerant TTL/CMOS compatible
- **Compliant to RoHS Directive 2002/95/EC**

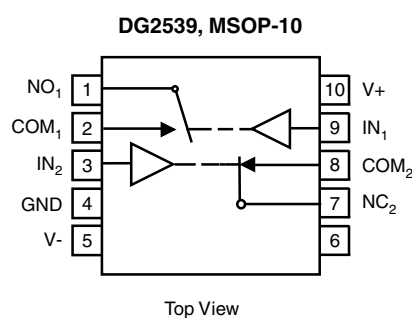
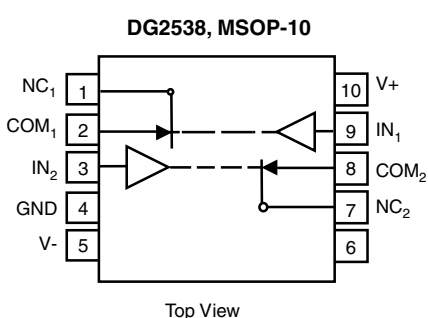
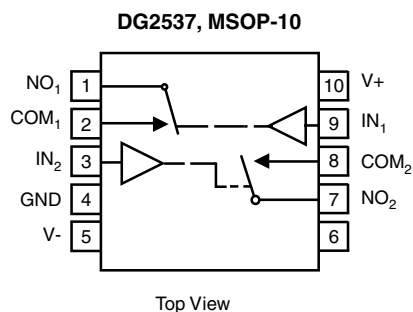


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- Healthcare and medical devices
- Test instruments
- Portable meters
- Data acquisitions
- Control and automation
- PDAs and modems
- Communication systems
- Audio, video systems
- Mechanical reed relay replacement

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE (DG2537, DG2538)			
Logic	DG2537	DG2538	Switches
0	0	1	Off
1	1	0	On

TRUTH TABLE (DG2539)		
Logic	Switch-1	Switch-2
0	Off	On
1	On	Off

ORDERING INFORMATION		
Temperature Range	Package	Part Number
- 40 °C to 85 °C	MSOP-10	DG2537DQ-T1-GE3
	MSOP-10	DG2538DQ-T1-GE3
	MSOP-10	DG2539DQ-T1-GE3

**ABSOLUTE MAXIMUM RATINGS**

Parameter	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)	± 50	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)	± 200	
Storage Temperature (D Suffix)	- 65 to 150	°C
Power Dissipation (Packages) <sup>b</sup>	MSOP-10 <sup>c</sup>	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 mW/°C above 70 °C.

**SPECIFICATIONS (V+ = 3 V, V- = 0 V)**

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, V- = 0 V, ± 10 %, V <sub>IN</sub> = 0.4 V or 1.5 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>	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- = 0 V, V <sub>COM</sub> = 0 V to V+, I <sub>NO</sub> , I <sub>NC</sub> = - 10 mA	Room Full		6.5	10	Ω
R <sub>ON</sub> Flatness <sup>d</sup>	R <sub>ON</sub> Flatness	V+ = 2.7 V, V- = 0 V, V <sub>COM</sub> = 1.1 V to 1.6 V, I <sub>NO</sub> , I <sub>NC</sub> = - 10 mA	Room		0.4		
R <sub>ON</sub> Match <sup>d</sup>	R <sub>ON</sub> Match	V+ = 2.7 V, V- = 0 V, V <sub>D</sub> = 1.1 V to 1.6 V, I <sub>D</sub> = - 10 mA	Room Full		0.3	0.9	
Switch Off Leakage Current	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = 3.3 V, V- = 0 V, V <sub>NO</sub> , V <sub>NC</sub> = 1 V/3 V, V <sub>COM</sub> = 3 V/1 V	Room Full	- 0.25 - 0.35		0.25 0.35	nA
	I <sub>COM(off)</sub>		Room Full	- 0.25 - 0.35		0.25 0.35	
Channel-On Leakage Current	I <sub>COM(on)</sub>	V+ = 3.3 V, V- = 0 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 1 V/3 V	Room Full	- 0.25 - 0.35		0.25 0.35	
Digital Control							
Input High Voltage	V <sub>INH</sub>		Full	2			V
Input Low Voltage	V <sub>INL</sub>		Full			0.4	
Input Capacitance <sup>d</sup>	C <sub>in</sub>	f = 1 MHz	Full		2.4		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 2 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF, figures 1 and 2	Room Full		16	55	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		7	40	
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, figure 3	Room		1.8		pC
Bandwidth <sup>d</sup>	BW	V+ = 3 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, - 3dB	Room		319		MHz
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		- 67		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 92		
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 10 MHz	Room		- 47		
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 90		
Source-Off Capacitance <sup>d</sup>	C <sub>NC/NO(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		8		pF
Drain-Off Capacitance <sup>d</sup>	C <sub>COM(off)</sub>		Room		9		
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		22		
Power Supply							
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+, V+ = 3.3 V				1	μA



