



# Precision Low-Voltage, Low-Glitch CMOS Analog Switches

## FEATURES

- 2.7- thru 12-V Single Supply or  $\pm 2.7$ - thru  $\pm 6$ -Dual Supply
- Low On-Resistance— $r_{DS(on)}$ :  $2.0 \Omega$  @ 12 V
- Fast Switching— $t_{ON}$ : 28 ns  
— $t_{OFF}$ : 22 ns
- TTL and Low Voltage Logic
- Low Leakage: 10 pA (typ)
- > 2000-V ESD Protection

## BENEFITS

- High Accuracy
- High Speed, Low Glitch
- Single and Dual Supply Capability
- Low  $r_{ON}$  in Small TSOP Package
- Low Leakage
- Low Power Consumption

## APPLICATIONS

- Automatic Test Equipment
- Data Acquisition
- XDSL and DSLAM
- PBX Systems
- Reed Relay Replacement
- Audio and Video Signal Routing

## DESCRIPTION

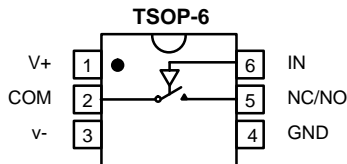
Using BiCMOS wafer fabrication technology allows the DG9421/DG9422 to operate on single and dual supplies.

Designed for optimal performance at single 5 V and dual  $\pm 5$  V, the DG9421/9422 combine low and flat on-resistance ( $3 \Omega$ ), fast speed ( $t_{ON} = 38$  ns) and low charge injection (less

than 1 pC) and is well suited for applications where signal switching accuracy, low noise and low distortion is critical.

The DG9421 and DG9422 respond to opposite control logic as shown in the Truth Table.

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Top View

Device Marking:

DG9421DV = 4Exxx  
DG9422DV = 4Fxxx

### TRUTH TABLE

Logic	DG9421	DG9422
0	ON	OFF
1	OFF	ON

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

Switches Shown for Logic "0" Input

### ORDERING INFORMATION

-40 to 85°C	6-Pin TSOP	DG9421DV
		DG9422DV



**ABSOLUTE MAXIMUM RATINGS**

V+ to V-	-0.3 TO 13 V
GND to V-	7 V
V <sub>IN</sub> <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>	-0.3 to (V+ +0.3 V) or 50 mA, whichever occurs first
Continuous Current (Any Terminal)	50 mA
Peak Current, S or D (Pulsed 1 ms, 10% Duty Cycle)	100 mA
Storage Temperature	-65 to 150°C

Power Dissipation (Package) <sup>b</sup>	
6-Pin TSOP <sup>c</sup>	570 mW

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 7 mW/°C above 25°C

SPECIFICATIONS <sup>a</sup> (SINGLE SUPPLY 12 V)							
Parameter	Symbol	Test Conditions Unless Specified V+ = 12 V, V- = 0 V V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup>	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>a</sup>	V <sub>ANALOG</sub>		Full	0		12	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	V+ = 10.8 V, V- = 0 V I <sub>S</sub> = 5 mA, V <sub>D</sub> = 2/9 V	Room Full		2.0	3 3.4	Ω
Switch Off Leakage Current	I <sub>S(off)</sub>	V <sub>D</sub> = 1/11 V, V <sub>S</sub> = 11/1 V	Room Full	-1 -10		1 10	nA
	I <sub>D(off)</sub>		Room Full	-1 -10		1 10	
Channel On Leakage Current	I <sub>D(on)</sub>	V <sub>S</sub> = V <sub>D</sub> = 11/1 V	Room Full	-1 -10		1 10	
<b>Digital Control</b>							
Input Current, V <sub>IN</sub> Low	I <sub>IL</sub>	V <sub>IN</sub> Under Test = 0.8 V	Full	-1	0.02	1	μA
Input Current, V <sub>IN</sub> High	I <sub>IH</sub>	V <sub>IN</sub> Under Test = 2.4 V	Full	-1	0.02	1	
<b>Dynamic Characteristics</b>							
Turn-On Time <sup>e</sup>	t <sub>ON</sub>	R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF V <sub>S</sub> = 5 V See Figure 2	Room Full		20	45 49	ns
Turn-Off Time <sup>e</sup>	t <sub>OFF</sub>		Room Full		25	47 59	
Charge Injection <sup>e</sup>	Q	V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF	Room		0.8		pC
Off Isolation <sup>e</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz	Room		-60		dB
Source Off Capacitance <sup>e</sup>	C <sub>S(off)</sub>	f = 1 MHz	Room		31		pF
Drain Off Capacitance <sup>e</sup>	C <sub>D(off)</sub>		Room		30		
Channel On Capacitance <sup>e</sup>	C <sub>D(on)</sub>		Room		71		
<b>Power Supplies</b>							
Positive Supply Current	I+	V <sub>IN</sub> = 0 or 12 V	Room Full		0.02	1 5	μA
Negative Supply Current	I-		Room Full	-1 -5	-0.002		
Ground Current	I <sub>GND</sub>		Room Full	-1 -5	-0.002		



