

Low-Voltage Single SPDT Analog Switch

DESCRIPTION

The DG2012 is a single-pole/double-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, high speed (t_{ON} : 17 ns, t_{OFF} : 13 ns), low on-resistance ($r_{DS(on)}$: 1 Ω) and small physical size (SC70), the DG2012 is ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2012 is built on Vishay Siliconix's low voltage submicron CMOS process. An epitaxial layer prevents latchup. Break-before -make is guaranteed for DG2012.

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

FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance - $r_{DS(on)}$: 1 Ω Typ.
- Fast Switching - t_{ON} : 17 ns, t_{OFF} : 13 ns
- Low Leakage
- TTL/CMOS Compatible
- 6-Pin SC-70 Package



RoHS*
COMPLIANT

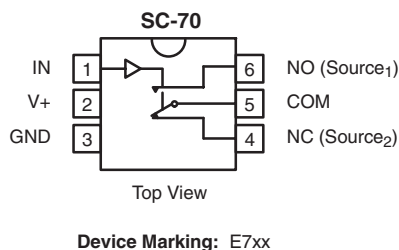
BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space

APPLICATIONS

- Cellular Phones
- Communication Systems
- Portable Test Equipment
- Battery Operated Systems
- Sample and Hold Circuits

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE

Logic	NC	NO
0	ON	OFF
1	OFF	ON

ORDERING INFORMATION

Temp Range	Package	Part Number
- 40 to 85 °C	SC70-6	DG2012DL-T1 DG2012DL-T1-E3

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

ABSOLUTE MAXIMUM RATINGS

Parameter	Limit	Unit
Referenced V+ to GND	- 0.3 to + 6	V
IN, COM, NC, NO ^a	- 0.3 to (V+ + 0.3)	
Continuous Current (NO, NC and COM Pins)	± 100	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)	± 300	
Storage Temperature (D Suffix)	- 65 to 150	°C
Power Dissipation (Packages) ^b	6-Pin SO70 ^c	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 3.1 mW/°C above 70 °C.

SPECIFICATIONS (V+ = 2.0 V)

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2.0 V, ± 10 %, V _{IN} = 0.4 or 1.6 V ^e	Temp ^a	Limits - 40 to 85 °C			Unit
				Min ^b	Typ ^c	Max ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On-Resistance	r _{ON}	V+ = 1.8 V, V _{COM} = 0.2 V/0.9 V I _{NO} , I _{NC} = 10 mA	Room Full ^d		2.7 2.7	5.3 5.3	Ω
r _{ON} Flatness ^d	r _{ON} Flatness	V+ = 1.8 V, V _{COM} = 0 to V+, I _{NO} , I _{NC} = 10 mA	Room			3	
r _{ON} Match ^d	Δr _{ON}		Room			0.25	
Switch Off Leakage Current ^f	I _{NO(off)} I _{NC(off)}	V+ = 2.2 V V _{NO} , V _{NC} = 0.5 V/1.5 V, V _{COM} = 1.5 V/0.5 V	Room Full	- 0.5 - 5.0		0.5 5.0	nA
	I _{COM(off)}		Room Full ^d	- 0.5 - 5.0		0.5 5.0	
Channel-On Leakage Current ^f	I _{COM(on)}	V+ = 2.2 V, V _{NO} , V _{NC} = V _{COM} = 0.5 V/1.5 V	Room Full ^d	- 0.5 - 5.0		0.5 5.0	
Digital Control							
Input High Voltage	V _{INH}		Full	1.6			V
Input Low Voltage	V _{INL}		Full			0.4	
Input Capacitance ^d	C _{in}		Full		3		pF
Input Current ^f	I _{INL} or I _{INH}	V _{IN} = 0 or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time ^d	t _{ON}	V _{NO} or V _{NC} = 1.5 V, R _L = 300 Ω, C _L = 35 pF Figures 1 and 2	Room Full ^d		43	63 65	ns
Turn-Off Time ^d	t _{OFF}		Room Full ^d		23	45 46	
Break-Before-Make Time ^d	t _d		Room	2			
Charge Injection ^d	Q _{INJ}	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, Figure 3	Room		7		pC
Off-Isolation ^d	OIRR	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk ^d	X _{TALK}		Room		- 64		
N _O , N _C Off Capacitance ^d	C _{NO(off)} C _{NC(off)}	V _{IN} = 0 or V+, f = 1 MHz	Room		22		pF
Channel-On Capacitance ^d	C _{ON}		Room		58		



