

# Precision Monolithic Quad SPST CMOS Analog Switches

## DESCRIPTION

The DG417B/418B/419B monolithic CMOS analog switches were designed to provide high performance switching of analog signals. Combining low power, low leakages, high speed, low on-resistance and small physical size, the DG417B series is ideally suited for portable and battery powered industrial and military applications requiring high performance and efficient use of board space.

To achieve high-voltage ratings and superior switching performance, the DG417B series is built on Vishay Siliconix's high voltage silicon gate (HVSG) process. Break-before-make is guaranteed for the DG419B, which is an SPDT configuration. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

The DG417B and DG418B respond to opposite control logic levels as shown in the Truth Table.

## FEATURES

- $\pm 15$  V Analog Signal Range
- On-Resistance -  $r_{DS(on)}$ : 15  $\Omega$
- Fast Switching Action -  $t_{ON}$ : 110 ns
- TTL and CMOS Compatible
- MSOP-8 and SOIC-8 Package



Available  
**RoHS\***  
COMPLIANT

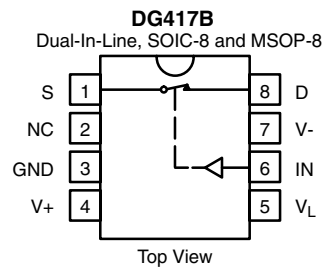
## BENEFITS

- Widest Dynamic Range
- Low Signal Errors and Distortion
- Break-Before-Make Switching Action
- Simple Interfacing
- Reduced Board Space
- Improved Reliability

## APPLICATIONS

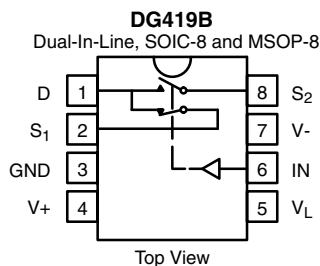
- Precision Test Equipment
- Precision Instrumentation
- Battery Powered Systems
- Sample-and-Hold Circuits
- Military Radios
- Guidance and Control Systems
- Hard Disk Drivers

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
Logic	DG417B	DG418B
0	ON	OFF
1	OFF	ON

Logic "0"  $\leq 0.8$  V  
Logic "1"  $\geq 2.4$  V



TRUTH TABLE - DG419B		
Logic	SW <sub>1</sub>	SW <sub>2</sub>
0	ON	OFF
1	OFF	ON

Logic "0"  $\leq 0.8$  V  
Logic "1"  $\geq 2.4$  V

\* Pb containing terminations are not RoHS compliant, exemptions may apply

ORDERING INFORMATION			
Temp Range	Package	Part Number	
<b>DG417B/418B</b>			
- 40 to 85 °C	8-Pin Plastic MiniDIP	DG417BDJ DG417BDJ-E3	
		DG418BDJ DG418BDJ-E3	
	8-Pin Narrow SOIC	DG417BDY DG417BDY-E3 DG417BDY-T1 DG417BDY-T1-E3	
		DG418BDY DG418BDY-E3 DG418BDY-T1 DG418BDY-T1-E3	
		DG417BDQ-T1-E3 DG418BDQ-T1-E3	
	8-Pin MSOP	DG417BDQ-T1-E3	
		DG418BDQ-T1-E3	
	<b>DG419B</b>		
	- 40 to 85 °C	8-Pin Plastic MiniDIP	DG419BDJ DG419BDJ-E3
8-Pin Narrow SOIC		DG419BDY DG419BDY-E3 DG419BDY-T1 DG419BDY-T1-E3	
8-Pin MSOP		DG419BDQ-T1-E3	

ABSOLUTE MAXIMUM RATINGS			
Parameter	Limit	Unit	
V-	- 20	V	
V+	20		
GND	25		
V <sub>L</sub>	(GND - 0.3 V) to (V+) + 0.3		
Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>	(V-) - 2 V to (V+) + 2 or 30 mA, whichever occurs first		
Current, (Any Terminal) Continuous	30	mA	
Current (S or D) Pulsed at 1 ms, 10 % duty cycle	100		
Storage Temperature	- 65 to 150	°C	
Power Dissipation (Package) <sup>b</sup>	8-Pin Plastic MiniDIP <sup>c</sup>	400	mW
	8-Pin Narrow SOIC <sup>c</sup>	400	
	8-Pin MSOP <sup>d</sup>	400	
	8-Pin CerDIP <sup>e</sup>	600	

Notes:

- Signals on S<sub>x</sub>, D<sub>x</sub>, or IN<sub>x</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- All leads welded or soldered to PC Board.
- Derate 5.3 mW/°C above 75 °C.
- Derate 4 mW/°C above 70 °C.
- Derate 8 mW/°C above 75 °C.

