

## Low Voltage, Dual Supply, Low $R_{ON}$ , Quad SPST Analog Switches

### DESCRIPTION

The DG9424, DG9425, DG9426 are low voltage precision monolithic quad single-pole-single-throw analog switches.

Using BiCMOS wafer fabrication technology allows the DG9424, DG9425, DG9426 to operate on single and dual supplies. Single supply voltage ranges from 3 V to 12 V while dual supply operation is recommended with  $\pm 3$  V to  $\pm 6$  V.

Combining high speed ( $t_{ON}$ : 42 ns), flat  $R_{DS(on)}$  over the analog signal range ( $\Omega$ ), minimal insertion lose (-3 dB at 190 MHz), and excellent crosstalk and off-isolation performance, the DG9424, DG9425, DG9426 are ideally suited for audio and video signal switching.

The DG9424 and DG9425 respond to opposite control logic as shown in the truth table. The DG9426 has two normally open and two normally closed switches.

### FEATURES

- 2.7 V thru 12 V single supply or  $\pm 3$  thru  $\pm 6$  dual supply
- On-resistance -  $R_{DS(on)}$ : 1.7  $\Omega$
- Fast switching -  $t_{ON}$ : 42 ns  
-  $t_{OFF}$ : 28 ns
- TTL, CMOS compatible
- Low leakage: 0.2 nA
- 2000 V ESD protection

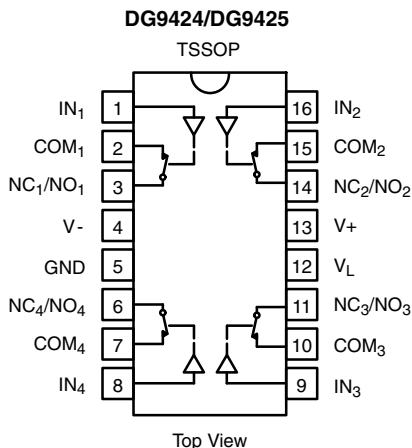
### BENEFITS

- Widest dynamic range
- Low signal errors and distortion
- Break-before-make switching action
- Simple interfacing

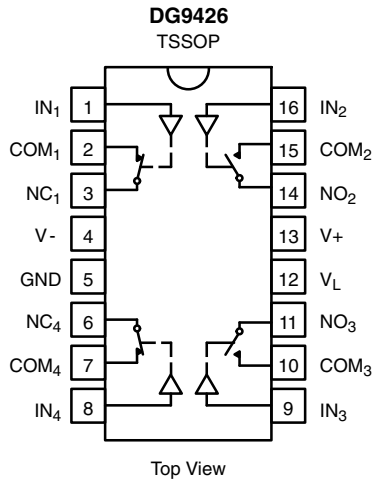
### APPLICATIONS

- Automatic test equipment
- Data acquisition systems
- Communication systems
- ADC systems
- xDSL and PBX / PABX
- Audio signal routing

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
LOGIC	DG9424	DG9425
0	OFF	ON
1	ON	OFF

**FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION**


TRUTH TABLE		
LOGIC	SW <sub>1</sub> , SW <sub>4</sub>	SW <sub>2</sub> , SW <sub>3</sub>
0	ON	OFF
1	OFF	ON

ORDERING INFORMATION		
TEMP. RANGE	PACKAGE	PART NUMBER
-40 °C to +85 °C	16-Pin TSSOP	DG9424DQ-T1-E3
		DG9425DQ-T1-E3
		DG9426DQ-T1-E3

ABSOLUTE MAXIMUM RATINGS			
PARAMETER		LIMIT	UNIT
V+ to V-		-0.3 to +13	V
GND to V-		7	
V <sub>L</sub>		(GND - 0.3) to (V+) + 0.3	
IN, COM, NC, NO <sup>a</sup>		(V-) - 0.3 to (V+) + 0.3	
Continuous Current (NO, NC, COM Pins)		100	mA
Peak Current, S or D (Pulsed 1 ms, 10 % Duty Cycle)		200	
Storage Temperature		-65 to +150	°C
Power Dissipation (Package) <sup>b</sup>	16-Pin TSSOP <sup>c</sup>	450	mW
Thermal Resistance <sup>b</sup>		178	°C/W

