Precision Low-Voltage, Low-Glitch CMOS Analog Switches

FEATURES

- 2.7- thru 12-V Single Supply or ±2.7- thru ±6-Dual Supply
- Low On-Resistance—$r_{DS(on)}$: 2.0 Ω @ 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

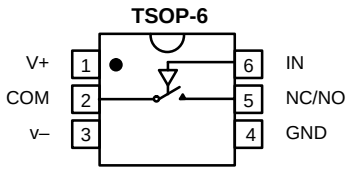
DESCRIPTION

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 ±5 V, the DG9421/9422 combine low and flat on-resistance (3 Ω), 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" ≤ 0.8 V
Logic "1" ≥ 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_{IN}[a], V_S, V_D . . . . . –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)b
6-Pin TSOP[c] . . . . . 570 mW

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 7 mW/°C above 25°C

SPECIFICATIONS[a] (SINGLE SUPPLY 12 V)

Parameter	Symbol	Test Conditions Unless Specified V+ = 12 V, V– = 0 V V_{IN} = 2.4 V, 0.8 V[f]	Temp[b]	Limits –40 to 85°C Min[d]	Typ[c]	Max[d]	Unit
Analog Switch							
Analog Signal Range[a]	V_{ANALOG}		Full	0		12	V
Drain-Source On-Resistance	$r_{DS(on)}$	V+ = 10.8 V, V– = 0 V I_S = 5 mA, V_D = 2/9 V	Room Full		2.0	3 3.4	Ω
Switch Off Leakage Current	$I_{S(off)}$	V_D = 1/11 V, V_S = 11/1 V	Room Full	–0.2 –2.0	±0.01	0.2 2.0	nA
	$I_{D(off)}$		Room Full	–0.2 –2.0	±0.01	0.2 2.0	
Channel On Leakage Current	$I_{D(on)}$	V_S = V_D = 11/1 V	Room Full	–0.2 –3.0	±0.01	0.2 3.0	
Digital Control							
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.8 V	Full	–1	0.02	1	µA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 2.4 V	Full	–1	0.02	1	
Dynamic Characteristics							
Turn-On Time[e]	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = 5 V See Figure 2	Room Full		20	45 49	ns
Turn-Off Time[e]	t_{OFF}		Room Full		25	47 59	
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room		0.8		pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–60		dB
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room		31		pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room		30		
Channel On Capacitance[e]	$C_{D(on)}$		Room		71		
Power Supplies							
Positive Supply Current	I+	V_{IN} = 0 or 12 V	Room Full		0.02	1 5	µA
Negative Supply Current	I–		Room Full	–1 –5	–0.002		
Ground Current	I_{GND}		Room Full	–1 –5	–0.002		

SPECIFICATIONS[a] (DUAL SUPPLY ±5 V)

Parameter	Symbol	Test Conditions Unless Specified V+ = 5 V, V– = –5 V V_{IN} = 2.4 V, 0.8 V[f]	Temp[b]	Limits –40 to 85°C Min[d]	Typ[c]	Max[d]	Unit
Analog Switch							
Analog Signal Range[e]	V_{ANALOG}		Full	–5		5	V
Drain-Source On-Resistance	$r_{DS(on)}$	V+ = 5 V, V– = –5 V I_S = 5 mA, V_D = ±3.5 V	Room Full		2.2	3.2 3.6	Ω
Switch Off Leakage Current[g]	$I_{S(off)}$	V+ = 5 V, V– = –5 V V_D = ±4.5 V, V_S = ∓4.5 V	Room Full	–0.2 –2.0	±0.01	0.2 2.0	nA
	$I_{D(off)}$		Room Full	–0.2 –2.0	±0.01	0.2 2.0	
Channel On Leakage Current[g]	$I_{D(on)}$	V+ = 5 V, V– = –5 V V_S = V_D = ±4.5 V	Room Full	–0.2 3.0	±0.01	0.2 3.0	
Digital Control							
Input Current, V_{IN} Low[e]	I_{IL}	V_{IN} Under Test = 0.8 V	Full	–1	0.02	1	µA
Input Current, V_{IN} High[e]	I_{IH}	V_{IN} Under Test = 2.4 V	Full	–1	0.02	1	
Dynamic Characteristics							
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = ±3.5 V See Figure 2	Room Full		38	63 68	ns
Turn-Off Time	t_{OFF}		Room Full		45	83 97	
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room		0.6		pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–57		dB
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room		32		pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room		31		
Channel On Capacitance[e]	$C_{D(on)}$		Room		71		
Power Supplies							
Positive Supply Current[e]	I+	V_{IN} = 0 or 5 V	Room Full		0.03	1 5	µA
Negative Supply Current[e]	I–		Room Full	–1 –5	–0.002		
Ground Current[e]	I_{GND}		Room Full	–1 –5	–0.002		

