

## Sub-Ω, Low Voltage, SPDT Analog Switches with Over Current Protection

**DESCRIPTION**

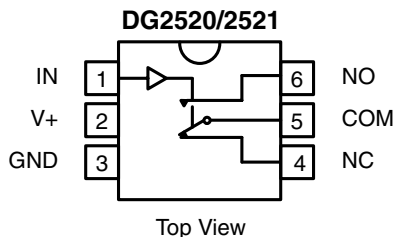
The DG2520/DG2521 are low-voltage single single-pole/double-throw monolithic CMOS analog switches. Designed to operate from 1.8 V to 5.5 V power supply, the DG2520/DG2521 provide low on-resistance (0.8 Ω), excellent on-resistance matching (0.06 Ω) and flatness (0.2 Ω) over the entire signal range.

The DG2520/DG2521 offers the advantage of high linearity that reduces signal distortion, making ideal for audio, video, and USB signal routing applications. Additionally, the DG2520/DG2521 are 1.6 V logic compatible within the full operation voltage range.

The DG2520/DG2521 offer over current protection. The protection circuitry activates when voltage drop across switch reaches 0.6 V typical. A direct/sustained short circuit will cause the switch to pulse on for typically less than 1 μs, then turn off. The switch turns on after 5 ms. If the short circuit condition remains, the switch turns off and on to produce a pulsed output. The current limiting circuitry is not instantaneous, and therefore will not activate when the output charges a small 0.1 μF capacitor.

Built on Vishay Siliconix's proprietary sub-micron high-density process, the DG2520/DG2521 brings low power consumption at the same time as reduces PCB spacing with the TSOP6 package

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 termination, the lead (Pb)-free "- E3" suffix is being used as a designator.

**FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION**

**FEATURES**

- 1.8 to 5.5 V Single Supply Operation
- Low Ron: Typical 0.4 Ω at 4.5 V
- + 1.6 V Logic Compatible
- Over Current Protection


**RoHS**  
COMPLIANT

**BENEFITS**

- High Linearity
- Low Power Consumption
- High Bandwidth
- Full Rail Signal Swing Range

**APPLICATIONS**

- USB/UART Signal Switching
- Audio/Video Switching
- Cellular Phone
- Media Players
- Modems
- Hard Drives
- PCMCIA

**TRUTH TABLE**

Logic	NC	NO
0	ON	OFF
1	OFF	ON

**ORDERING INFORMATION**

Temp Range	Package	Part Number
- 40 to 85 °C	TSOP-6	DG2520DV-T1-E3
		DG2521DV-T1-E3

**DEVICE MARKING:**

DG2520DV = F9xxx

DG2521DV = F0xxx



ABSOLUTE MAXIMUM RATINGS			
Reference to GND		Limit	Unit
V+		- 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>	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/°C above 70 °C.

SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, V <sub>IN</sub> = 0.4 or 1.8 V <sup>e</sup>	Temp <sup>a</sup>	Limits - 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>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 <sub>COM</sub> = 1.5 V I <sub>NO/NC</sub> = 100 mA	Room Full		0.6	1.0 1.2	Ω
r <sub>ON</sub> Flatness	r <sub>ON</sub> Flatness	V+ = 2.7 V, V <sub>COM</sub> = 0, 0.75, 1.5 V I <sub>NO/NC</sub> = 100 mA	Room Full		0.12	0.16 0.18	
r <sub>ON</sub> Match Between Channels	Δr <sub>ON</sub>	V+ = 2.7 V, V <sub>COM</sub> = 1.5 V I <sub>NO/NC</sub> = 100 mA	Full			0.06	
<b>Digital Control</b>							
Input High Voltage <sup>d</sup>	V <sub>INH</sub>		Full	1.8			V
Input Low Voltage	V <sub>INL</sub>		Full			0.4	
Input Capacitance	C <sub>IN</sub>		Full		7		pF
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full	- 1		1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time DG2520	t <sub>ON</sub>	V+ = 2.7 V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Room Full		30	45 60	ns
Turn-Off Time DG2520	t <sub>OFF</sub>		Room Full		10	17 22	
Break-Before-Make Time DG2520	t <sub>bbm</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Full	1	25		
Turn-On Time DG2521	t <sub>ON</sub>	V+ = 2.7 V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Room Full		18	25 40	
Turn-Off Time DG2521	t <sub>OFF</sub>		Room Full		25	45 55	
Make-Before-Break Time DG2521	t <sub>mbb</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 1.5 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Full	1	10		
Charge Injection <sup>d</sup>	Q	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		115		pC
- 3 dB Bandwidth	BW	0 dBm, C <sub>L</sub> = 5 pF, R <sub>L</sub> = 50 Ω	Room		40		MHz
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF	Room		- 51		dB
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		f = 1 MHz f = 1 MHz	Room		- 57	
N <sub>O</sub> , N <sub>C</sub> Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub>	V <sub>IN</sub> = 0 or V+, f = 1 MHz	Room		50		pF
	C <sub>NC(off)</sub>		Room		50		
Channel On Capacitance <sup>d</sup>	C <sub>NO(on)</sub>		Room		160		
	C <sub>NC(on)</sub>		Room		160		
<b>Power Supply</b>							
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+	Full			20	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<sub>IN</sub> = input voltage to perform proper function.
- f. Guaranteed by 5 V leakage testing, not production tested.