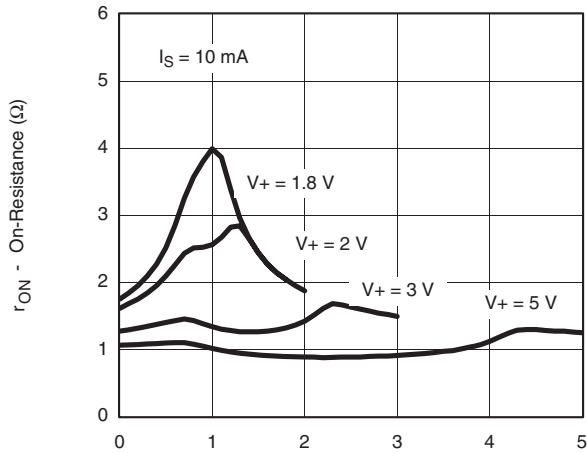
SPECIFICATIONS (V+ = 3.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, V _{IN} = 0.6 or 2.0 V ^e	Temp ^a	Limits - 40 to 85 °C			Unit
				Min ^b	Typ ^c	Max ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On-Resistance	r _{ON}	V+ = 2.7 V, V _{COM} = 0.2 V/1.5 V, I _{NO} I _{NC} = 10 mA	Room Full		1.4 1.6	2.1 2.3	Ω
r _{ON} Flatness	r _{ON} Flatness	V+ = 2.7 V, V _{COM} = 0 to V+, I _{NO} , I _{NC} = 10 mA	Room			0.85	
r _{ON} MatchFlat	Δr _{ON}		Room			0.25	
Switch Off Leakage Current ^f	I _{NO(off)} I _{NC(off)}	V+ = 3.3 V V _{NO} , V _{NC} = 1 V/3 V, V _{COM} = 3 V/1 V	Room Full	- 0.5 - 5.0		0.5 5.0	nA
	I _{COM(off)}		Room Full	- 0.5 - 5.0		0.5 5.0	
Channel-On Leakage Current ^f	I _{COM(on)}	V+ = 3.3 V, V _{NO} , V _{NC} = V _{COM} = 1 V/3 V	Room Full	- 0.5 - 5.0		0.5 5.0	
Digital Control							
Input High Voltage	V _{INH}		Full	2			V
Input Low Voltage	V _{INL}		Full			0.6	
Input Capacitance ^d	C _{in}		Full		3		pF
Input Current ^f	I _{INL} or I _{INH}	V _{IN} = 0 or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time	t _{ON}	V _{NO} or V _{NC} = 2.0 V, R _L = 300 Ω, C _L = 35 pF Figures 1 and 2	Room Full		27	47 48	ns
Turn-Off Time	t _{OFF}		Room Full		17	37 38	
Break-Before-Make Time	t _d		Room	1			
Charge Injection ^d	Q _{INJ}	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, Figure 3	Room		10		pC
Off-Isolation ^d	OIRR	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk ^d	X _{TALK}		Room		- 64		
NO, NC Off Capacitance ^d	C _{NO(off)} C _{NC(off)}	V _{IN} = 0 or V+, f = 1 MHz	Room		21		pF
Channel-On Capacitance ^d	C _{ON}		Room		57		
Power Supply							
Power Supply Range	V+			1.8		5.5	V
Power Supply Current	I+	V _{IN} = 0 or V+			0.01	1.0	μA