SPECIFICATIONS <sup>a</sup> (DUAL SUPPLY ± 5 V)							
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 5\text{ V}, V_- = -5\text{ V}$ $V_{IN} = 2.4\text{ V}, 0.8\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full	-5		5	V
Drain-Source On-Resistance	$r_{DS(on)}$	$V_+ = 5\text{ V}, V_- = -5\text{ V}$ $I_S = 5\text{ mA}, V_D = \pm 3.5\text{ V}$	Room Full		2.2	3.2 3.6	$\Omega$
Switch Off Leakage Current <sup>g</sup>	$I_{S(off)}$	$V_+ = 5.5\text{ V}, V_- = -5.5\text{ V}$ $V_D = \pm 4.5\text{ V}, V_S = \mp 4.5\text{ V}$	Room Full	-1 -10		1 10	nA
	$I_{D(off)}$		Room Full	-1 -10		1 10	
Channel On Leakage Current <sup>g</sup>	$I_{D(on)}$	$V_+ = 5.5\text{ V}, V_- = -5.5\text{ V}$ $V_S = V_D = \pm 4.5\text{ V}$	Room Full	-1 10		1 10	
<b>Digital Control</b>							
Input Current, $V_{IN}$ Low <sup>e</sup>	$I_{IL}$	$V_{IN}$ Under Test = 0.8 V	Full	-1	0.02	1	$\mu\text{A}$
Input Current, $V_{IN}$ High <sup>e</sup>	$I_{IH}$	$V_{IN}$ Under Test = 2.4 V	Full	-1	0.02	1	
<b>Dynamic Characteristics</b>							
Turn-On Time	$t_{ON}$	$R_L = 300\ \Omega, C_L = 35\text{ pF}$ $V_S = \pm 3.5\text{ V}$ See Figure 2	Room Full		38	63 68	ns
Turn-Off Time	$t_{OFF}$		Room Full		45	83 97	
Charge Injection <sup>e</sup>	Q	$V_g = 0\text{ V}, R_g = 0\ \Omega, C_L = 1\text{ nF}$	Room		0.6		pC
Off Isolation <sup>e</sup>	OIRR	$R_L = 50\ \Omega, C_L = 5\text{ pF},$ $f = 1\text{ MHz}$	Room		-57		dB
Source Off Capacitance <sup>e</sup>	$C_{S(off)}$	f = 1 MHz	Room		32		pF
Drain Off Capacitance <sup>e</sup>	$C_{D(off)}$		Room		31		
Channel On Capacitance <sup>e</sup>	$C_{D(on)}$		Room		71		
<b>Power Supplies</b>							
Positive Supply Current <sup>e</sup>	I+	$V_{IN} = 0\text{ or }5\text{ V}$	Room Full		0.03	1 5	$\mu\text{A}$
Negative Supply Current <sup>e</sup>	I-		Room Full	-1 -5	-0.002		
Ground Current <sup>e</sup>	$I_{GND}$		Room Full	-1 -5	-0.002		

SPECIFICATIONS <sup>a</sup> (SINGLE SUPPLY 5 V)							
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 5\text{ V}, V_- = 0\text{ V}$ $V_{IN} = 2.4\text{ V}, 0.8\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full	0		5	V
Drain-Source On-Resistance	$r_{DS(on)}$	$V_+ = 4.5\text{ V}, I_S = 5\text{ mA}$ $V_D = 1\text{ V}, 3.5\text{ V}$	Room Full		3.6	6.0 6.6	$\Omega$
<b>Dynamic Characteristics</b>							
Turn-On Time <sup>e</sup>	$t_{ON}$	$R_L = 300\ \Omega, C_L = 35\text{ pF}$ $V_S = 3.5\text{ V}$ , See Figure 2	Room Hot		43	67 74	ns
Turn-Off Time <sup>e</sup>	$t_{OFF}$		Room Hot		30	67 80	
Charge Injection <sup>e</sup>	Q	$V_g = 0\text{ V}, R_g = 0\ \Omega, C_L = 1\text{ nF}$	Room		0.3		pC