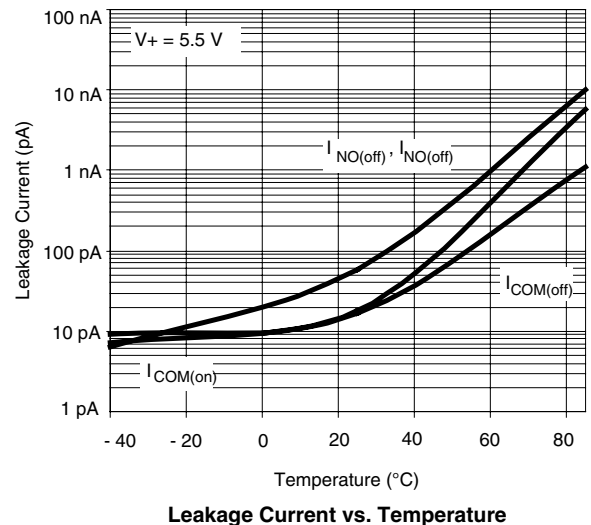
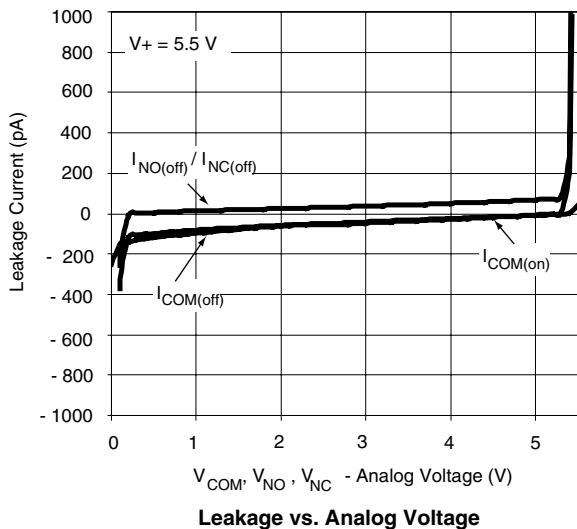
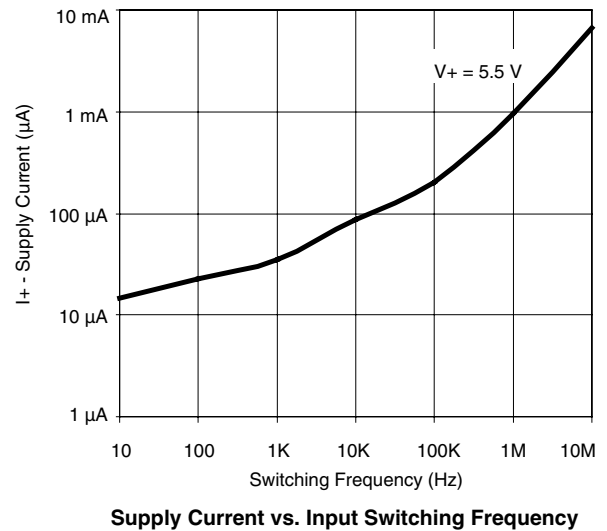
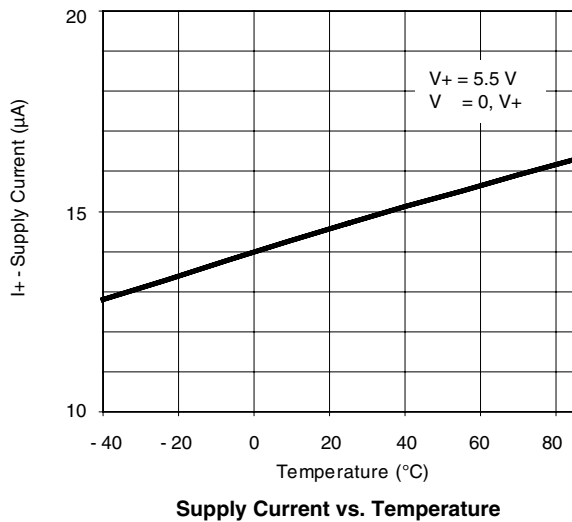
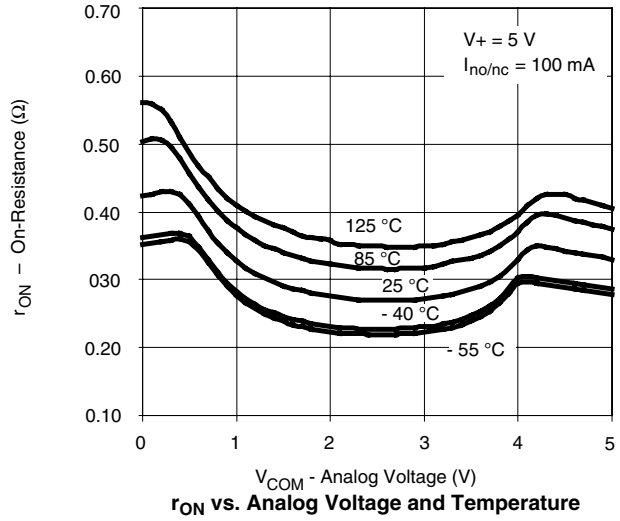
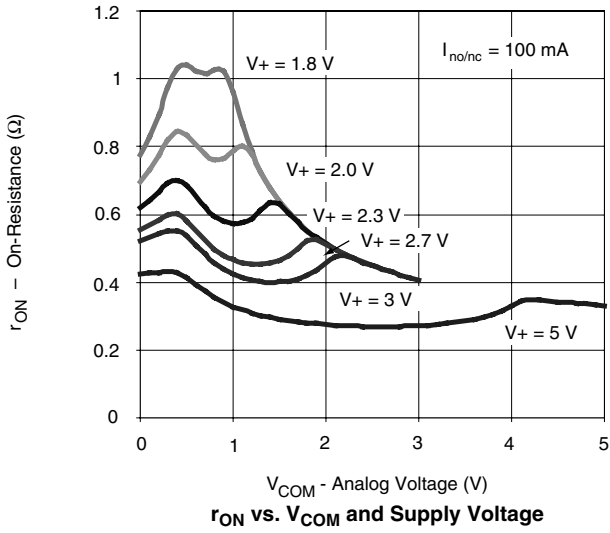
SPECIFICATIONS (V+ = 5 V)								
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, VIN = 0.8 or 2.4 V <sup>e</sup>	Temp <sup>a</sup>	Limits - 40 to 85 °C			Unit	
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>		
<b>Analog Switch</b>								
Analog Signal Range <sup>d</sup>	V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub>		Full	0		V+	V	
On-Resistance	r <sub>ON</sub>	V+ = 4.5 V, V <sub>COM</sub> = 3.5 V, I <sub>NO/NC</sub> = 100 mA	Room Full		0.4	0.8 1.0	Ω	
r <sub>ON</sub> Flatness	r <sub>ON</sub> Flatness	V+ = 4.5 V, V <sub>COM</sub> = 0, 1, 2 V, I <sub>NO/NC</sub> = 100 mA	Room Full		0.15	0.2 0.22		
r <sub>ON</sub> Match Between Channels	Δr <sub>ON</sub>	V+ = 4.5 V, V <sub>COM</sub> = 3.5 V I <sub>NO/NC</sub> = 100 mA	Full			0.06		
Switch Off Leakage Current	I <sub>NO(off)</sub> , I <sub>NC(off)</sub>	V+ = 5.5 V, V <sub>NO</sub> , V <sub>NC</sub> = 1 V/4.5 V, V <sub>COM</sub> = 4.5 V/1 V	Room Full	- 2 - 20		2 20	nA	
	I <sub>COM(off)</sub>		Room Full	- 2 - 20		2 20		
Channel On Leakage Current	I <sub>COM(on)</sub>	V+ = 5.5 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 1 V/4.5 V	Room Full	- 2 - 20		2 20		
<b>Digital Control</b>								
Input High Voltage <sup>d</sup>	V <sub>INH</sub>		Full	2.4			V	
Input Low Voltage	V <sub>INL</sub>		Full			0.8		
Input Capacitance	C <sub>IN</sub>		Full		10		pF	
