

## Precision 8-Ch/Dual 4-Ch/Triple 2-Ch Low Voltage Analog Switches/Multiplexers

**DESCRIPTION**

The DG9051/9052/9053 are low-voltage monolithic CMOS analog switches and multiplexers. DG9051 is an 8-channel multiplexer; DG9052 is a dual 4-channel multiplexer; and DG9053 is a triple single-pole/double throw (SPDT) switch.

They are designed to operate from a +2.7 to +12-V single supply or  $\pm 2.7$  to  $\pm 6$ -V dual power supplies. All control logic inputs have guaranteed 2-V logic high/0.8-V logic low when operating from a single 5 V or dual  $\pm 5$ -V supplies, and 2.4-V logic high/0.8-V logic low when  $V_{+} = 12$  V.

Built on Vishay Siliconix's proprietary high-density process, the DG9051/9052/9053 offer the advantage of bi-directional signal, rail to rail analog signal handling.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the Lead (Pb)-Free device terminations. For analog switching products manufactured with 100 % matte tin device termination, the Lead (Pb)-Free "-E3" suffix is being used as a designator.

**FEATURES**

- 2.7 to 12-V Single Supply or  $\pm 2.7$  to  $\pm 6$ -V Dual Supply Operation
- Guaranteed Ron Matching
- Low Voltage CMOS Logic Compatible

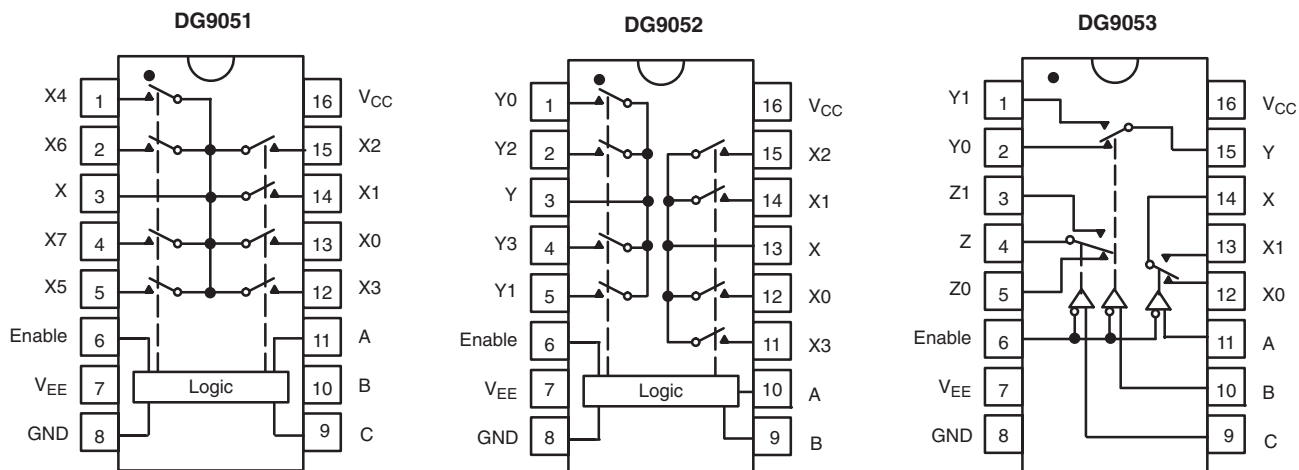

**RoHS**  
COMPLIANT

**BENEFITS**

- Wide Operation Voltage Range
- Pin Compatible with 74HC4051/2/5
- Guaranteed Low Leakage

**APPLICATIONS**

- Battery Powered Equipment
- Test Process Equipment
- Communication Systems
- A/V and Mixed Signal Routing
- Automotive

**FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION**

**ORDERING INFORMATION**

Temp Range	Package	Part Number
-40 to 85°C	TSSOP-16	DG9051DQ-T1-E3
		DG9052DQ-T1-E3
		DG9053DQ-T1-E3

The information shown here is a preliminary product proposal, not a commercial product data sheet. Siliconix is not committed to produce this or any similar product. This information should not be used for design purposes, nor construed as an offer to furnish or sell such products