**SCHEMATIC DIAGRAM (TYPICAL CHANNEL)**


Figure 1.

<b>SPECIFICATIONS<sup>a</sup></b>											
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_L = 5\text{ V}$ , $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^f$		Temp <sup>b</sup>	Typ <sup>c</sup>	A Suffix - 55 to 125 °C		D Suffix - 40 to 85 °C		Unit	
						Min <sup>d</sup>	Max <sup>d</sup>	Min <sup>d</sup>	Max <sup>d</sup>		
<b>Analog Switch</b>											
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$			Full		- 15	15	- 15	15	V	
Drain-Source On-Resistance	$r_{DS(on)}$	$I_S = -10\text{ mA}$ , $V_D = \pm 12.5\text{ V}$ $V_+ = 13.5\text{ V}$ , $V_- = -13.5\text{ V}$		Room Full	15		25 34		25 29	$\Omega$	
Switch Off Leakage Current	$I_{S(off)}$	$V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$ $V_D = \pm 15.5\text{ V}$ , $V_S = \pm 15.5\text{ V}$		Room Full	- 0.1	- 0.25 - 20	0.25 20	- 0.25 - 5	0.25 5	nA	
	$I_{D(off)}$			DG417B DG418B	Room Full	- 0.1	- 0.25 - 20	0.25 20	- 0.25 - 5		0.25 5
				DG419B	Room Full	- 0.1	- 0.75 - 60	0.75 60	- 0.75 - 12		0.75 12
Channel On Leakage Current	$I_{D(on)}$	$V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$ $V_S = V_D = \pm 15.5\text{ V}$		DG417B DG418B	Room Full	- 0.4 - 40	0.4 40	- 0.4 - 10	0.4 10	nA	
				DG419B	Room Full	- 0.4	- 0.75 - 60	0.75 60	- 0.75 - 12		0.75 12
<b>Digital Control</b>											
Input Current, $V_{IN}$ Low	$I_{IL}$			Full		- 0.5	0.5	- 0.5	0.5	$\mu\text{A}$	
Input Current, $V_{IN}$ High	$I_{IH}$			Full		- 0.5	0.5	- 0.5	0.5	$\mu\text{A}$	
<b>Dynamic Characteristics</b>											
Turn-On Time	$t_{ON}$	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = \pm 10\text{ V}$ , See Switching Time Test Circuit		DG417B DG418B	Room Full	62	89 106		89 99	ns	
Turn-Off Time	$t_{OFF}$			DG417B DG418B	Room Full	53	80 88		80 86		
Transition Time	$t_{TRANS}$	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_{S1} = \pm 10\text{ V}$ , $V_{S2} = \pm 10\text{ V}$		DG419B	Room Full	60	87 96		87 93		
Break-Before-Make Time Delay	$t_D$	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_{S1} = V_{S2} = \pm 10\text{ V}$		DG419B	Room	16	3		3		
Charge Injection	Q	$C_L = 10\text{ nF}$ $V_{gen} = 0\text{ V}$ , $R_{gen} = 0\ \Omega$		Room	4					pC	
Off Isolation <sup>e</sup>	OIRR	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$		Room	- 86					dB	
Channel-to-Channel Crosstalk <sup>e</sup>	$X_{TALK}$			DG419B	Room	- 87				dB	