SPECIFICATIONS (V+ = 5.0 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, V _{IN} = 0.8 or 2.4 V ^e	Temp ^a	Limits - 40 to 85 °C			Unit
				Min ^b	Typ ^c	Max ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On-Resistance	r _{ON}	V+ = 4.5 V, V _{COM} = 0.5 V/2.5 V I _{NO} , I _{NC} = 10 mA	Room Full		1.0 1.2	1.8 1.9	Ω
r _{ON} Flatness ^d	r _{ON} Flatness	V+ = 4.5 V, V _{COM} = 0 to V+, I _{NO} , I _{NC} = 10 mA	Room			0.55	
r _{ON} Match ^d	Δr _{ON}		Room			0.25	
Switch Off Leakage Current	I _{NO(off)} I _{NC(off)}	V+ = 5.0 V V _{NO} , V _{NC} = 0.5 V/4.5 V, V _{COM} = 4.5 V/0.5 V	Room Full	- 0.5 - 5.0		0.5 5.0	nA
	I _{COM(off)}		Room Full	- 0.5 - 5.0		0.5 5.0	
Channel-On Leakage Current	I _{COM(on)}	V+ = 5.0 V, V _{NO} , V _{NC} = V _{COM} = 0.5 V/4.5 V	Room Full	- 0.5 - 5.0		0.5 5.0	
Digital Control							
Input High Voltage	V _{INH}		Full	2.4			V
Input Low Voltage	V _{INL}		Full			0.8	
Input Capacitance	C _{in}		Full		3		pF
Input Current	I _{INL} or I _{INH}	V _{IN} = 0 or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time ^d	t _{ON}	V _{NO} or V _{NC} = 3 V, R _L = 300 Ω, C _L = 35 pF Figures 1 and 2	Room Full		17	38 39	ns
Turn-Off Time ^d	t _{OFF}		Room Full		13	32 33	
Break-Before-Make Time ^d	t _d		Room	1			
Charge Injection ^d	Q _{INJ}	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, Figure 3	Room		20		pC
Off-Isolation ^d	OIRR	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk ^d	X _{TALK}		Room		- 64		
Source-Off Capacitance ^d	C _{NO(off)} C _{NC(off)}	V _{IN} = 0 or V+, f = 1 MHz	Room		20		pF
Channel-On Capacitance ^d	C _{ON}		Room		56		

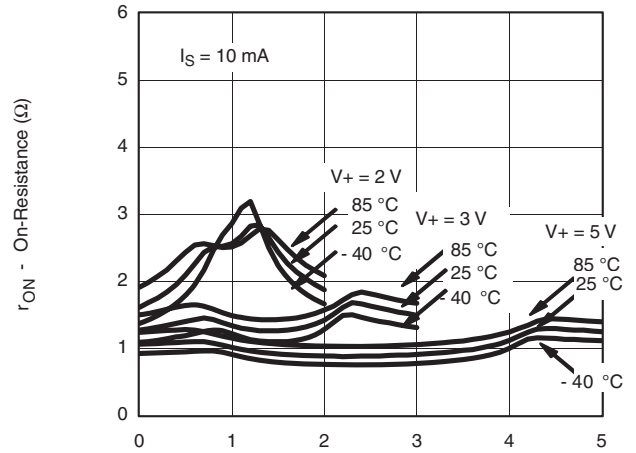
Notes:

- Room = 25 °C, Full = as determined by the operating suffix.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- Guarantee by design, nor subjected to production test.
- V_{IN} = input voltage to perform proper function.
- Guaranteed by 5 V leakage testing, not production tested.

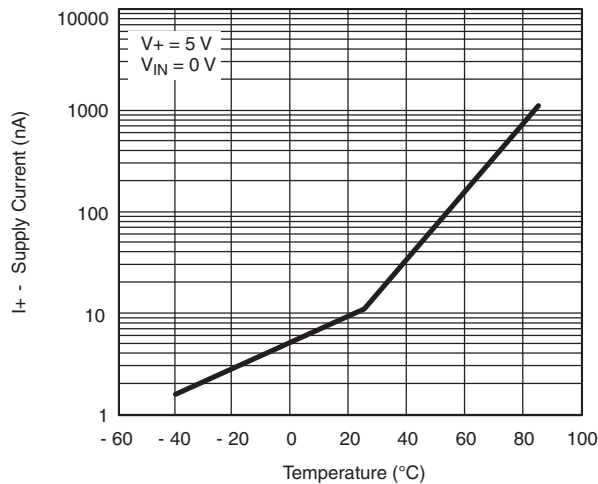
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted


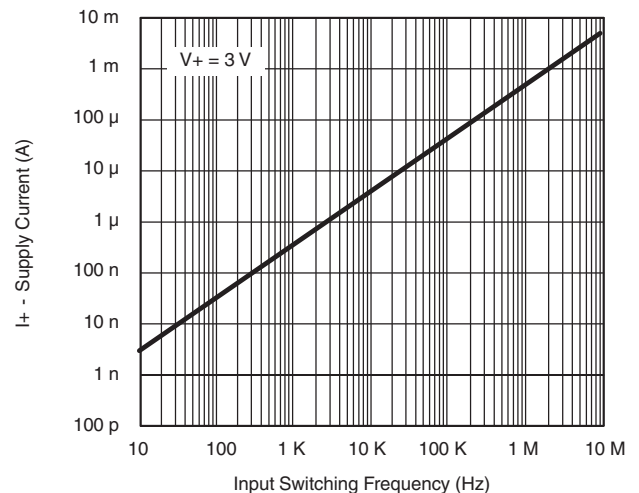
r_{ON} vs. V_{COM} and Supply Voltage



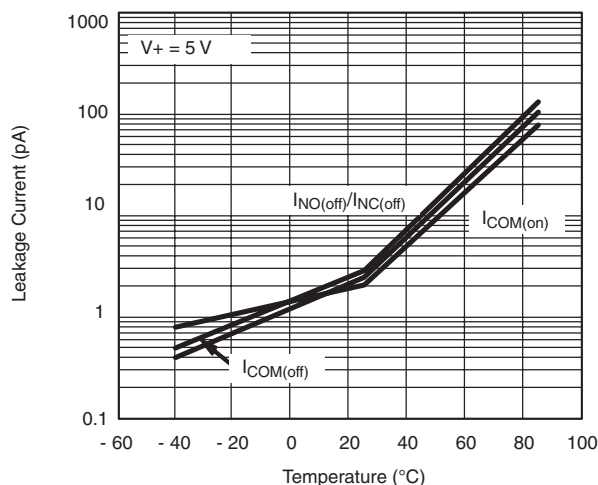
r_{ON} vs. Analog Voltage and Temperature



