

# Precision 8-Channel/Dual 4-Channel CMOS Analog Multiplexers

## DESCRIPTION

The DG508B is an 8-channel single-ended analog multiplexer designed to connect one of eight inputs to a common output as determined by a 3-bit binary address (A0, A1, A2). The DG509B is a dual 4-channel differential analog multiplexer designed to connect one of four differential inputs to a common dual output as determined by its 2-bit binary address (A0, A1). Break-before-make switching action protects against momentary crosstalk between adjacent channels.

An on channel conducts current equally well in both directions. In the off state each channel blocks voltages up to the power supply rails. An enable (EN) function allows the user to reset the multiplexer/demultiplexer to all switches off for stacking several devices. All control inputs, addresses (Ax) and enable (EN) are TTL compatible over the full specified operating temperature range.

The DG508B and DG509B are fabricated on an enhanced SG-II CMOS process that achieves improved performance on: reduced charge injection, lower device leakage, and minimized parasitic capacitance.

As the DG508, DG509 has a long history in the industry with many suppliers offering copies - and in some cases improved variations - with the best in class improvements, the Vishay Siliconix new version of the DG508B, DG509B are the superior alternatives to what is currently available.

Applications for the DG508B, DG509B include high speed and high precision data acquisition, audio signal switching and routing, ATE systems, and avionics. High performance and low power dissipation make them ideal for battery operated and remote instrumentation applications.

The DG508B and DG509B have the absolute maximum voltage rating extended to 44 V. Additionally, single supply operation is also allowed. An epitaxial layer prevents latch-up.

The DG508B and DG509B are both available in 16-lead SOIC and TSSOP package options with extended temperature range of -40 °C to +125 °C.

For more information, refer to Vishay Siliconix DG508B, DG509B evaluation board note.

## FEATURES

- Operate with single or dual power supply
- V+ to V- analog signal swing range
- 44 V power supply maximum rating
- Extended operate temperature range:
  - 40 °C to + 125 °C
- Low leakage typically < 3 pA
- Low charge injection -  $Q_{INJ} = 2$  pC
- Low power -  $I_{SUPPLY} = 10$   $\mu$ A
- TTL compatible logic
- > 250 mA latch up current per JESD78
- Available in SOIC16 and TSSOP16 packages
- Superior alternative to:
  - ADG508A, DG508A, HI-508
  - ADG509A, DG509A, HI-509
- Compliant to RoHS directive 2002/95/EC
- Halogen-free according to IEC 61249-2-21 definition



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

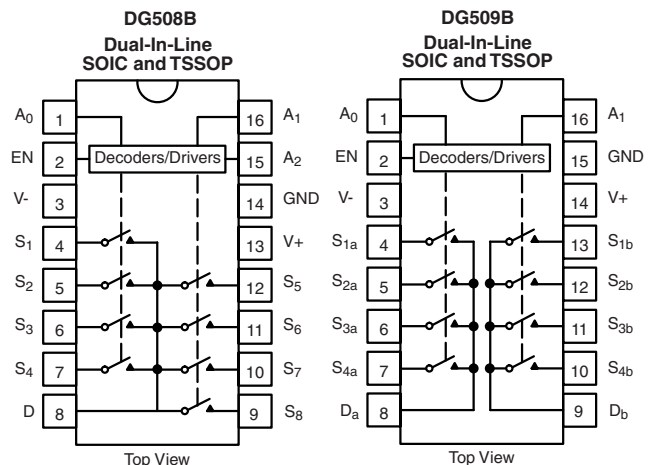
## BENEFITS

- Reduced switching errors
- Reduced glitching
- Improved data throughput
- Reduced power consumption
- Increased ruggedness
- Wide supply ranges ( $\pm 5$  V to  $\pm 20$  V)

## APPLICATIONS

- Data acquisition systems
- Audio and video signal routing
- ATE systems
- Medical instrumentation

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



## TRUTH TABLES AND ORDERING INFORMATION

TRUTH TABLE DG508B				
A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	EN	On Switch
X	X	X	0	None
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

TRUTH TABLE DG509B			
A <sub>1</sub>	A <sub>0</sub>	EN	On Switch
X	X	0	None
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

Logic "0" =  $V_{IL} \leq 0.8\text{ V}$   
 Logic "1" =  $V_{IH} \geq 2.0\text{ V}$   
 X = Do not care

ORDERING INFORMATION DG508B		
Temp. Range	Package	Part Number
- 40 °C to 125 °C	16-Pin SOIC	DG508BEY-T1-E3
	16-Pin TSSOP	DG508BEQ-T1-E3

ORDERING INFORMATION DG509B		
Temp. Range	Package	Part Number
- 40 °C to 125 °C	16-Pin SOIC	DG509BEY-T1-E3
	16-Pin TSSOP	DG509BEQ-T1-E3

ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Voltages Referenced to V-	V+	44	V
	GND	25	
Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub>		(V-) - 2 to (V+) + 2 or 20 mA, whichever occurs first	
Current (Any terminal)		30	mA
Peak Current, S or D (Pulsed at 1 ms, 10 % duty cycle max.)		100	
Storage Temperature	(EY, EQ suffix)	- 65 to 150	°C
Power Dissipation (Packages) <sup>b</sup>	16-Pin Narrow SOIC <sup>c</sup>	640	mW
	16-Pin TSSOP <sup>d</sup>	450	
Thermal Resistance ( $\theta_{J-A}$ ) <sup>b</sup>	16-Pin Narrow SOIC <sup>c</sup>	125	°C/W
	16-Pin TSSOP <sup>d</sup>	178	

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub> or IN<sub>X</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads soldered or welded to PC board.
- c. Derate 8.0 mW/°C above 70 °C.
- d. Derate 5.6 mW/°C above 70 °C.

