Precision Monolithic Quad SPST CMOS Analog Switches

DESCRIPTION

The DG417B, DG418B, DG419B 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.

BENEFITS

- Widest dynamic range
- Low signal errors and distortion
- Break-before-make switching action
- Simple interfacing
- Reduced board space
- Improved reliability

FEATURES

- ± 15 V analog signal range
- On-resistance - $R_{DS(on)}$: 15 Ω
- Fast switching action - t_{on}: 110 ns
- TTL and CMOS compatible
- MSOP-8 and SOIC-8 package

Pb-free Available

RoHS* Available

Note

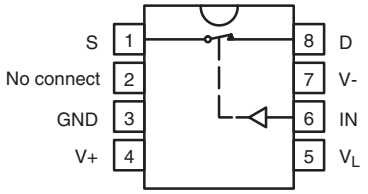
* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

APPLICATIONS

- Precision test equipment
- Precision instrumentation
- Battery powered systems
- Sample-and-hold circuits
- Military radios
- Guidance and control systems
- Hard disk drivers

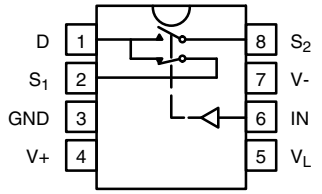
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG417B
Dual-In-Line, SOIC-8 and MSOP-8



Top View

DG419B
Dual-In-Line, SOIC-8 and MSOP-8



Top View

TRUTH TABLE		
LOGIC	**DG417B**	**DG418B**
0	On	Off
1	Off	On

Note

- Logic "0" ≤ 0.8 V
  Logic "1" ≥ 2.4 V

TRUTH TABLE (DG419B)		
LOGIC	**SW_1**	**SW_2**
0	On	Off
1	Off	On

Note

- Logic "0" ≤ 0.8 V
  Logic "1" ≥ 2.4 V

ORDERING INFORMATION		
TEMP. RANGE	**PACKAGE**	**PART NUMBER**
DG417B, DG418B		
-40 °C to +85 °C	8-pin narrow SOIC	DG417BDY-E3 DG417BDY-T1-E3
		DG418BDY-E3 DG418BDY-T1-E3
	8-pin MSOP	DG417BDQ-T1-E3
		DG418BDQ-T1-E3
DG419B		
-40 °C to +85 °C	8-pin narrow SOIC	DG419BDY-E3 DG419BDY-T1-E3
	8-pin MSOP	DG419BDQ-T1-E3

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)			
PARAMETER		**LIMIT**	**UNIT**
V-		-20	V
V+		20	
GND		25	
V_L		(GND - 0.3) to (V+) + 0.3	
Digital inputs [a], V_S, V_D		(V-) - 2 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) [b]	8-pin narrow SOIC [d]	400	mW
	8-pin MSOP [e]	400	
	8-pin CerDIP [e]	600	

Notes

a. Signals on S_X, D_X, or IN_X exceeding V+ or 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 5.3 mW/°C above 75 °C
d. Derate 4 mW/°C above 70 °C
e. Derate 8 mW/°C above 75 °C

SCHEMATIC DIAGRAM (Typical Channel)

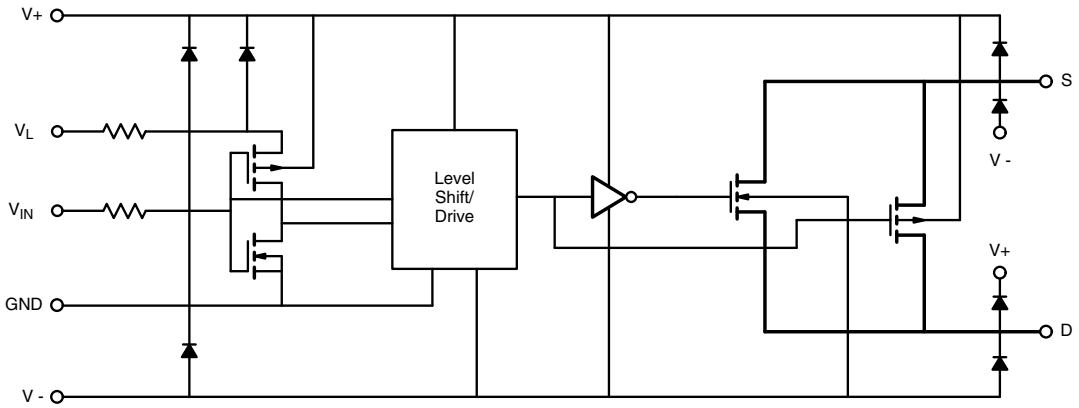


Fig. 1

SPECIFICATIONS [a]

PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 15 V, V- = -15 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]		TEMP. [b]	TYP. [c]	A SUFFIX -55 °C to +125 °C		D SUFFIX -40 °C to +85 °C		UNIT
						MIN. [d]	MAX. [d]	MIN. [d]	MAX. [d]	
Analog Switch										
Analog signal range [e]	V_{ANALOG}			Full	-	-15	15	-15	15	V
Drain-source on-resistance	$R_{DS(on)}$	I_S = -10 mA, V_D = ± 12.5 V, V+ = 13.5 V, V- = -13.5 V		Room	15	-	25	-	25	Ω
				Full	-	-	34	-	29	
Switch off leakage current	$I_{S(off)}$	V+ = 16.5, V- = -16.5 V, V_D = ± 15.5 V, V_S = ± 15.5 V		Room	-0.1	-0.25	0.25	-0.25	0.25	nA
				Full	-	-20	20	-5	5	
	$I_{D(off)}$		DG417B DG418B	Room	-0.1	-0.25	0.25	-0.25	0.25	
				Full	-	-20	20	-5	5	
			DG419B	Room	-0.1	-0.75	0.75	-0.75	0.75	
				Full	-	-60	60	-12	12	
Channel on leakage current	$I_{D(on)}$	V+ = 16.5 V, V- = -16.5 V, V_S = V_D = ± 15.5 V	DG417B DG418B	Room	-0.4	-0.4	0.4	-0.4	0.4	
				Full	-	-40	40	-10	10	
			DG419B	Room	-0.4	-0.75	0.75	-0.75	0.75	
				Full	-	-60	60	-12	12	
Digital Control										
Input current V_{IN} low	I_{IL}			Full	-	-0.5	0.5	-0.5	0.5	µA
Input current V_{IN} high	I_{IH}			Full	-	-0.5	0.5	-0.5	0.5	
Dynamic Characteristics										
Turn-on time	t_{on}	R_L = 300 Ω, C_L = 35 pF, V_S = ± 10 V, see Switching Time Test Circuit	DG417B DG418B	Room	62	-	89	-	89	ns
				Full	-	-	106	-	99	
Turn-off time	t_{off}		DG417B DG418B	Room	53	-	80	-	80	
				Full	-	-	88	-	86	
Transition time	t_{TRANS}	R_L = 300 Ω, C_L = 35 pF, V_{S1} = ± 10 V, V_{S2} = ± 10 V	DG419B	Room	60	-	87	-	87	
				Full	-	-	96	-	93	
Break-before-make time delay	t_D	R_L = 300 W, C_L = 35 pF, V_{S1} = V_{S2} = ± 10 V	DG419B	Room	16	3	-	3	-	
Charge injection	Q	C_L = 10 nF, V_{gen} = 0 V, R_{gen} = 0 Ω		Room	38	-	-	-	-	pC
Off isolation [e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz		Room	-82	-	-	-	-	dB
Channel-to-channel crosstalk [e]	X_{TALK}		DG419B	Room	-88	-	-	-	-	
Source off capacitance [e]	$C_{S(off)}$	f = 1 MHz, V_S = 0 V		Room	12					pF
Drain off capacitance [e]	$C_{D(off)}$		DG417B DG418B	Room	12					
Channel on capacitance [e]	$C_{D(on)}$	f = 1 MHz, V_S = 0 V	DG417B DG418B	Room	50					
			DG419B	Room	57					
Power Supplies										
Positive supply current	I+	V+ = 16.5 V, V- = -16.5 V, V_{IN} = 0 V or 5 V		Room	0.001	-	1	-	1	µA
				Full	-	-	5	-	5	
Negative supply current	I-			Room	-0.001	-1	-	-1	-	
				Full	-	-5	-	-5	-	
Logic supply current	I_L			Room	0.001	-	1	-	1	
				Full	-	-	5	-	5	
Ground current	I_{GND}			Room	-0.001	-1	-	-1	-	
				Full	-	-5	-	-5	-	

SPECIFICATIONS [a]