SPECIFICATIONS[a] (SINGLE SUPPLY 5 V)

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

SPECIFICATIONS[a] (SINGLE SUPPLY 5 V)

Parameter	Symbol	Test Conditions Unless Specified V+ = 5 V, V– = 0 V V_{IN} = 2.4 V, 0.8 V[f]	Temp[b]	Limits –40 to 85°C Min[d]	Typ[c]	Max[d]	Unit
Power Supplies							
Positive Supply Current[e]	I+	V_{IN} = 0 or 5 V	Room Hot		0.02	1 5	µA
Negative Supply Current[e]	I–		Room Hot	–1 –5	–0.002		
Ground Current[e]	I_{GND}		Room Hot	–1 –5	–0.002		

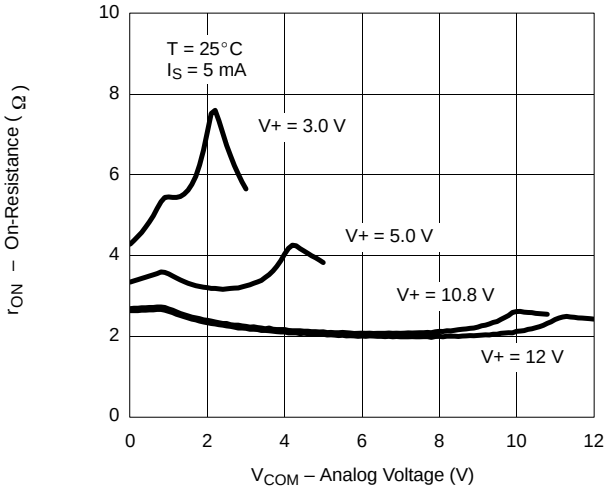
SPECIFICATIONS[a] (SINGLE SUPPLY 3 V)

Parameter	Symbol	Test Conditions Unless Specified V+ = 3 V, V– = 0 V V_{IN} = 0.4 V[f]	Temp[b]	Limits –40 to 85°C Min[d]	Typ[c]	Max[d]	Unit
Analog Switch							
Analog Signal Range[e]	V_{ANALOG}		Full	0		3	V
Drain-Source On-Resistance	$r_{DS(on)}$	V+ = 2.7 V, V– = 0 V I_S = 5 mA, V_D = 0.5, 2.2 V	Room Full		7.3	8.8 10.1	Ω
Switch Off Leakage Current[g]	$I_{S(off)}$	V+ = 3 V, V– = 0 V V_D = 1, 2 V, V_S = 2, 1 V	Room Full	–0.2 –2.0	±0.01	0.2 2.0	nA
	$I_{D(off)}$		Room Full	–0.2 –2.0	±0.01	0.2 2.0	
Channel On Leakage Current[g]	$I_{D(on)}$	V+ = 3 V, V– = 0 V V_S = V_D = 1, 2 V	Room Full	–0.2 –3.0	±0.01	0.2 3.0	
Digital Control							
Input Current, V_{IN} Low[e]	I_{IL}	V_{IN} Under Test = 0.4 V	Full	–1	0.02	1	µA
Input Current, V_{IN} High[e]	I_{IH}	V_{IN} Under Test = 2.4 V	Full	–1	0.02	1	
Dynamic Characteristics							
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = 1.5 V See Figure 2	Room Full		90	110 125	ns
Turn-Off Time	t_{OFF}		Room Full		32	84 99	
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room		0.3		pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–60		dB
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room		35		pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room		34		
Channel On Capacitance[e]	$C_{D(on)}$		Room		77		