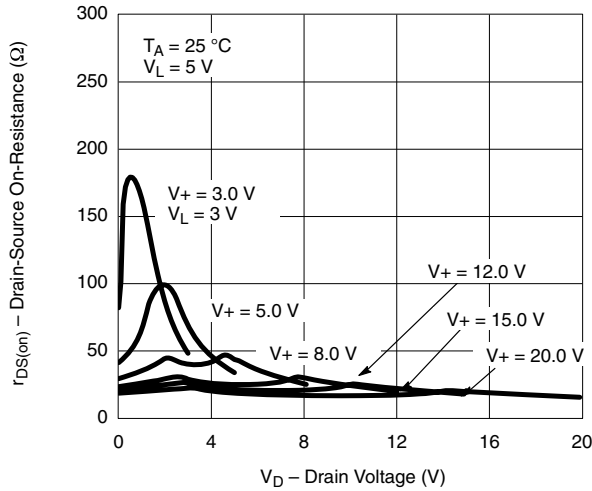
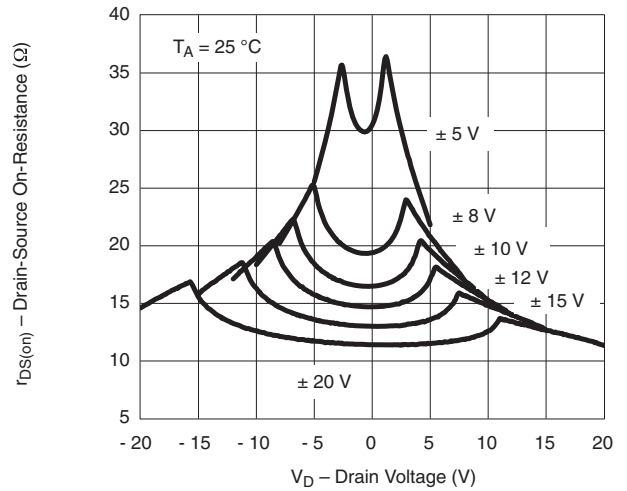
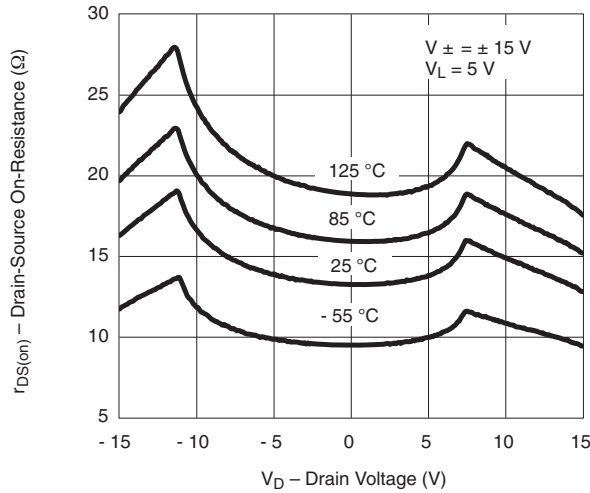
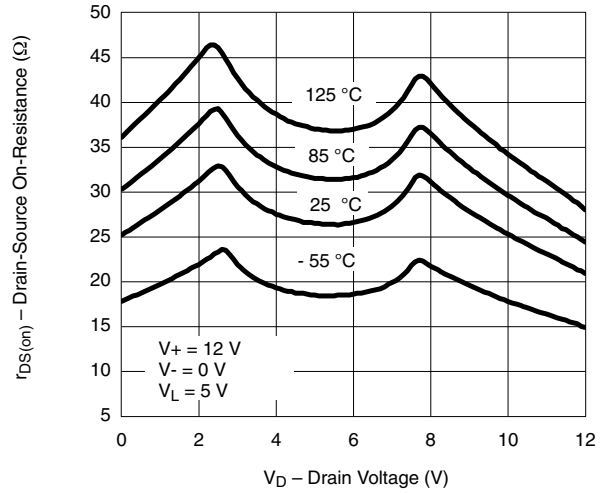
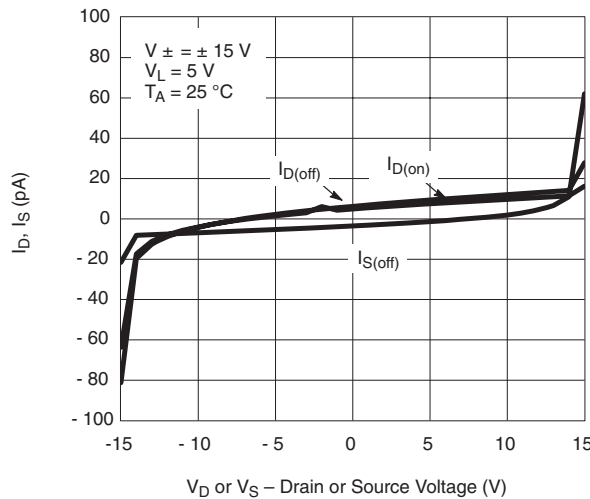
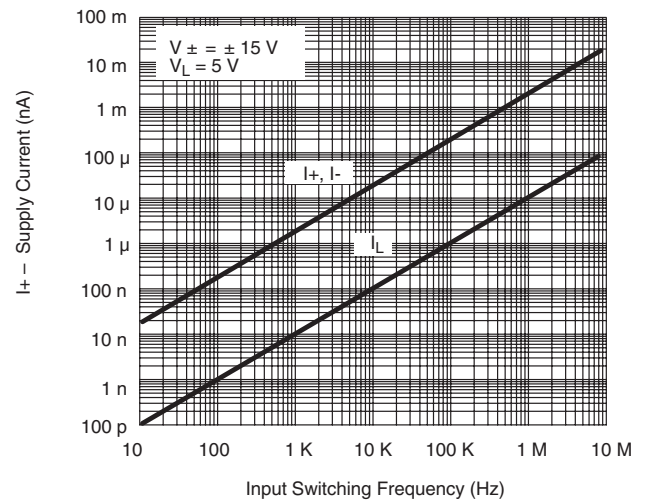
SPECIFICATIONS <sup>a</sup>											
Parameter	Symbol	Test Conditions Unless Otherwise Specified V <sub>+</sub> = 15 V, V <sub>-</sub> = -15 V V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup>		Temp <sup>b</sup>	Typ <sup>c</sup>	A Suffix - 55 to 125 °C		D Suffix - 40 to 85 °C		Unit	
						Min <sup>d</sup>	Max <sup>d</sup>	Min <sup>d</sup>	Max <sup>d</sup>		
Source Off Capacitance <sup>e</sup>	C <sub>S(off)</sub>	f = 1 MHz, V <sub>S</sub> = 0 V		Room	12					pF	
Drain Off Capacitance <sup>e</sup>	C <sub>D(off)</sub>			DG417B DG418B	Room	12					
Channel On Capacitance <sup>e</sup>	C <sub>D(on)</sub>			DG417B DG418B DG419B	Room	50					
<b>Power Supplies</b>											
Positive Supply Current	I <sub>+</sub>	V <sub>+</sub> = 16.5 V, V <sub>-</sub> = -16.5 V V <sub>IN</sub> = 0 or 5 V		Room Full	0.001		1 5		1 5	μA	
Negative Supply Current	I <sub>-</sub>			Room Full	- 0.001	- 1 - 5		- 1 - 5			
Logic Supply Current	I <sub>L</sub>			Room Full	0.001		1 5		1 5		
Ground Current	I <sub>GND</sub>			Room Full	- 0.001	- 1 - 5		- 1 - 5			

