

## High Voltage, Single and Dual Supply SPDT Analog Switch with Enable Pin

### DESCRIPTION

The DG469, DG470 are high voltage SPDT switches, with a typical on resistance of  $3.6 \Omega$  and typical flatness of  $0.4 \Omega$ . The DG469, DG470 are identical, except the DG470 provides an enable input. When the enable input is activated, both sides of the switch are in a high impedance mode (Off), maintaining a "Safe State" at power up. This function can also be used as a quick "disconnect" in the event of a fault condition. For audio switching, the enable pin provides a mute function. These are high voltage switches that are fully specified with dual supplies at  $\pm 4.5 \text{ V}$  and  $\pm 15 \text{ V}$  and a single supply of  $12 \text{ V}$  over an operating temperature range from  $-40 \text{ }^\circ\text{C}$  to  $+125 \text{ }^\circ\text{C}$ . Fast switching speeds coupled with high signal bandwidth makes these parts suitable for video switching applications. All digital inputs have  $0.8 \text{ V}$  and  $2.4 \text{ V}$  logic thresholds ensuring low voltage TTL/CMOS compatibility. Each switch conducts equally well in both directions when on and can handle an input signal range that extends to the supply voltage rails. They exhibit break-before-make switching action to prevent momentary shorting when switching between channels. The DG469, DG470 are offered in a MSOP 8 and SOIC 8 package.

### FEATURES

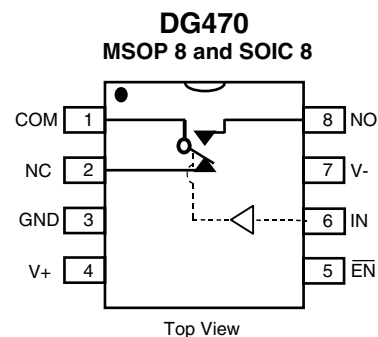
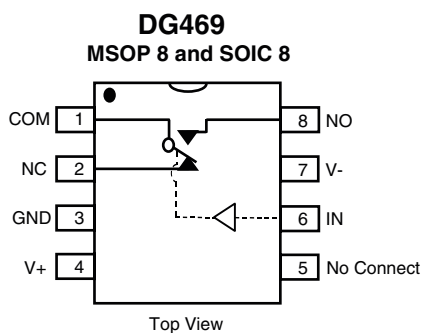
- Low on resistance ( $3.6 \Omega$  typical)
- On resistance flatness ( $0.4 \Omega$  typical)
- $44 \text{ V}$  supply maximum rating
- $\pm 15 \text{ V}$  analog signal range
- Fully specified at supply voltages of  $\pm 4.5 \text{ V}$ ,  $12 \text{ V}$  and  $\pm 15 \text{ V}$
- TTL/CMOS compatible
- Break before make switching guaranteed
- Total harmonic distortion  $0.0145 \%$
- Compliant to RoHS Directive 2002/95/EC


**RoHS**  
COMPLIANT

### APPLICATIONS

- Audio and video signal switching
- Precision automatic test equipment
- Precision data acquisition
- Relay replacement
- Communications systems
- Automotive applications
- Sample and hold systems
- Power routing applications
- Telecom signal switching
- Medical equipment
- Portable and battery power systems

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE DG469		
Logic	NC	NO
0	ON	OFF
1	OFF	ON

TRUTH TABLE DG470			
ENABLE	Logic	NC	NO
0	0	ON	OFF
0	1	OFF	ON
1	X	OFF	OFF

ORDERING INFORMATION		
Temp. Range	Package	Part Number
DG469, DG470		
- 40 °C to 125 °C <sup>a</sup>	8-Pin MSOP	DG469EQ-T1-E3 DG470EQ-T1-E3
	8-Pin Narrow SOIC	DG469EY-T1-E3 DG470EY-T1-E3

Notes:

a. - 40 °C to 85 °C datasheet limits apply.

ABSOLUTE MAXIMUM RATINGS $T_A = 25\text{ °C}$ , unless otherwise noted			
Parameter	Limit	Unit	
V+ to V-	44	V	
GND to V-	25		
Digital Inputs <sup>a</sup> , $V_S$ , $V_D$	(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first		
Continuous Current (NO, NC, or COM)	120	mA	
Current (Any terminal except NO, NC, or COM)	30		
Peak Current, (Pulsed 1 ms, 10 % Duty Cycle)	200		
Storage Temperature	- 65 to 150	°C	
Power Dissipation (Package) <sup>b</sup>	8-Pin MSOP <sup>c</sup>	320	mW
	8-Pin Narrow SOIC <sup>d</sup>	400	

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 4.0 mW/°C above 70 °C.

d. Derate 5.0 mW/°C above 70 °C.