SPECIFICATIONS (V+ = 5 V, V- = 0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, V- = 0 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, V- = 0 V, VCOM = 0 V to V+, INO, INC = 10 mA	Room Full		2.5	4.5 5	Ω
RON Flatness <sup>d</sup>	RON Flatness	V+ = 4.5 V, V- = 0 V, VCOM = 1.3 V to 3 V, INO, INC = 10 mA	Room		0.75	1.5	
RON Match <sup>d</sup>	RON Match	V+ = 4.5 V, V- = 0 V, ID = 10 mA, VCOM = 1.3 V to 3 V	Room		0.2	0.9	
Switch Off Leakage Current	INO(off) INC(off)	V+ = 5.5 V, V- = 0 V, VNO, VNC = 1 V/4.5 V, VCOM = 4.5 V/1 V	Room Full	- 0.25 - 0.35		0.25 0.35	nA
	ICOM(off)		Room Full	- 0.25 - 0.35		0.25 0.35	
Channel-On Leakage Current	ICOM(on)	V+ = 5.5 V, V- = 0 V, VNO, VNC = VCOM = 1 V/4.5 V	Room Full	- 0.25 - 0.35		0.25 0.35	
Digital Control							
Input High Voltage	VINH		Full	2.4			V
Input Low Voltage	VINL		Full			0.8	
Input Capacitance	Cin	f = 1 MHz	Full		2.2		pF
Input Current	IINL or IINH	VIN = 0 or V+	Full	- 0.1	0.005	0.1	μA
Dynamic Characteristics							
Turn-On Time <sup>d</sup>	tON	VNO or VNC = 3 V, RL = 300 Ω, CL = 35 pF, figures 1 and 2	Room Full		17	30 40	ns
Turn-Off Time <sup>d</sup>	tOFF		Room Full		9	35	
Charge Injection <sup>d</sup>	QINJ	CL = 1 nF, VGEN = 0 V, RGEN = 0 Ω, figure 3	Room		2.2		pC
Bandwidth <sup>d</sup>	BW	V+ = 5 V, RL = 50 Ω, CL = 5 pF, - 3 dB	Room		366		MHz
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 1 MHz	Room		- 67		dB
Crosstalk <sup>d</sup>	XTALK		Room		- 90		
Off-Isolation <sup>d</sup>	OIRR	RL = 50 Ω, CL = 5 pF, f = 10 MHz	Room		- 47		
Crosstalk <sup>d</sup>	XTALK		Room		- 90		
Source-Off Capacitance <sup>d</sup>	CNC/NO(off)	VIN = 0 or V+, f = 1 MHz	Room		8		pF
Drain-Off Capacitance <sup>d</sup>	CCOM(off)		Room		9		
Channel-On Capacitance <sup>d</sup>	CON		Room		22		
Power Supply							
Power Supply Range	V+			2.6		4.3	V
Power Supply Current	I+	VIN = 0 or V+, V+ = 5.5 V	Full			2	μA

