Low-Voltage Dual SPST Analog Switch

FEATURES

- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance - $r_{DS(on)}$: 1.2 Ω
- Fast Switching - 14 ns
- Low Charge Injection - Q_{INJ}: 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- MSOP-8 Package

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

DESCRIPTION

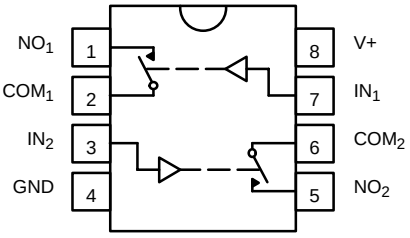
The DG2003/2004/2005 are dual single-pole/single-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, fast switching, low on-resistance ($r_{DS(on)}$: 1.2 Ω) and small physical size (MSOP-8), the DG2003/2004/2005 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2003/2004/2005 are built on Vishay Siliconix's low voltage JI2 process. 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.

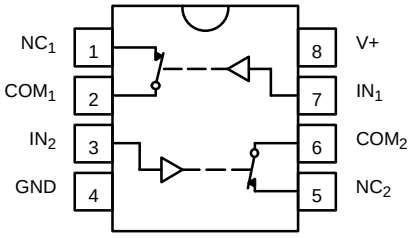
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG2003



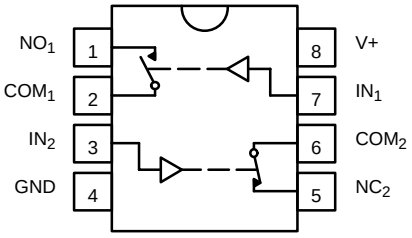
Top View

DG2004



Top View

DG2005



Top View

TRUTH TABLE - DG2003

Logic	NO
0	Off
1	On

TRUTH TABLE - DG2004

Logic	NC
0	On
1	Off

TRUTH TABLE - DG2005

Logic	NO_1	NC_2
0	Off	On
1	On	Off

ORDERING INFORMATION

Temp Range	Package	Part Number
-40 to 85°C	MSOP-8	DG2003DQ
		DG2004DQ
		DG2005DQ

ABSOLUTE MAXIMUM RATINGS

Reference to GND
V+ ..... -0.3 to +6 V
IN, COM, NC, NO[a] ..... -0.3 to (V+ + 0.3 V)
Continuous Current (Any terminal) ..... ±50 mA
Peak Current ..... ±200 mA
(Pulsed at 1 ms, 10% duty cycle)
Storage Temperature (D Suffix) ..... -65 to 150°C

Power Dissipation (Packages)[b]
MSOP-8[c] ..... 320 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 6.5 mW/°C above 25°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 Min[b]	Typ[c]	Max[b]	Unit
Analog Switch							
Analog Signal Range[d]	V_{NO}, V_{NC}, V_{COM}		Full	0		V+	V
On-Resistance	r_{ON}	V+ = 2.0 V, V_{COM} = 1.0 V, I_{NO}, I_{NC} = 1 mA	Room Full[d]		7.0 12.5	10.0 16.0	Ω
r_{ON} Flatness[d]	r_{ON} Flatness	V+ = 2.0 V, V_{COM} = 0 to V+, I_{NO}, I_{NC} = 1 mA	Room		5		Ω
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[d]	–500 –4.0		500 4.0	pA nA
	$I_{COM(off)}$		Room Full[d]	–500 –4.0		500 4.0	pA nA
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]	–500 –4.0		500 4.0	pA nA
Digital Control							
Input High Voltage	V_{INH}		Full	1.6			V
Input Low Voltage	V_{INL}		Full			0.4	V
Input Capacitance[d]	C_{in}		Full		5		pF
Input Current	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} = 1.5 V, R_L = 300 Ω, C_L = 35 pF Figures 1 and 2	Room Full[d]		30	47 48	ns
Turn-Off Time	t_{OFF}		Room Full[d]		22	37 48	ns
Charge Injection[d]	Q_{INJ}	C_L = 1 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 3	Room		2		pC
Off-Isolation[d]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–61		dB
Crosstalk[d]	X_{TALK}		Room		–67		dB
NO, NC Off Capacitance[d]	$C_{NO(off)}$, $C_{NC(off)}$	V_{IN} = 0 or V+, f = 1 MHz	Room		53		pF
Channel-On Capacitance[d]	C_{ON}		Room		110		pF
Power Supply							
Power Supply Range	V+			1.8		2.2	V
Power Supply Current[d]	I+	V_{IN} = 0 or V+			0.02	1.0	µA
Power Consumption	P_C					2.2	µW