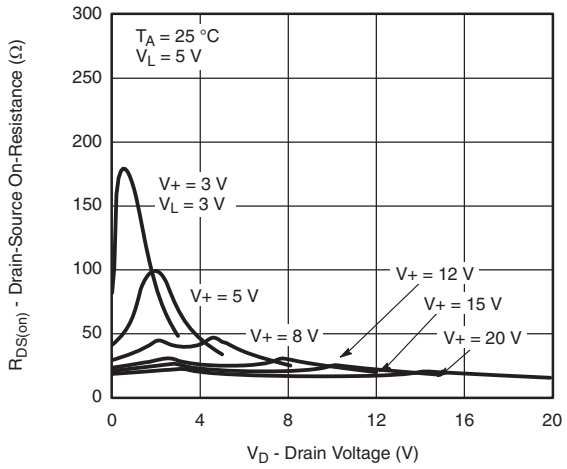
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 12 V, V- = 0 V, V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]		TEMP. [b]	TYP. [c]	A SUFFIX -55 °C to +125 °C		D SUFFIX -40 °C to +85 °C		UNIT
						MIN. [d]	MAX. [d]	MIN. [d]	MAX. [d]	
Analog Switch										
Analog signal range [e]	V_{ANALOG}			Full	-	0	12	0	12	V
Drain-source on-resistance	$R_{DS(on)}$	I_S = -10 mA, V_D = 3.8 V, V+ = 10.8 V		Room	26	-	35	-	35	Ω
				Full	-	-	52	-	45	
Dynamic Characteristics										
Turn-on time	t_{on}	R_L = 300 Ω, C_L = 35 pF, V_S = 8 V, see Switching Time Test Circuit		Room	100	-	125	-	125	ns
				Full	-	-	155	-	143	
Turn-off time	t_{off}			Room	38	-	66	-	66	
				Full	-	-	73	-	69	
Break-before-make time delay	t_D	R_L = 300 Ω, C_L = 35 pF	DG419B	Room	62	25	-	25	-	
Transition time	t_{TRANS}	R_L = 300 Ω, C_L = 35 pF, V_{S1} = 0 V, 8 V, V_{S2} = 8 V, 0 V		Room	95	-	119	-	119	
				Full	-	-	153	-	141	
Charge injection	Q	C_L = 10 nF, V_{gen} = 0 V, R_{gen} = 0 Ω		Room	18	-	-	-	-	pC
Power Supplies										
Positive supply current	I+	V+ = 13.2 V, V_L = 5.25 V, V_{IN} = 0 V or 5 V		Room	0.001	-	1	-	1	µA
				Full	-	-	5	-	5	
Negative supply current	I-			Room	-0.001	-1	-	-1	-	
				Full	-	-5	-	-5	-	
Logic supply current	I_L			Room	0.001	-	1	-	1	
				Full	-	-	5	-	5	
Ground current	I_{GND}			Room	-0.001	-1	-	-1	-	
				Full	-	-5	-	-5	-	

Notes

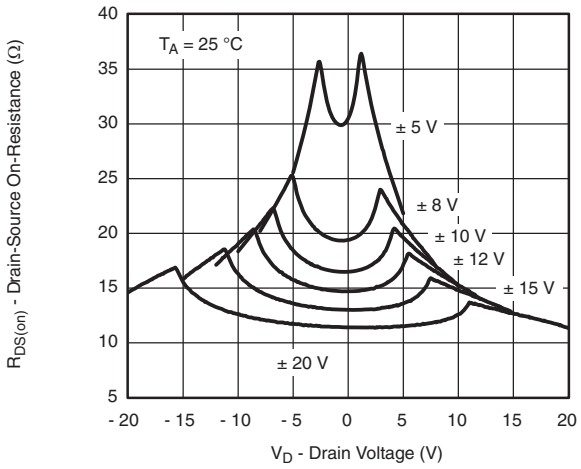
a. Refer to PROCESS OPTION FLOWCHART
b. Room = 25 °C, full = as determined by the operating temperature suffix
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet
e. Guaranteed by design, not subject to production test
f. V_{IN} = 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.

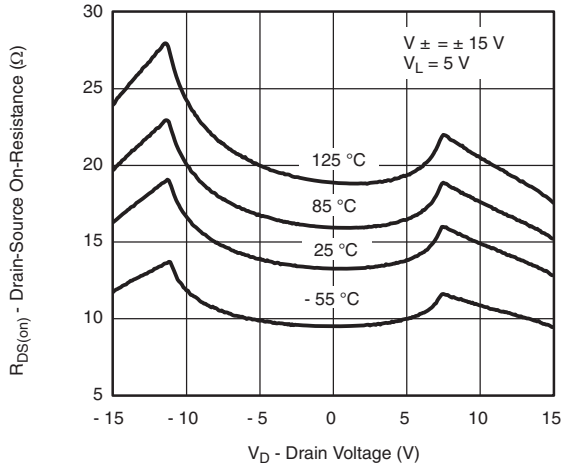
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



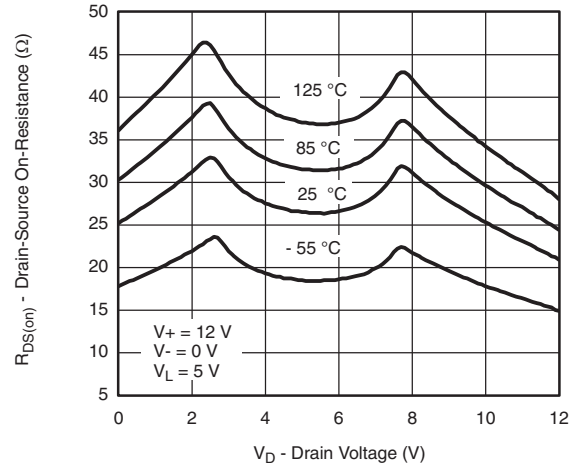
On-Resistance vs. V_D and Unipolar Power