TRUTH TABLE						
Enable Input	Select Inputs			On Switches		
	C*	B	A	DG9051	DG9052	DG9053
H	X	X	X	All switches open	All switches open	All switches open
L	L	L	L	X – X0	X – X0, Y – Y0	X – X0, Y – Y0, Z – Z0
L	L	L	H	X – X1	X – X1, Y – Y1	X – X1, Y – Y0, Z – Z0
L	L	H	L	X – X2	X – X2, Y – Y2	X – X0, Y – Y1, Z – Z0
L	L	H	H	X – X3	X – X3, Y – Y3	X – X1, Y – Y1, Z – Z0
L	H	L	L	X – X4	X – X0, Y – Y0	X – X0, Y – Y0, Z – Z1
L	H	L	H	X – X5	X – X1, Y – Y1	X – X1, Y – Y0, Z – Z1
L	H	H	L	X – X6	X – X2, Y – Y2	X – X0, Y – Y1, Z – Z1
L	H	H	H	X – X7	X – X3, Y – Y3	X – X1, Y – Y1, Z – Z1

X = Don't care

ABSOLUTE MAXIMUM RATINGS $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted				
Parameter		Symbol	Limit	Unit
Voltage Referenced to V–	V+		13.5	V
	GND		7	
Digital Inputs <sup>a</sup>	V <sub>S</sub> , V <sub>D</sub>		(V–) –0.3 to (V+) +0.3	
Current (Any Terminal Except S or D)			30	mA
Continuous Current, S or D			100	
Peak Current, S or D (Pulsed at 1 ms, 10 % Duty Cycle Max)			200	
Package Solder Reflow Conditions <sup>b</sup>	IR/Convection		260	°C
Storage Temperature			–65 to 150	
Power Dissipation (Packages) <sup>c</sup>	$T_A = 70\text{ }^\circ\text{C}$ , TSSOP-16 <sup>d</sup>		925	mW



SPECIFICATIONS (SINGLE SUPPLY 12 V)							
Parameter	Symbol	Test Condition Otherwise Unless Specified V+ = 12 V, ±10 %, V- = 0 V VA, VEN = 0.8 V or 2.4 V <sup>f</sup>	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>c</sup>	Typ <sup>d</sup>	Max <sup>c</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>D</sub> = 3.5 V, I <sub>S</sub> = 1 mA Sequence Each Switch On	Room Full		30	40 50	Ω
r <sub>ON</sub> Match Between Channels <sup>9</sup>	Δr <sub>ON</sub>	V <sub>D</sub> = 3.5 V, I <sub>S</sub> = 1 mA	Room			5	
Switch Off Leakage Current	I <sub>S(off)</sub>	V <sub>EN</sub> = 2.4 V, V <sub>D</sub> = 11 V or 1 V, V <sub>S</sub> = 1 V or 11 V	Room Full	-1 -20		1 20	nA
	I <sub>D(off)</sub>		Room Full	-1 -20		1 20	
Channel On Leakage Current	I <sub>D(on)</sub>	V <sub>EN</sub> = 0 V, V <sub>S</sub> = V <sub>D</sub> = 1 V or 11 V	Room Full	-2 -10		2 10	
<b>Digital Control</b>							
Logic High Input Voltage	V <sub>INH</sub>		Full	2.4			V
Logic Low Input Voltage	V <sub>INL</sub>		Full			0.8	
Input Current	I <sub>IN</sub>	V <sub>AX</sub> = V <sub>EN</sub> = 2.4 V or 0.8 V	Full	-1		1	μA
<b>Dynamic Characteristics</b>							
Transition Time	t <sub>TRANS</sub>	V <sub>NO</sub> /V <sub>NC</sub> = 8 V/0 V, 0 V/8 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room Full			26 35 55	ns
Break-Before-Make Time	t <sub>BBM</sub>	V <sub>X,Y,Z</sub> = 5 V, V <sub>S</sub> = 0 V, R <sub>L</sub> = 306 Ω, C <sub>L</sub> = 35 pF	Room Full	3		10	
Enable Turn-On Time	t <sub>ON(EN)</sub>		Room Full			20 35 45	
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		Room Full			16 30 40	
Charge Injection <sup>e</sup>	Q	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room			38	pC
Off-Isolation <sup>e,h</sup>	OIRR	f = 1 MHz, R <sub>L</sub> = 50 Ω	Room			-78	dB
Crosstalk <sup>e</sup>	X <sub>TALK</sub>		Room			-83	
Source Off Capacitance <sup>e</sup>	C <sub>S(off)</sub>	f = 1 MHz, V <sub>S</sub> = 0 V, V <sub>EN</sub> = 2.4 V	Room			4	pF
Drain Off Capacitance <sup>e</sup>	C <sub>D(off)</sub>	f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 2.4 V	Room			8	
Drain On Capacitance <sup>e</sup>	C <sub>D(on)</sub>	f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 0 V	Room			15	
<b>Power Supply</b>							
Power Supply Current	I+	V <sub>EN</sub> = V <sub>A</sub> = 0 V or V+	Room			1.0	μA