**Notes**

- Signals on NC, NO, COM or IN 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 OTHERWISE SPECIFIED V <sub>+</sub> = 12 V, V <sub>-</sub> = 0 V V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup>	TEMP. <sup>b</sup>	LIMITS -40 °C 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	-	12	V
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = 10.8 V, V <sub>-</sub> = 0 V I <sub>NO</sub> , I <sub>NC</sub> = 50 mA, V <sub>COM</sub> = 2 V / 9 V	Room	-	1.8	3	Ω
			Full	-	-	4	
<b>Digital Control</b>							
Input Current	I <sub>INL</sub> or I <sub>INH</sub>		Full	-1	0.01	1	μA
<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>NO</sub> , V <sub>NC</sub> = 5 V, see fig. 2	Room	-	42	57	ns
			Full	-	-	65	
Turn-Off Time <sup>e</sup>	t <sub>OFF</sub>		Room	-	28	42	
			Full	-	-	44	
Break-Before-Make Time Delay <sup>e</sup>	t <sub>D</sub>	DG9426 only, V <sub>NO</sub> , V <sub>NC</sub> = 5 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room	2	-	-	
Charge Injection <sup>e</sup>	Q <sub>INJ</sub>	V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF	Room	-	38	-	pC
Off-Isolation <sup>e</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF f = 1 MHz	Room	-	-56	-	dB
Channel-to-Channel Crosstalk <sup>e</sup>	X <sub>TALK</sub>		Room	-	-77	-	
NO, NC Off Capacitance <sup>e</sup>	C <sub>NO(off)</sub>	f = 1 MHz	Room	-	49	-	pF
	C <sub>NC(off)</sub>						
COM Off Capacitance <sup>e</sup>	C <sub>COM(off)</sub>		Room	-	37	-	
Channel On Capacitance <sup>e</sup>	C <sub>COM(on)</sub>		Room	-	89	-	
<b>Power Supplies</b>							
Positive Supply Current	I <sub>+</sub>	V <sub>IN</sub> = 0 or V <sub>L</sub>	Room	-	0.02	1	μA
			Full	-	-	5	
Negative Supply Current	I <sub>-</sub>		Room	-1	-0.002	-	
			Full	-5	-	-	
Logic Supply Current	I <sub>L</sub>		Room	-	0.002	1	
			Full	-	-	5	
Ground Current	I <sub>GND</sub>		Room	-1	-0.002	-	
			Full	-5	-	-	



SPECIFICATIONS <sup>a</sup> Dual Supply $\pm 5$ V								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED $V_+ = 5$ V, $V_- = 5$ V $V_L = 5$ V, $V_{IN} = 2.4$ V, 0.8 V <sup>f</sup>	TEMP. <sup>b</sup>	LIMITS -40 °C 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	
On-Resistance	$R_{ON}$	$V_+ = 4.5$ V, $V_- = -4.5$ V $I_{NO}, I_{NC} = 50$ mA, $V_{NO}, V_{COM} = \pm 3.5$ V	Room	-	2	3.3	$\Omega$	
			Full	-	-	4.3		
Switch Off Leakage Current	$I_{NO(off)}$	$V_+ = 5.5$ V, $V_- = -5.5$ V $V_{COM} = \pm 4.5$ V, $V_{NO}, V_{NC} = \pm 4.5$ V	Room	-1	-	1	nA	
	$I_{NC(off)}$		Full	-10	-	10		
	$I_{COM(off)}$		Room	-1	-	1		
			Full	-10	-	10		
Channel On Leakage Current	$I_{COM(on)}$	$V_+ = 5.5$ V, $V_- = -5.5$ V, $V_{NO}, V_{NC} = V_{COM} = \pm 4.5$ V	Room	-1	-	1		
			Full	-10	-	10		
<b>Digital Control</b>								
Input Current <sup>a</sup>	$I_{INL}$ or $I_{INH}$		Full	-1	0.05	1	$\mu$ A	
<b>Dynamic Characteristics</b>								
Turn-On Time <sup>e</sup>	$t_{ON}$	$R_L = 300 \Omega$ , $C_L = 35$ pF $V_{NO}, V_{NC} = \pm 3.5$ V, see fig. 2	Room	-	48	67	ns	
			Full	-	-	81		
Turn-Off Time <sup>e</sup>	$t_{OFF}$		Room	-	34	57		
			Full	-	-	67		
Break-Before-Make Time Delay <sup>e</sup>	$t_D$		DG9426 only, $V_{NO}, V_{NC} = 3.5$ V $R_L = 300 \Omega$ , $C_L = 35$ pF	Room	2	-		-
Charge Injection <sup>e</sup>	$Q_{INJ}$		$V_g = 0$ V, $R_g = 0 \Omega$ , $C_L = 1$ nF	Room	-	112		-
Off Isolation <sup>e</sup>	OIRR	$R_L = 50 \Omega$ , $C_L = 5$ pF, $f = 1$ MHz	Room	-	-56	-	dB	
Channel-to-Channel Crosstalk <sup>e</sup>	$X_{TALK}$		Room	-	-82	-		
Source Off Capacitance <sup>e</sup>	$C_{NO(off)}$ $C_{NC(off)}$	$f = 1$ MHz	Room	-	38	-	pF	
Drain Off Capacitance <sup>e</sup>	$C_{COM(off)}$		Room	-	38	-		
Channel On Capacitance <sup>e</sup>	$C_{COM(on)}$		Room	-	89	-		
<b>Power Supplies</b>								
Positive Supply Current <sup>e</sup>	$I_+$	$V_{IN} = 0$ or $V_L$	Room	-	0.03	1	$\mu$ A	
			Full	-	-	5		
Negative Supply Current <sup>e</sup>	$I_-$		Room	-1	-0.002	-		
			Full	-5	-	-		
Logic Supply Current <sup>e</sup>	$I_L$		Room	-	0.002	1		
			Full	-	-	5		
Ground Current <sup>e</sup>	$I_{GND}$		Room	-1	-0.002	-		
			Full	-5	-	-		