SPECIFICATIONS <sup>a</sup>										
Parameter	Symbol	Test Conditions Unless Otherwise Specified V <sub>+</sub> = 12 V, V <sub>-</sub> = 0 V V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup>		Temp <sup>b</sup>	Typ <sup>c</sup>	A Suffix - 55 to 125 °C		D Suffix - 40 to 85 °C		Unit
						Min <sup>d</sup>	Max <sup>d</sup>	Min <sup>d</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>										
Analog Signal Range <sup>e</sup>	V <sub>ANALOG</sub>			Full		0	12	0	12	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	I <sub>S</sub> = -10 mA, V <sub>D</sub> = 3.8 V V <sub>+</sub> = 10.8 V,		Room Full	26		35 52		35 45	Ω
<b>Dynamic Characteristics</b>										
Turn-On Time	t <sub>ON</sub>	R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF V <sub>S</sub> = 8 V, See Switching Time Test Circuit		Room Full	100		125 155		125 143	ns
Turn-Off Time	t <sub>OFF</sub>			Room Full	38		66 73		66 69	
Break-Before-Make Time Delay	t <sub>D</sub>	R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF		DG419B Room	62	25		25		
Transition Time	t <sub>TRANS</sub>	R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF V <sub>S1</sub> = 0 V, 8 V, V <sub>S2</sub> = 8 V, 0 V		Room Full	95		119 153		119 141	
Charge Injection	Q	C <sub>L</sub> = 10 nF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω		Room	3					pC
<b>Power Supplies</b>										
Positive Supply Current	I <sub>+</sub>	V <sub>+</sub> = 13.2 V, V <sub>L</sub> = 5.25 V V <sub>IN</sub> = 0 or 5 V		Room Full	0.001		1 5		1 5	μA
Negative Supply Current	I <sub>-</sub>			Room	- 0.001	- 1 - 5		- 1 - 5		
Logic Supply Current	I <sub>L</sub>			Room	0.001		1 5		1 5	
Ground Current	I <sub>GND</sub>			Room	- 0.001	- 1 - 5		- 1 - 5		