SPECIFICATIONS for Dual Supplies									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^a$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Analog Switch</b>									
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full		- 15	15	- 15	15	V
On-Resistance	$R_{ON}$	$I_S = 50\text{ mA}$ , $V_D = -10\text{ V}$ to $+10\text{ V}$	Room Full	3.6		6 8		6 7	Ω
On-Resistance Match	$\Delta R_{ON}$	$I_S = 50\text{ mA}$ , $V_D = \pm 10\text{ V}$	Room Full	0.12		0.4 0.9		0.4 0.5	
On-Resistance Flatness	$R_{FLATNESS}$	$I_S = 50\text{ mA}$ , $V_D = -5\text{ V}$ , $0\text{ V}$ , $+5\text{ V}$	Room Full	0.4		0.5 0.9		0.5 0.8	
Switch Off Leakage Current	$I_{S(off)}$	$V_D = \pm 14\text{ V}$ , $V_S = \pm 14\text{ V}$	Room Full	$\pm 0.1$	- 0.5 - 20	0.5 20	- 0.5 - 2.5	0.5 2.5	nA
	$I_{D(off)}$		Room Full	$\pm 0.1$	- 0.5 - 20	0.5 20	- 0.5 - 2.5	0.5 2.5	
Channel On Leakage Current	$I_{D(on)}$	$V_S = V_D = \pm 14\text{ V}$	Room Full	$\pm 0.2$	- 0.5 - 20	0.5 20	- 0.5 - 5	0.5 5	
<b>Digital Control</b>									
Input Current, $V_{IN}$ Low	$I_{IL}$	$V_{IN}$ Under Test = $0.8\text{ V}$	Full	0.05	- 1	1	- 1	1	μA
Input Current, $V_{IN}$ High	$I_{IH}$	$V_{IN}$ Under Test = $2.4\text{ V}$	Full	0.05	- 1	1	- 1	1	
Input Capacitance <sup>e</sup>	$C_{IN}$	$f = 1\text{ MHz}$	Room	3.7					pF

<b>SPECIFICATIONS for Dual Supplies</b>									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^a$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Dynamic Characteristics</b>									
Turn-On Time	$t_{ON}$	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = \pm 10\text{ V}$	Room	129		166		166	ns
Turn-Off Time	$t_{OFF}$		Room	80		108		108	
Break-Before-Make Time Delay	$t_D$	$V_S = 10\text{ V}$ $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	Room	15					
Charge Injection <sup>e</sup>	Q	$V_g = 0\text{ V}$ , $R_g = 0\ \Omega$ , $C_L = 1\text{ nF}$	Room	58					pC
Off Isolation <sup>e</sup>	OIRR	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ $f = 1\text{ MHz}$	Room	- 57					dB
Channel-to-Channel Crosstalk <sup>e</sup>	$X_{TALK}$		Room	- 63					
Source Off Capacitance <sup>e</sup>	$C_{S(off)}$	$f = 1\text{ MHz}$	Room	37					pF
Drain Off Capacitance <sup>e</sup>	$C_{D(off)}$		Room	85					
Channel On Capacitance <sup>e</sup>	$C_{D(on)}$		Room	125					
<b>Power Supplies</b>									
Power Supply Current	$I_+$	$V_+ = 16.5\text{ V}$ , $V_- = -16.5\text{ V}$ $V_{IN} = 0\text{ or }5\text{ V}$	Room	3.0		6		6	$\mu\text{A}$
Negative Supply Current	$I_-$		Room	- 0.4	- 0.5		- 0.5		
Ground Current	$I_{GND}$		Room	- 3.0	- 6		- 6		