SPECIFICATIONS (DUAL SUPPLY $V_+ = 5\text{ V}$ , $V_- = -5\text{ V}$ )							
Parameter	Symbol	Test Condition Otherwise Unless Specified $V_+ = 5\text{ V}$ , $V_- = -5\text{ V} \pm 10\%$ $V_A$ , $V_{\overline{EN}} = 0.8\text{ V}$ or $2.0\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>c</sup>	Typ <sup>d</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	$V_{\text{ANALOG}}$		Full	-5		5	V
On-Resistance	$r_{\text{ON}}$	$V_+ = 4.5\text{ V}$ , $V_- = -4.5\text{ V}$ , $V_D = \pm 3\text{ V}$ , $I_S = 1\text{ mA}$ Sequence Each Switch On	Room Full		35	55 60	Ω
$r_{\text{ON}}$ Match Between Channels <sup>g</sup>	$\Delta r_{\text{ON}}$		Room			5	
On-Resistance Flatness <sup>i</sup>	$r_{\text{ON}}$ Flatness	$V_+ = 4.5\text{ V}$ , $V_- = -4.5\text{ V}$ , $V_D = \pm 3.0\text{ V}$ , $I_S = 1\text{ mA}$	Room		7	10	
Switch Off Leakage Current <sup>a</sup>	$I_{\text{S(off)}}$	$V_+ = 5.5\text{ V}$ , $V_- = -5.5\text{ V}$ $V_{\overline{EN}} = 2.0\text{ V}$ , $V_D = \pm 4.5\text{ V}$ , $V_S = \pm 4.5\text{ V}$	Room Full	-1 -20		1 20	nA
	$I_{\text{D(off)}}$		Room Full	-1 -20		1 20	
Channel On Leakage Current <sup>a</sup>	$I_{\text{D(on)}}$	$V_+ = 5.5\text{ V}$ , $V_- = -5.5\text{ V}$ $V_{\overline{EN}} = 0\text{ V}$ , $V_D = \pm 4.5\text{ V}$ , $V_S = \pm 4.5\text{ V}$	Room Full	-2 -10		2 10	
<b>Digital Control</b>							
Logic High Input Voltage	$V_{\text{INH}}$		Full	2.0			V
Logic Low Input Voltage	$V_{\text{INL}}$		Full			0.8	
Input Current <sup>a</sup>	$I_{\text{IN}}$	$V_{\text{AX}} = V_{\text{EN}} = 2.0\text{ V}$ or $0.8\text{ V}$	Full	-1		1	μA
<b>Dynamic Characteristics</b>							
Transition Time <sup>e</sup>	$t_{\text{TRANS}}$	$V_+ = 4.5\text{ V}$ , $V_- = -4.5\text{ V}$ $V_{\text{NO/NC}} = \pm 3\text{ V}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	Room Full			35 50 65	ns
Break-Before-Make Time <sup>e</sup>	$t_{\text{BBM}}$	$V_{X,Y,Z} = +/ -3\text{ V}$ , $V_S = 0\text{ V}$ , $R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$	Room Full	5		12	
Enable Turn-On Time <sup>e</sup>	$t_{\text{ON}(\overline{\text{EN}})}$		Room Full			38 55 70	
Enable Turn-Off Time <sup>e</sup>	$t_{\text{OFF}(\overline{\text{EN}})}$		Room Full			22 35 50	
Source Off Capacitance <sup>e</sup>	$C_{\text{S(off)}}$	$f = 1\text{ MHz}$ , $V_S = 0\text{ V}$ , $V_{\overline{\text{EN}}} = 2.0\text{ V}$	Room			5	pF
Drain Off Capacitance <sup>e</sup>	$C_{\text{D(off)}}$	$f = 1\text{ MHz}$ , $V_D = 0\text{ V}$ , $V_{\overline{\text{EN}}} = 2.0\text{ V}$	Room			9	
Drain On Capacitance <sup>e</sup>	$C_{\text{D(on)}}$	$f = 1\text{ MHz}$ , $V_D = 0\text{ V}$ , $V_{\overline{\text{EN}}} = 0\text{ V}$	Room			13	
<b>Power Supply</b>							
Power Supply Current	$I_+$	$V_{\overline{\text{EN}}} = V_A = 0\text{ V}$ or $V_+$	Room			1.0	μA
	$I_-$		Room	-1.0			