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full	- 1		1	μA	
Overcurrent-Protection Current Threshold			Room		1.7		A	
<b>Dynamic Characteristics</b>								
Turn-On Time DG2520	t <sub>ON</sub>	V+ = 4.5 V, V <sub>NO</sub> or V <sub>NC</sub> = 3 V R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Room Full		25	35 40	ns	
Turn-Off Time DG2520	t <sub>OFF</sub>		Room Full		8	15 20		
Break-Before-Make Time DG2520	t <sub>bbm</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Full	1	15			
Turn-On Time DG2521	t <sub>ON</sub>	V+ = 4.5 V, V <sub>NO</sub> or V <sub>NC</sub> = 3 V R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Room Full		12	25 35		
Turn-Off Time DG2521	t <sub>OFF</sub>		Room Full		20	35 45		
Make-Before-Break Time DG2521	t <sub>mbb</sub>	V <sub>NO</sub> or V <sub>NC</sub> = 3 V, R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 35 pF	Full	1	12			
Charge Injection <sup>d</sup>	Q	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		224		pC	
- 3 dB Bandwidth	BW	0 dBm, C <sub>L</sub> = 5 pF, R <sub>L</sub> = 50 Ω	Room		40		MH	
Off-Isolation <sup>d</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF	Room	f = 1 MHz	- 51		dB	
Crosstalk <sup>d</sup>	X <sub>TALK</sub>		Room	f = 1 MHz	- 57			
Source Off Capacitance <sup>d</sup>	C <sub>NO(off)</sub>	f = 1 MHz	Room		50		pF	
	C <sub>NC(off)</sub>		Room		50			
Channel On Capacitance <sup>d</sup>	C <sub>NO(on)</sub>		Room		160			
	C <sub>NC(on)</sub>		Room		160			
<b>Power Supply</b>								
Power Supply Range	V+				1.8		5.5	V
Power Supply Current	I+	V <sub>IN</sub> = 0 or V+	Full			22	μA	