SPECIFICATIONS (V+ = 3.0 V)

Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ±10%, V_{IN} = 0.4 or 2.0 V[e]	Temp[a]	Limits –40 to 85°C Min[b]	Typ[c]	Max[b]	Unit
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} = 1.5 V, I_{NO}, I_{NC} = 10 mA	Room Full		2.2 2.4	3.5 3.7	Ω
r_{ON} Flatness[d]	r_{ON} Flatness	V+ = 2.7 V, V_{COM} = 0 to V+, I_{NO}, I_{NC} = 10 mA	Room		0.5		Ω
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	–500 –6.0		500 6.0	pA nA
	$I_{COM(off)}$		Room Full	–500 –6.0		500 6.0	pA nA
Channel-On Leakage Current[f]	$I_{COM(on)}$	V+ = 3.3 V, V_{NO}, V_{NC} = V_{COM} = 1 V/3 V	Room Full	–500 –6.0		500 6.0	pA nA
Digital Control							
Input High Voltage	V_{INH}		Full	2			V
Input Low Voltage	V_{INL}		Full			0.4	V
Input Capacitance[d]	C_{in}		Full		5		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} = 2.0 V, R_L = 300 Ω, C_L = 35 pF Figure 1 and 2	Room Full		19	35 36	ns
Turn-Off Time[d]	t_{OFF}		Room Full		17	31 34	ns
Charge Injection[d]	Q_{INJ}	C_L = 1 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 3	Room		1		pC
Off-Isolation[d]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–61		dB
Crosstalk[d]	X_{TALK}		Room		–67		dB
NO, NC Off Capacitance[d]	$C_{NO(off)}$, $C_{NC(off)}$	V_{IN} = 0 or V+, f = 1 MHz	Room		53		pF
Channel-On Capacitance[d]	C_{ON}		Room		110		pF
Power Supply							
Power Supply Range	V+			2.7		3.3	V
Power Supply Current	I+	V_{IN} = 0 or V+			0.02	1.0	µA
Power Consumption	P_C					3.3	µW

SPECIFICATIONS (V+ = 5.0 V)