SPECIFICATIONS (SINGLE SUPPLY 5 V)							
Parameter	Symbol	Test Condition Otherwise Unless Specified $V_+ = 5\text{ V}, \pm 10\%$ , $V_- = 0\text{ V}$ $V_A, V_{\overline{EN}} = 0.8\text{ V}$ or $2.0\text{ V}^f$	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>c</sup>	Typ <sup>d</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	$V_{\text{ANALOG}}$		Full	0		5	V
On-Resistance	$r_{\text{ON}}$	$V_+ = 4.5\text{ V}, V_D$ or $V_S = 3\text{ V}$ or $3.5\text{ V}, I_S = 1\text{ mA}$	Room Full		80	100 120	$\Omega$
$r_{\text{ON}}$ Match Between Channels <sup>g</sup>	$\Delta r_{\text{ON}}$	$V_+ = 4.5\text{ V}, V_D = 3\text{ V}, I_S = 1\text{ mA}$	Room			8.0	
Switch Off Leakage Current <sup>a</sup>	$I_{\text{S(off)}}$	$V_+ = 5.5\text{ V}, V_{\overline{EN}} = 2\text{ V}$ $V_S = 1\text{ V}$ or $4.5\text{ V}, V_D = 4.5\text{ V}$ or $1\text{ V}$	Room Full	-1 -20		1 20	nA
	$I_{\text{D(off)}}$		Room Full	-1 -20		1 20	
Channel On Leakage Current <sup>a</sup>	$I_{\text{D(on)}}$	$V_+ = 5.5\text{ V}, V_{\overline{EN}} = 0\text{ V}$ $V_D = V_S = 1\text{ V}$ or $4.5\text{ V}$	Room Full	-2 -10		2 10	
<b>Digital Control</b>							
Logic High Input Voltage	$V_{\text{INH}}$		Full	2.0			V
Logic Low Input Voltage	$V_{\text{INL}}$		Full			0.8	
Input Current <sup>a</sup>	$I_{\text{IN}}$	$V_{\text{AX}} = V_{\overline{EN}} = 2.0\text{ V}$ or $0.8\text{ V}$	Full	-1		1	$\mu\text{A}$
<b>Dynamic Characteristics</b>							
Transition Time	$t_{\text{TRANS}}$	$V_+ = 4.5\text{ V}, V_- = 0\text{ V}, V_{\text{NO/NC}} = 3\text{ V} / 0\text{ V},$ $0\text{ V} / 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$	Room		40		ns
Break-Before-Make Time	$t_{\text{BBM}}$	$V_+ = 4.5\text{ V}, V_{\text{X,Y,Z}} = 3\text{ V}, V_S = 0\text{ V},$ $R_L = 300\ \Omega, C_L = 35\text{ pF}$	Room		15		
Enable Turn-On Time	$t_{\text{ON}(\overline{\text{EN}})}$		Room		40		
Enable Turn-Off Time	$t_{\text{OFF}(\overline{\text{EN}})}$		Room		20		
Charge Injection <sup>e</sup>	Q	$C_L = 1\text{ nF}, V_{\text{GEN}} = 0\text{ V}, R_{\text{GEN}} = 0\ \Omega$	Room		20		pC
Off-Isolation <sup>e,h</sup>	OIRR	$f = 1\text{ MHz}, R_L = 50\ \Omega$	Room		-79		dB
Crosstalk <sup>e</sup>	$X_{\text{TALK}}$		Room		-83		
Source Off Capacitance <sup>e</sup>	$C_{\text{S(off)}}$	$f = 1\text{ MHz}, V_S = 0\text{ V}, V_{\overline{EN}} = 0\text{ V}$	Room		4		pF
Drain Off Capacitance <sup>e</sup>	$C_{\text{D(off)}}$	$f = 1\text{ MHz}, V_D = 0\text{ V}, V_{\overline{EN}} = 2.0\text{ V}$	Room		8		
Drain On Capacitance <sup>e</sup>	$C_{\text{D(on)}}$	$f = 1\text{ MHz}, V_D = 0\text{ V}, V_{\overline{EN}} = 0\text{ V}$	Room		15		
<b>Power Supply</b>							
Power Supply Current	$I_+$	$V_{\overline{EN}} = V_A = 0\text{ V}$ or $V_+$	Room			1.0	$\mu\text{A}$