<b>SPECIFICATIONS for Dual Supplies</b>									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 4.5\text{ V}$ , $V_- = -4.5\text{ V}$ $V_{IN} = 2.4\text{ V}$ , $0.8\text{ V}^a$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	- 45 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Analog Switch</b>									
Analog Signal Range <sup>e</sup>	$V_{ANALOG}$		Full		- 4.5	4.5	- 4.5	4.5	V
On-Resistance <sup>e</sup>	$R_{ON}$	$I_S = 50\text{ mA}$ , $V_D = -2\text{ V to }+2\text{ V}$	Room	8		11		11	$\Omega$
On-Resistance Match <sup>e</sup>	$\Delta R_{ON}$	$I_S = 50\text{ mA}$ , $V_D = \pm 2\text{ V}$	Room	0.6		0.7		0.7	
<b>Dynamic Characteristics</b>									
Turn-On Time <sup>e</sup>	$t_{ON}$	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ $V_S = 2\text{ V}$	Room	245		265		65	ns
Turn-Off Time <sup>e</sup>	$t_{OFF}$		Room	145		163		163	
Break-Before-Make <sup>e</sup> Time Delay	$t_D$	$V_S = 2\text{ V}$ $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	Room	15					
Charge Injection <sup>e</sup>	Q	$V_g = 0\text{ V}$ , $R_g = 0\ \Omega$ , $C_L = 1\text{ nF}$	Full	58					pC
<b>Power Supplies</b>									
Power Supply Current <sup>e</sup>	$I_+$	$V_{IN} = 0\text{ or }4.5\text{ V}$	Room	3.0		6		6	$\mu\text{A}$
Negative Supply Current <sup>e</sup>	$I_-$		Room	- 0.4	- 0.5		- 0.5		
Ground Current <sup>e</sup>	$I_{GND}$		Room	3.0	- 6		- 6		



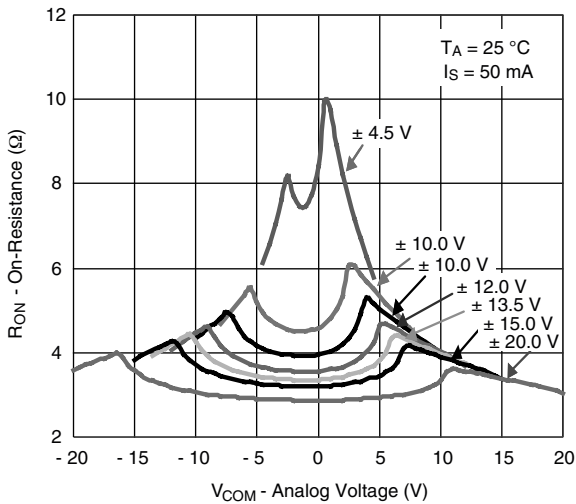
SPECIFICATIONS for Unipolar Supplies									
Parameter	Symbol	Test Conditions Unless Specified V+ = 12 V, V- = 0 V V <sub>IN</sub> = 2.4 V, 0.8 V <sup>a</sup>	Temp. <sup>b</sup>	Typ. <sup>c</sup>	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
<b>Analog Switch</b>									
Analog Signal Range <sup>e</sup>	V <sub>ANALOG</sub>		Full			12		12	V
On-Resistance	R <sub>ON</sub>	I <sub>S</sub> = 25 mA, V <sub>D</sub> = 0 V to + 10 V	Room Full	7.5		8.5 14		8.5 11.3	Ω
On-Resistance Match	ΔR <sub>ON</sub>	I <sub>S</sub> = 25 mA, V <sub>D</sub> = + 10 V	Room Full	0.4		0.45 0.9		0.45 0.5	
On-Resistance Flatness	R <sub>FLATNESS</sub>	I <sub>S</sub> = 25 mA, V <sub>D</sub> = 0 V, + 5 V, + 10 V	Room Full	2.5		2.6 2.9		2.6 2.8	
<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>S</sub> = 10 V	Room Full	190		200 255		200 240	ns
Turn-Off Time	t <sub>OFF</sub>		Room Full	100		110 135		110 120	
Break-Before-Make Time Delay	t <sub>D</sub>	V <sub>S</sub> = 10 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room	50					
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	2.4					pC
<b>Power Supplies</b>									
Power Supply Current	I+	V <sub>IN</sub> = 0 or 5 V	Room Full	3.0		6 7		6 7	μA
Negative Supply Current	I-		Room Full	- 0.4	- 0.5 - 4.5		- 0.5 - 4.5		
Ground Current	I <sub>GND</sub>		Room Full	- 3.0	- 6 - 7		- 6 - 7		

Notes:

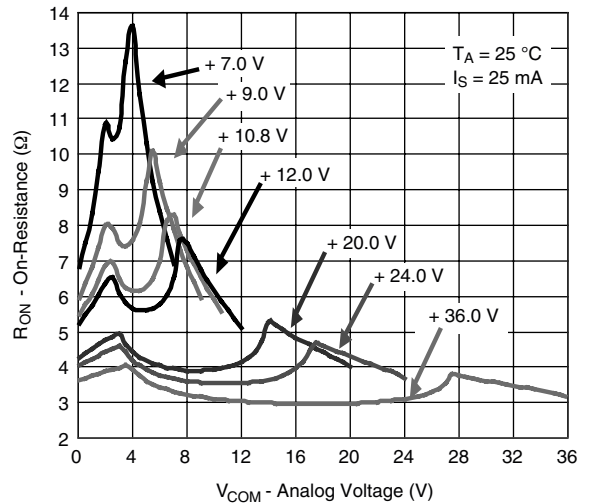
- a. V<sub>IN</sub> = input voltage to perform proper function.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The algebraic convention whereby the most negative value is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

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.