Notes:

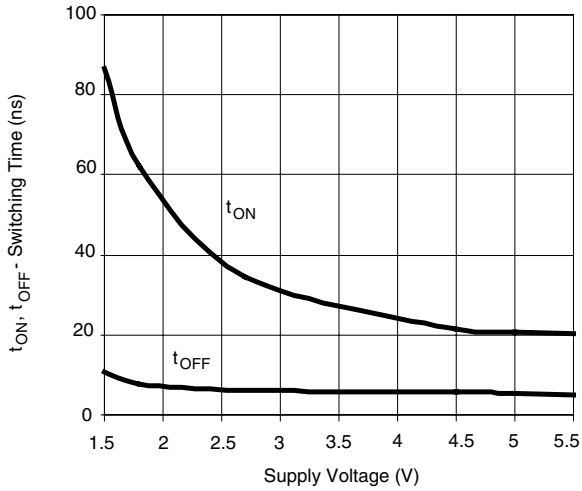
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- d. Guarantee by design, nor subject to production test.
- e. V<sub>IN</sub> = input voltage to perform proper function.
- f. Guaranteed by 5 V leakage testing, not production tested.

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.

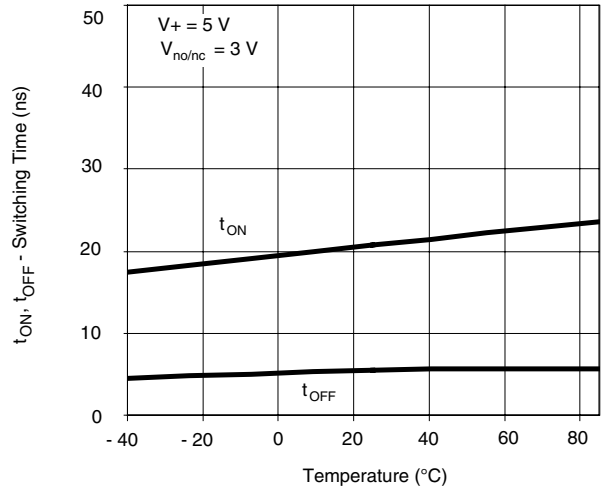
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



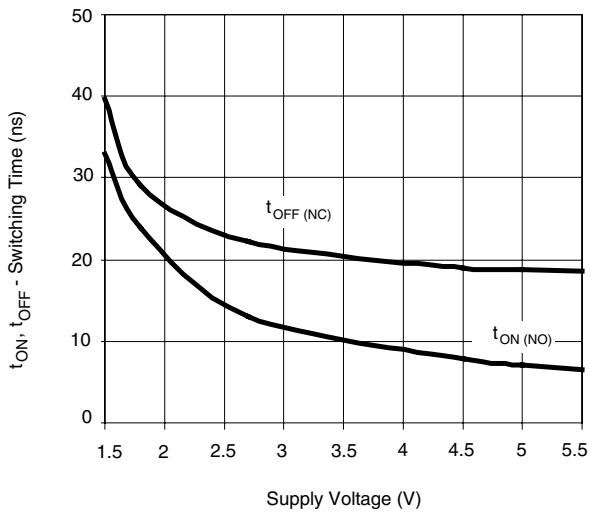
**TYPICAL CHARACTERISTICS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



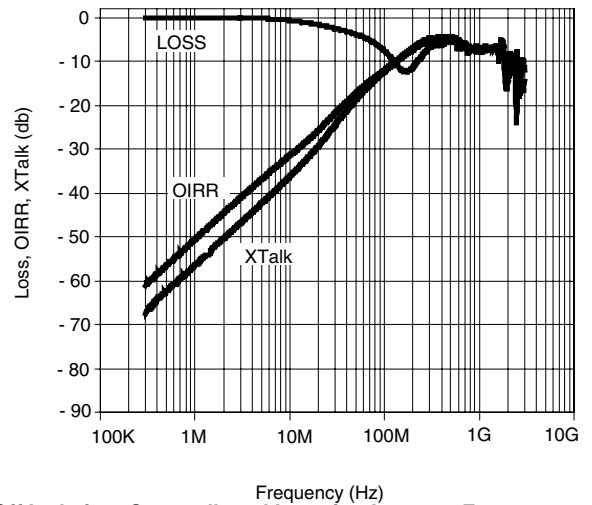
Switching Time vs. Supply Voltage, DG2520