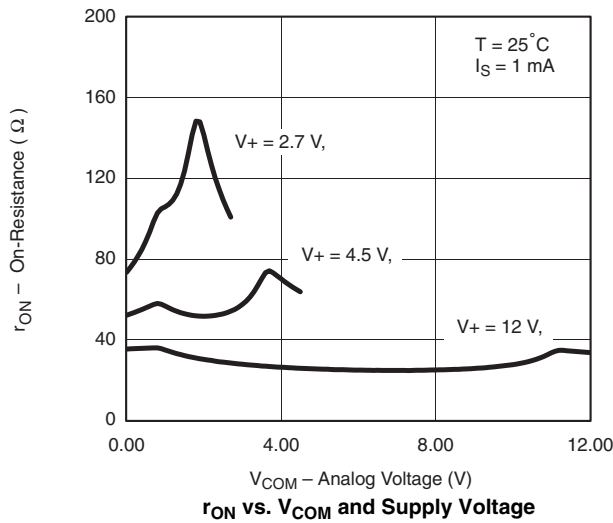
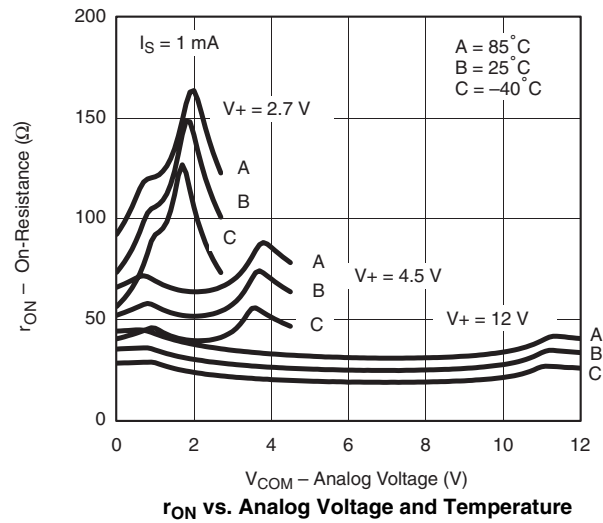
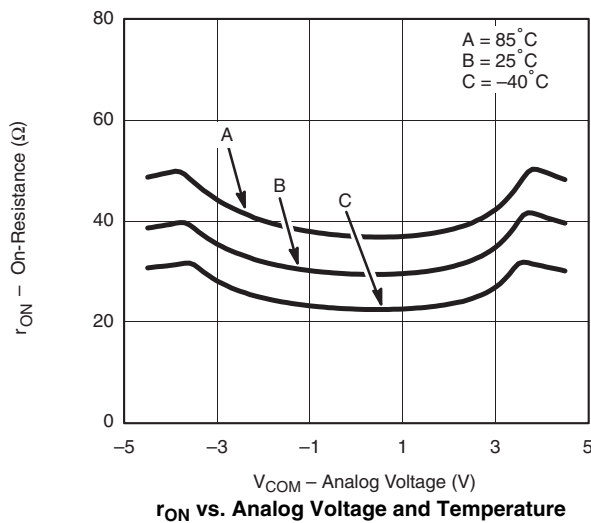