<b>SPECIFICATIONS</b> <sup>a</sup> Single Supply 5 V								
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V <sub>+</sub> = 5 V, V <sub>-</sub> = 0 V V <sub>L</sub> = 5 V, V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup>	TEMP. <sup>b</sup>	LIMITS -40 °C 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	-	-	5	V	
On-Resistance <sup>e</sup>	R <sub>ON</sub>	V <sub>+</sub> = 4.5 V, I <sub>NO</sub> , I <sub>NC</sub> = 50 mA, V <sub>COM</sub> = 1 V, 3.5 V	Room	-	3.4	4.8	Ω	
			Full	-	-	5.8		
<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>NO</sub> , V <sub>NC</sub> = 3.5 V, see fig. 2	Room	-	71	86	ns	
			Hot	-	-	106		
Turn-Off Time <sup>e</sup>	t <sub>OFF</sub>		Room	-	37	51		
			Hot	-	-	56		
Break-Before-Make Time Delay <sup>e</sup>	t <sub>D</sub>		DG9426 only, V <sub>NO</sub> , V <sub>NC</sub> = 3.5 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room	5	-		-
Charge Injection <sup>e</sup>	Q <sub>INJ</sub>		V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF	Room	-	10		-
<b>Power Supplies</b>								
Positive Supply Current <sup>e</sup>	I <sub>+</sub>	V <sub>IN</sub> = 0 or V <sub>L</sub>	Room	-	0.02	1	μA	
			Hot	-	-	5		
Negative Supply Current <sup>e</sup>	I <sub>-</sub>		Room	-1	-0.002	-		
			Hot	-5	-	-		
Logic Supply Current <sup>e</sup>	I <sub>L</sub>		Room	-	0.002	1		
			Hot	-	-	5		
Ground Current <sup>e</sup>	I <sub>GND</sub>		Room	-1	-0.002	-		
			Hot	-5	-	-		



SPECIFICATIONS <sup>a</sup> Single Supply 3 V							
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V <sub>+</sub> = 3 V, V <sub>-</sub> = 0 V V <sub>L</sub> = 3 V, V <sub>IN</sub> = 2.4 V, 0.4 V <sup>f</sup>	TEMP. <sup>b</sup>	LIMITS -40 °C 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
On-Resistance	R <sub>ON</sub>	V <sub>+</sub> = 2.7 V, V <sub>-</sub> = 0 V I <sub>NO</sub> , I <sub>NC</sub> = 5 mA, V <sub>COM</sub> = 0.5 V, 2.2 V	Room	-	8	13.8	Ω
			Full	-	-	15.1	
Switch Off Leakage Current <sup>a</sup>	I <sub>NO(off)</sub>	V <sub>+</sub> = 3.3 V, V <sub>-</sub> = 0 V V <sub>COM</sub> = 0.3 V, 3 V, V <sub>NO</sub> , V <sub>NC</sub> = 3, 0.3 V	Room	-1	-	1	nA
	I <sub>NC(off)</sub>		Full	-10	-	10	
	I <sub>COM(off)</sub>		Room	-1	-	1	
			Full	-10	-	10	
Channel On Leakage Current <sup>a</sup>	I <sub>COM(on)</sub>	V <sub>+</sub> = 3.3 V, V <sub>-</sub> = 0 V, V <sub>NO</sub> , V <sub>NC</sub> = V <sub>COM</sub> = 0.3 V, 3 V	Room	-1	-	1	
			Full	-10	-	10	
<b>Digital Control <sup>e</sup></b>							
Input Current	I <sub>INL</sub> OR I <sub>INH</sub>		Full	-1	0.005	1	μA
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF V <sub>NO</sub> , V <sub>NC</sub> = 1.5 V, see fig. 2	Room	-	140	163	ns
			Full	-	-	193	
Turn-Off Time	t <sub>OFF</sub>		Room	-	65	80	
			Full	-	-	89	
Break-Before-Make Time Delay	t <sub>D</sub>	DG9426 only, V <sub>NO</sub> , V <sub>NC</sub> = 1.5 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room	5			
Charge Injection <sup>e</sup>	Q <sub>INJ</sub>	V <sub>g</sub> = 0 V, R <sub>g</sub> = 0 Ω, C <sub>L</sub> = 1 nF	Room	-	15	-	pC
Off Isolation <sup>e</sup>	OIRR	R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 5 pF f = 1 MHz	Room	-	-56	-	dB
Channel-to-Channel Crosstalk <sup>e</sup>	X <sub>TALK</sub>		Room	-	-80	-	
Source Off Capacitance <sup>e</sup>	C <sub>NO(off)</sub>	f = 1 MHz	Room	-	53	-	pF
	C <sub>NC(off)</sub>		Room	-	42	-	
Drain Off Capacitance <sup>e</sup>	C <sub>COM(off)</sub>		Room	-	92	-	
Channel On Capacitance <sup>e</sup>	C <sub>COM(on)</sub>		Room	-			