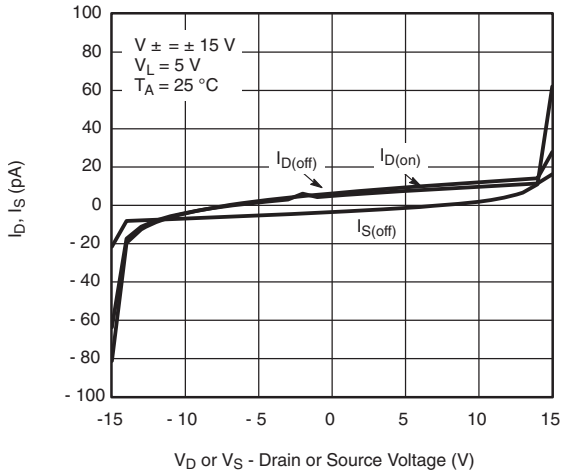
On-Resistance vs. V_D and Dual Supply Voltage



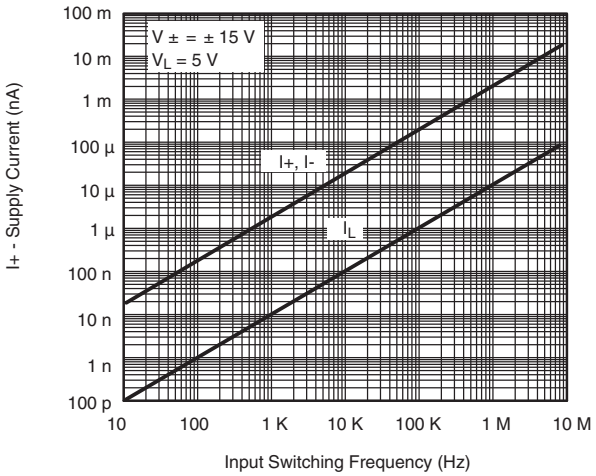
On-Resistance vs. V_D and Temperature



On-Resistance vs. V_D and Temperature

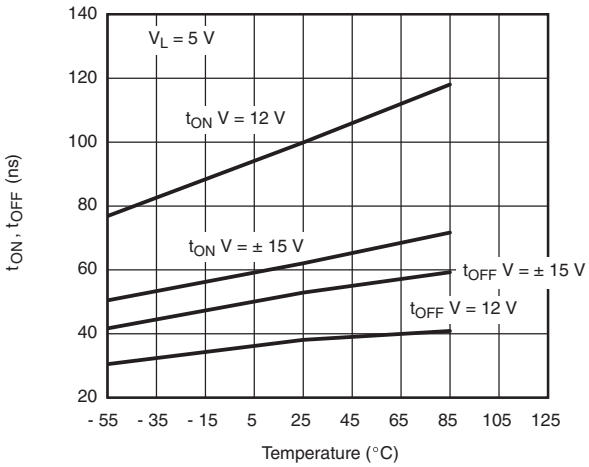


Leakage vs. Analog Voltage

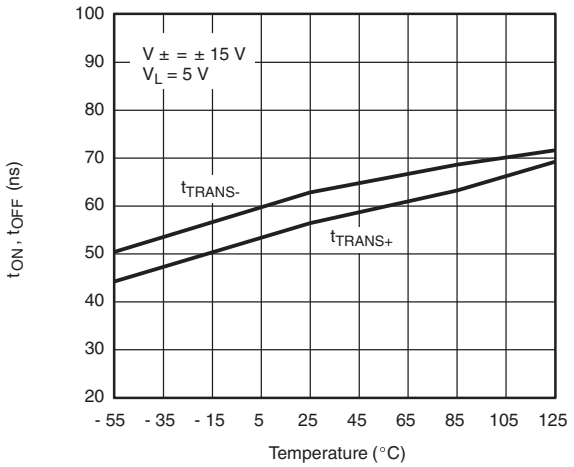


Supply Current vs. Input Switching Frequency

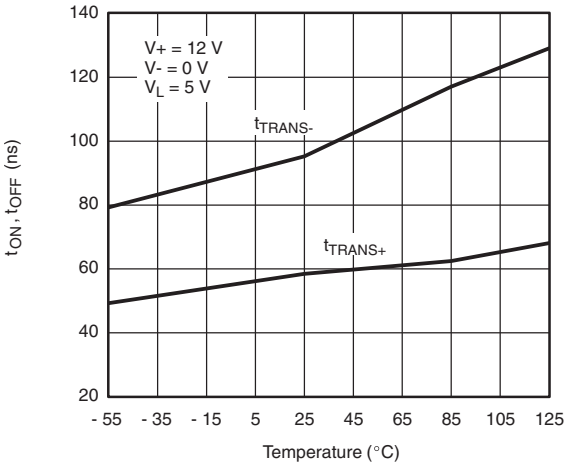
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