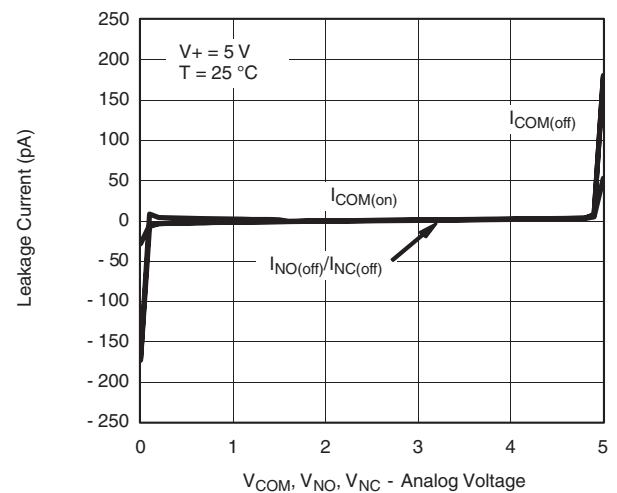
Supply Current vs. Temperature



Supply Current vs. Input Switching Frequency

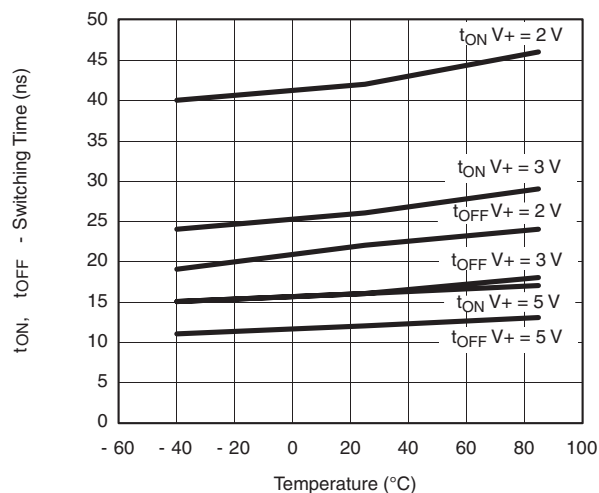


Leakage Current vs. Temperature

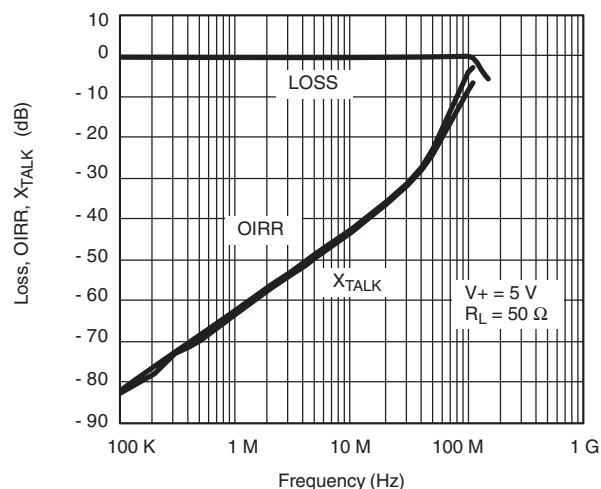


Leakage vs. Analog Voltage

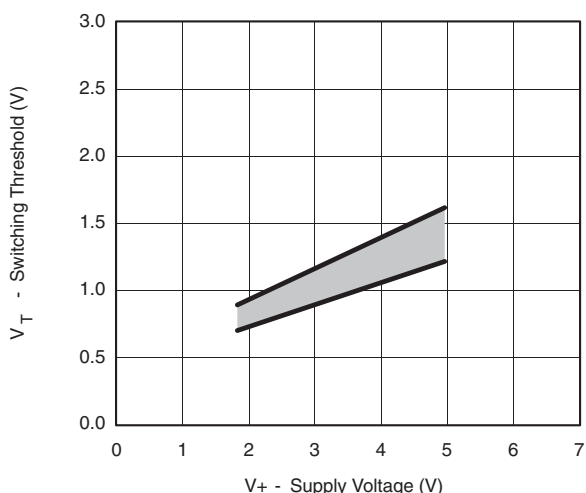
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



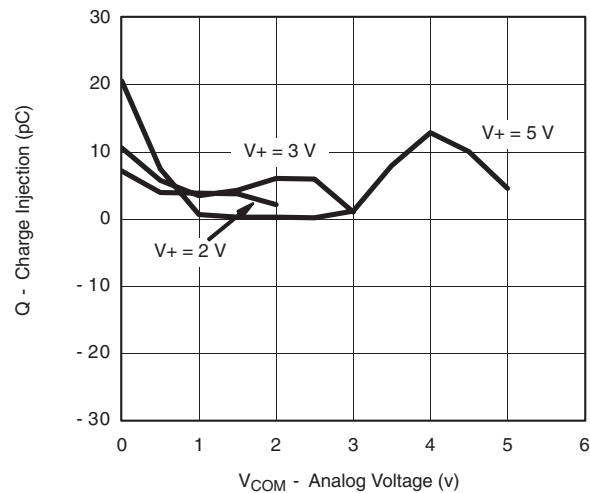
Switching Time vs. Temperature and Supply Voltage



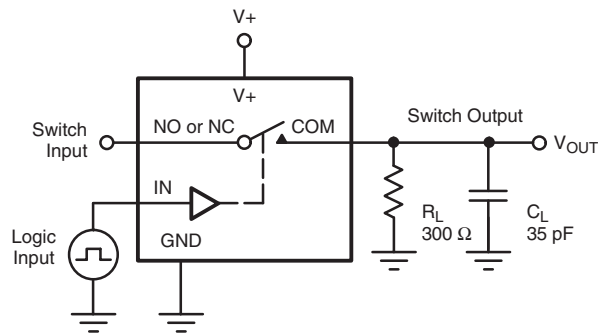
Insertion Loss, Off-Isolation Crosstalk vs. Frequency