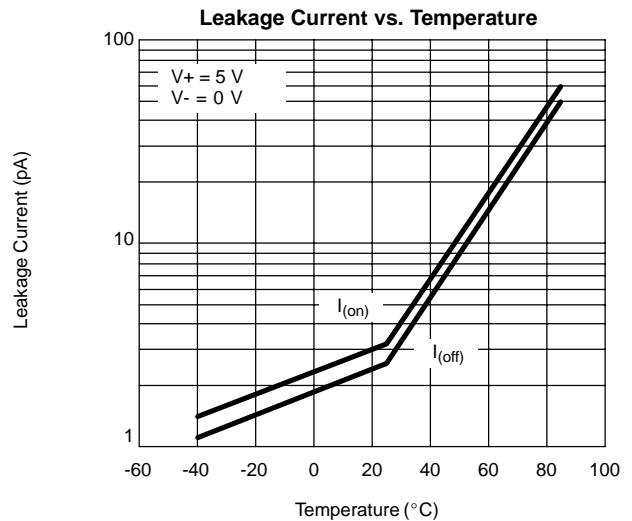
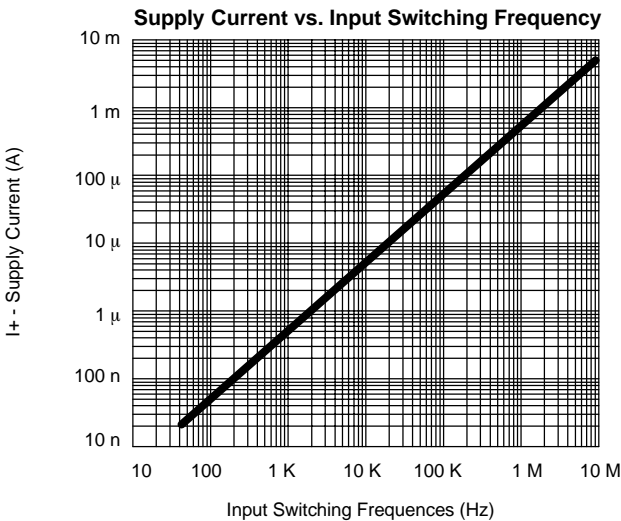
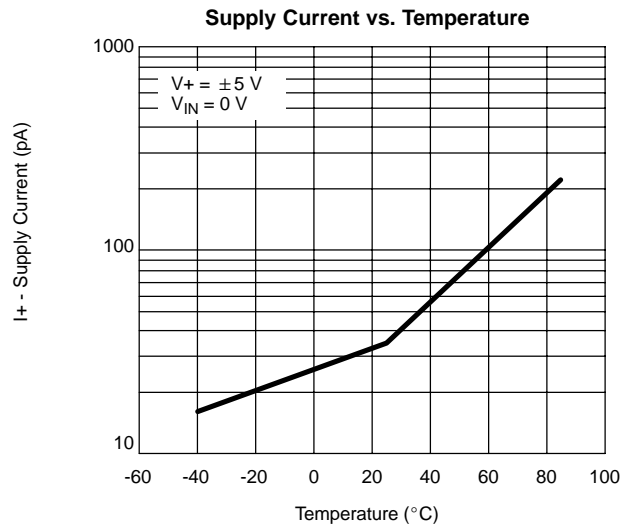
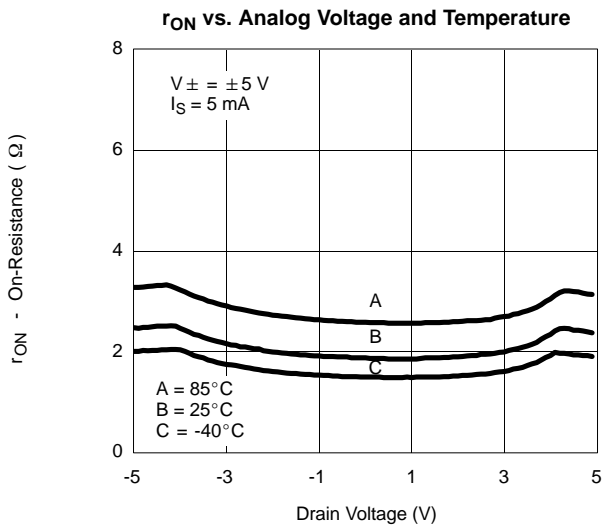
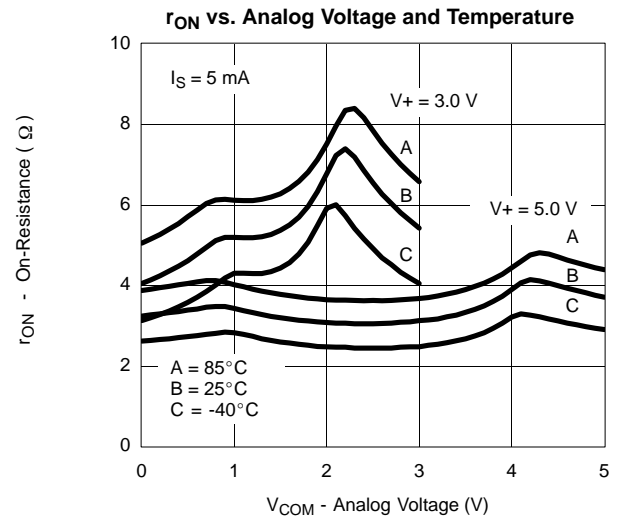
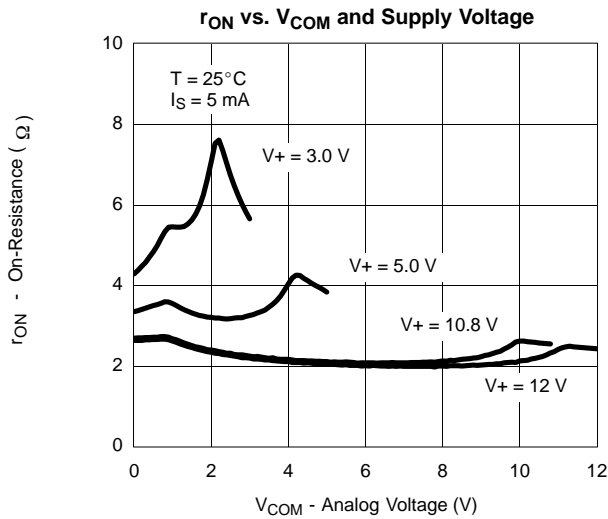
SPECIFICATIONS <sup>a</sup> (SINGLE SUPPLY 5 V)							
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 5\text{ V}, V_- = 0\text{ V}$ $V_{IN} = 2.4\text{ V}, 0.8\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Power Supplies</b>							
Positive Supply Current <sup>e</sup>	I+	$V_{IN} = 0\text{ or }5\text{ V}$	Room Hot		0.02	1 5	μA
Negative Supply Current <sup>e</sup>	I-		Room Hot	-1 -5	-0.002		
Ground Current <sup>e</sup>	I <sub>GND</sub>		Room Hot	-1 -5	-0.002		