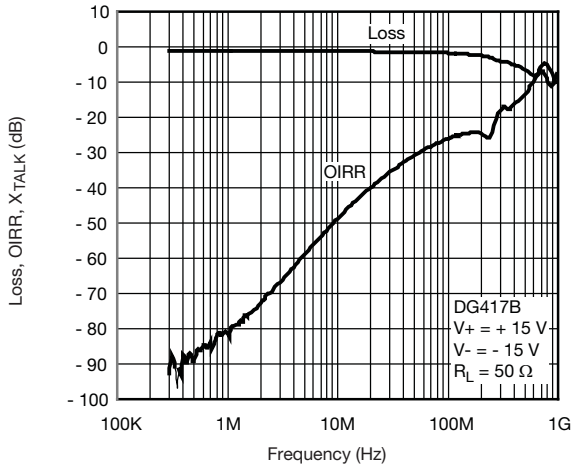
Switching Time vs. Temperature



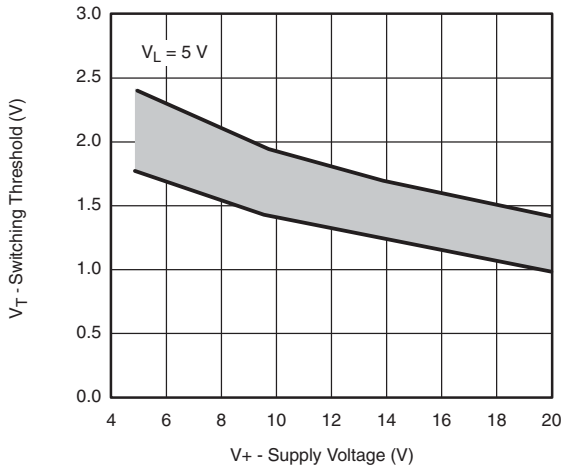
Transition Time vs. Temperature



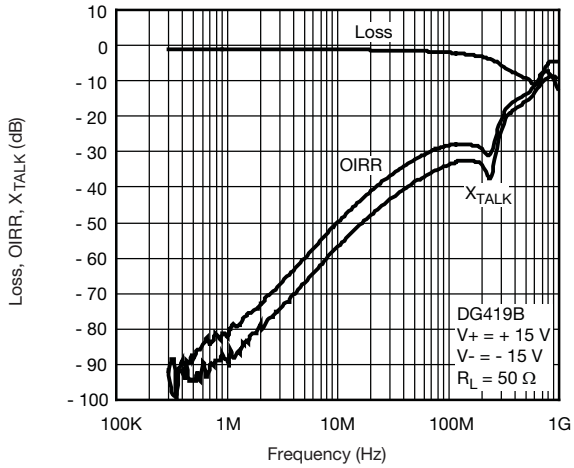
Transition Time vs. Temperature



Insertion Loss, Off -Isolation Crosstalk vs. Frequency

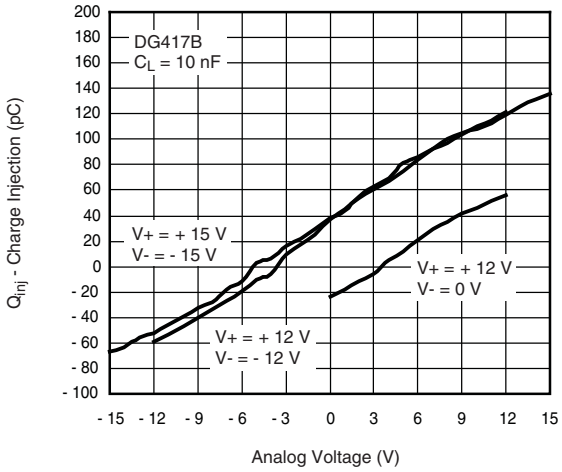


Switching Threshold vs. Supply Voltage

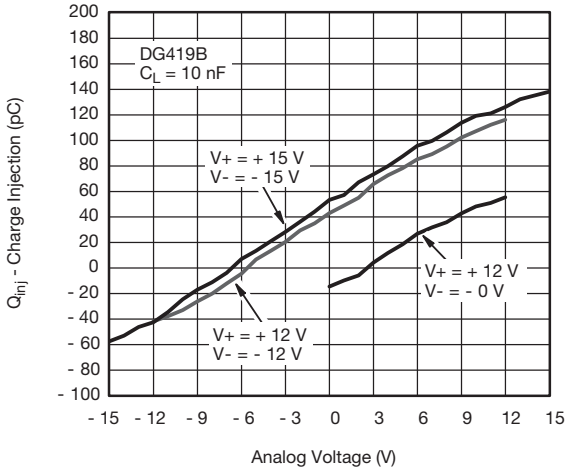


Insertion Loss, Off -Isolation Crosstalk vs. Frequency

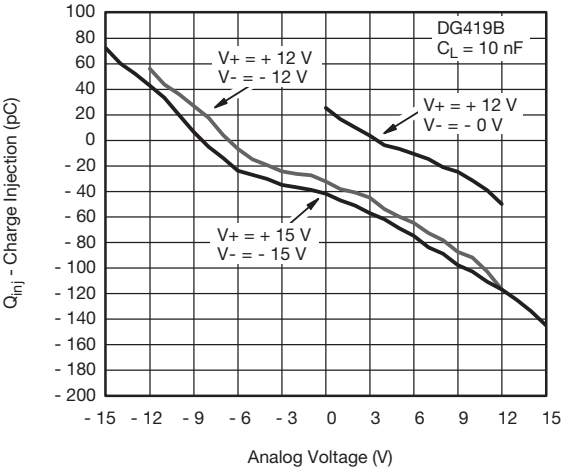
TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)



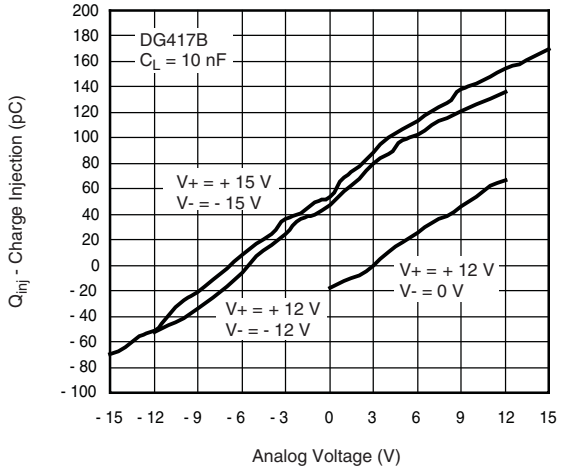