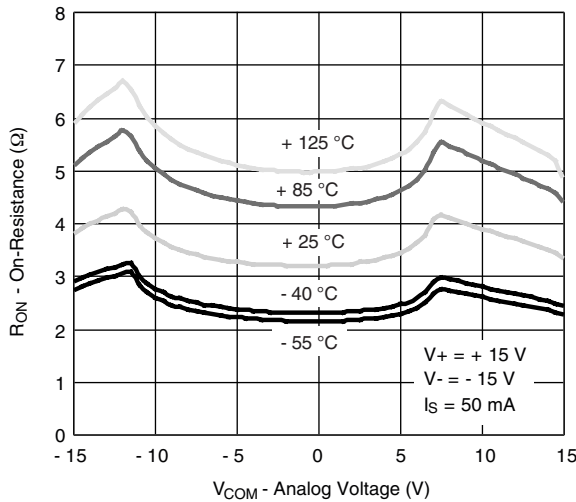
**TYPICAL CHARACTERISTICS**



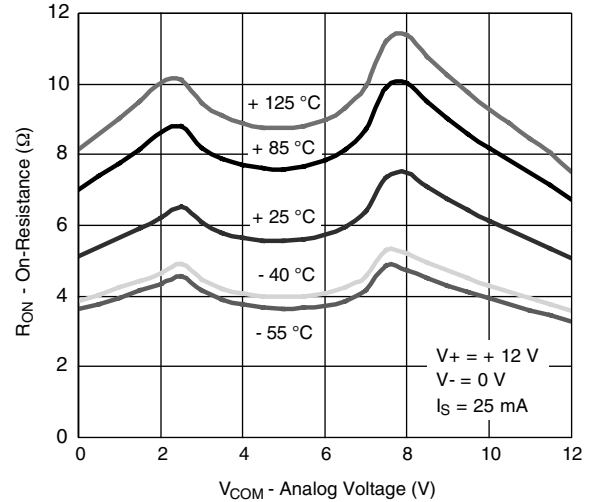
**On-Resistance vs.  $V_D$  and Dual Supply Voltage**



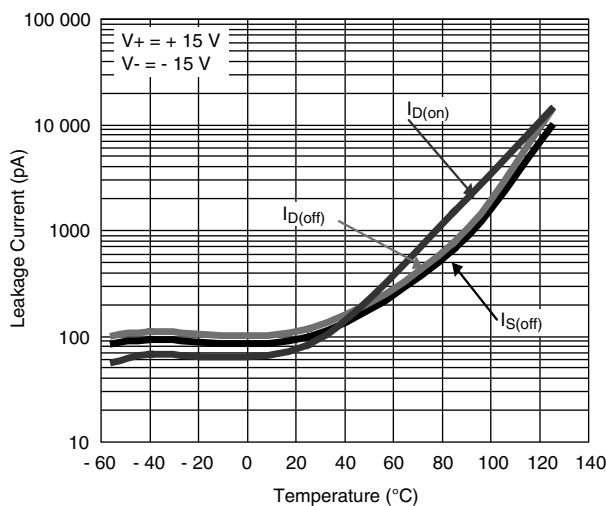
**On-Resistance vs.  $V_D$  and Single Supply Voltage**



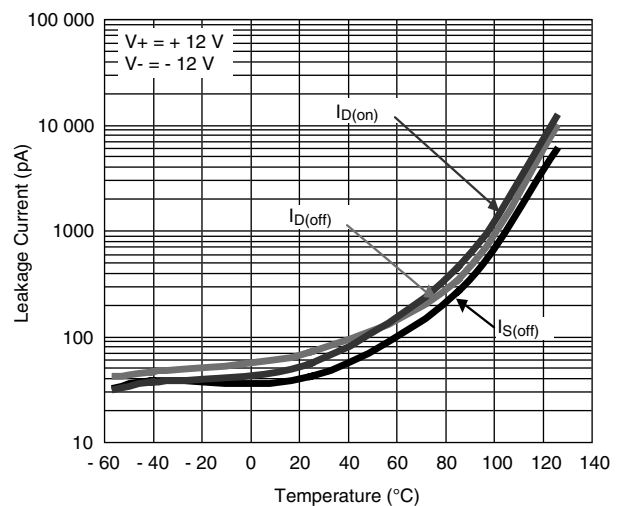
**On-Resistance vs.  $V_D$  and Temperature**