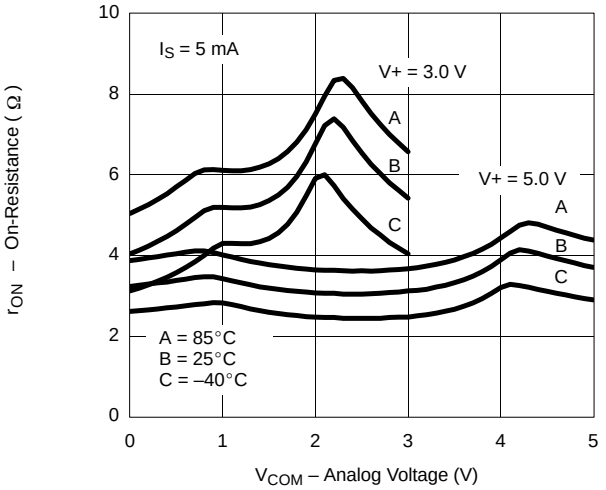
Notes:
a. Refer to PROCESS OPTION FLOWCHART.
b. Room = 25°C, Full = as determined by the operating temperature suffix.
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
e. Guaranteed by design, not subject to production test.
f. V_{IN} = input voltage to perform proper function.
g. Leakage parameters are guaranteed by worst case test conditions and not subject to test.

TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

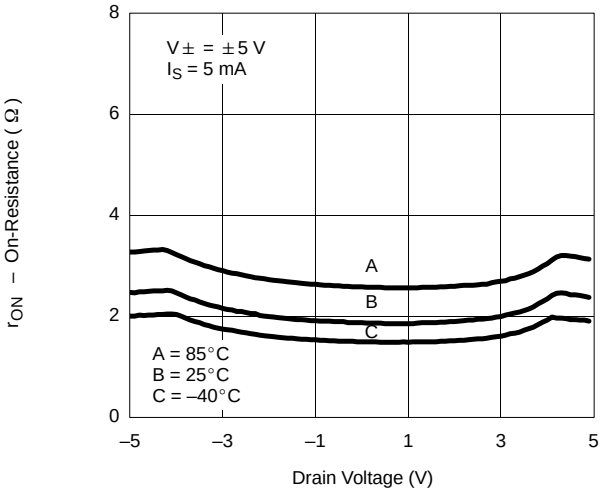
r_{ON} vs. V_{COM} and Supply Voltage



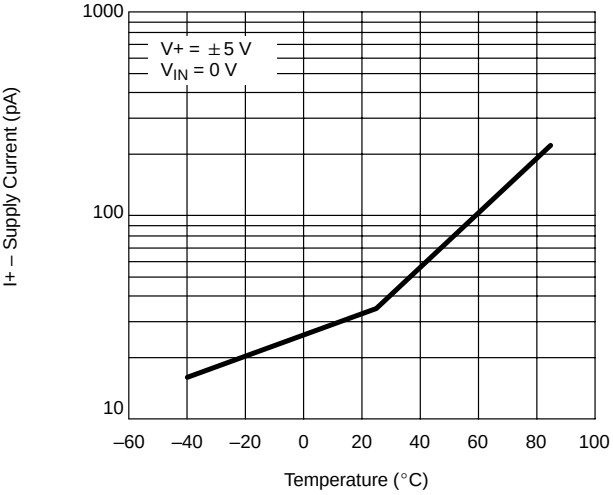
r_{ON} vs. Analog Voltage and Temperature



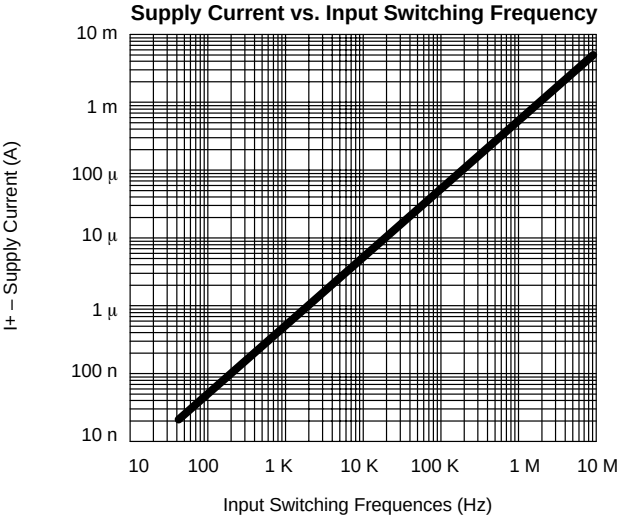
r_{ON} vs. Analog Voltage and Temperature