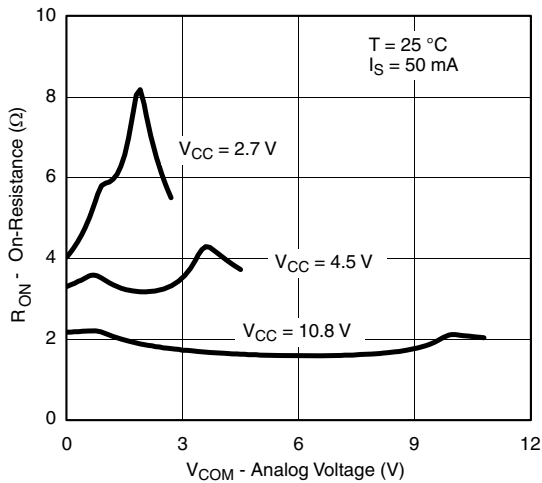
**Notes**

- a. Leakage parameters are guaranteed by worst case test conditions and not subject to production test.
- 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<sub>IN</sub> = Input voltage to perform proper function.

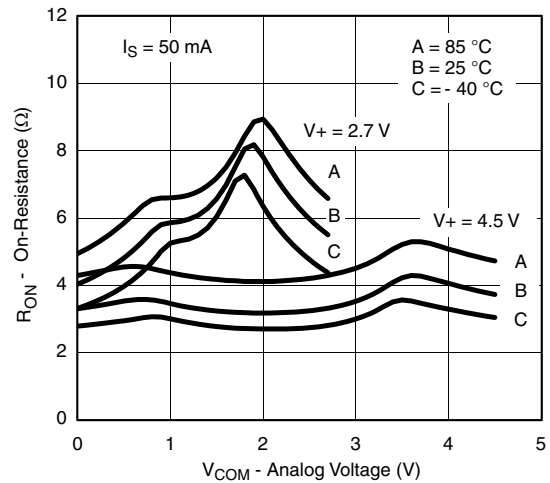
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



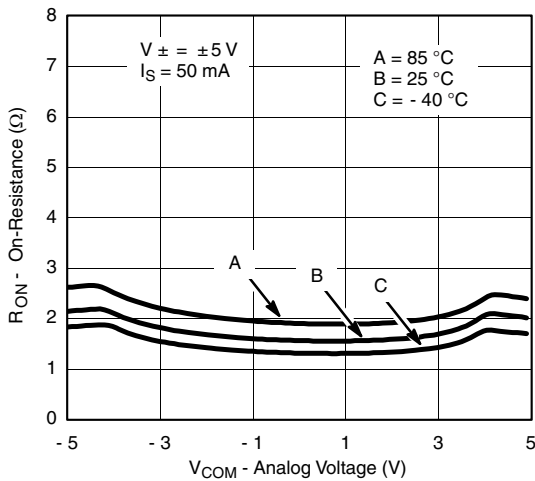
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



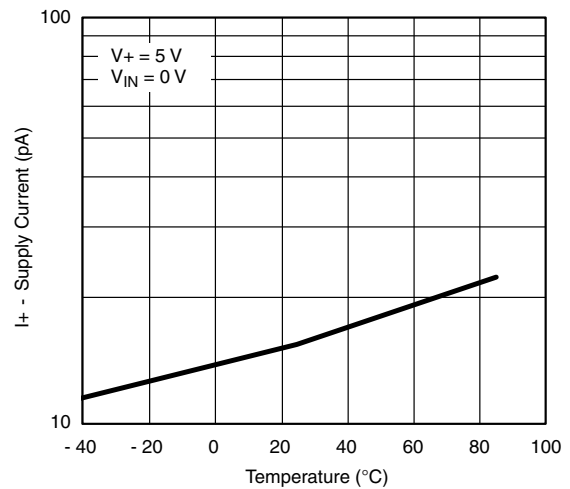
**RON vs. VCOM and Supply Voltage**



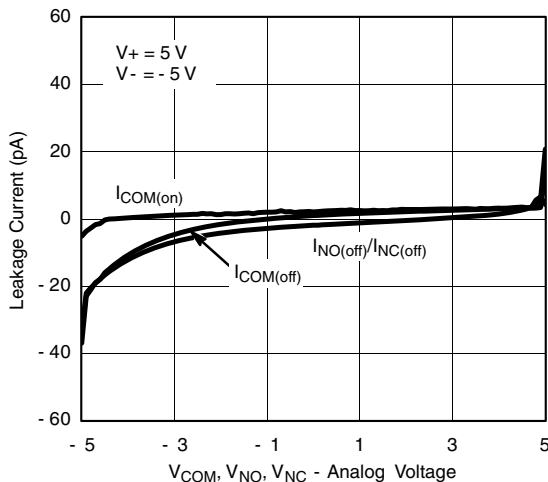
**RON vs. Analog Voltage and Temperature**