**On-Resistance vs.  $V_D$  and Temperature**

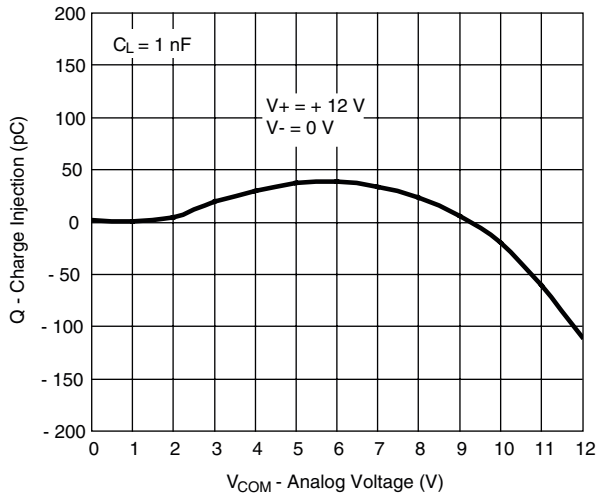


**Leakage Current vs. Temperature**

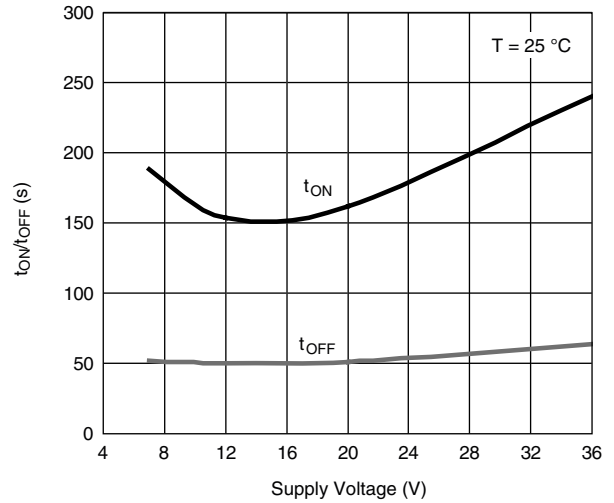


**Leakage Current vs. Temperature**

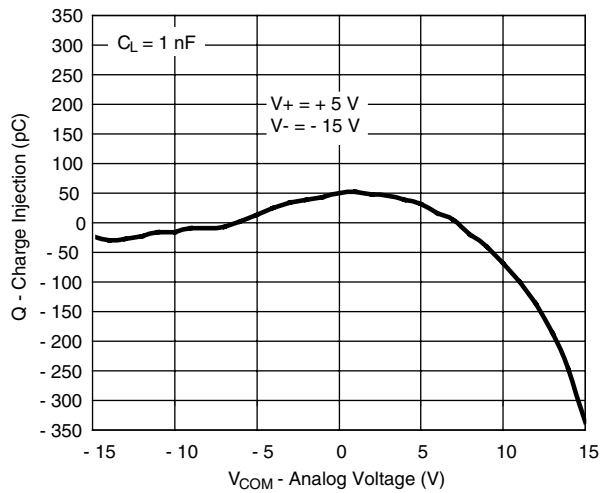
## TYPICAL CHARACTERISTICS



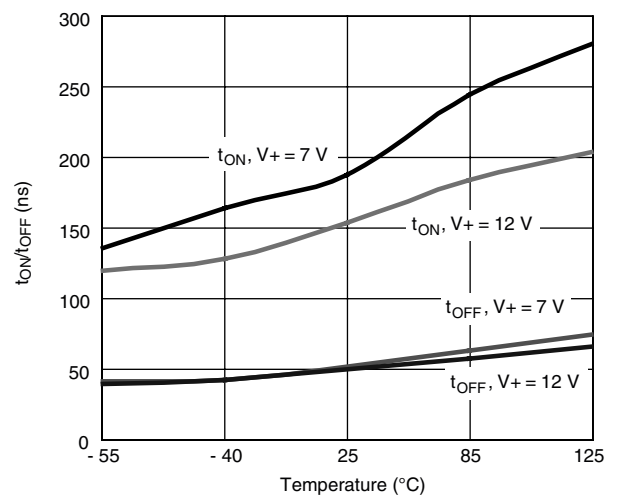
Charge Injection vs. Analog Voltage



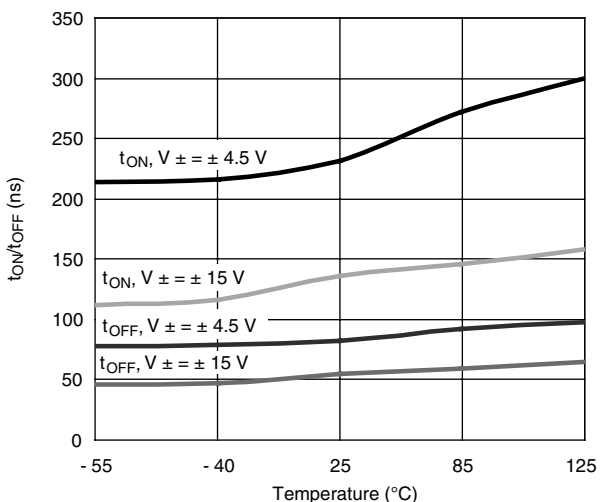
Switching Time vs. Single Supply Voltage