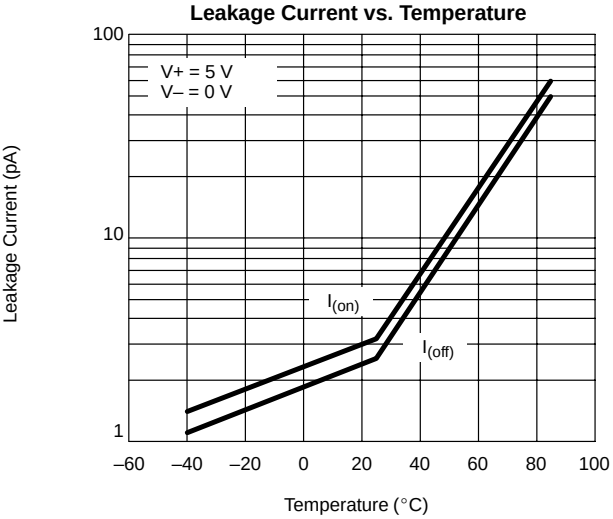
Supply Current vs. Temperature



Supply Current vs. Input Switching Frequency

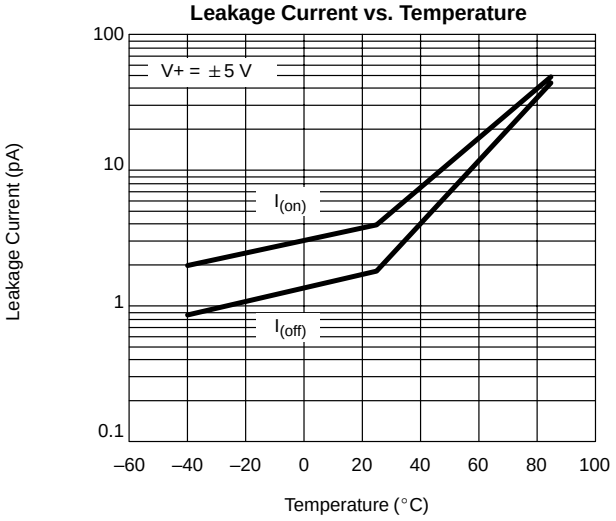


Leakage Current vs. Temperature

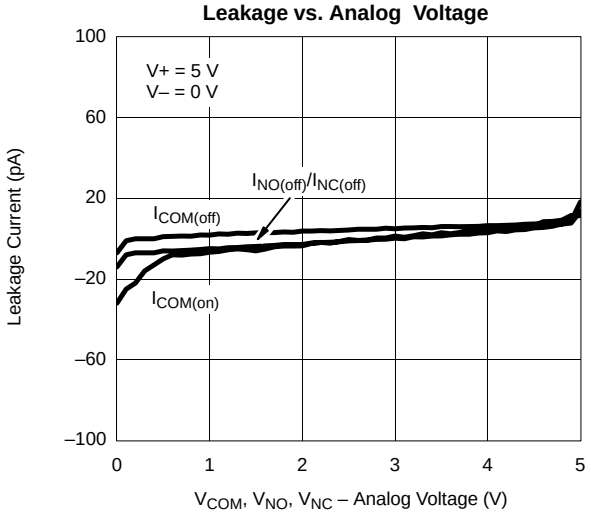


TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

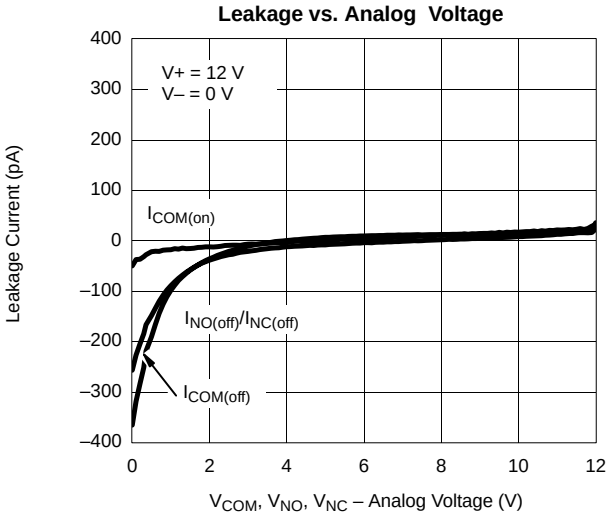
Leakage Current vs. Temperature



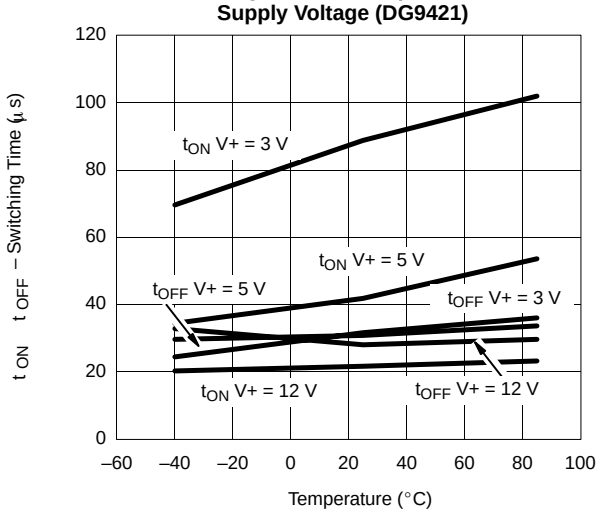
Leakage vs. Analog Voltage