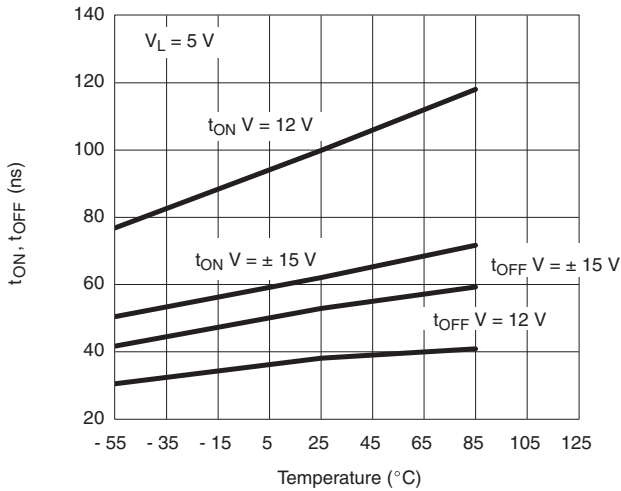
**Notes:**

- Refer to PROCESS OPTION FLOWCHART.
- Room = 25 °C, Full = as determined by the operating temperature 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.
- Guaranteed by design, not subject to production test.
- V<sub>IN</sub> = input voltage to perform proper function.

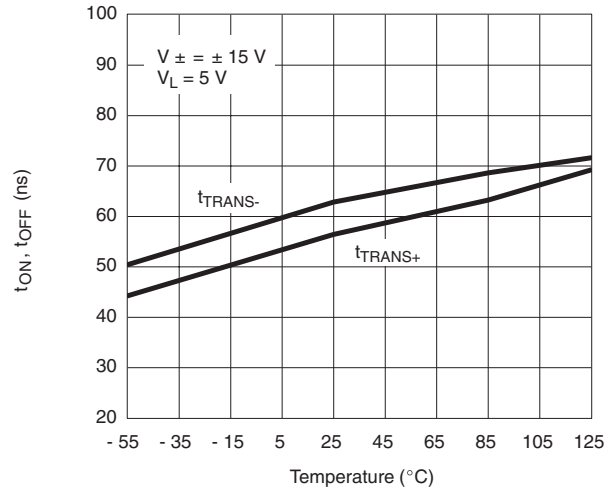
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

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

**On-Resistance vs.  $V_D$  and Unipolar Power Supply Voltage**

**On-Resistance vs.  $V_D$  and Dual Supply Voltage**

**On-Resistance vs.  $V_D$  and Temperature**

**On-Resistance vs.  $V_D$  and Temperature**

**Leakage vs. Analog Voltage**

**Supply Current vs. Input Switching Frequency**

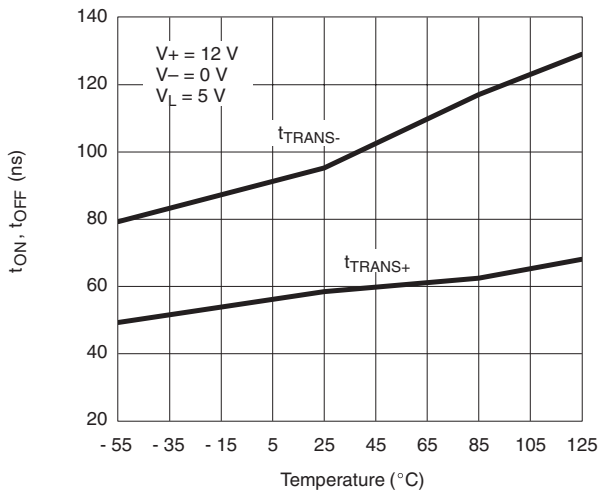
### TYPICAL CHARACTERISTICS $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