<b>SPECIFICATIONS</b>										
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 15\text{ V}$ , $V_- = -15\text{ V}$ ( $\pm 10\%$ ) $V_{AX}$ , $V_{EN} = 2.0\text{ V}$ , $0.8\text{ V}^a$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	A Suffix - 40 °C to 125 °C		D Suffix - 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	
Drain-Source On-Resistance	$R_{DS(on)}$	$V_D = \pm 10\text{ V}$ , $I_S = -1\text{ mA}$	Room	180		380		380	$\Omega$	
			Full			480		450		
$R_{DS(on)}$ Matching	$\Delta R_{DS(on)}$	$V_D = \pm 10\text{ V}$	Room	10						
Source Off Leakage Current	$I_{S(off)}$	$V_D = \pm 10\text{ V}$ $V_S = \mp 10\text{ V}$ $V_{EN} = 0\text{ V}$	Room		- 1	1	- 1	1	nA	
			Full			- 50	50	- 50		50
Drain Off Leakage Current	$I_{D(off)}$		DG508B	Room		- 1	1	- 1		1
				Full		- 100	100	- 100		100
			DG509B	Room		- 1	1	- 1		1
				Full		- 50	50	- 50		50
Drain On Leakage Current	$I_{D(on)}$	$V_S = V_D = \mp 10$ sequence each switch on	DG508B	Room		- 1	1	- 1	1	
				Full		- 100	100	- 100	100	
	Room				- 1	1	- 1	1		
	Full				- 50	50	- 50	50		
<b>Digital Control</b>										
Logic High Input Voltage	$V_{INH}$		Full		2.0		2.0		V	
Logic Low Input Voltage	$V_{INL}$		Full			0.8		0.8		
Logic High Input Current	$I_{IH}$	$V_{AX}$ , $V_{EN} = 2.0\text{ V}$	Full		- 1	1	- 1	1	$\mu\text{A}$	
Logic Low Input Current	$I_{IL}$	$V_{AX}$ , $V_{EN} = 0.8\text{ V}$	Full		- 1	1	- 1	1		
Logic Input Capacitance <sup>e</sup>	$C_{in}$	$f = 1\text{ MHz}$	Room	4					pF	
<b>Dynamic Characteristics</b>										
Transition Time	$t_{TRANS}$	$V_{S1} = +10\text{ V}/-10\text{ V}$ , $V_{S8} = -10\text{ V}/+10\text{ V}$ , $R_L = 1\text{ M}\Omega$ , $C_L = 35\text{ pF}$	Room	145		300		300		
			Full			400		400		
Break-Before-Make Interval	$t_{OPEN}$	$V_{S1} = V_{S8} = 5.0\text{ V}$ , $C_L = 35\text{ pF}$ , $R_L = 1\text{ k}\Omega$	Room	37	15		15		ns	
			Full		1		1			
Enable Turn-On Time	$t_{ON(EN)}$	$V_{S1} = 5\text{ V}$ , $V_{S2}$ to $V_{S8} = 0\text{ V}$ , $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$	Room	100		250		250		
			Full			300		300		
Enable Turn-Off Time	$t_{OFF(EN)}$		Room	90		240		240		
			Full			340		340		
Charge Injection <sup>e</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}$ , $R_{GEN} = 0\ \Omega$ , $V_{GEN} = 0\text{ V}$	Full	2					pC	
Off Isolation <sup>e</sup>	OIRR	$C_L = 5\text{ pF}$ , $R_L = 50\ \Omega$ , $f = 1\text{ MHz}$	Room	- 81					dB	
Crosstalk <sup>e</sup>	XTALK		Room	- 88						
- 3 dB Bandwidth <sup>e</sup>	BW	$R_L = 50\ \Omega$	Room	250					MHz	
Total Harmonic Distortion <sup>e</sup>	THD	$R_L = 10\text{ k}\Omega$ , $5\text{ V}_{rms}$ $f = 20\text{ Hz}$ to $20\text{ kHz}$	Room	0.04					%	
Source Off Capacitance <sup>e</sup>	$C_{S(off)}$	$f = 1\text{ MHz}$	Room	3					pF	
Drain Off Capacitance <sup>e</sup>	$C_{D(off)}$		DG508B	Room	13					
			DG509B	Room	8					
Drain On Capacitance <sup>e</sup>	$C_{D(on)}$		DG508B	Room	18					
		DG509B	Room	11						
<b>Power Supply</b>										
Positive Supply Current	I+	$V_{AX}$ , $V_{EN} = 0\text{ V}$ or $V_+$	Room	0.01		0.5		0.5	mA	
			Full			0.6		0.6		
Negative Supply Current	I-		Full			- 200		- 200	$\mu\text{A}$	

SPECIFICATIONS Single Supply 12 V										
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$ ( $\pm 10\%$ ) $V_{AX}$ , $V_{EN} = 2.0\text{ V}$ , $0.8\text{ V}^a$	Temp. <sup>b</sup>	Typ. <sup>c</sup>	A Suffix - 40 °C to 125 °C		D Suffix - 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		0	12	0	12	V	
On-Resistance	$R_{DS(on)}$	$V_D = 10\text{ V}/0\text{ V}$ , $I_S = 1\text{ mA}$	Room	265		500		500	$\Omega$	
$R_{DS(on)}$ Matching	$\Delta R_{DS(on)}$		Full			650		600		
Switch Off Leakage Current	$I_{S(off)}$	$V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$ $V_D = 0\text{ V}/10\text{ V}$ , $V_S = 10\text{ V}/0\text{ V}$	Room		- 1	1	- 1	1	nA	
			Full		- 50	- 50	- 50	50		
	$I_{D(off)}$		DG508B	Room		- 1	1	- 1		1
			DG509B	Room		- 1	1	- 1		1
	$I_{D(on)}$		DG508B	Room		- 1	1	- 1		1
			DG509B	Room		- 1	1	- 1		1
Channel On Leakage Current	$I_{D(on)}$	DG508B	Room		- 1	1	- 1	1		
		DG508B	Full		- 100	100	- 100	100		
		DG509B	Room		- 1	1	- 1	1		
		DG509B	Full		- 50	50	- 50	50		
<b>Digital Control</b>										
Logic High Input Voltage	$V_{INH}$		Full		2.0		2.0		V	
Logic Low Input Voltage	$V_{INL}$		Full			0.8		0.8		
Logic High Input Current	$I_{IH}$	$V_{AX}$ , $V_{EN} = 2.0\text{ V}$	Full		- 1	1	- 1	1	$\mu\text{A}$	
Logic Low Input Current	$I_{IL}$	$V_{AX}$ , $V_{EN} = 0.8\text{ V}$	Full		- 1	1	- 1	1		
Logic Input Capacitance <sup>e</sup>	$C_{in}$	$f = 1\text{ MHz}$	Room	4					pF	
<b>Dynamic Characteristics</b>										
Transition Time	$t_{TRANS}$	$V_{S1} = 10\text{ V}/0\text{ V}$ , $V_{S8} = 0\text{ V}/10\text{ V}$ , $R_L = 1\text{ M}\Omega$ , $C_L = 35\text{ pF}$	Room	165		400		400	ns	
			Full			550		500		
Break-Before-Make Interval	$t_{OPEN}$	$V_{S1} = V_{S8} = 5\text{ V}$ , $C_L = 35\text{ pF}$ , $R_L = 1\text{ k}\Omega$	Room	37	15		15			
			Full		1		1			
Enable Turn-On Time	$t_{ON(EN)}$	$V_{S1} = 5\text{ V}$ , $V_{S2}$ to $V_{S8} = 0\text{ V}$ , $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$	Room	125		300		300		
			Full			550		425		
Enable Turn-Off Time	$t_{OFF(EN)}$		Room	75		250		250		
			Full			350		300		
Charge Injection <sup>e</sup>	$Q_{INJ}$	$C_L = 1\text{ nF}$ , $R_{GEN} = 0\ \Omega$ , $V_{GEN} = 0\text{ V}$	Full	2.5					pC	
Off Isolation <sup>e</sup>	OIRR	$C_L = 5\text{ pF}$ , $R_L = 50\ \Omega$ $f = 1\text{ MHz}$	Room	- 80					dB	
Crosstalk <sup>e</sup>	$X_{TALK}$		Room	- 88						
- 3 dB Bandwidth <sup>e</sup>	BW	$R_L = 50\ \Omega$	Room	200					MHz	
Total Harmonic Distortion <sup>e</sup>	THD	$R_L = 10\text{ k}\Omega$ , $5\text{ V}_{RMS}$ , $f = 20\text{ Hz}$ to $20\text{ kHz}$	Room	0.26					%	