SPECIFICATIONS <sup>a</sup> (SINGLE SUPPLY 3 V)							
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 3\text{ V}, V_- = 0\text{ V}$ $V_{IN} = 0.4\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>d</sup>	Typ <sup>c</sup>	Max <sup>d</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	V <sub>ANALOG</sub>		Full	0		3	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	$V_+ = 2.7\text{ V}, V_- = 0\text{ V}$ $I_S = 5\text{ mA}, V_D = 0.5, 2.2\text{ V}$	Room Full		7.3	8.8 10.1	Ω
Switch Off Leakage Current <sup>g</sup>	I <sub>S(off)</sub>	$V_+ = 3.3\text{ V}, V_- = 0\text{ V}$ $V_D = 1, 2\text{ V}, V_S = 2, 1\text{ V}$	Room Full	-1 -10		1 10	nA
	I <sub>D(off)</sub>		Room Full	-1 -10		1 10	
Channel On Leakage Current <sup>g</sup>	I <sub>D(on)</sub>	$V_+ = 3.3\text{ V}, V_- = 0\text{ V}$ $V_S = V_D = 1, 2\text{ V}$	Room Full	-1 -10		1 10	
<b>Digital Control</b>							
Input Current, V <sub>IN</sub> Low <sup>e</sup>	I <sub>IL</sub>	V <sub>IN</sub> Under Test = 0.4 V	Full	-1	0.02	1	μA
Input Current, V <sub>IN</sub> High <sup>e</sup>	I <sub>IH</sub>	V <sub>IN</sub> Under Test = 2.4 V	Full	-1	0.02	1	
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	$R_L = 300\text{ Ω}, C_L = 35\text{ pF}$ $V_S = 1.5\text{ V}$ See Figure 2	Room Full		90	110 125	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full		32	84 99	
Charge Injection <sup>e</sup>	Q	$V_g = 0\text{ V}, R_g = 0\text{ Ω}, C_L = 1\text{ nF}$	Room		0.3		pC
Off Isolation <sup>e</sup>	OIRR	$R_L = 50\text{ Ω}, C_L = 5\text{ pF},$ $f = 1\text{ MHz}$	Room		-60		dB
Source Off Capacitance <sup>e</sup>	C <sub>S(off)</sub>	f = 1 MHz	Room		35		pF
Drain Off Capacitance <sup>e</sup>	C <sub>D(off)</sub>		Room		34		
Channel On Capacitance <sup>e</sup>	C <sub>D(on)</sub>		Room		77		