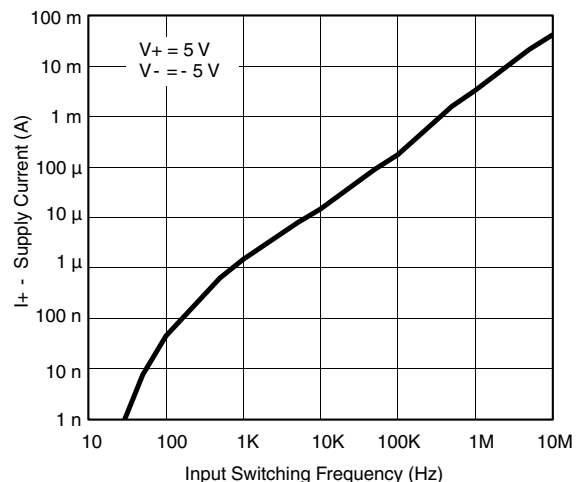
**RON vs. Analog Voltage and Temperature**



**Supply Current vs. Temperature**



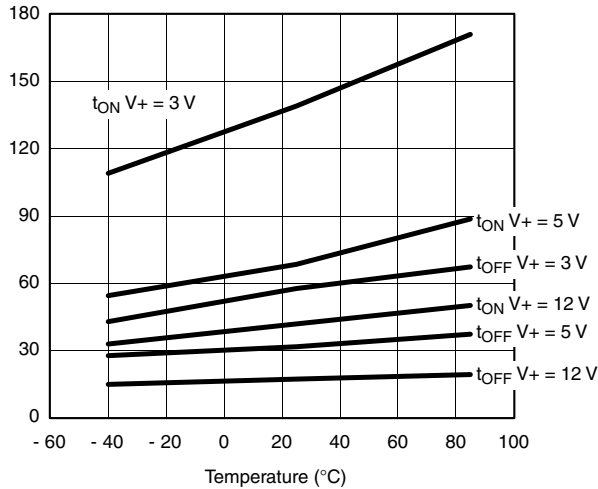
**Leakage Current vs. Analog Voltage**



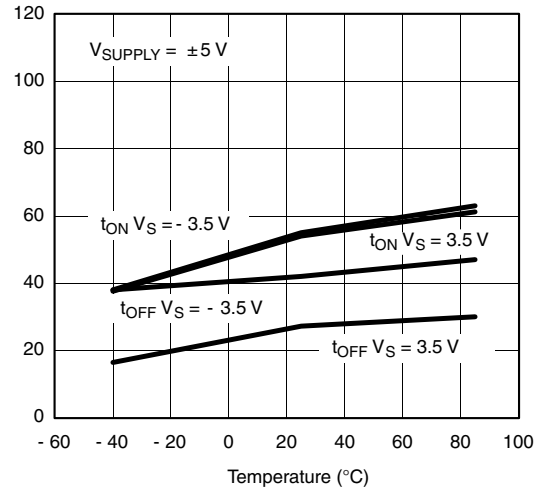
**Switching Current vs. Input Switching Frequency**



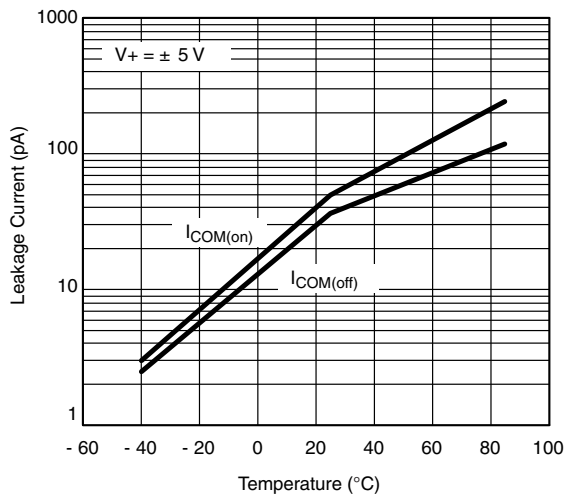
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



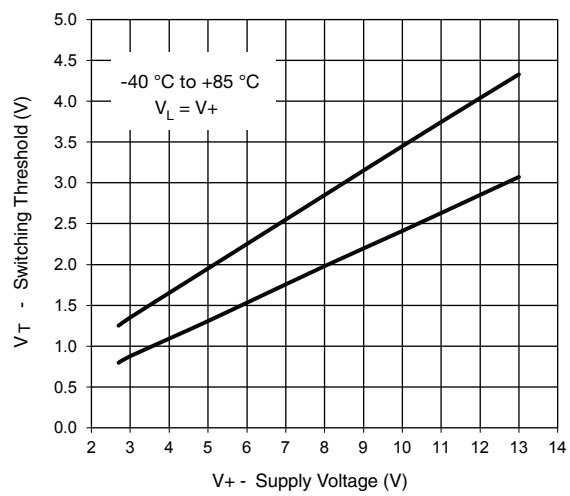
Switching Time vs. Temperature and Single Supply Voltage