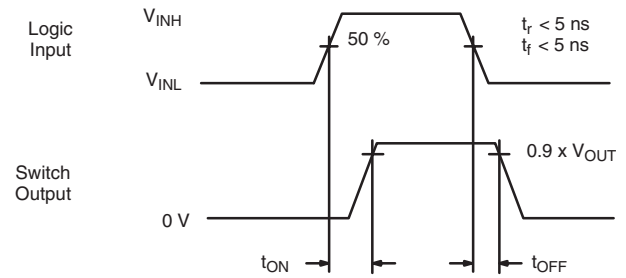
Switching Threshold vs. Supply Voltage



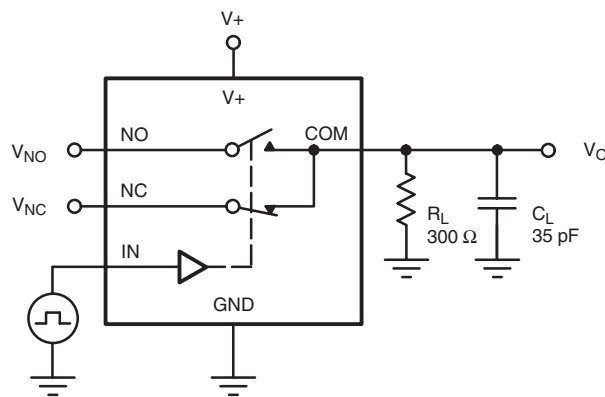
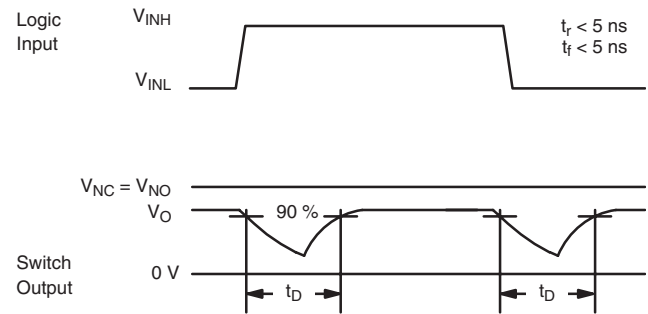
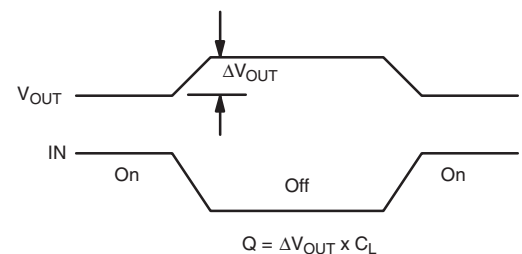
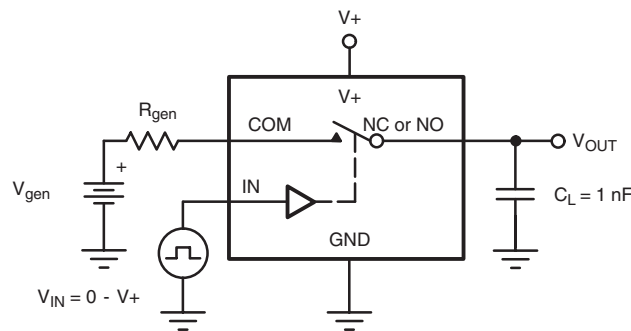
Charge Injection vs. Analog Voltage

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


IN depends on switch configuration: input polarity determined by sense of switch.

Figure 3. Charge Injection

TEST CIRCUITS

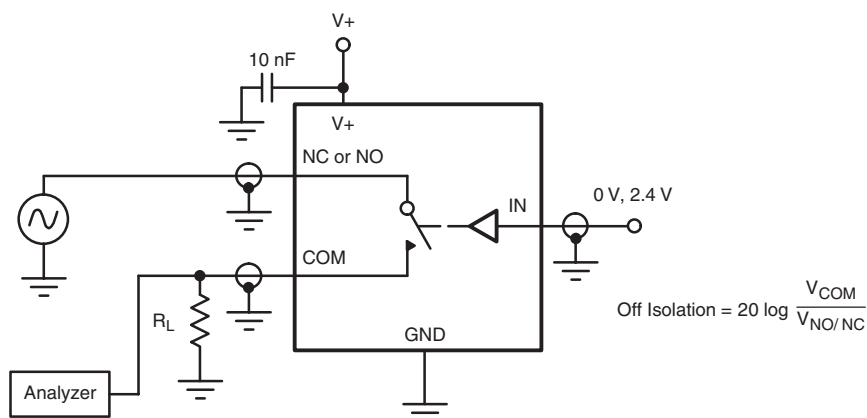


Figure 4. Off-Isolation

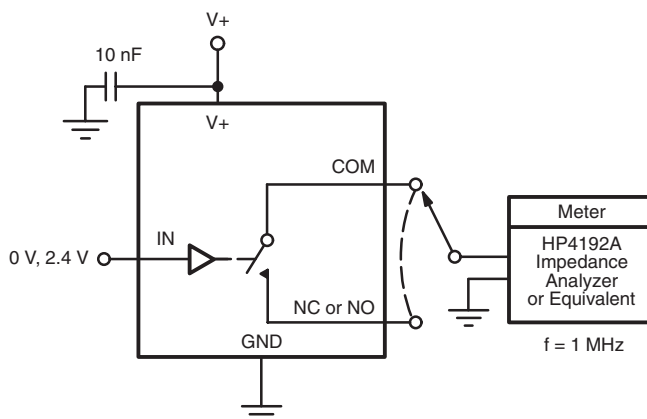


Figure 5. Channel Off/On Capacitance

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