Charge Injection vs. Analog Voltage (measured at drain pin)



Charge Injection vs. Analog Voltage (measured at source pin)



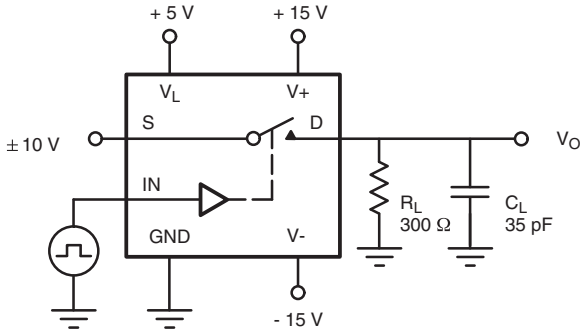
Charge Injection vs. Analog Voltage (measured at drain pin)



Charge Injection vs. Analog Voltage (measured at source pin)

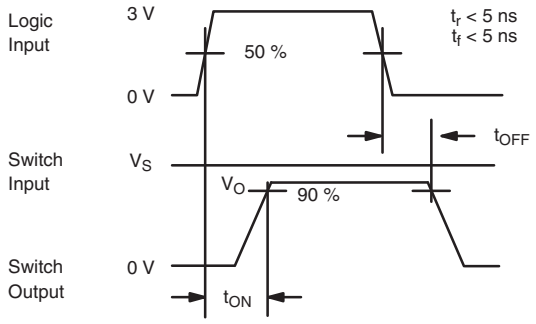
TEST CIRCUITS

V_O is the steady state output with the switch on.



C_L (includes fixture and stray capacitance)

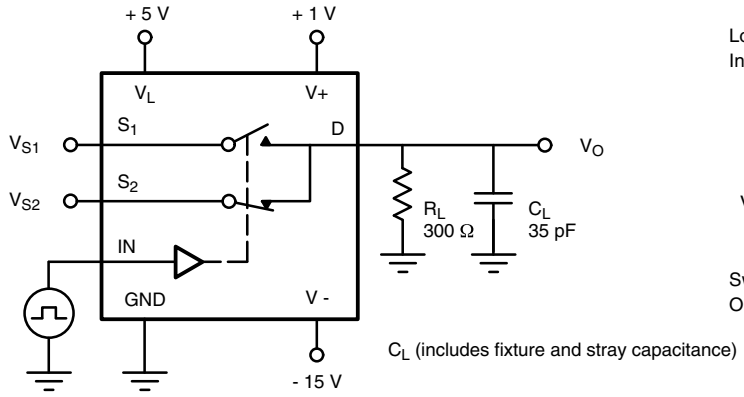
$$V_O = V_S \frac{R_L}{R_L + R_{DS(on)}}$$



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

Fig. 2 - Switching Time (DG417B/DG418B)