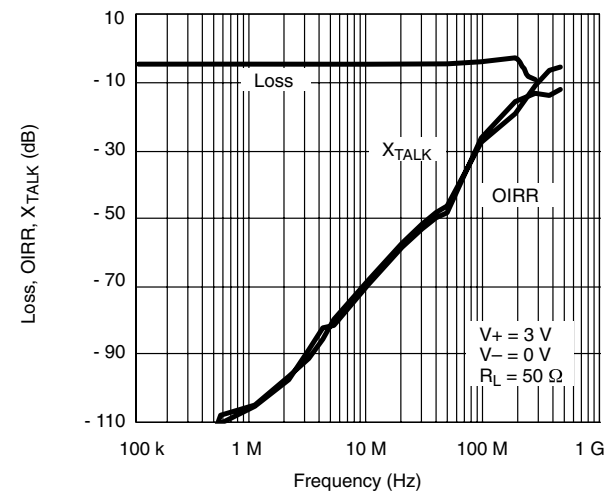
Switching Time vs. Temperature



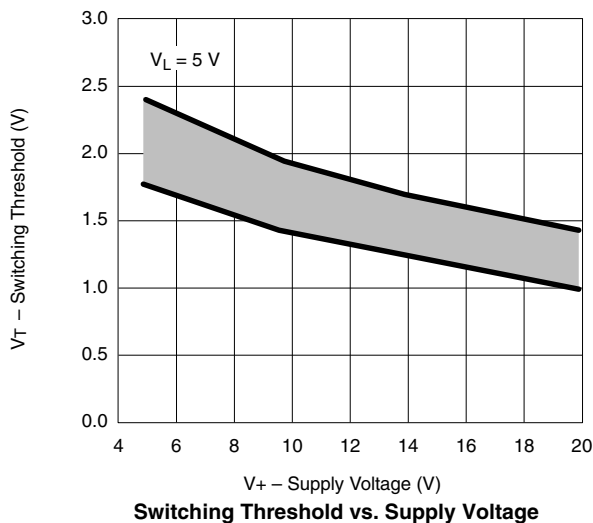
Transition Time vs. Temperature



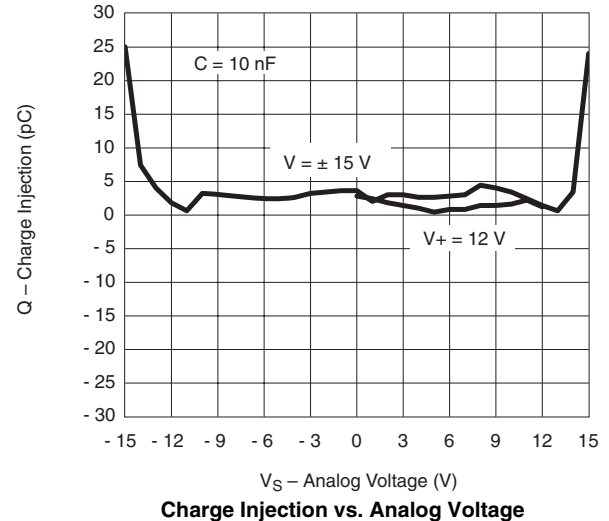
Transition Time vs. Temperature



Insertion Loss, Off-Isolation Crosstalk vs. Frequency



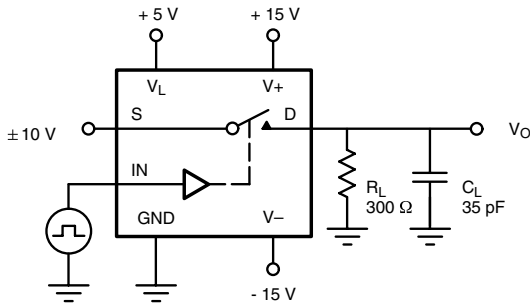
Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage

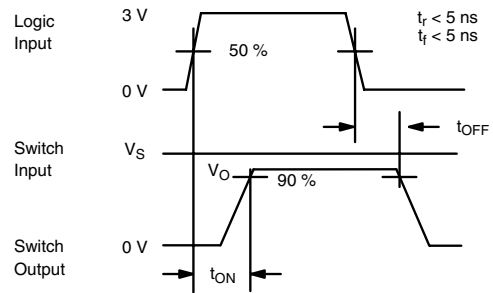
## TEST CIRCUITS

$V_O$  is the steady state output with the switch on.