Notes:

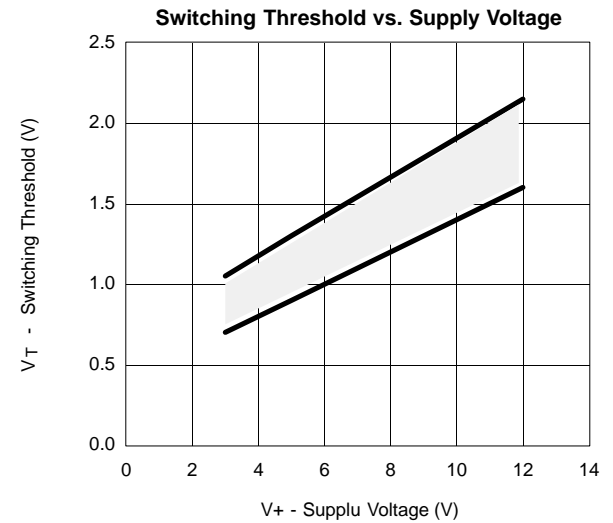
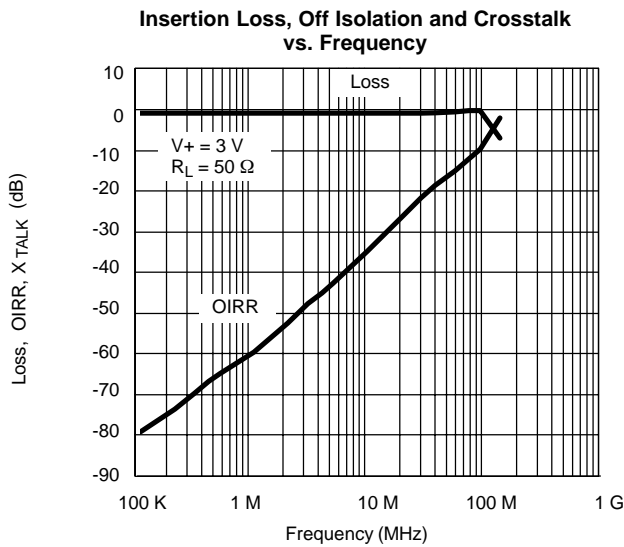
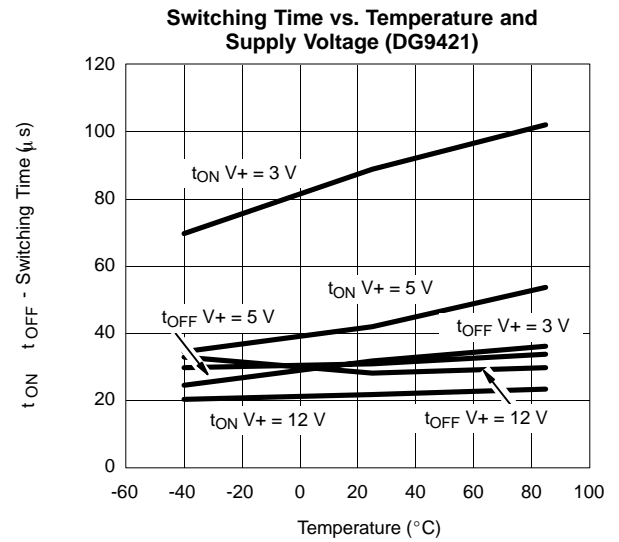
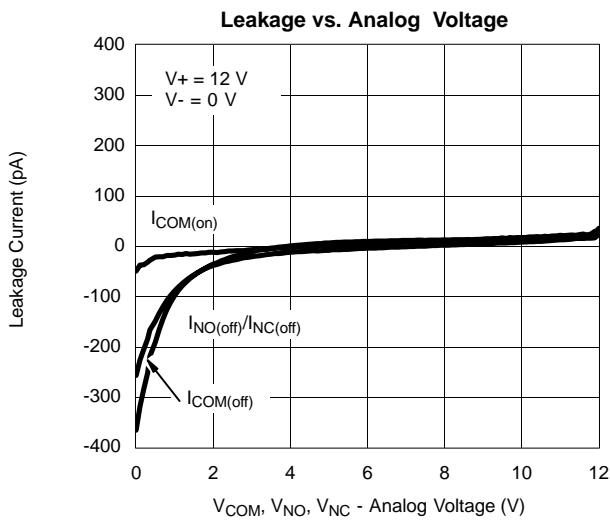
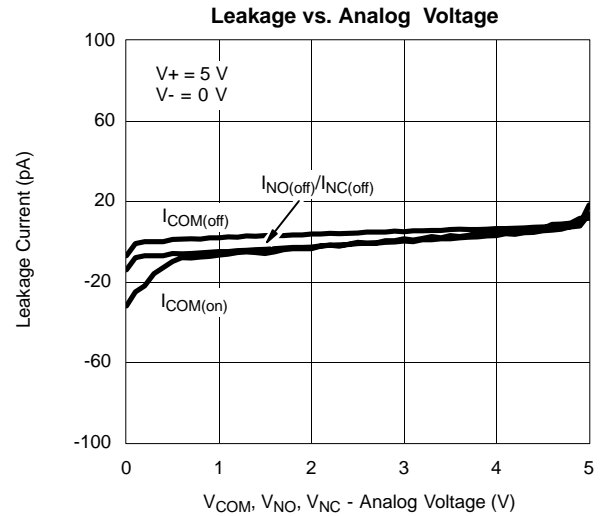
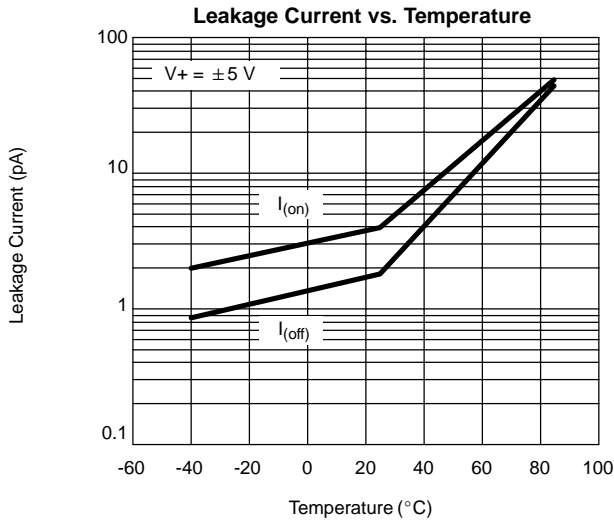
- Refer to PROCESS OPTION FLOWCHART.
- Room = 25°C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- V<sub>IN</sub> = input voltage to perform proper function.
- Leakage parameters are guaranteed by worst case test conditions and not subject to test.