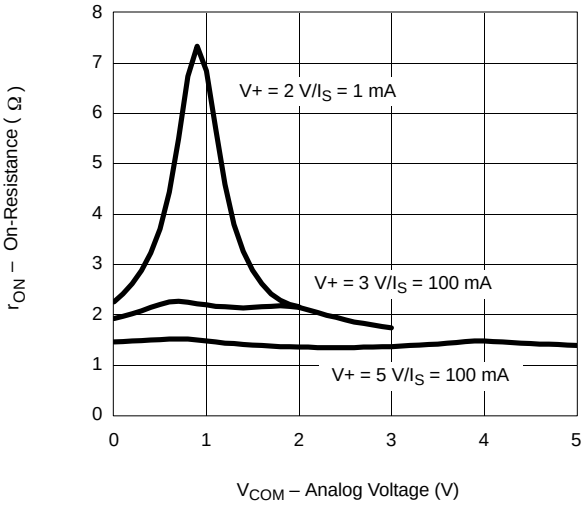
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ±10%, V_{IN} = 0.8 or 2.4 V[e]	Temp[a]	Limits –40 to 85°C Min[b]	Typ[c]	Max[b]	Unit
Analog Switch							
Analog Signal Range[d]	V_{NO}, V_{NC}, V_{COM}		Full	0		V+	V
On-Resistance	r_{ON}	V+ = 4.5 V, V_{COM} = 3 V, I_{NO}, I_{NC} = 10 mA	Room Full		1.2 1.6	2.5 2.7	Ω
r_{ON} Flatness[d]	r_{ON} Flatness	V+ = 4.5 V, V_{COM} = 0 to V+, I_{NO}, I_{NC} = 10 mA	Room		0.2		Ω
Switch Off Leakage Current	$I_{NO(off)}$, $I_{NC(off)}$	V+ = 5.5 V V_{NO}, V_{NC} = 1 V/4.5 V, V_{COM} = 4.5 V/1 V	Room Full	–1.0 –8.0		1.0 8.0	nA
	$I_{COM(off)}$		Room Full	–1.0 –8.0		1.0 8.0	nA
Channel-On Leakage Current	$I_{COM(on)}$	V+ = 5.5 V, V+ = 5.5 V V_{NO}, V_{NC} = V_{COM} = 1 V/4.5 V	Room Full	–1.0 –8.0		1.0 8.0	nA
Digital Control							
Input High Voltage	V_{INH}		Full	2.4			V
Input Low Voltage	V_{INL}		Full			0.8	V
Input Capacitance	C_{in}		Full		5		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 Figure 1 and 2	Room Full		13	28 31	ns
Turn-Off Time[d]	t_{OFF}		Room Full		19	22 31	ns
Charge Injection[d]	Q_{INJ}	C_L = 1 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω, Figure 3	Room		1		pC
Off-Isolation[d]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room		–61		dB
Crosstalk[d]	X_{TALK}		Room		–67		dB
Source-Off Capacitance[d]	$C_{NO(off)}$, $C_{NC(off)}$	V_{IN} = 0 or V+, f = 1 MHz	Room		51		pF
Channel-On Capacitance[d]	C_{ON}		Room		110		pF
Power Supply							
Power Supply Range	V+			4.5		5.5	V
Power Supply Current	I+	V_{IN} = 0 or V+			0.02	1.0	µA
Power Consumption	P_C					5.5	µW

Notes:

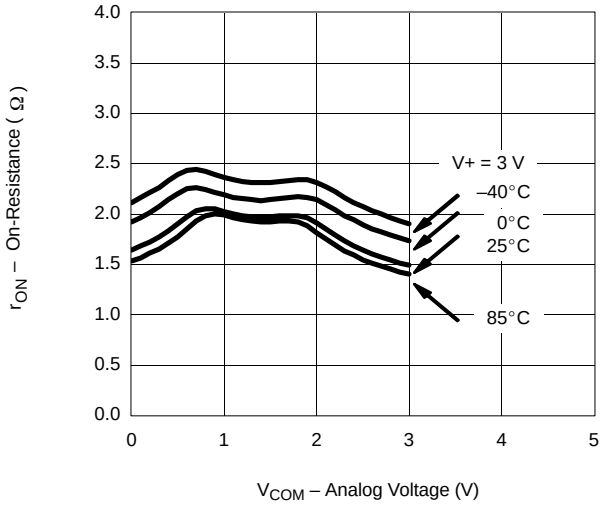
a. Room = 25°C, Full = as determined by the operating suffix.
b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
c. Typical values are for design aid only, not guaranteed nor subject to production testing.
d. Guarantee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

TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

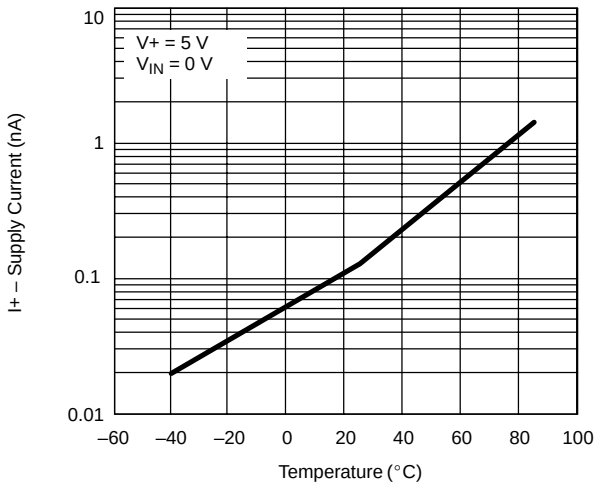
r_{ON} vs. V_{COM} Supply Voltage



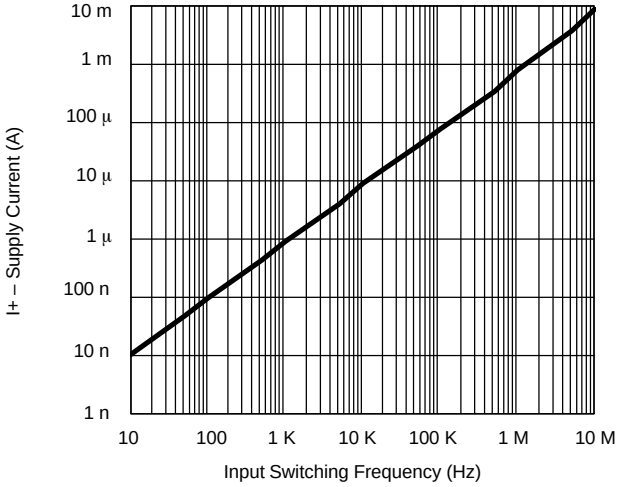
r_{ON} vs. Analog Voltage and Temperature



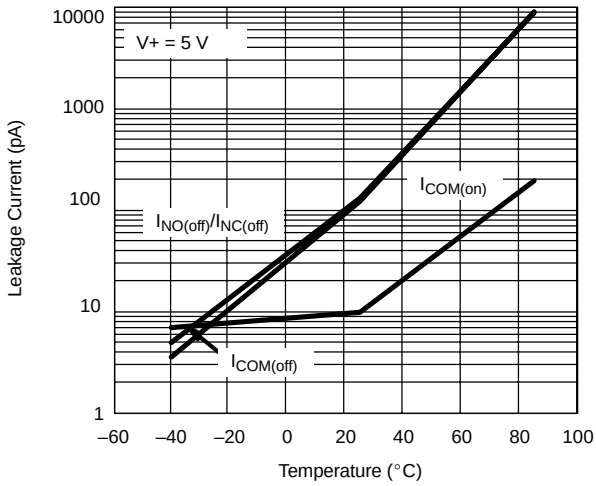
Supply Current vs. Temperature



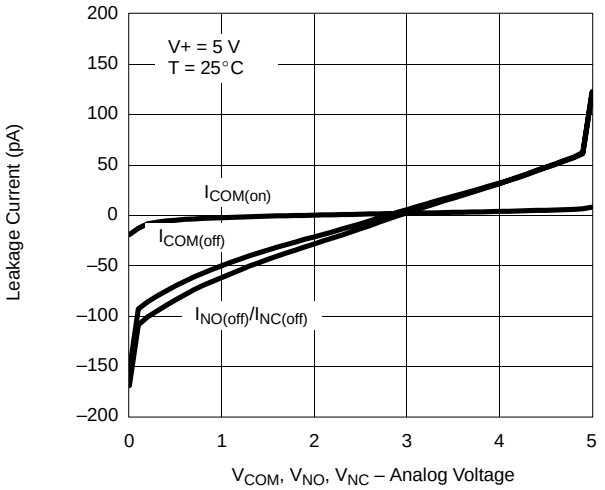
Supply Current vs. Input Switching Frequency