SPECIFICATIONS (V+ = + 2.5 V, V- = - 2.5 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = + 2.5 V, V- = - 2.5 V, ± 10 %, V <sub>IN</sub> = 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	V <sub>NO</sub> , V <sub>NC</sub> V <sub>COM</sub>		Full	V-		V+	V
On-Resistance	R <sub>ON</sub>	V+ = + 2.25 V, V- = - 2.25 V, V <sub>COM</sub> = V- to V+, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room Full		3.6	4.5 5	Ω
R <sub>ON</sub> Flatness	R <sub>ON</sub> Flatness	V+ = + 2.25 V, V- = - 2.25 V, V <sub>COM</sub> = ± 1.2 V, 0 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room		0.7	1.5	
R <sub>ON</sub> Match	R <sub>ON</sub> Match	V+ = + 2.25 V, V- = - 2.25 V, V <sub>COM</sub> = ± 1.4 V, I <sub>NO</sub> , I <sub>NC</sub> = 10 mA	Room		0.2	0.9	
Switch Off Leakage Current	I <sub>NO(off)</sub> I <sub>NC(off)</sub>	V+ = + 2.75 V, V- = - 2.75 V, V <sub>S</sub> = ± 2.5 V, V <sub>D</sub> = ± 2.5 V	Room Full	- 0.25 - 0.35		0.25 0.35	nA
	I <sub>COM(off)</sub>		Room Full	- 0.25 - 0.35		0.25 0.35	
Switch on Leakage	I <sub>COM(on)</sub>	V+ = + 2.75 V, V- = - 2.25 V, V <sub>S</sub> = V <sub>D</sub> = ± 2.5 V	Room Full	- 0.25 - 0.35		0.25 0.35	
Digital Control							
Input High Voltage	V <sub>INH</sub>		Full	2.4			V
Input Low Voltage	V <sub>INL</sub>		Full			0.8	
Input Capacitance	C <sub>in</sub>	f = 1 MHz	Full		2.2		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>	V <sub>IN</sub> = 0 or V+	Full	- 0.1		0.1	μA
Dynamic Characteristics							
Turn-On Time <sup>d</sup>	t <sub>ON</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 2 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room Full			35 40	ns
Turn-Off Time <sup>d</sup>	t <sub>OFF</sub>		Room Full			20 25	
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		2.2		pC
Bandwidth <sup>d</sup>	BW	V+ = + 2.5 V, V- = - 2.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, - 3dB	Room		366		MHz
Off-Isolation <sup>d</sup>	OIRR	V+ = + 2.5 V, V- = - 2.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, - 3dB, f = 1 MHz	Room		- 67		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 90		
Off-Isolation <sup>d</sup>	OIRR	V+ = + 2.5 V, V- = - 2.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, - 3dB, f = 10 MHz	Room		- 47		
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room		- 90		
Source-Off Capacitance <sup>d</sup>	C <sub>NC/NO(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		6		pF
Drain-Off Capacitance <sup>d</sup>	C <sub>COM(off)</sub>		Room		12		
Channel-On Capacitance <sup>d</sup>	C <sub>ON</sub>		Room		24		
Power Supply							
Power Supply Range	V+			1.25		2.75	V
Power Supply	I+	V <sub>IN</sub> = 0 or V+, V+ = 2.5 V				2	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.