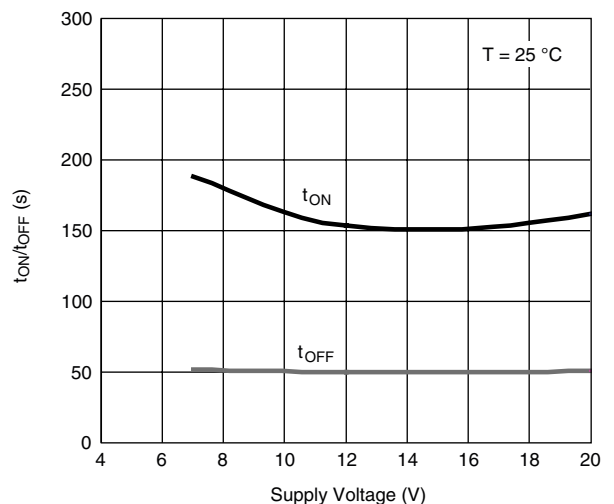
Charge Injection vs. Analog Voltage



Switching Time vs. Temperature and Single Supply Voltage

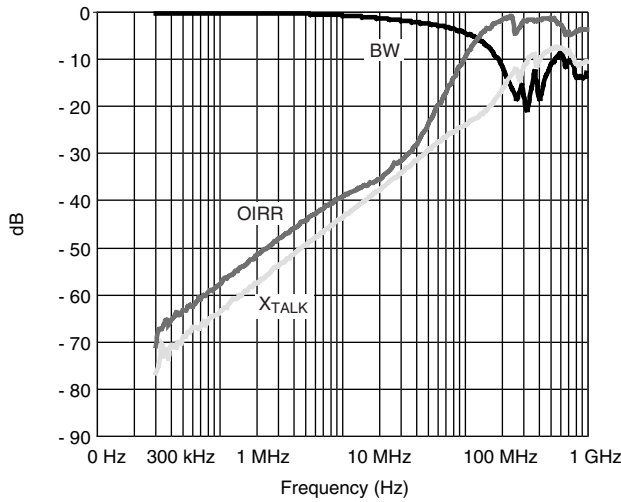


Switching Time vs. Temperature and Dual Supply Voltage

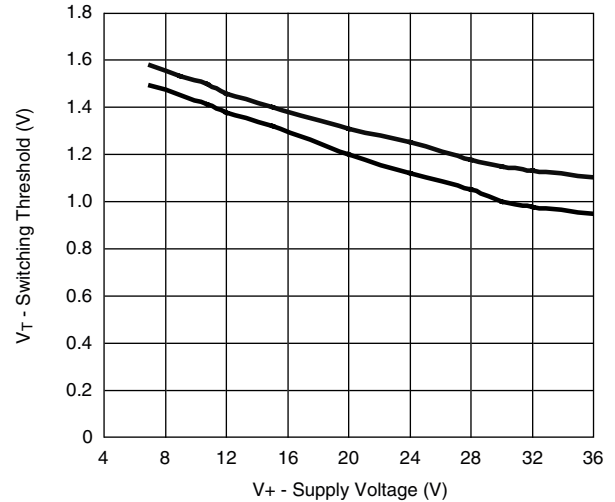


Switching Time vs. Dual Supply Voltage

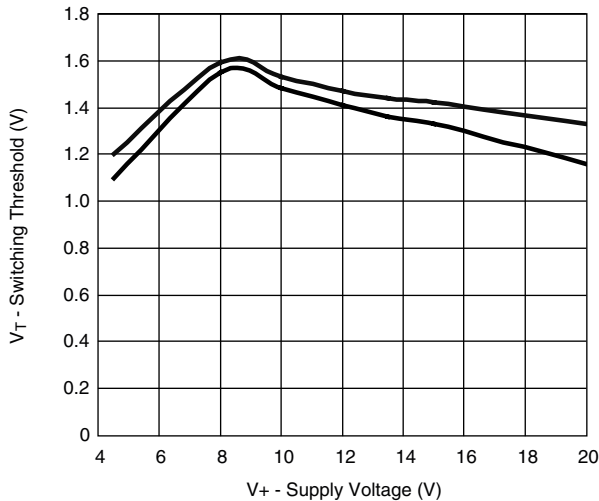
**TYPICAL CHARACTERISTICS**



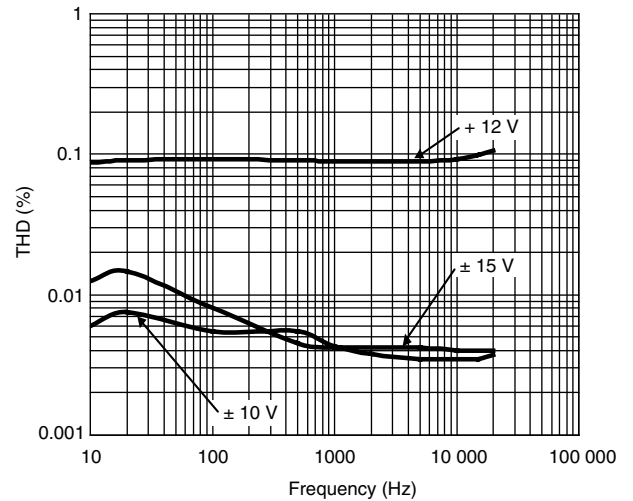