**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**

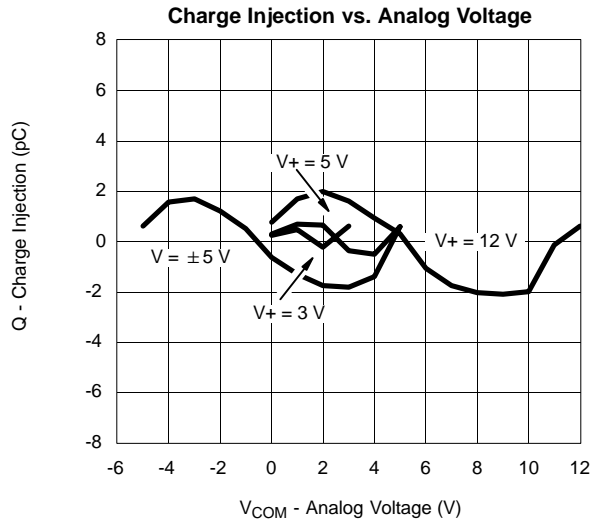




**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



**TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)**



**SCHEMATIC DIAGRAM (TYPICAL CHANNEL)**

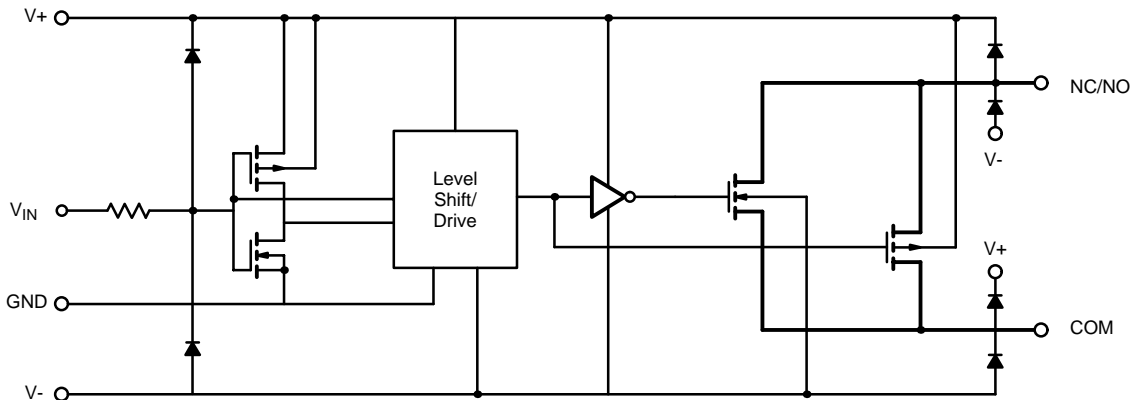
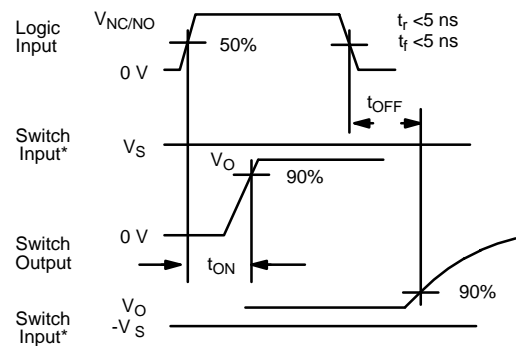
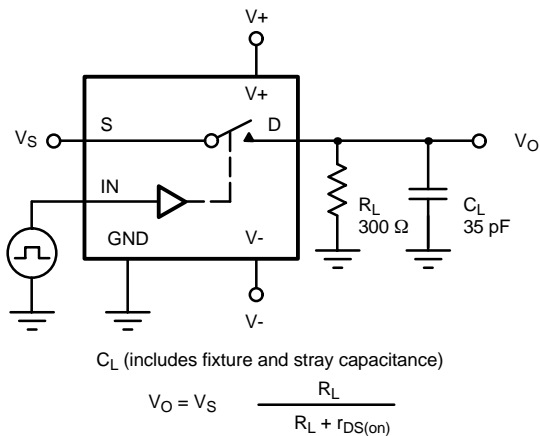


FIGURE 1.