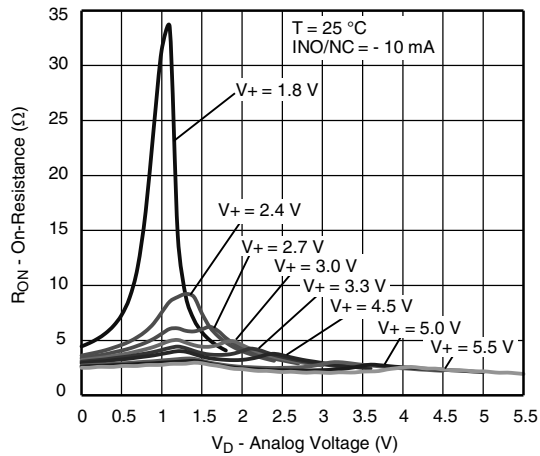
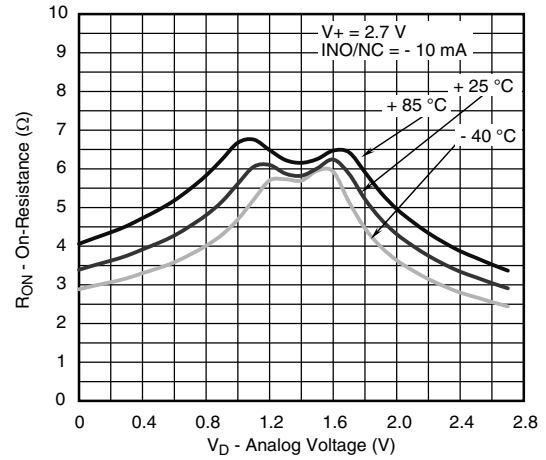
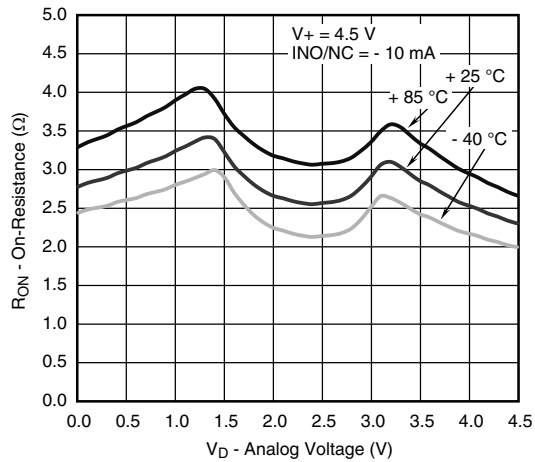
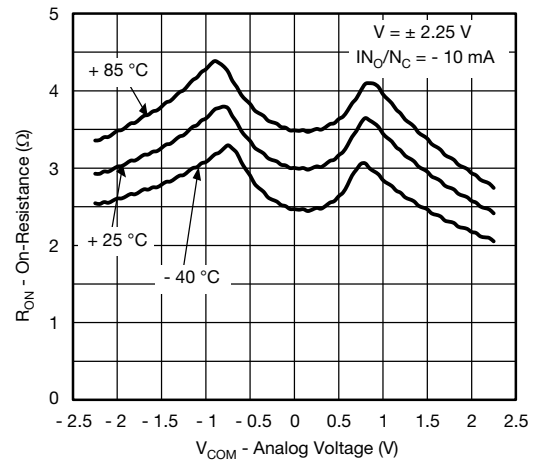
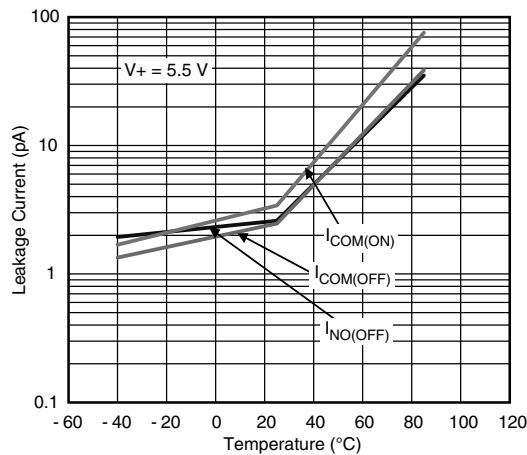
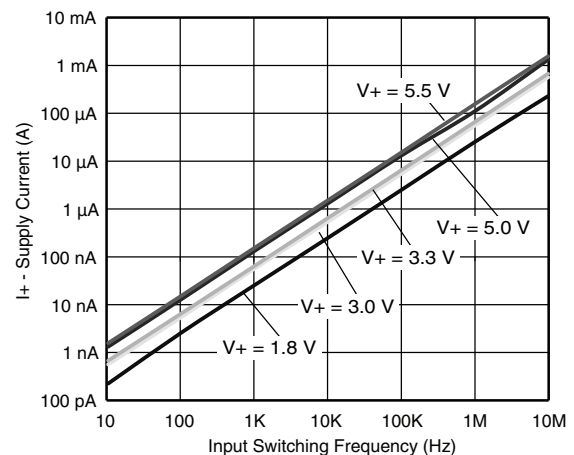
c. Typical values are for design aid only, not guaranteed nor subject to production testing.