SPECIFICATIONS Single Supply 12 V										
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_+ = 12\text{ V}$ , $V_- = 0\text{ V}$ ( $\pm 10\%$ ) $V_{AX}$ , $V_{EN} = 2.0\text{ V}$ , $0.8\text{ V}^a$		Temp. <sup>b</sup>	Typ. <sup>c</sup>	A Suffix - 40 °C to 125 °C		D Suffix - 40 °C to 85 °C		Unit
						Min. <sup>d</sup>	Max. <sup>d</sup>	Min. <sup>d</sup>	Max. <sup>d</sup>	
Source Off Capacitance <sup>e</sup>	$C_{S(off)}$	f = 1 MHz		Room	2				pF	
Drain Off Capacitance <sup>e</sup>	$C_{D(off)}$				DG508B	13				
					DG509B	8				
Channel On Capacitance <sup>e</sup>	$C_{D(on)}$				DG508B	17				
			DG509B	12						
Power Supply										
Power Supply Current	$I_+$	$V_{AX}$ , $V_{EN} = 0\text{ V}$ , or $V_+$		Room	0.01		0.5		0.5	mA
				Full			0.6		0.6	

**Notes:**

- $V_{AX}$ ,  $V_{EN}$  = input voltage perform proper function.
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- $\Delta R_{DS(on)} = R_{DS(on) \text{ max.}} - R_{DS(on) \text{ min.}}$

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.

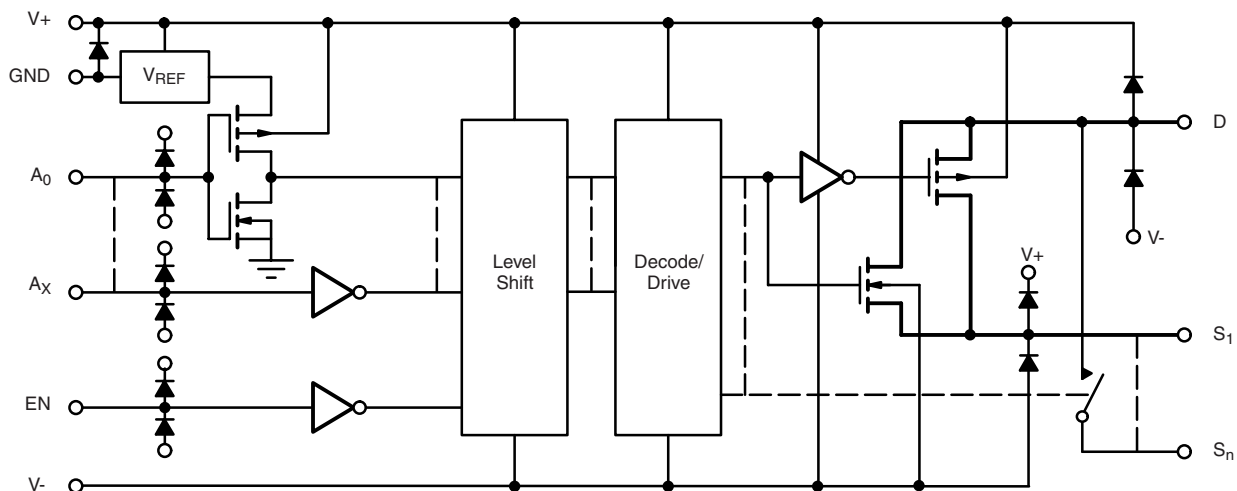
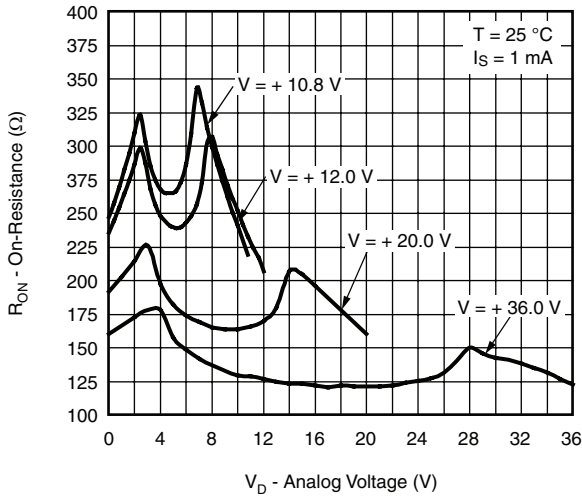
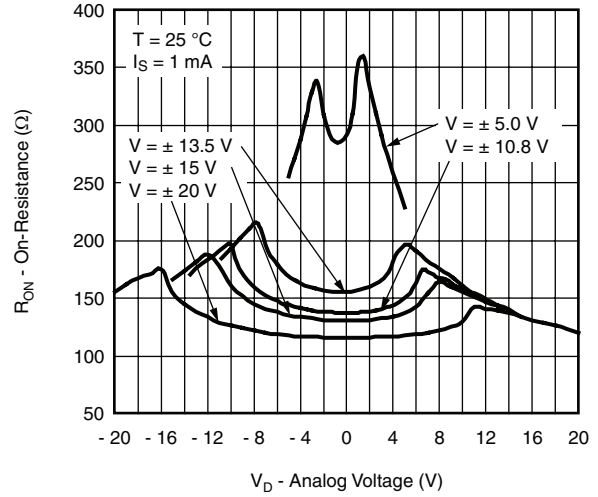
**SCHEMATIC DIAGRAM** Typical Channel