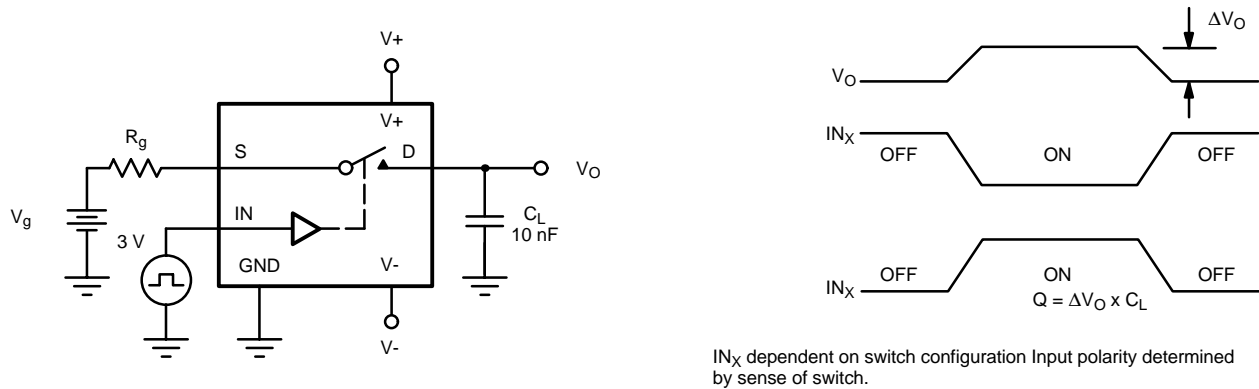
**TEST CIRCUITS**



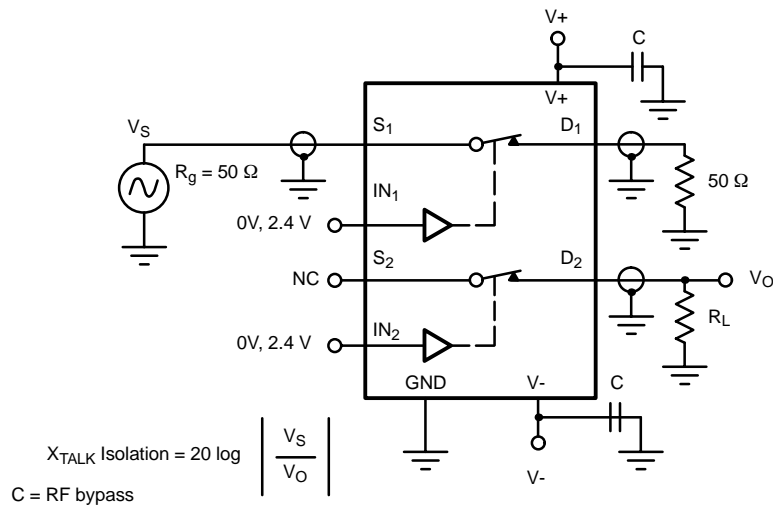
Note: Logic input waveform is inverted for switches that have the opposite logic sense control

FIGURE 2. Switching Time

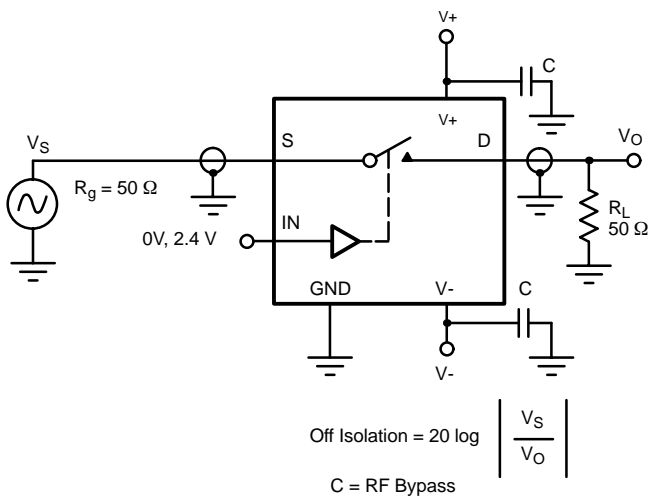
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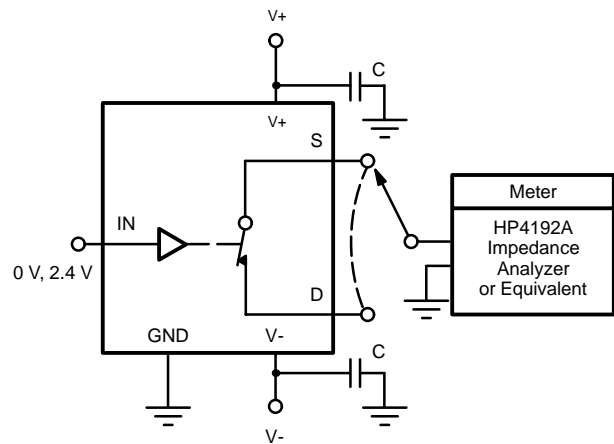
**FIGURE 3.** Charge Injection



**FIGURE 4.** Crosstalk



**FIGURE 5.** Off Isolation



**FIGURE 6.** Source/Drain Capacitances