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

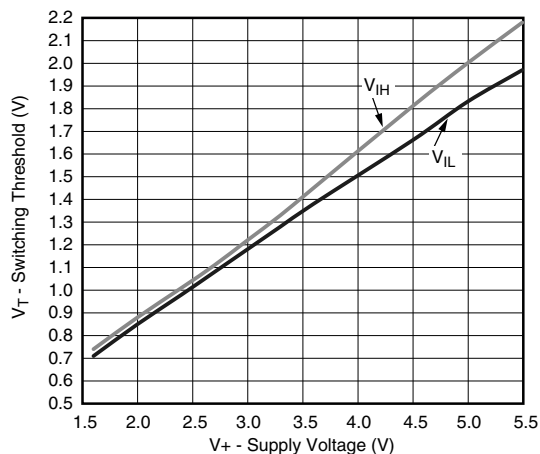
e. V<sub>IN</sub> = input voltage to perform proper function.

f. Not production tested.

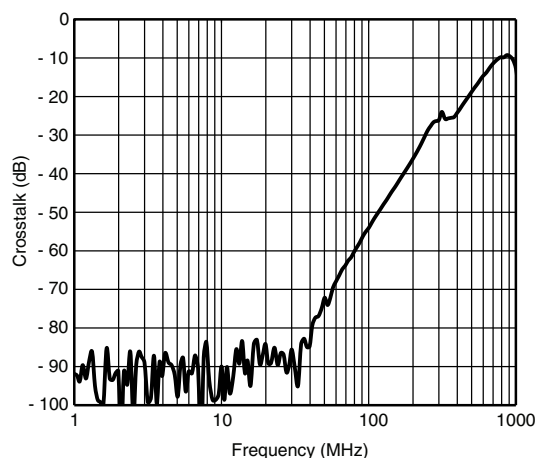
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

 **$R_{ON}$  vs.  $V_D$  and Single Supply Voltage**

 **$R_{ON}$  vs. Analog Voltage and Temperature**

 **$R_{ON}$  vs. Analog Voltage and Temperature**

 **$R_{ON}$  vs. Analog Voltage and Temperature**

**Leakage Current vs. Temperature**

**Supply Current vs. Input Switching Frequency**

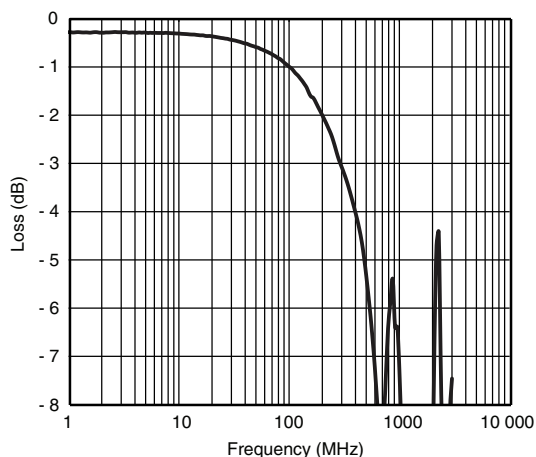
### TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