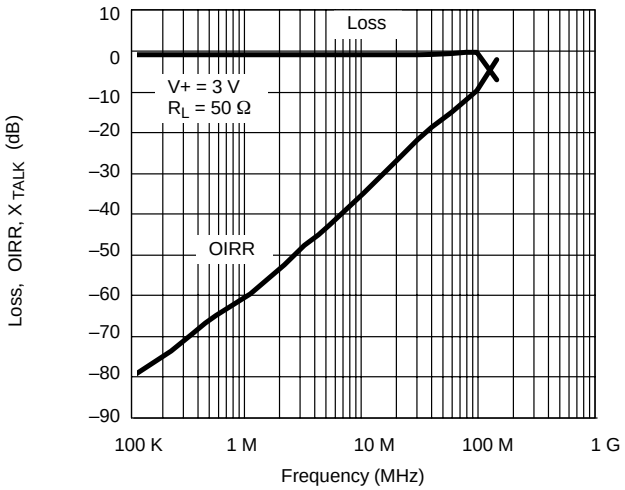
Leakage vs. Analog Voltage



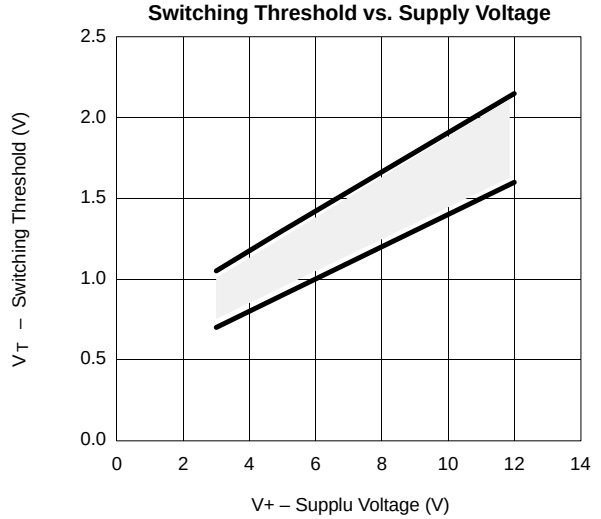
Switching Time vs. Temperature and Supply Voltage (DG9421)



Insertion Loss, Off Isolation and Crosstalk vs. Frequency



Switching Threshold vs. Supply Voltage



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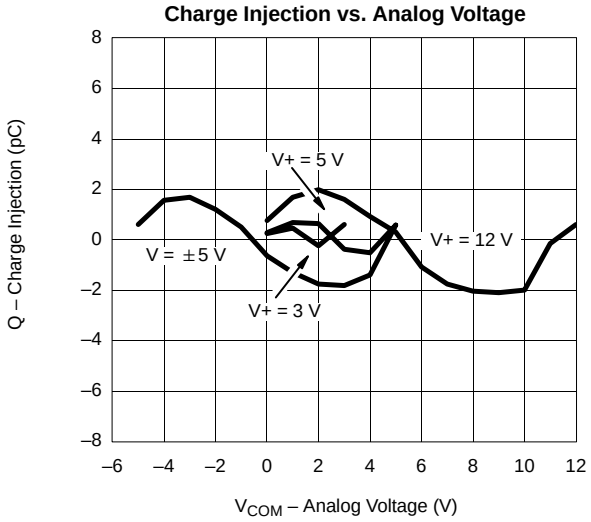
TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)