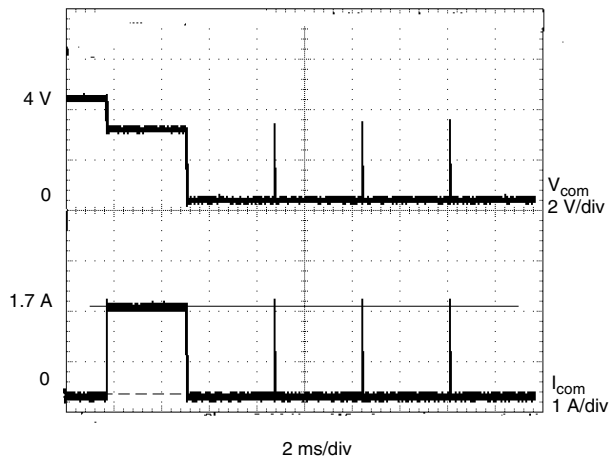
Switching Time vs. Temperature, DG2520



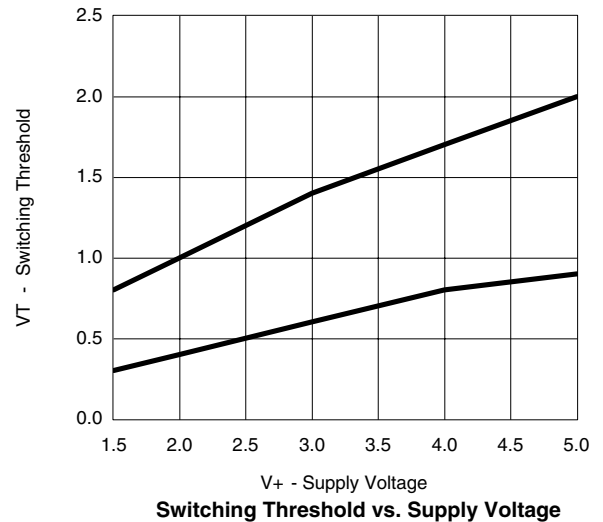
Switching Time vs. Supply Voltage, DG2521