TEST CIRCUITS



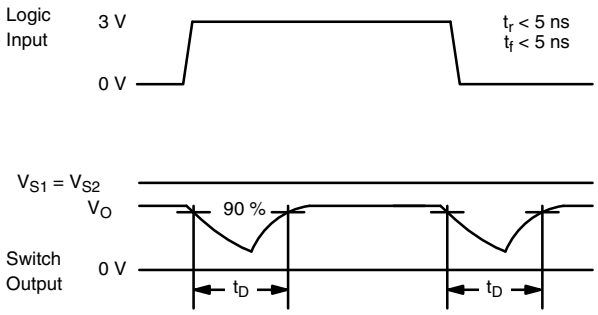
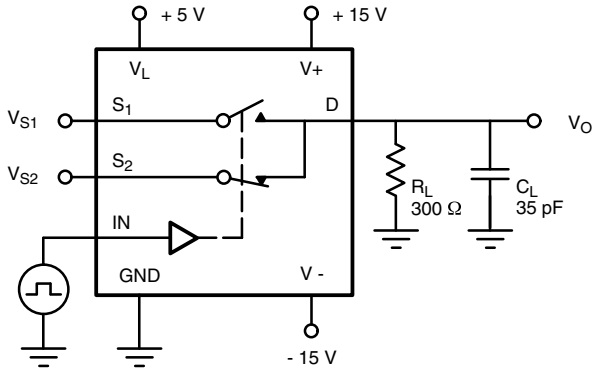


Fig. 3 - Break-Before-Make (DG419B)



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

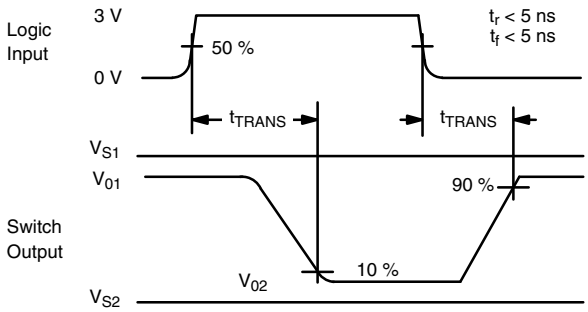
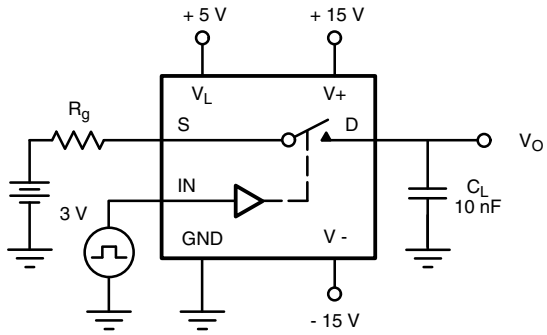
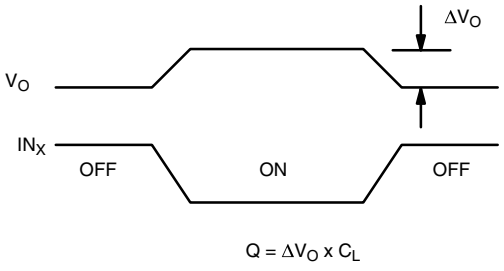


Fig. 4 - Transition Time (DG419B)