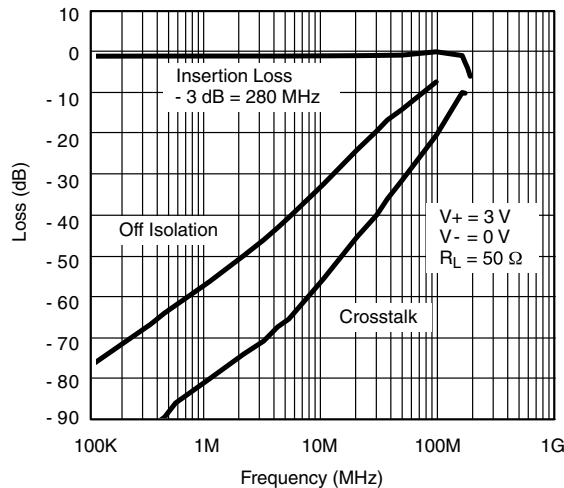
Switching Time vs. Temperature and Dual Supply Voltage



Leakage Current vs. Temperature



Switching Threshold vs. Supply Voltage



Insertion Loss, Off Isolation and Crosstalk vs. Frequency



**SCHEMATIC DIAGRAM** (typical channel)

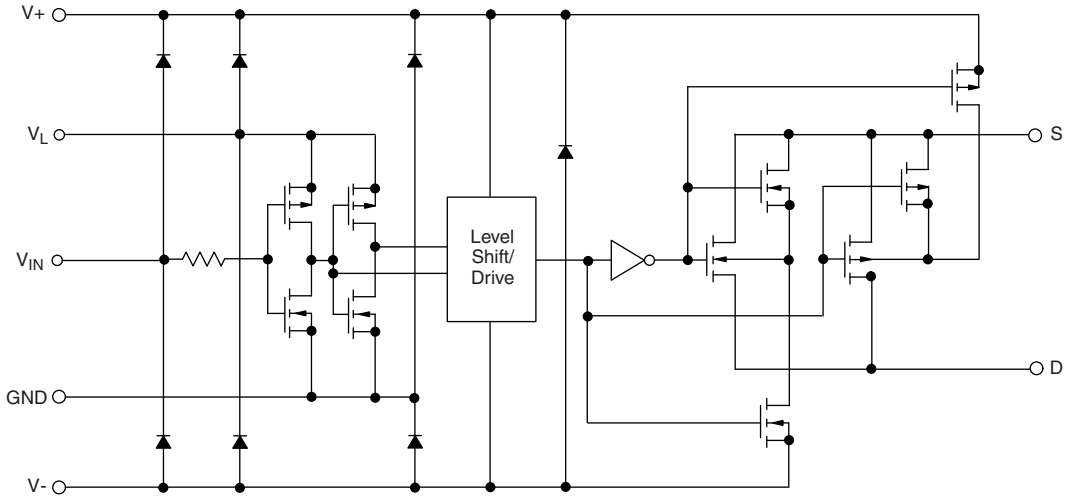
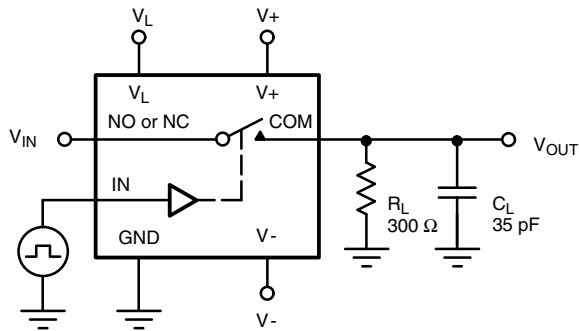


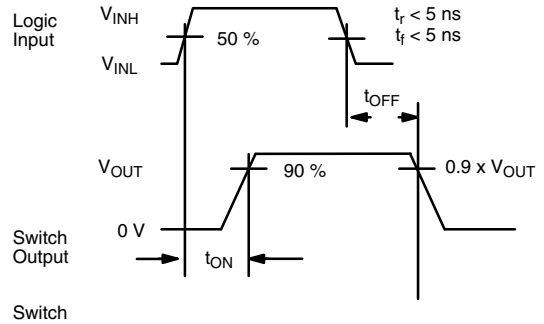
Fig. 1

**TEST CIRCUITS**



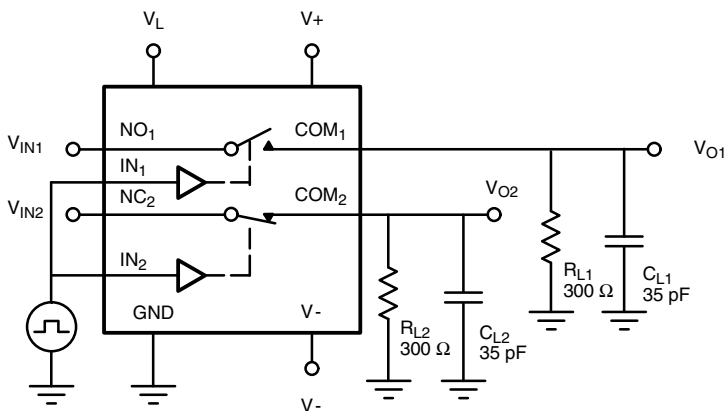
$C_L$  (includes fixture and stray capacitance)

$$V_{OUT} = V_{IN} \frac{R_L}{R_L + r_{ON}}$$



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

Fig. 2 - Switching Time



$C_L$  (includes fixture and stray capacitance)