Figure 1.

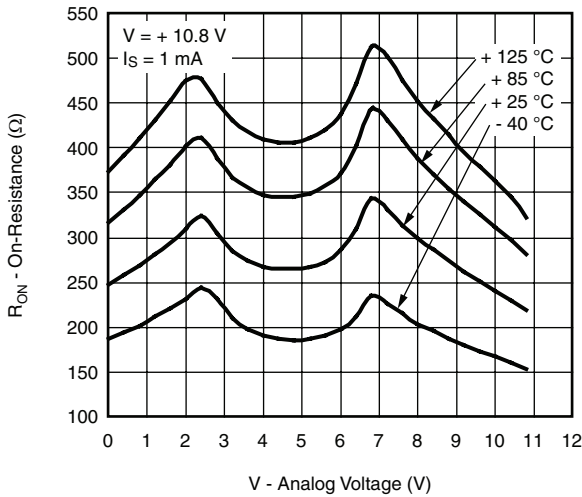
### TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



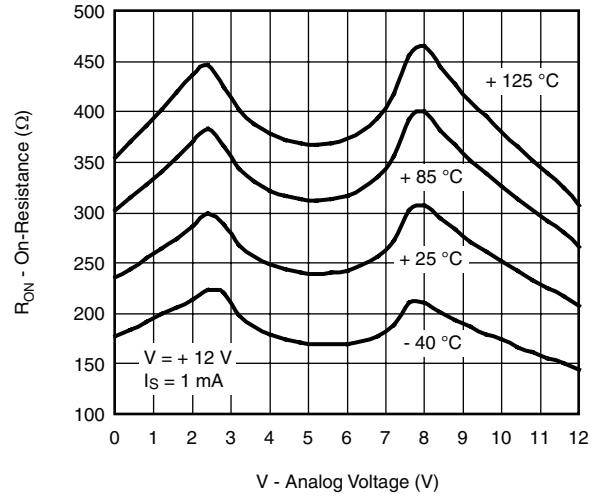
On-Resistance vs.  $V_D$  and Single Supply Voltage



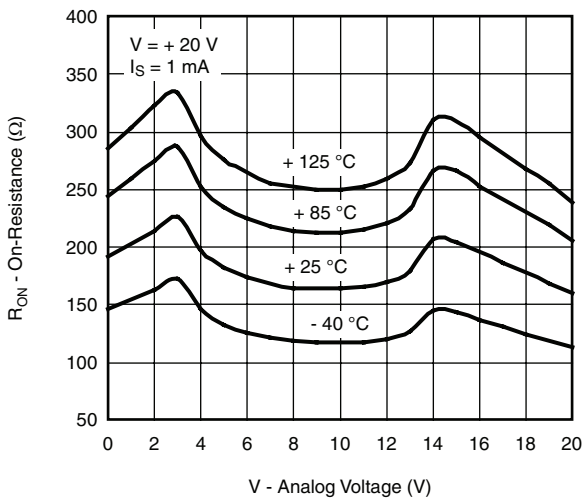
On-Resistance vs.  $V_D$  and Dual Supply Voltage



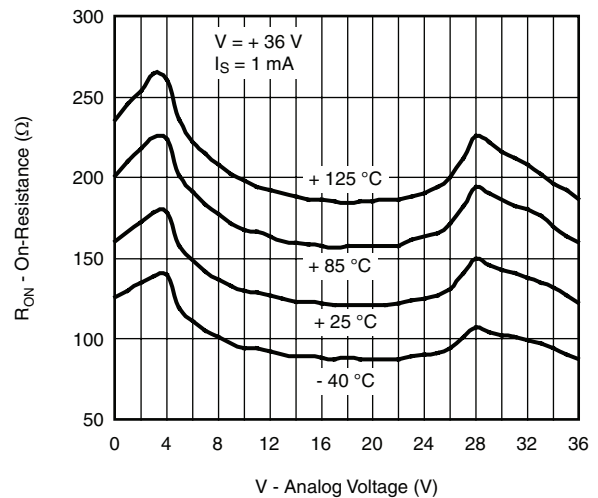
On-Resistance vs. Analog Voltage and Temperature