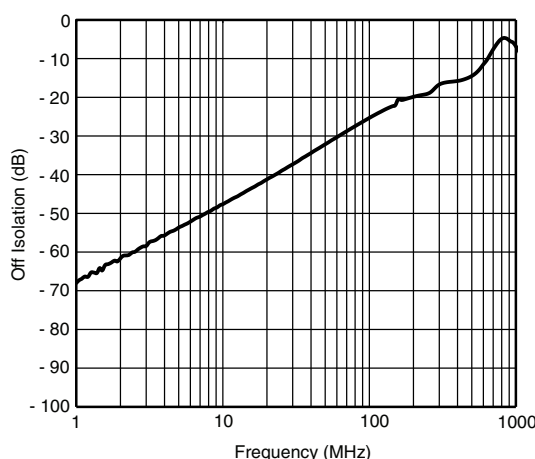
Switching Threshold vs. Supply Voltage



Crosstalk vs. Frequency



Insertion Loss vs. Frequency



Off Isolation vs. Frequency

### TEST CIRCUITS

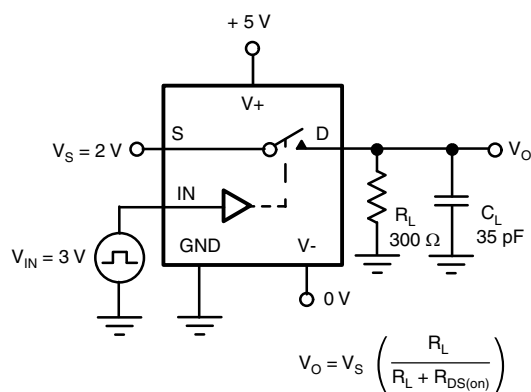
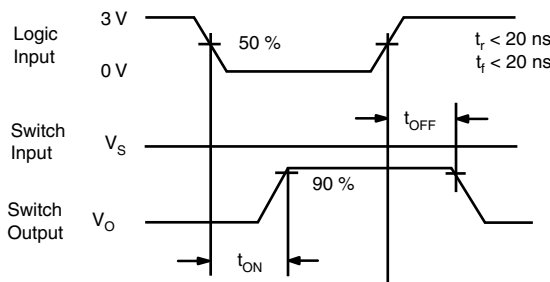
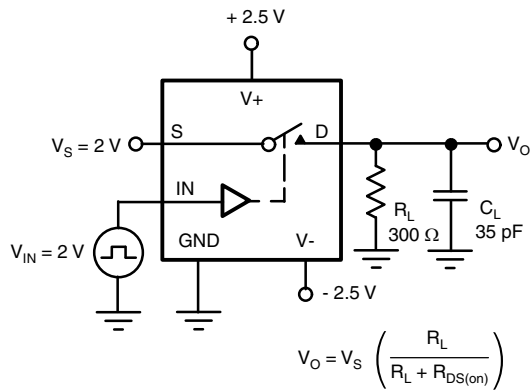
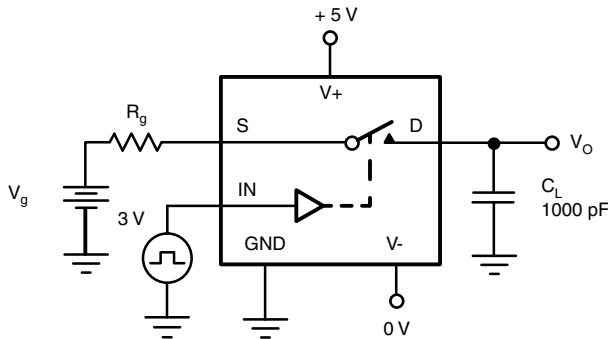
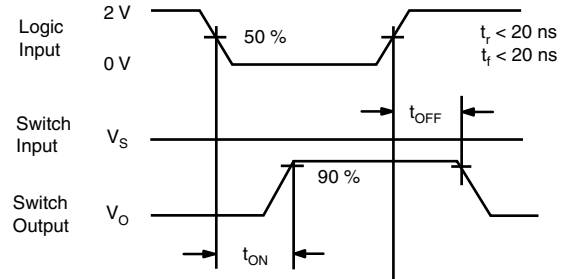
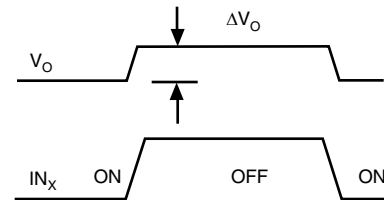
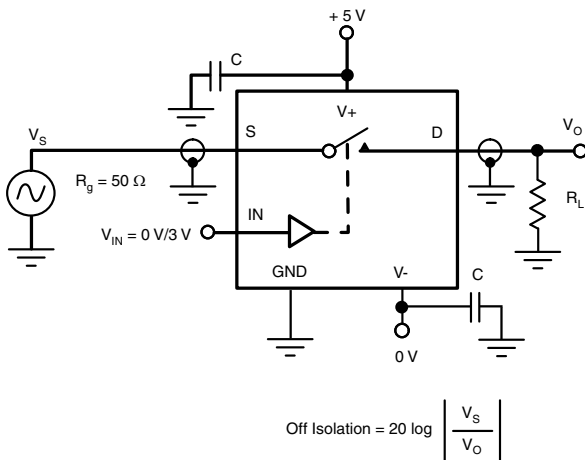
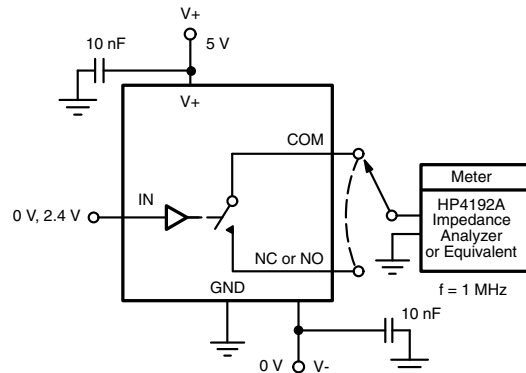