SCHEMATIC DIAGRAM (TYPICAL CHANNEL)

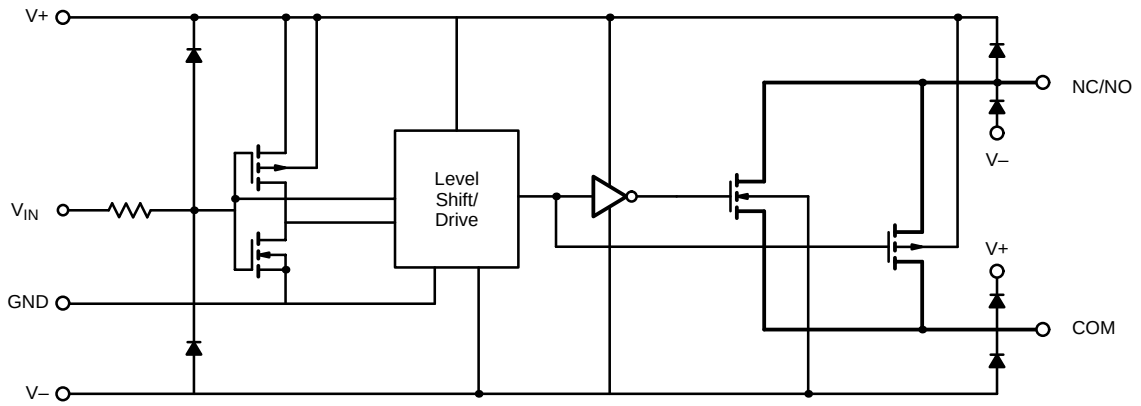
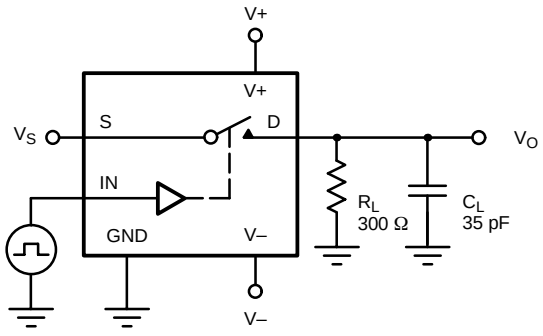


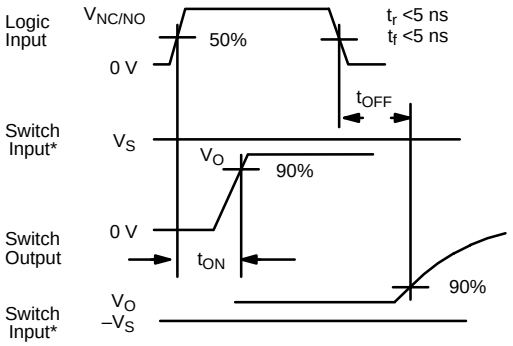
FIGURE 1.

TEST CIRCUITS



C_L (includes fixture and stray capacitance)

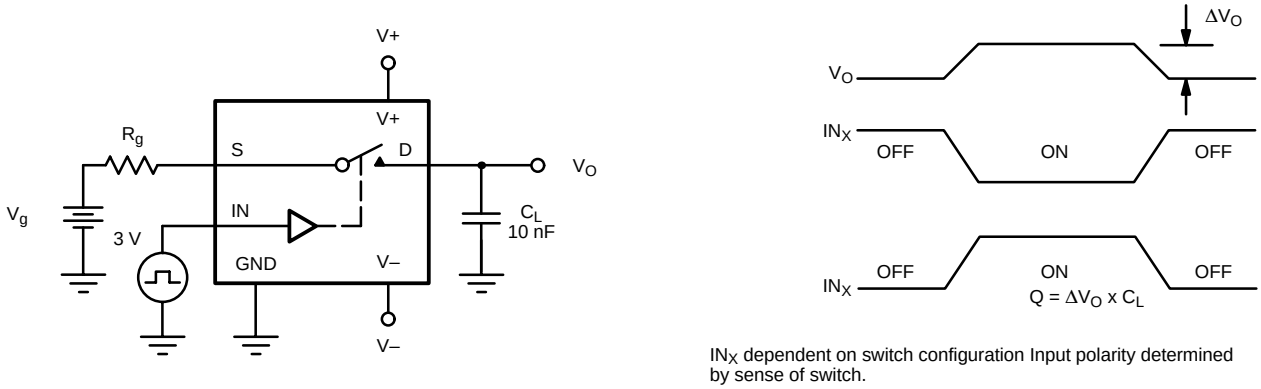
$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$