**Insertion Loss, Off-Isolation, Crosstalk vs. Frequency**



**Switching Threshold vs. Signal Supply Voltage**

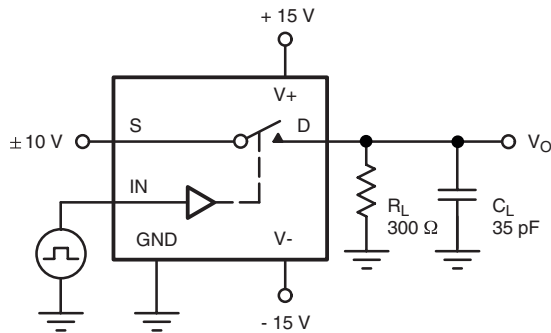


**Switching Threshold vs. Dual Supply Voltage**



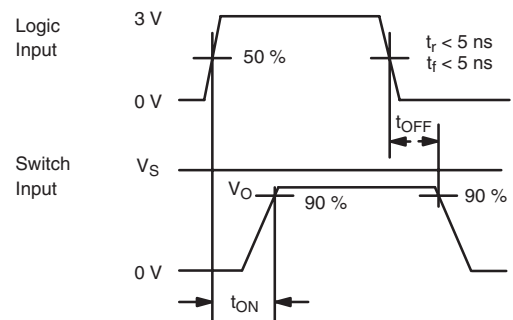
**DG469, DG470 Total Harmonic Distortion**

**TEST CIRCUITS**



$C_L$  (includes fixture and stray capacitance)

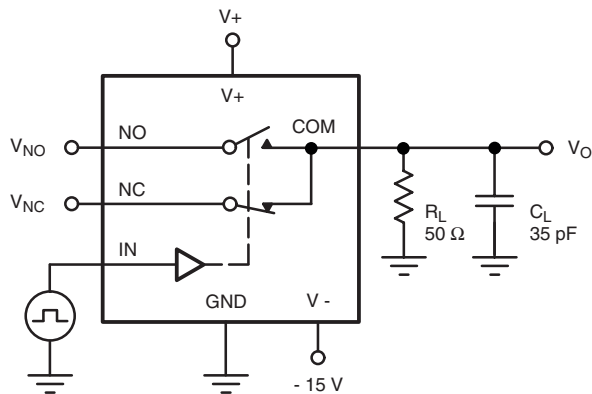
$$V_O = V_S \frac{R_L}{R_L + \tau_{DS(on)}}$$