$$Q = \Delta V_O \times C_L$$

Fig. 5 - Charge Injection

TEST CIRCUITS

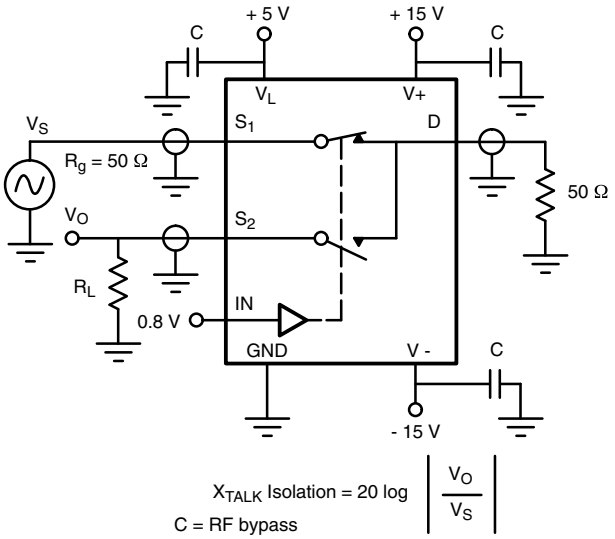


Fig. 6 - Crosstalk

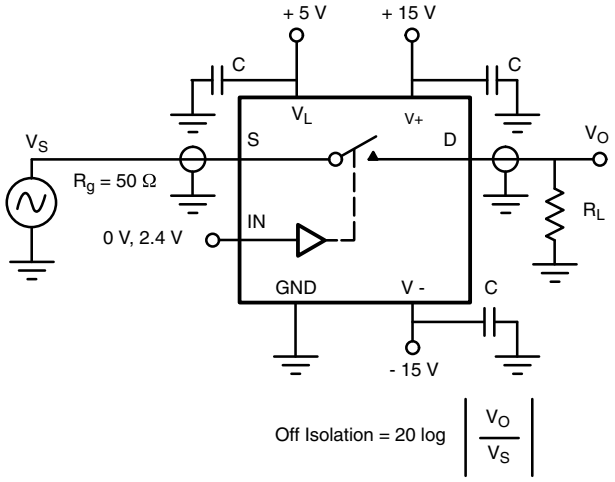


Fig. 7 - Off isolation

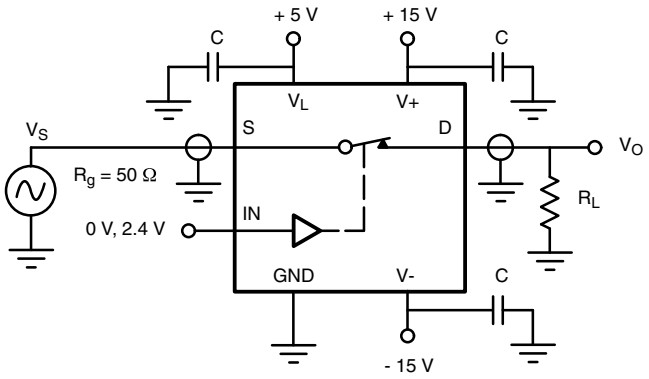


Fig. 8 - Insertion Loss

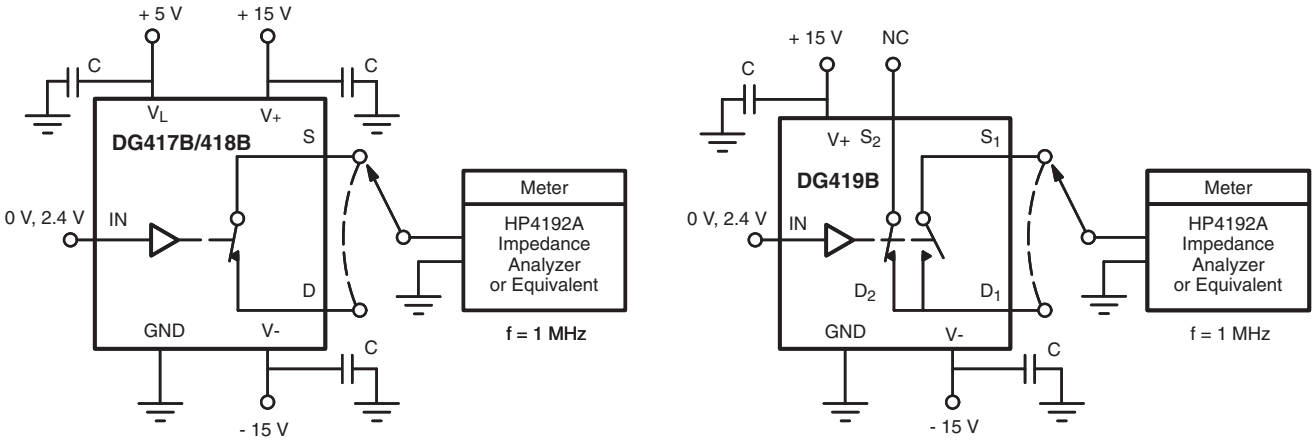


Fig. 9 - Source/Drain Capacitances

PRODUCT SUMMARY						
Part number	DG417B	DG417B	DG418B	DG418B	DG419B	DG419B
Status code	2	2	2	2	2	2
Configuration	SPST x 1, NC	SPST x 1, NC	SPST x 1, NO	SPST x 1, NO	SPDT x 1	SPDT x 1
Single supply min. (V)	5	5	5	5	5	5
Single supply max. (V)	36	36	36	36	36	36
Dual supply min. (V)	5	5	5	5	5	5
Dual supply max. (V)	20	20	20	20	20	20
On-resistance (Ω)	15	15	15	15	15	15
Charge injection (pC)	38	38	38	38	38	38
Source on capacitance (pF)	50	50	50	50	57	57
Source off capacitance (pF)	12	12	12	12	12	12
Leakage switch on typ. (nA)	0.4	0.4	0.4	0.4	0.4	0.4
Leakage switch off max. (nA)	0.25	0.25	0.25	0.25	0.75	0.75
-3 dB bandwidth (MHz)	-	-	-	-	-	-
Package	SO-8 (narrow) AS	MSOP-8	SO-8 (narrow) AS	MSOP-8	SO-8 (narrow) AS	MSOP-8
Functional circuit / applications	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare	Multi purpose, instrumentation, medical and healthcare
Interface	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Single supply operation	Yes	Yes	Yes	Yes	Yes	Yes
Dual supply operation	Yes	Yes	Yes	Yes	Yes	Yes
Turn on time max. (ns)	89	89	89	89	89	89
Crosstalk and off isolation	-88	-88	-88	-88	-88	-88

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