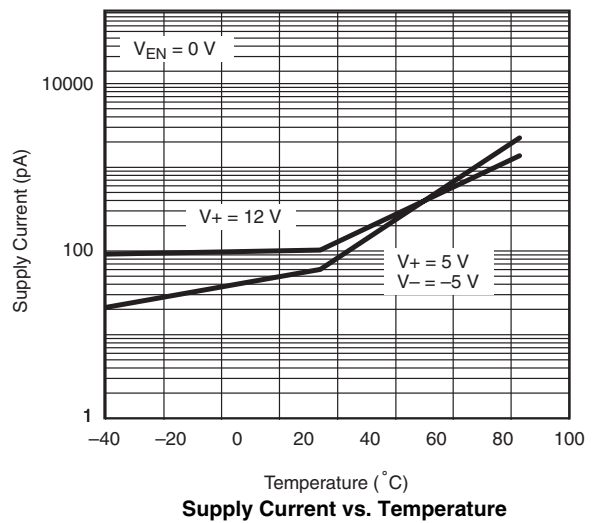
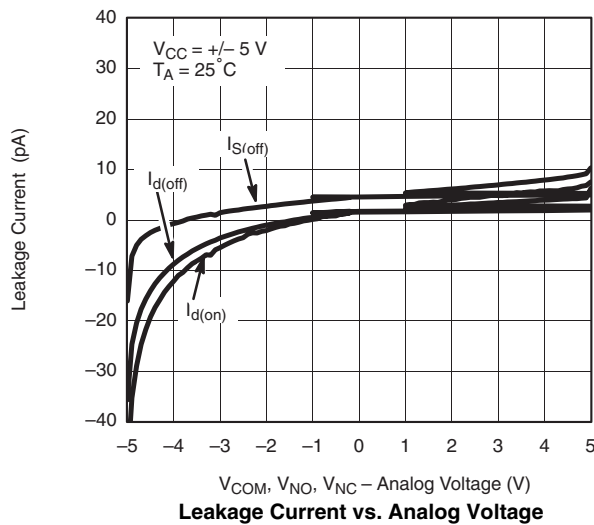
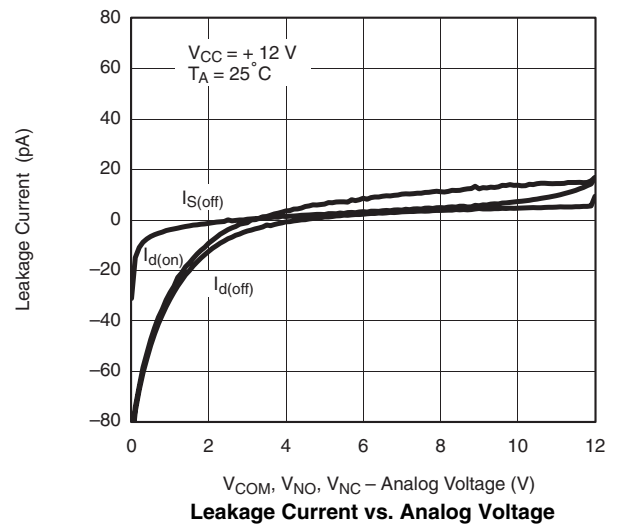