On-Resistance vs. Analog Voltage and Temperature

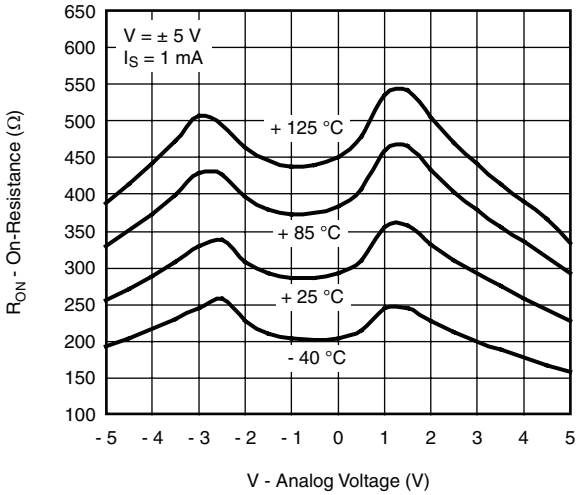


On-Resistance vs. Analog Voltage and Temperature

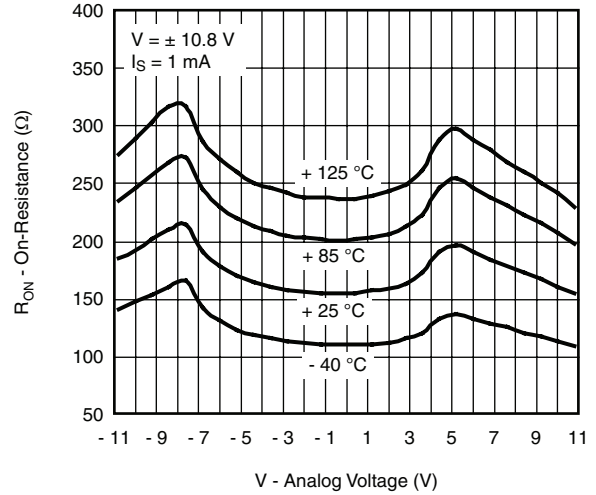


On-Resistance vs. Analog Voltage and Temperature

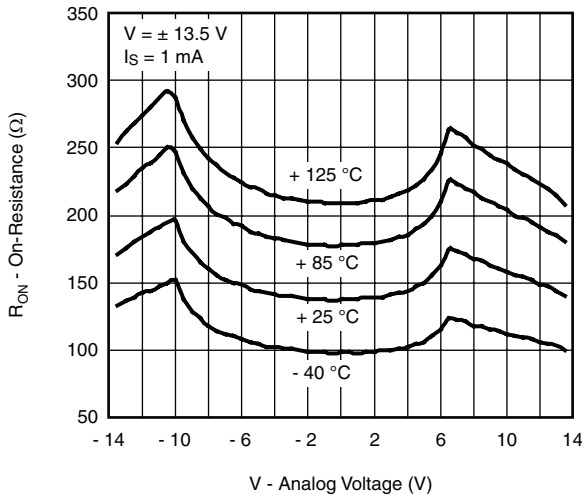
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



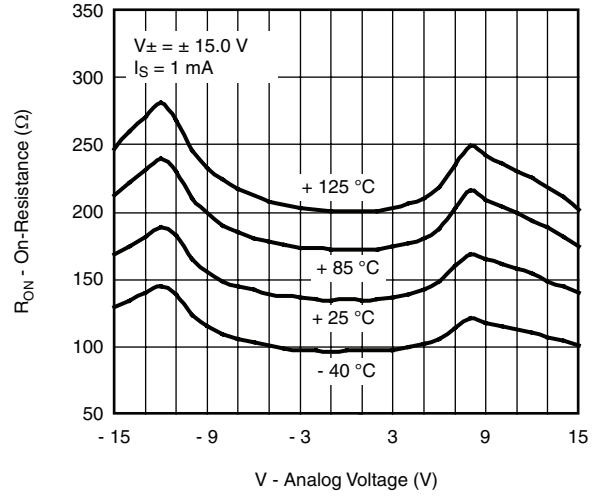
**On-Resistance vs. Analog Voltage and Temperature**



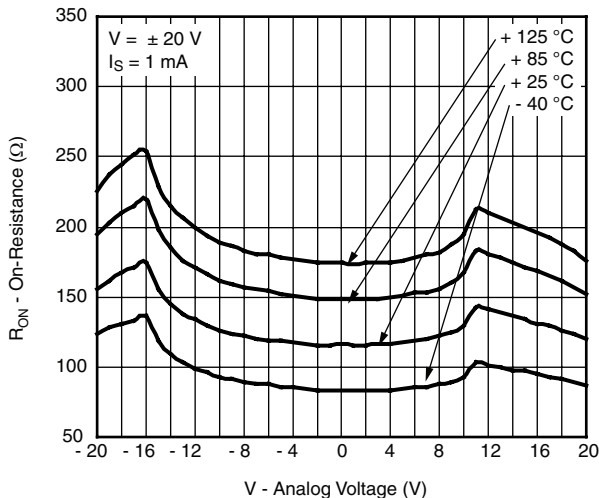
**On-Resistance vs. Analog Voltage and Temperature**



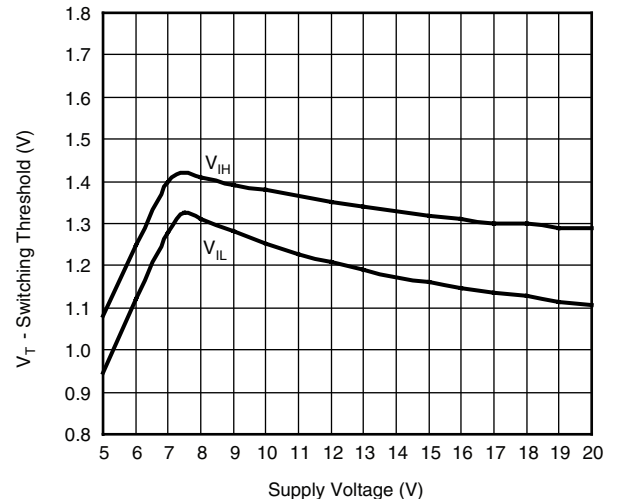
**On-Resistance vs. Analog Voltage and Temperature**