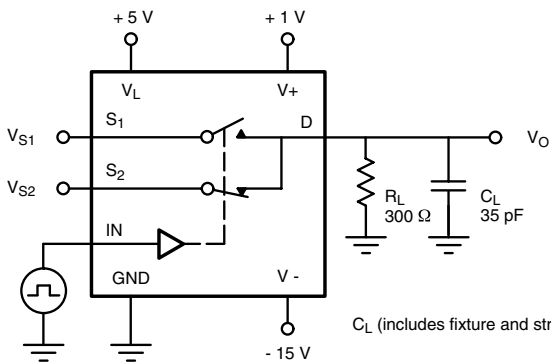
$C_L$  (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$

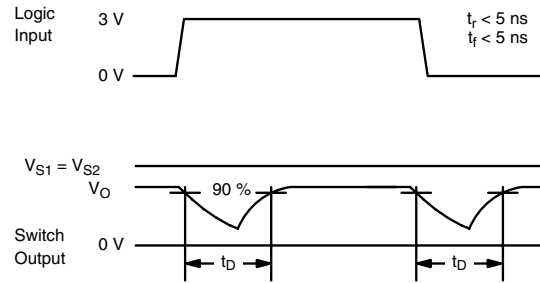


Note: Logic input waveform is inverted for switches that have the opposite logic sense.

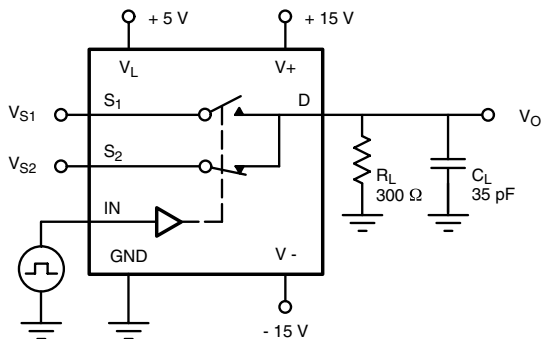
**Figure 2. Switching Time (DG417B/418B)**



$C_L$  (includes fixture and stray capacitance)

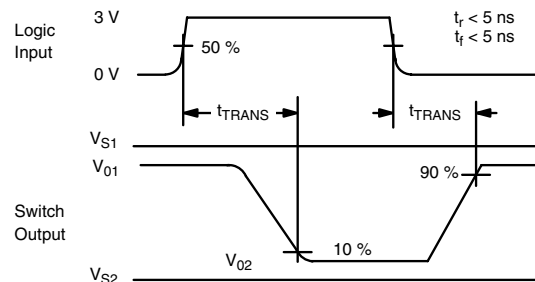


**Figure 3. Break-Before-Make (DG419B)**



$C_L$  (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$



**Figure 4. Transition Time (DG419B)**

TEST CIRCUITS

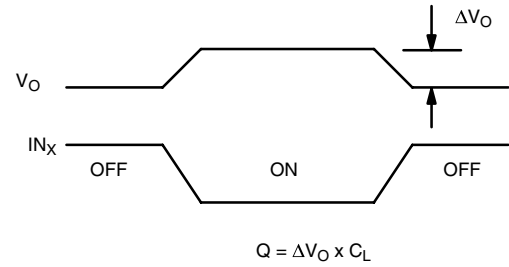
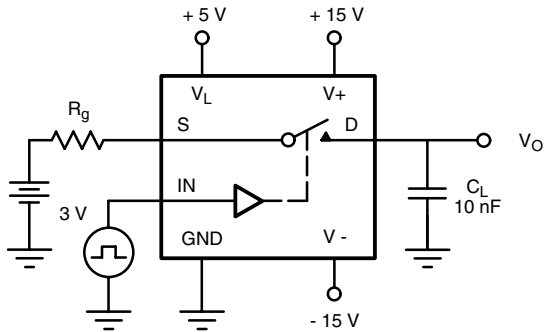