Off Isolation, Crosstalk and Insertion Loss vs. Frequency

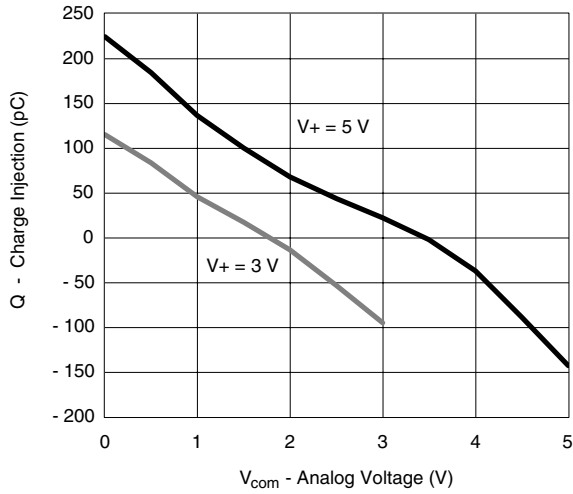


Overcurrent Response

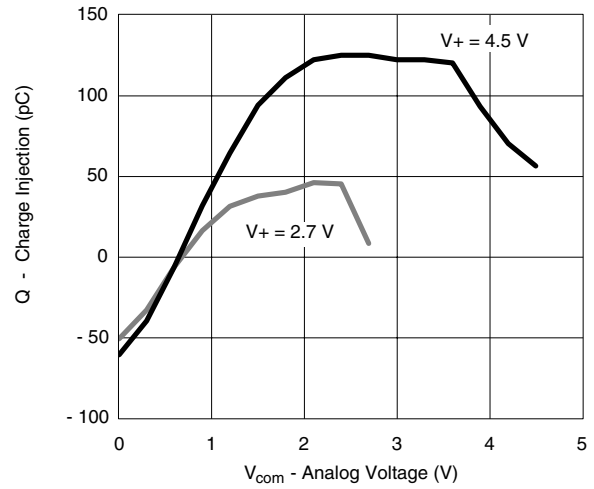


Switching Threshold vs. Supply Voltage

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

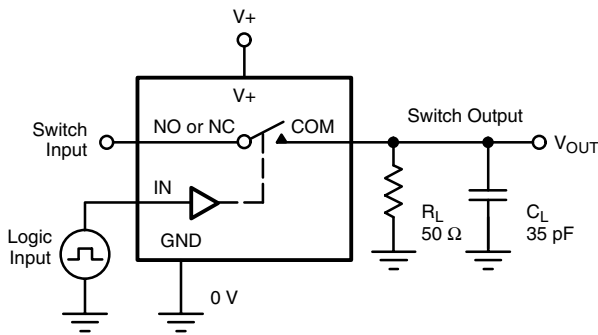


Charge Injection vs. Analog Voltage, DG2520



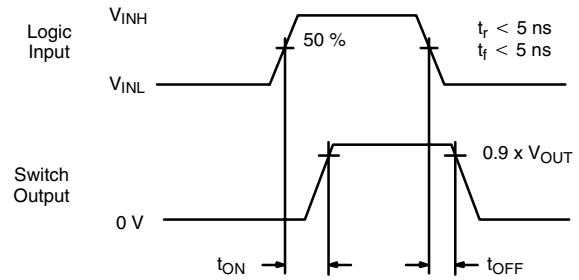
Charge Injection vs. Analog Voltage, DG2521

**TEST CIRCUITS**



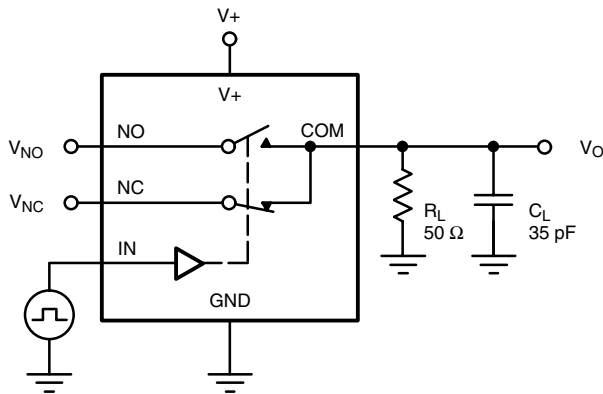
$C_L$  (includes fixture and stray capacitance)

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



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)