Figure 1. Single Supply Switching Time



**TEST CIRCUITS**

**Figure 2. Dual Supply Switching Time**

**Figure 3. Charge Injection**


$\Delta V_O$  = measured voltage error due to charge injection  
The charge injection in coulombs is  $\Delta Q = C_L \times \Delta V_O$


**Figure 4. Off-Isolation**

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

## TEST CIRCUITS

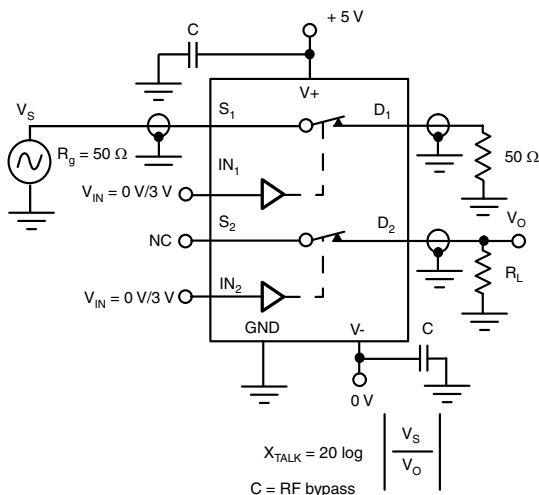


Figure 6. Channel to Channel Crosstalk

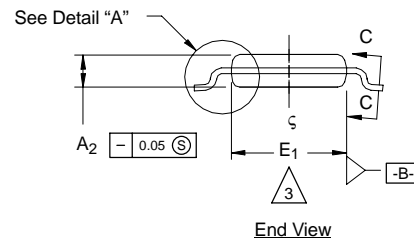
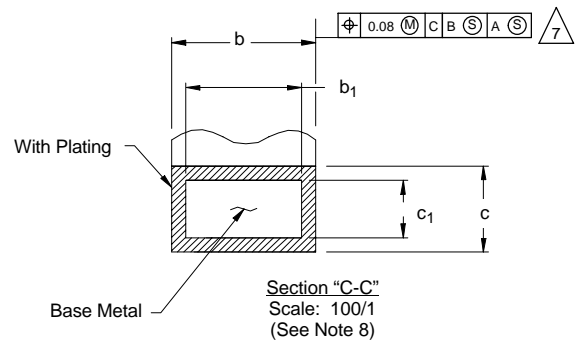
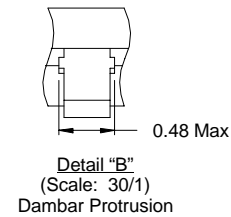
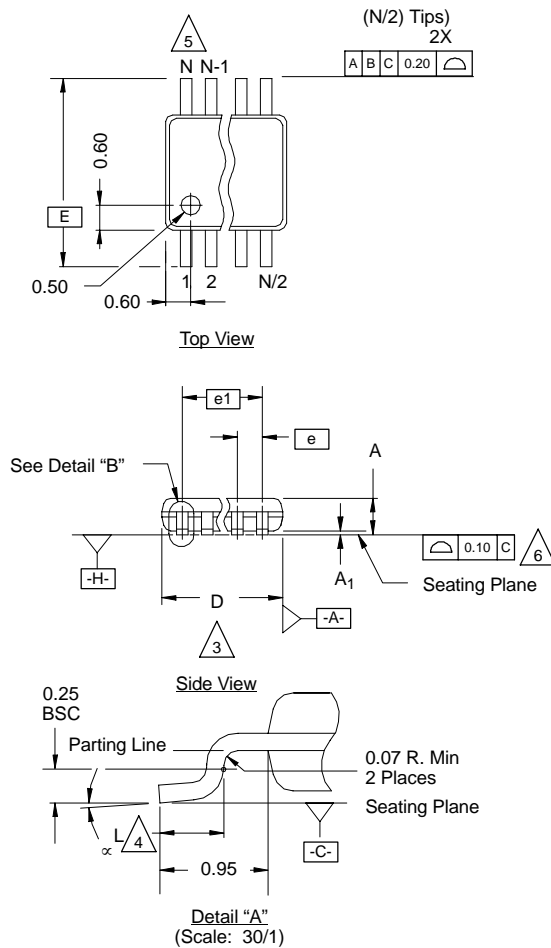
Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg?63370](http://www.vishay.com/ppg?63370).





### MSOP: 10-LEADS

JEDEC Part Number: MO-187, (Variation AA and BA)



#### NOTES:

- Die thickness allowable is  $0.203 \pm 0.0127$ .
- Dimensioning and tolerances per ANSI.Y14.5M-1994.
- Dimensions "D" and "E<sub>1</sub>" do not include mold flash or protrusions, and are measured at Datum plane  $\square\text{H}\square$ , mold flash or protrusions shall not exceed 0.15 mm per side.
- Dimension is the length of terminal for soldering to a substrate.
- Terminal positions are shown for reference only.