Figure 5. Charge Injection

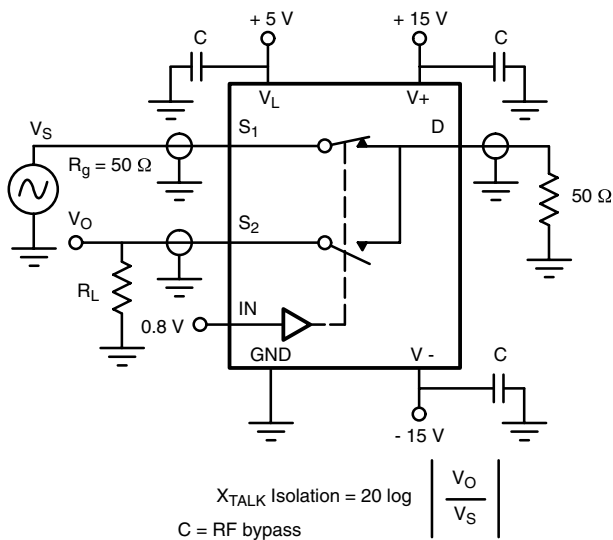


Figure 6. Crosstalk

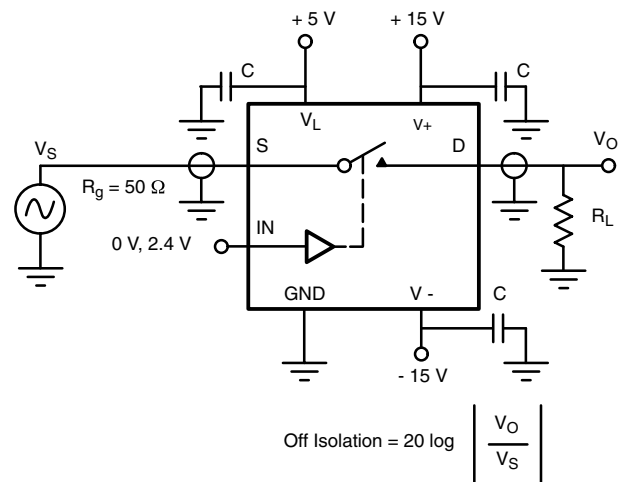


Figure 7. Off isolation

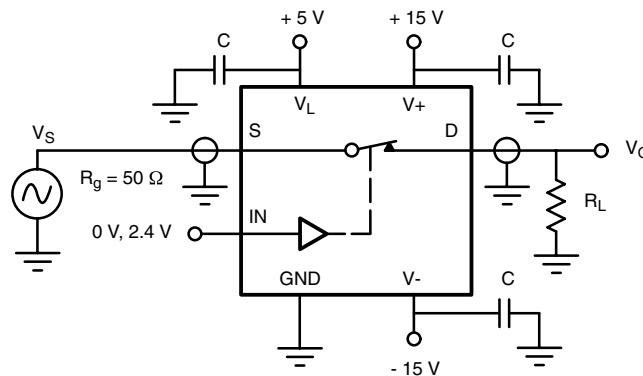


Figure 8. Insertion Loss



## TEST CIRCUITS

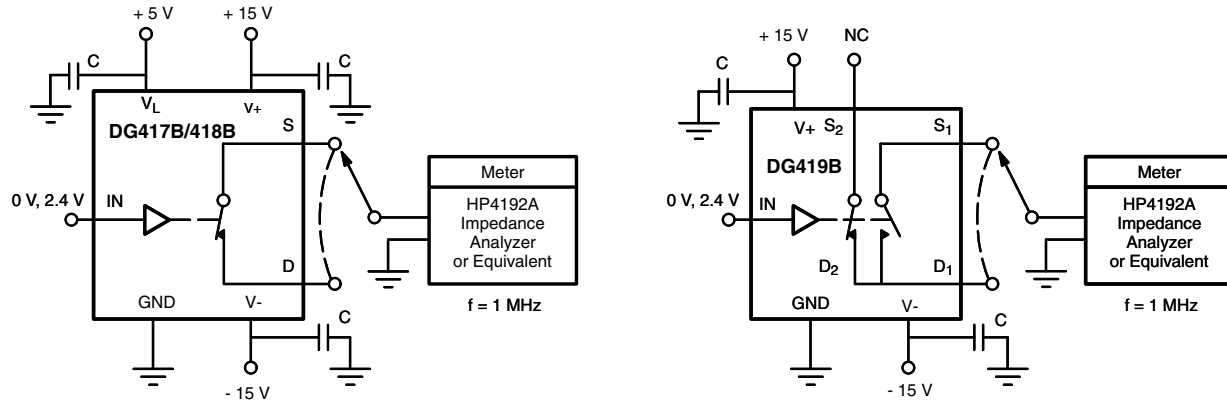


Figure 9. Source/Drain Capacitances

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?72107>.



## Disclaimer

All product specifications and data are subject to change without notice.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained herein or in any other disclosure relating to any product.

Vishay disclaims any and all liability arising out of the use or application of any product described herein or of any information provided herein to the maximum extent permitted by law. The product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein, which apply to these products.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications unless otherwise expressly indicated. Customers using or selling Vishay products not expressly indicated for use in such applications do so entirely at their own risk and agree to fully indemnify Vishay for any damages arising or resulting from such use or sale. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

Product names and markings noted herein may be trademarks of their respective owners.