Leakage Current vs. Temperature

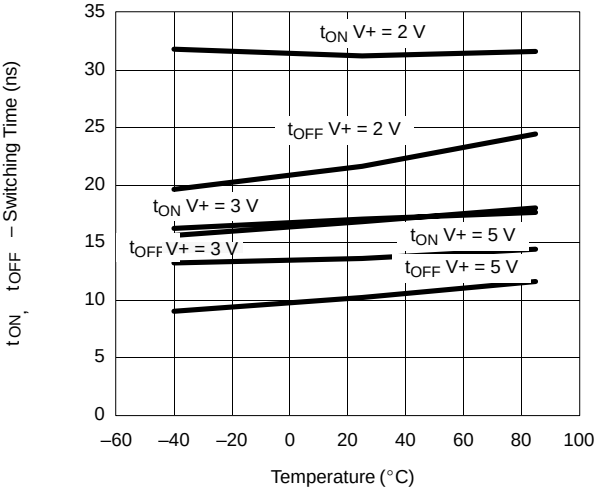


Leakage vs. Analog Voltage

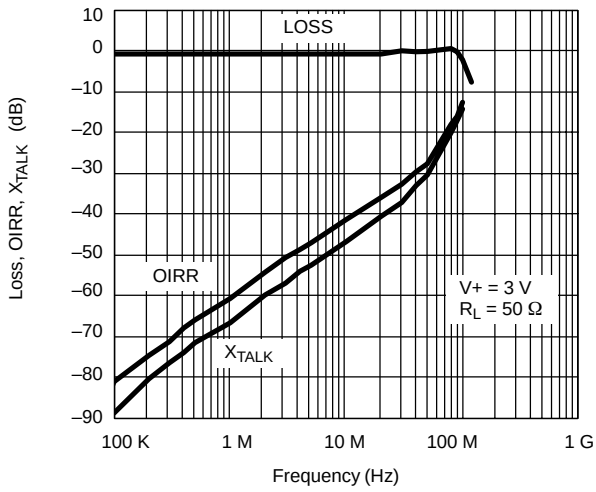


TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

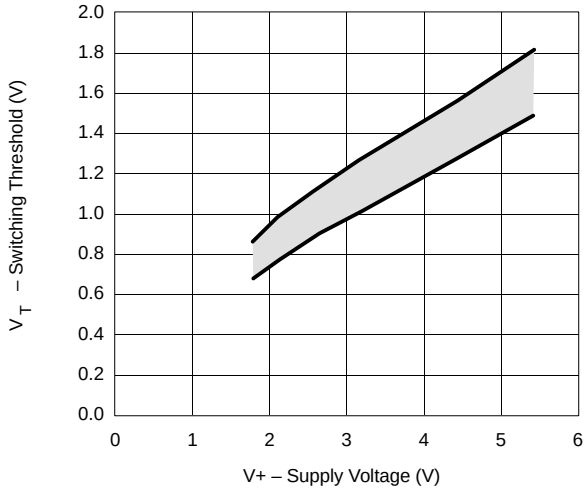
Switching Time vs. Temperature and Supply Voltage



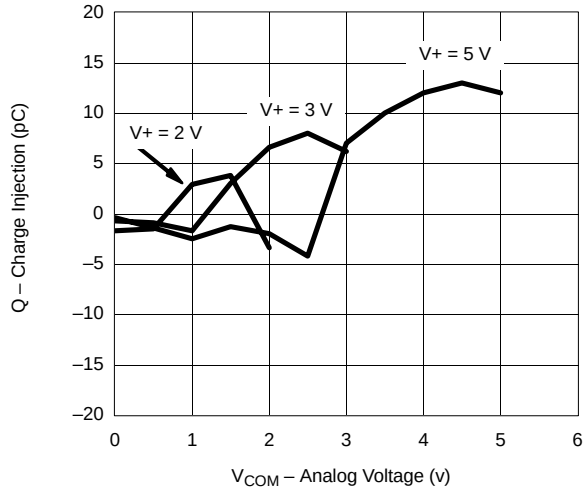
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