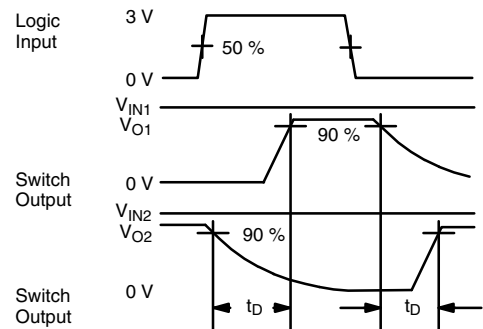


Fig. 3 - Break-Before-Make (DG9426)

TEST CIRCUITS

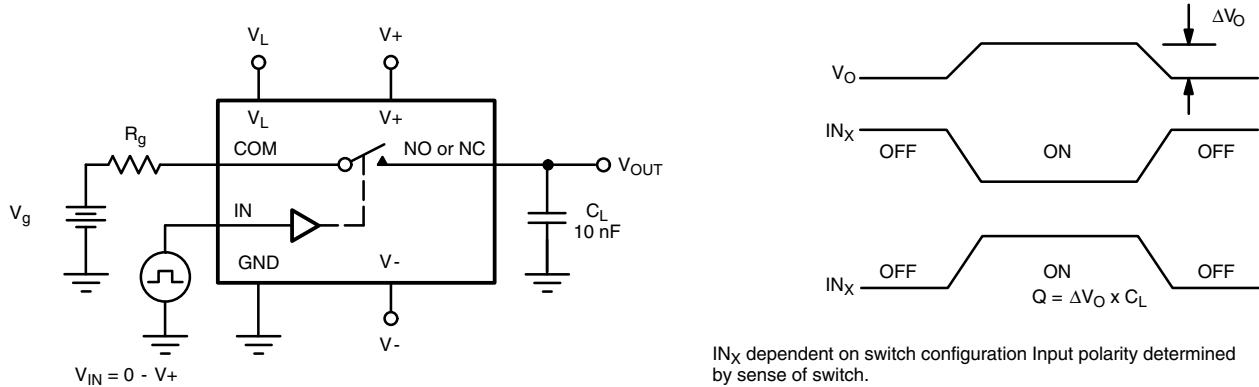


Fig. 4 - Charge Injection

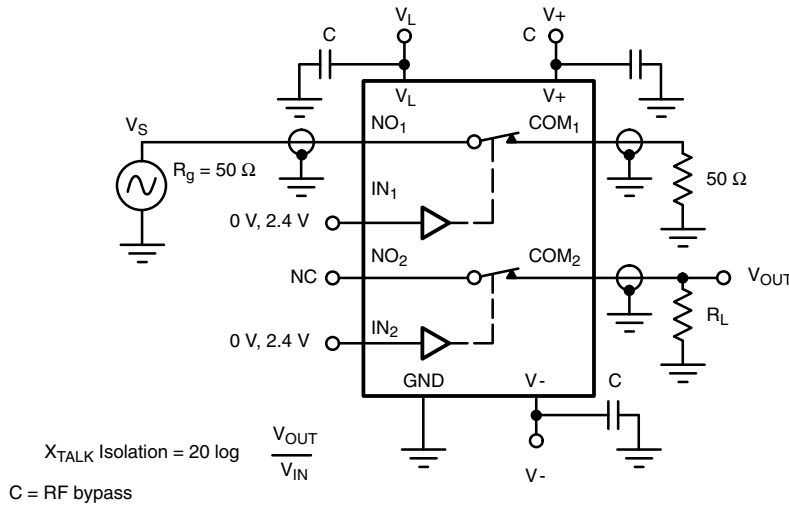


Fig. 5 - Crosstalk

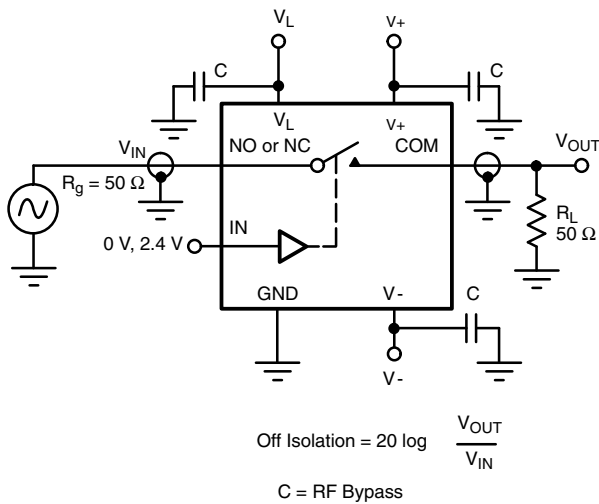


Fig. 6 - Off-Isolation

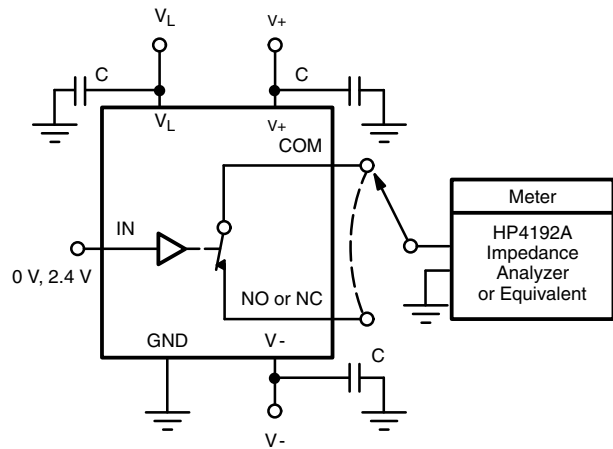


Fig. 7 - Source / Drain Capacitances

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## TSSOP: 16-LEAD