SPECIFICATIONS (SINGLE SUPPLY 3 V)							
Parameter	Symbol	Test Condition Otherwise Unless Specified V+ = 3 V, ±10 %, V- = 0 V V <sub>EN</sub> = 0.4 V or 2.0 V	Temp <sup>b</sup>	Limits -40 to 85°C			Unit
				Min <sup>c</sup>	Typ <sup>d</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>e</sup>	V <sub>ANALOG</sub>		Full	0		3	V
On-Resistance	r <sub>ON</sub>	V+ = 2.7 V, V <sub>D</sub> = 1.5 V, I <sub>S</sub> = 0.1 mA	Room		130		Ω
r <sub>ON</sub> Match Between Channels <sup>g</sup>	Δr <sub>ON</sub>	V+ = 2.7 V, V <sub>D</sub> = 1.5 V, I <sub>S</sub> = 0.1 mA	Room			12	
Switch Off Leakage Current <sup>a</sup>	I <sub>S(off)</sub>	V+ = 3.3 V, V <sub>EN</sub> = 2.0 V V <sub>S</sub> = 3 or 0.3 V, V <sub>D</sub> = 0.3 or 3 V	Room	-1		1	nA
	I <sub>D(off)</sub>		Full	-20		20	
Channel On Leakage Current <sup>a</sup>	I <sub>D(on)</sub>	V+ = 3.3 V, V <sub>EN</sub> = 0 V V <sub>S</sub> = 3 or 0.3 V, V <sub>D</sub> = 0.3 or 3 V	Room	-2		2	
			Full	-10		10	
<b>Digital Control</b>							
Logic High Input Voltage	V <sub>INH</sub>		Full	2.0			V
Logic Low Input Voltage	V <sub>INL</sub>		Full			0.4	
Input Current <sup>a</sup>	I <sub>IN</sub>	V <sub>AX</sub> = V <sub>EN</sub> = 2.0 V or 0.4 V	Full	-1		1	μA
<b>Dynamic Characteristics</b>							
Transition Time	t <sub>TRANS</sub>	V+ = 2.7 V, V <sub>NO/NC</sub> = 1.5 V/0 V, 0 V/1.5 V R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room		80		ns
Break-Before-Make Time	t <sub>BBM</sub>	V+ = 2.7 V, V <sub>X,Y,Z</sub> = 1.5 V, V <sub>S</sub> = 0 V, R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF	Room	5	25		
Enable Turn-On Time	t <sub>ON(EN)</sub>		Full		90		
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		Room		30		
Charge Injection <sup>e</sup>	Q	C <sub>L</sub> = 1 nF, V <sub>GEN</sub> = 0 V, R <sub>GEN</sub> = 0 Ω	Room		9		pC
Off-Isolation <sup>e,h</sup>	OIRR	f = 1 MHz, R <sub>L</sub> = 50 Ω	Room		-78		dB
Crosstalk <sup>e</sup>	X <sub>TALK</sub>		Room		-83		
Source Off Capacitance <sup>e</sup>	C <sub>S(off)</sub>	f = 1 MHz, V <sub>S</sub> = 0 V, V <sub>EN</sub> = 1.8 V	Room		5		pF
Drain Off Capacitance <sup>e</sup>	C <sub>D(off)</sub>	f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 1.8 V	Room		10		
Drain On Capacitance <sup>e</sup>	C <sub>D(on)</sub>	f = 1 MHz, V <sub>D</sub> = 0 V, V <sub>EN</sub> = 0 V	Room		15		
<b>Power Supply</b>							
Power Supply Current	I+	V <sub>EN</sub> = V <sub>A</sub> = 0 V or V+	Room			1.0	μA