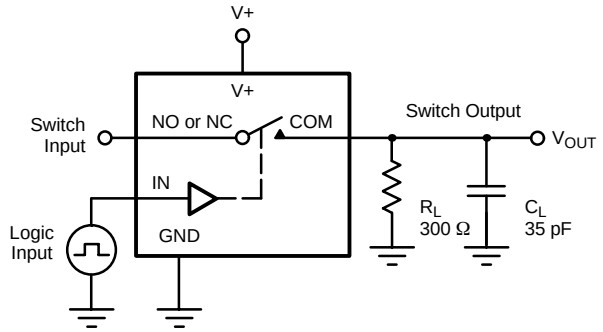
Switching Threshold vs. Supply Voltage



Charge Injection vs. Analog Voltage

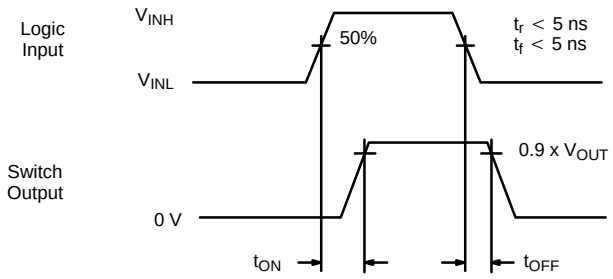


TEST CIRCUITS



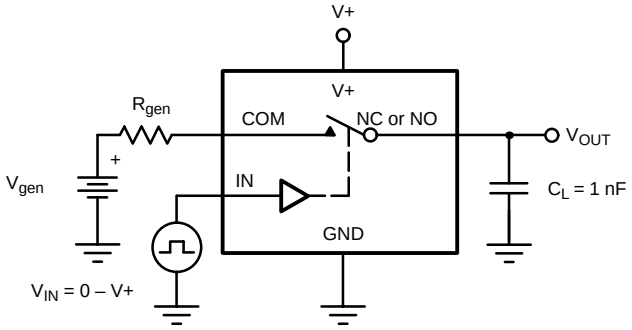
C_L (includes fixture and stray capacitance)

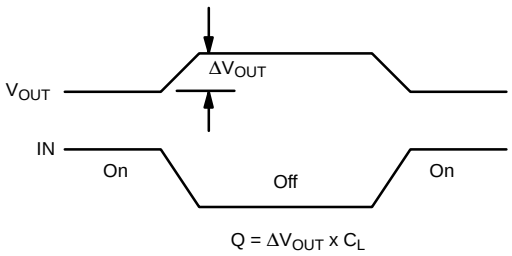
$$V_{OUT} = V_{COM}\left(\frac{R_L}{R_L + R_{ON}}\right)$$



Logic "1" = Switch On
Logic input waveforms inverted for switches that have the opposite logic sense.

FIGURE 1. Switching Time

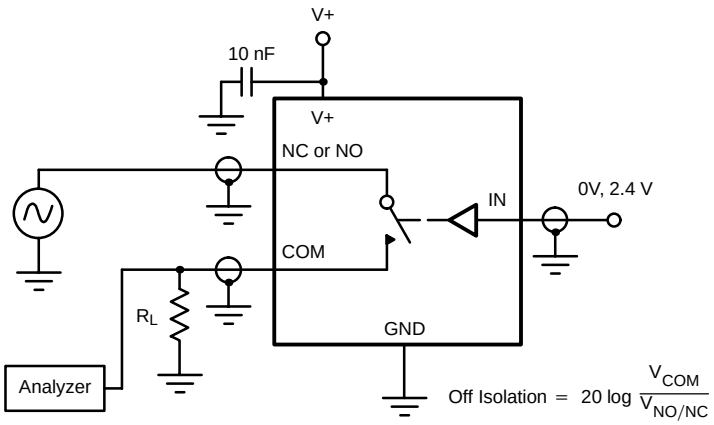




$Q = \Delta V_{OUT} \times C_L$

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

FIGURE 2. Charge Injection



$$\text{Off Isolation} = 20 \log \frac{V_{COM}}{V_{NO/NC}}$$

FIGURE 3. Off-Isolation

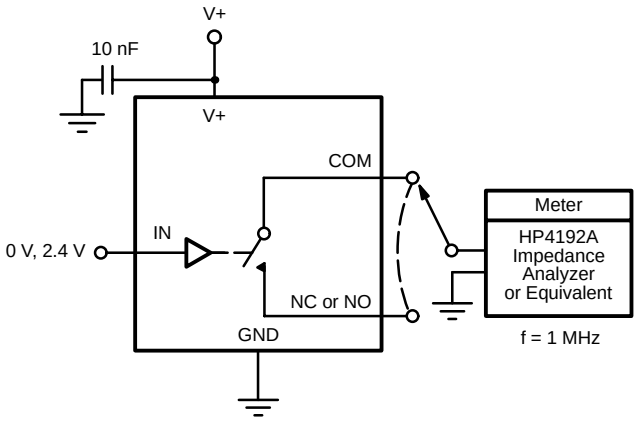


FIGURE 4. Channel Off/On Capacitance

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