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

FIGURE 2. Switching Time

TEST CIRCUITS



IN_X dependent on switch configuration Input polarity determined by sense of switch.

FIGURE 3. Charge Injection

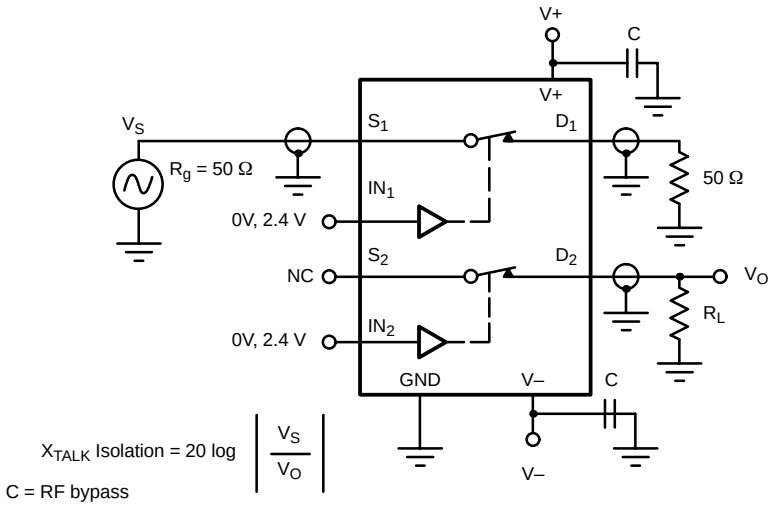


FIGURE 4. Crosstalk

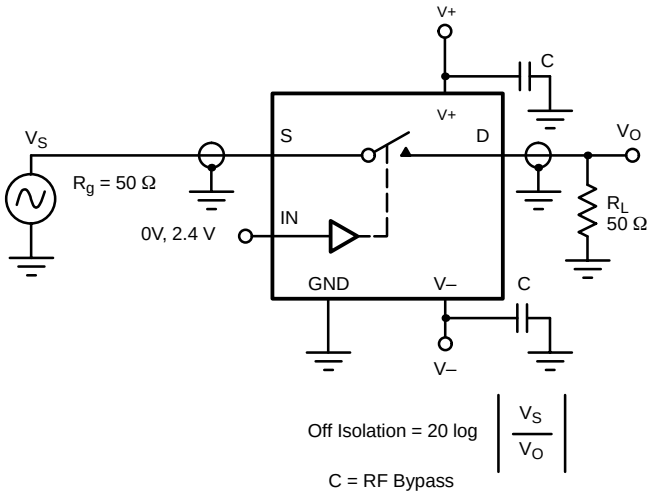


FIGURE 5. Off Isolation

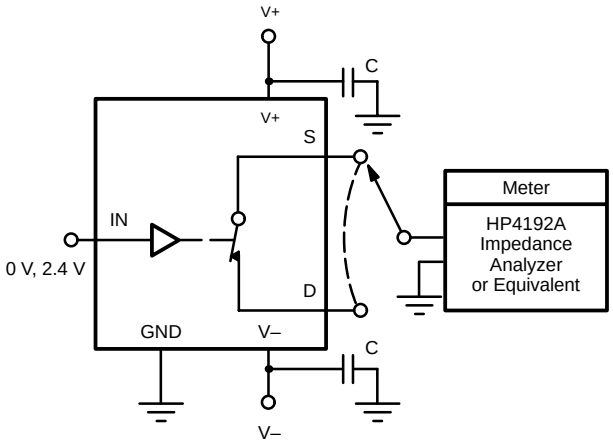


FIGURE 6. Source/Drain Capacitances