**On-Resistance vs. Analog Voltage and Temperature**

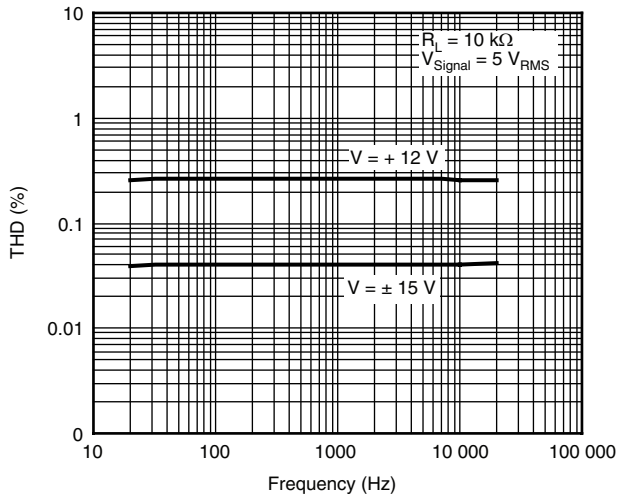


**On-Resistance vs. Analog Voltage and Temperature**

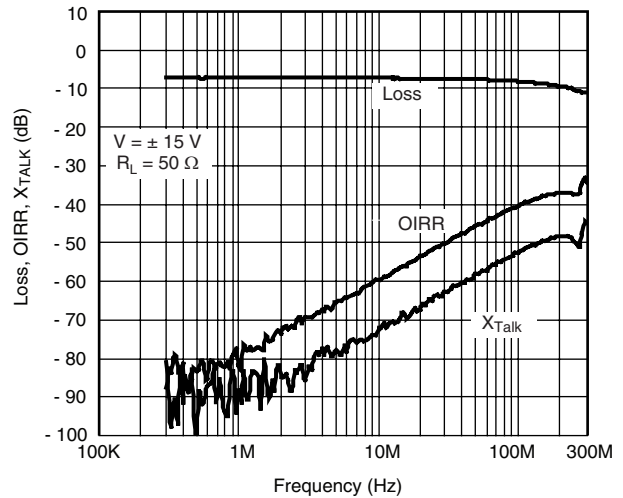


**Switching Threshold vs. Supply Voltage**

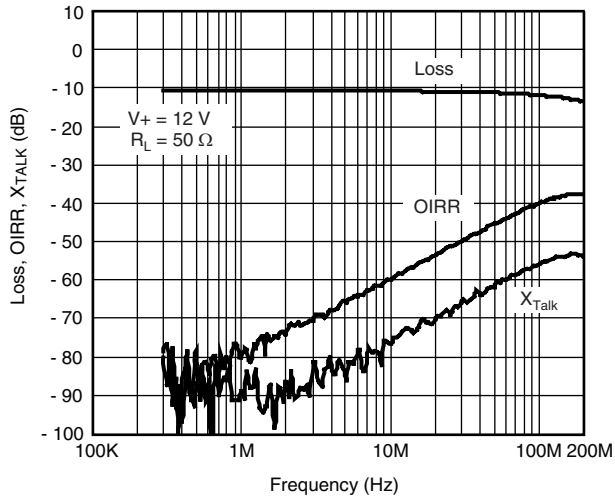
### TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



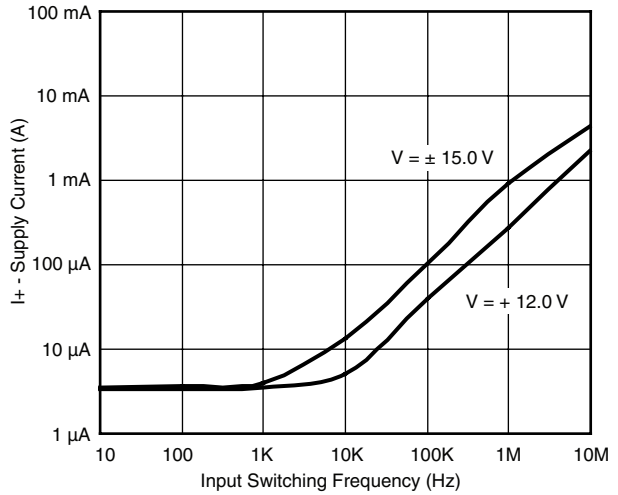
THD vs. Frequency



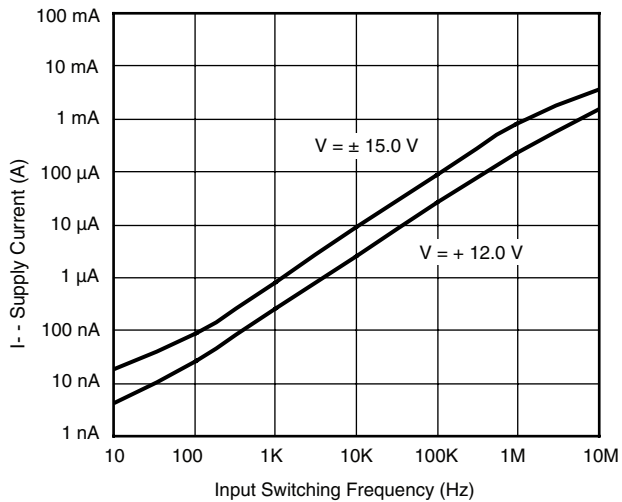
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



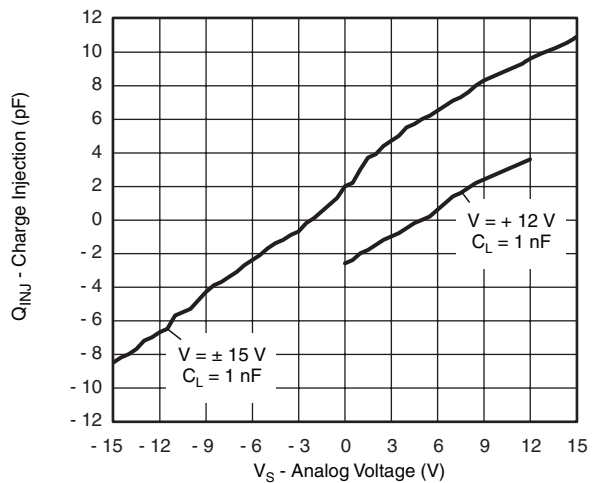
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