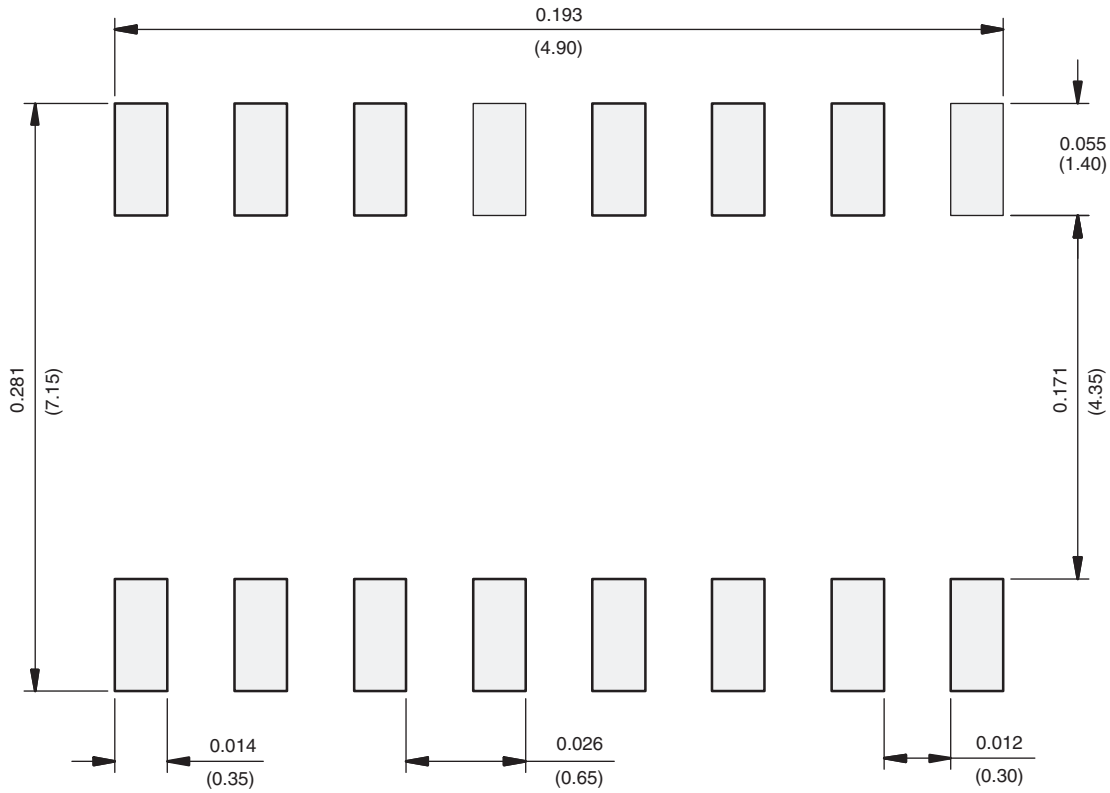


Symbols	DIMENSIONS IN MILLIMETERS		
	Min	Nom	Max
A	-	1.10	1.20
A1	0.05	0.10	0.15
A2	-	1.00	1.05
B	0.22	0.28	0.38
C	-	0.127	-
D	4.90	5.00	5.10
E	6.10	6.40	6.70
E1	4.30	4.40	4.50
e	-	0.65	-
L	0.50	0.60	0.70
L1	0.90	1.00	1.10
y	-	-	0.10
θ1	0°	3°	6°

ECN: S-61920-Rev. D, 23-Oct-06  
DWG: 5624



## RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads  
Dimensions in inches (mm)



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