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

**Figure 1. Switching Time**

## TEST CIRCUITS



$C_L$  (includes fixture and stray capacitance)

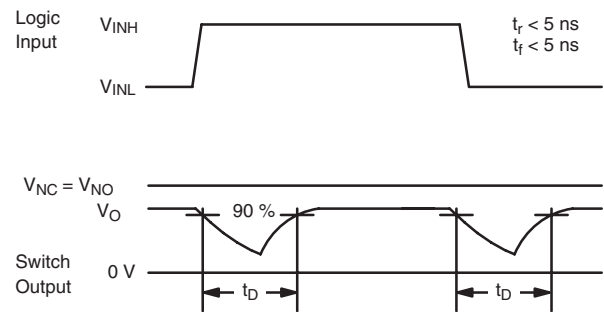


Figure 2. Break-Before-Make

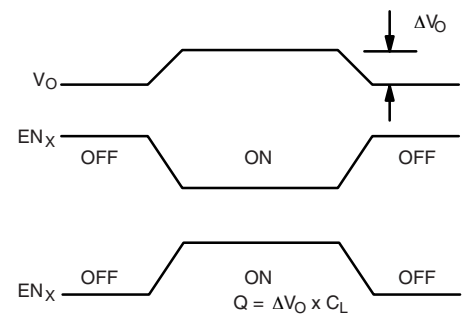
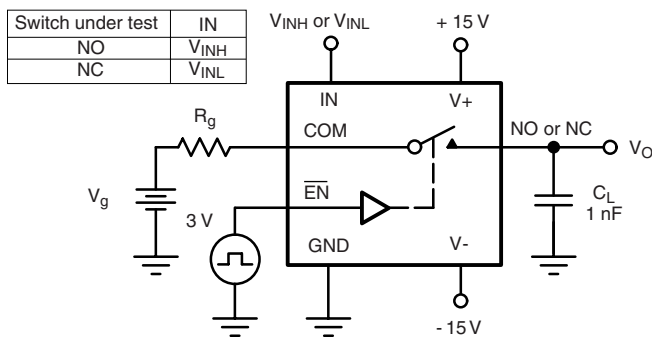


Figure 3. Charge Injection

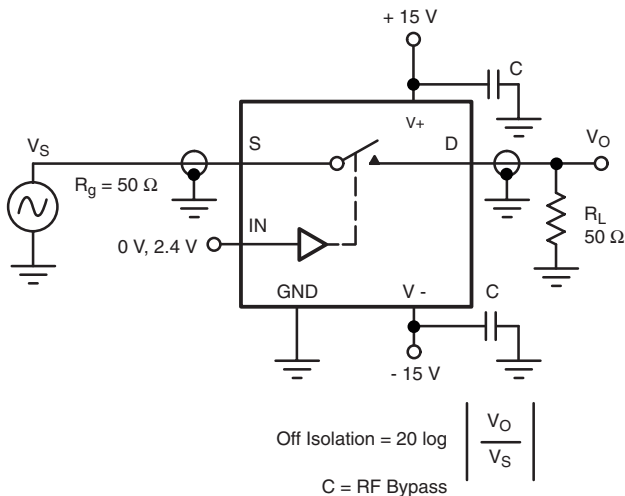


Figure 4. Off-Isolation

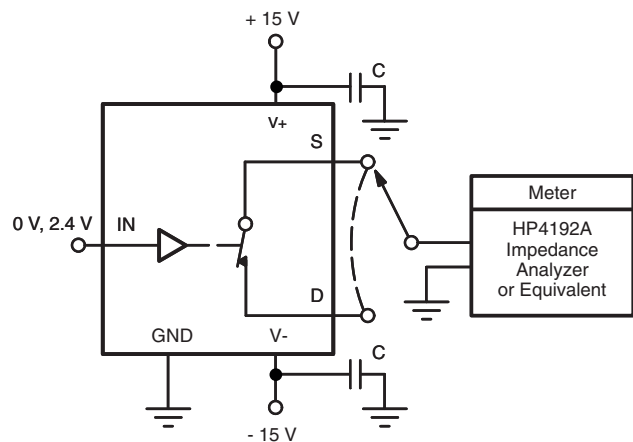


Figure 5. Source/Drain Capacitances

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