Supply Current vs. Input Switching Frequency

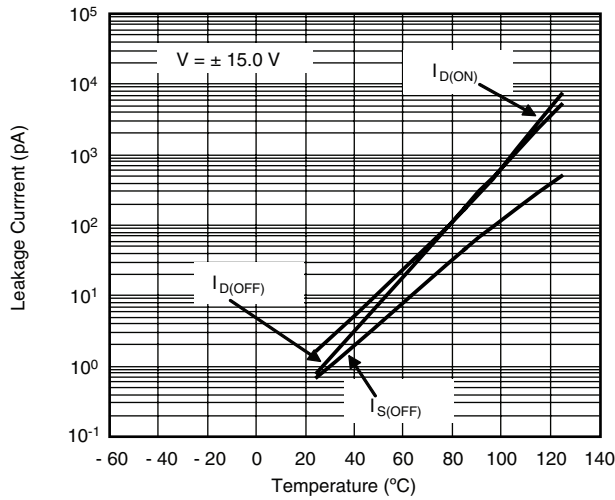
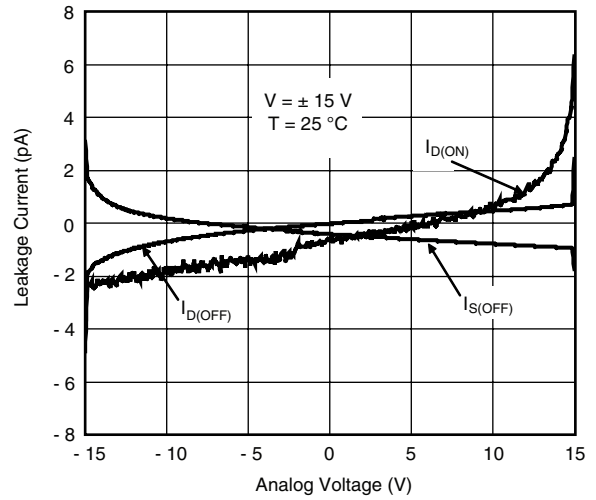
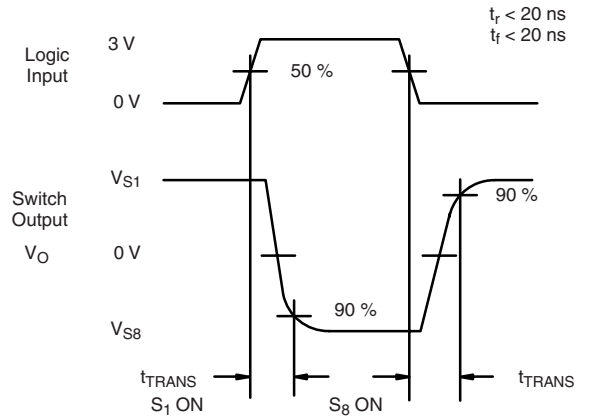
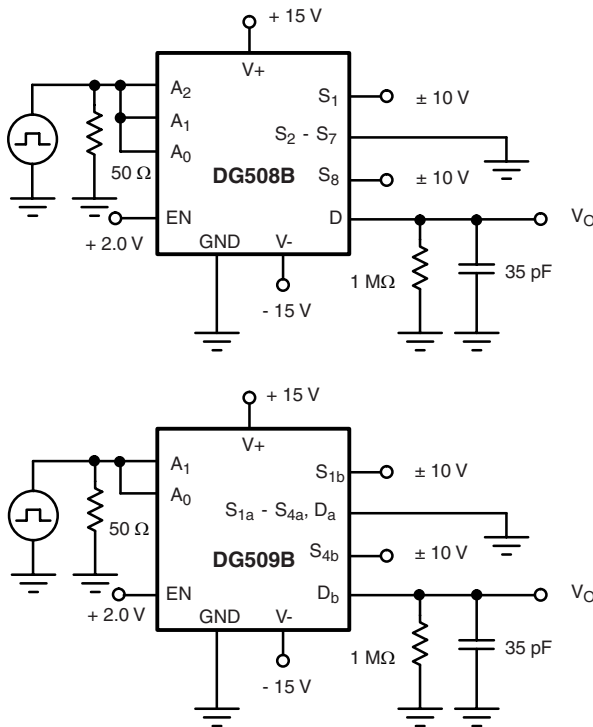


Supply Current vs. Input Switching Frequency



Charge Injection vs. Analog Voltage



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

**Leakage Current vs. Temperature**

**Leakage Current vs. Analog Voltage**
**TEST CIRCUITS**

**Figure 2. Transition Time**

## TEST CIRCUITS

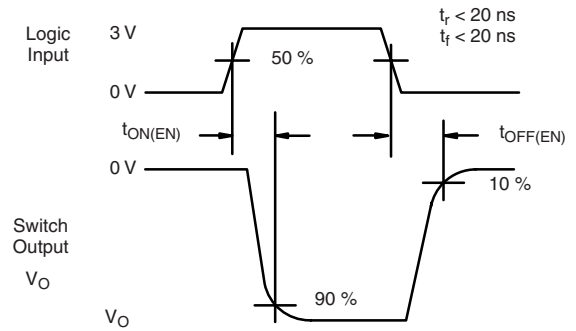
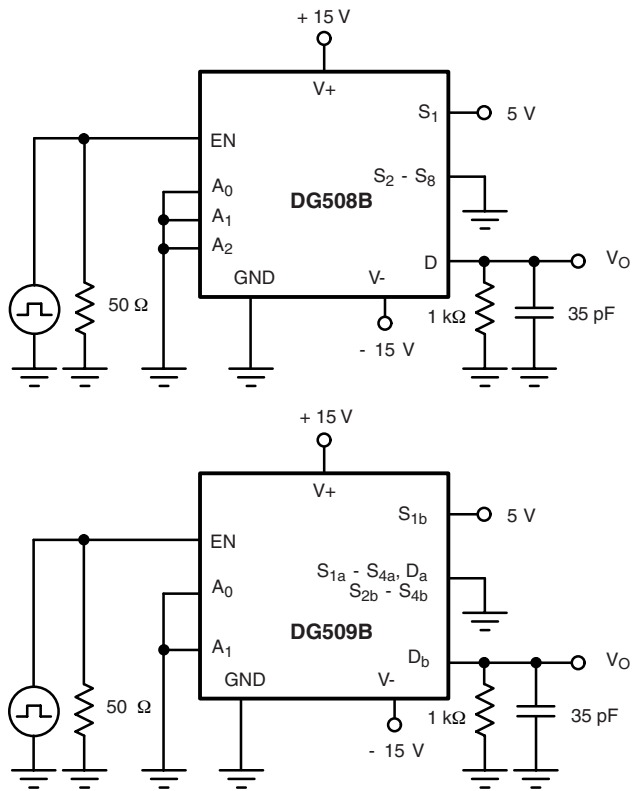