- Formed leads shall be planar with respect to one another within 0.10 mm at seating plane.
- The lead width dimension does not include Dambar protrusion. Allowable Dambar protrusion shall be 0.08 mm total in excess of the lead width dimension at maximum material condition. Dambar cannot be located on the lower radius or the lead foot. Minimum space between protrusions and an adjacent lead to be 0.14 mm. See detail "B" and Section "C-C".
- Section "C-C" to be determined at 0.10 mm to 0.25 mm from the lead tip.
- Controlling dimension: millimeters.
- This part is compliant with JEDEC registration MO-187, variation AA and BA.
- Datums  $\square\text{A}\square$  and  $\square\text{B}\square$  to be determined Datum plane  $\square\text{H}\square$ .
- Exposed pad area in bottom side is the same as the leadframe pad size.

**N = 10L**

Dim	MILLIMETERS			Note
	Min	Nom	Max	
A	-	-	1.10	
A <sub>1</sub>	0.05	0.10	0.15	
A <sub>2</sub>	0.75	0.85	0.95	
b	0.17	-	0.27	8
b <sub>1</sub>	0.17	0.20	0.23	8
c	0.13	-	0.23	
c <sub>1</sub>	0.13	0.15	0.18	
D	3.00 BSC			3
E	4.90 BSC			
E <sub>1</sub>	2.90	3.00	3.10	3
e	0.50 BSC			
e <sub>1</sub>	2.00 BSC			
L	0.40	0.55	0.70	4
N	10			5
α	0°	4°	6°	

ECN: T-02080—Rev. C, 15-Jul-02  
DWG: 5867



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