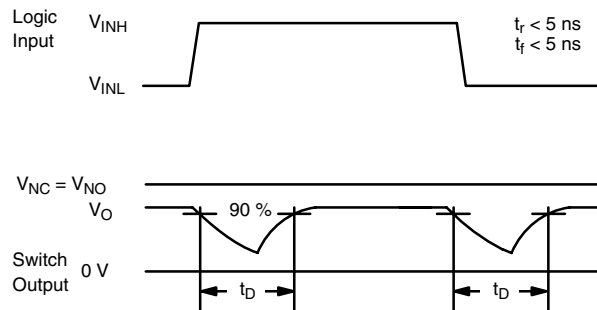
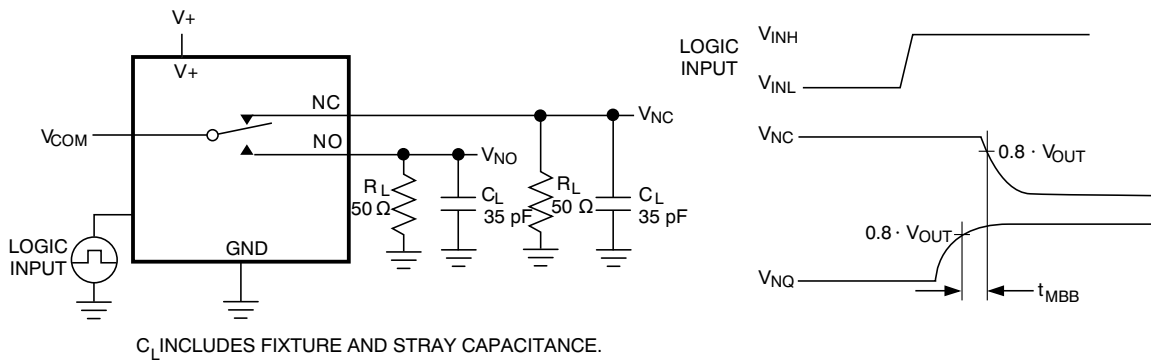
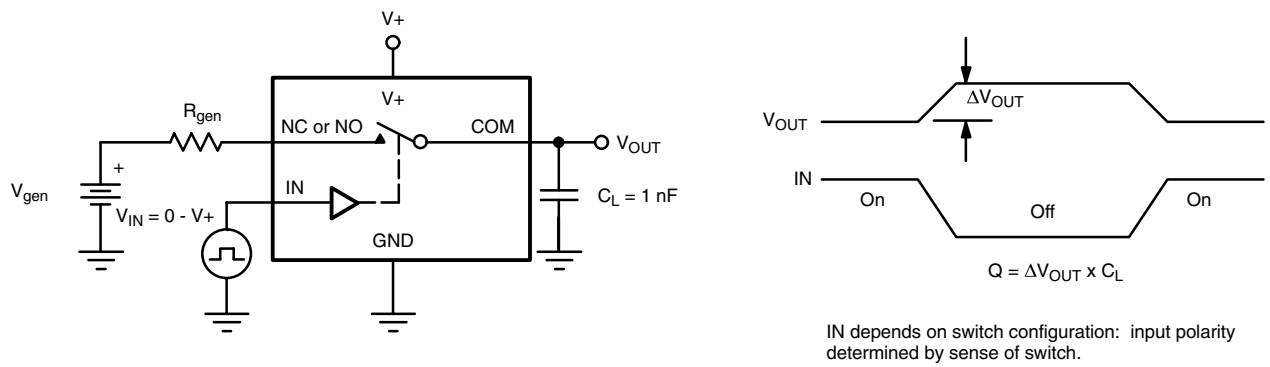


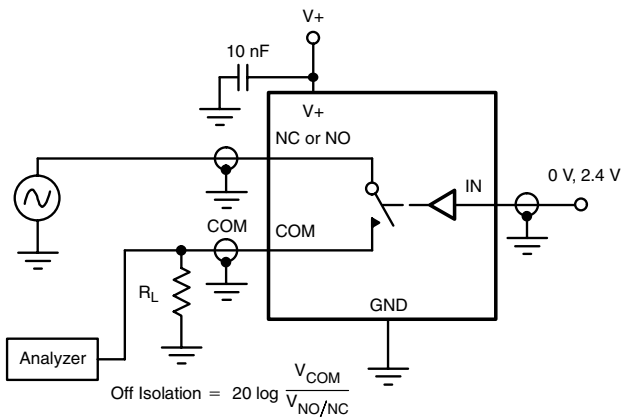
Figure 2. Break-Before-Make Interval



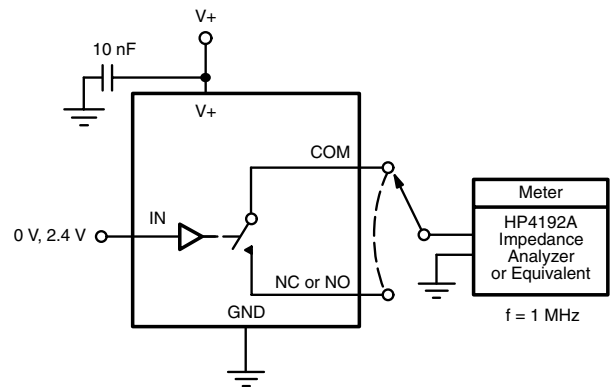
**Figure 3. Make-Before-Break Interval**



**Figure 4. Charge Injection**



**Figure 5. Off-Isolation**



**Figure 6. 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?73898>.



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