Figure 3. Enable Switching Time

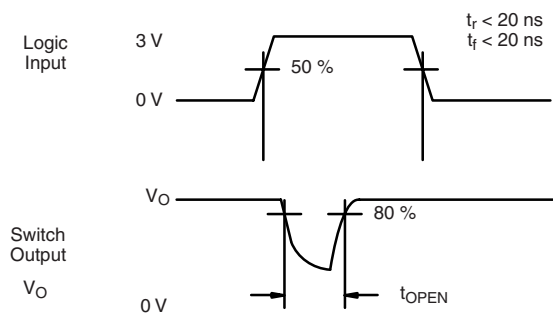
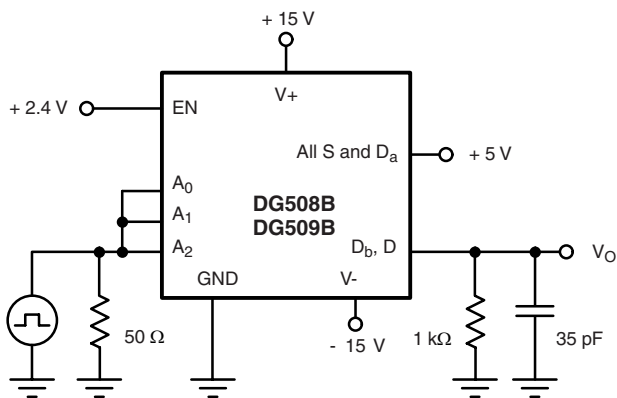
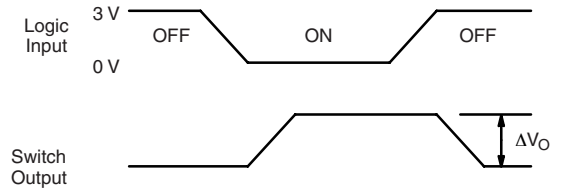
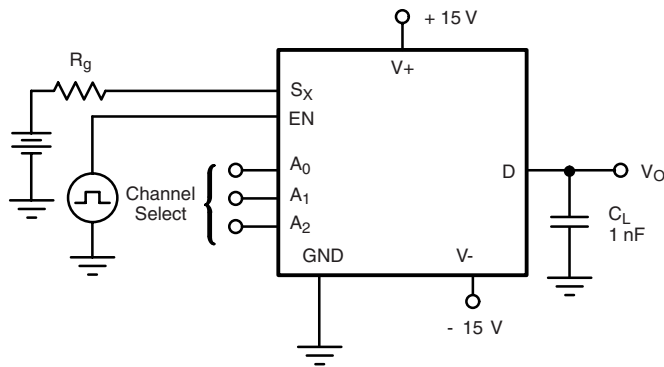
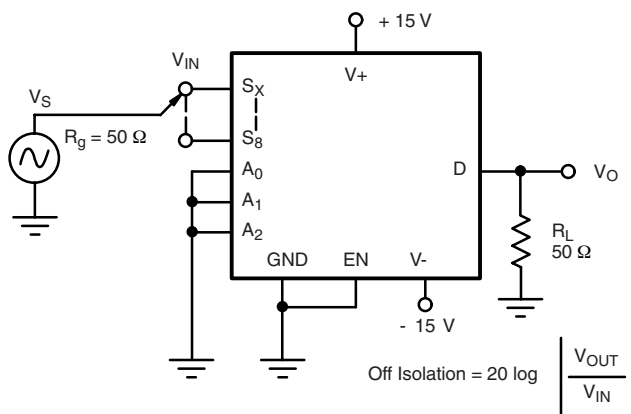


Figure 4. Break-Before-Make Interval

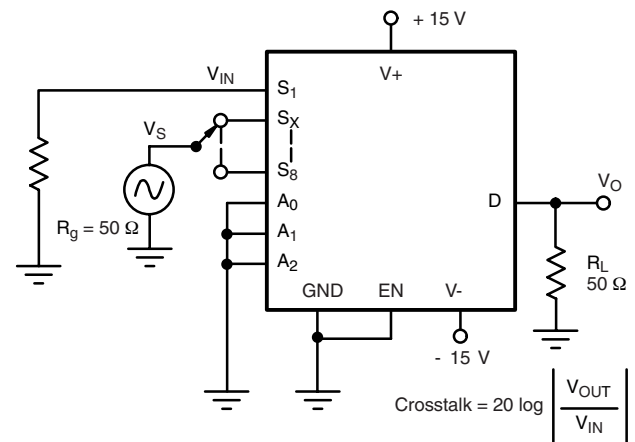
**TEST CIRCUITS**


$\Delta V_O$  is the measured voltage due to charge transfer error  $Q$ , when the channel turns off.

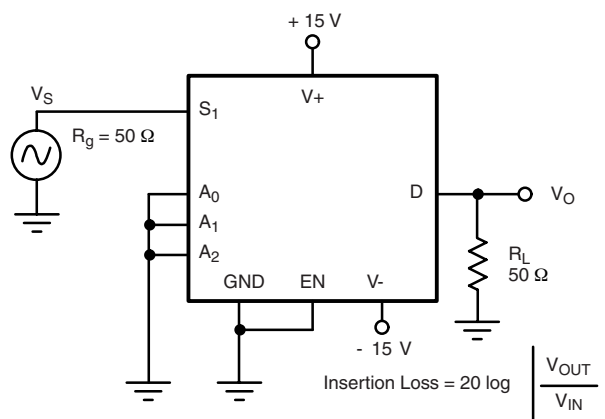
$$Q_{INJ} = C_L \times \Delta V_O$$

**Figure 5. Charge Injection**


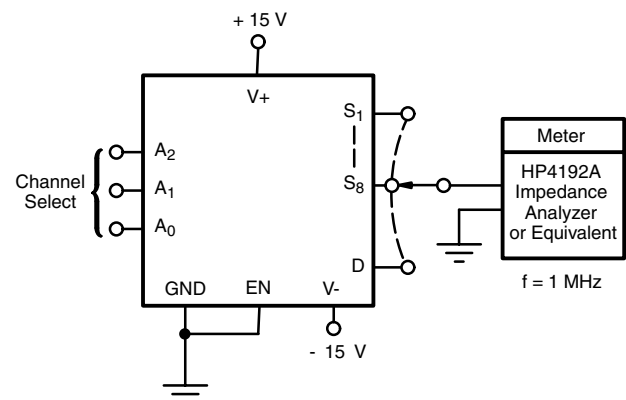
$$\text{Off Isolation} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

**Figure 6. Off Isolation**


$$\text{Crosstalk} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

**Figure 7. Crosstalk**


$$\text{Insertion Loss} = 20 \log \left| \frac{V_{OUT}}{V_{IN}} \right|$$

**Figure 8. Insertion Loss**

**Figure 9. Source Drain Capacitance**

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