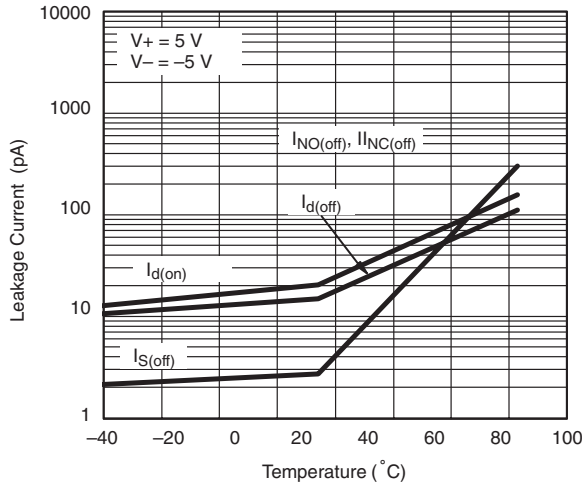
Notes

- a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
- b. Room = 25°C, Full = as determined by the operating temperature suffix.
- c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- d. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.
- g. Δr<sub>DON</sub> = r<sub>DON</sub> Max - r<sub>DON</sub> Min.
- h. Worst case isolation occurs on Channel 4 due to proximity to the drain pin.
- i. r<sub>DON</sub> flatness is measured as the difference between the minimum and maximum measured values across a defined Analog signal.

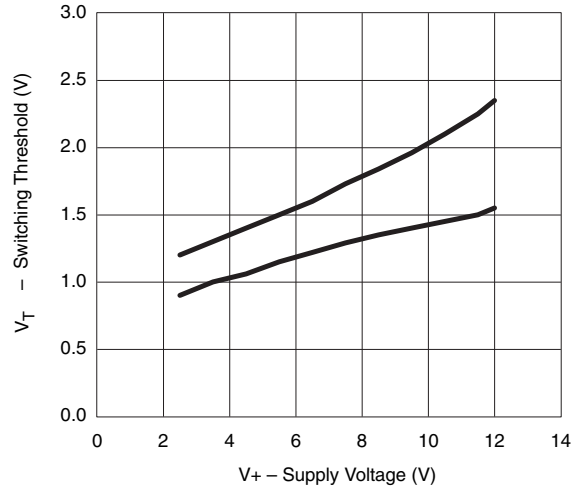
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

**TYPICAL CHARACTERISTICS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted

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

 **$r_{ON}$  vs. Analog Voltage and Temperature**

 **$r_{ON}$  vs. Analog Voltage and Temperature**

**Supply Current vs. Temperature**

**Leakage Current vs. Analog Voltage**

**Leakage Current vs. Analog Voltage**

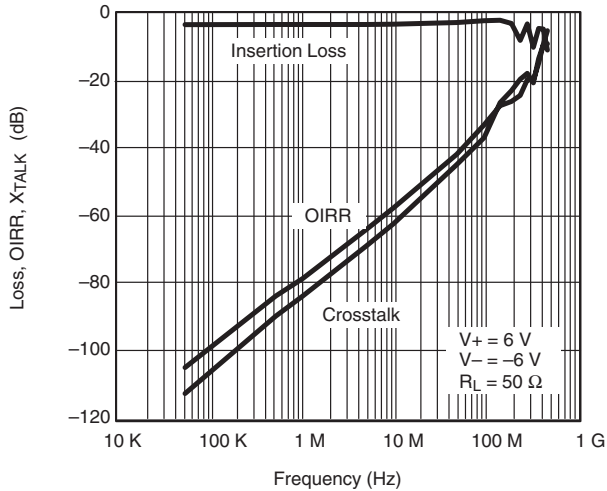
**TYPICAL CHARACTERISTICS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



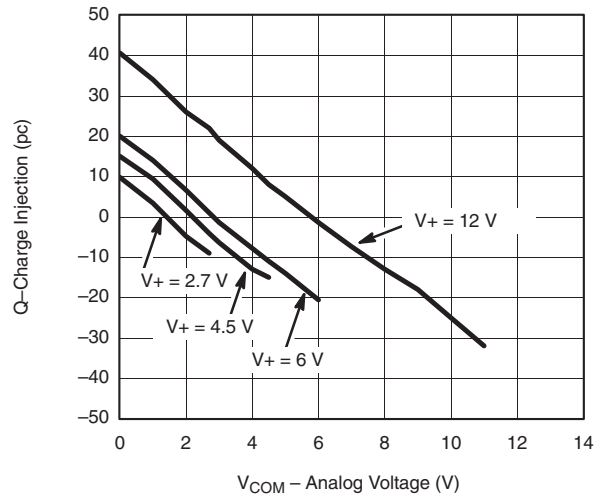
**Leakage Current vs. Temperature**



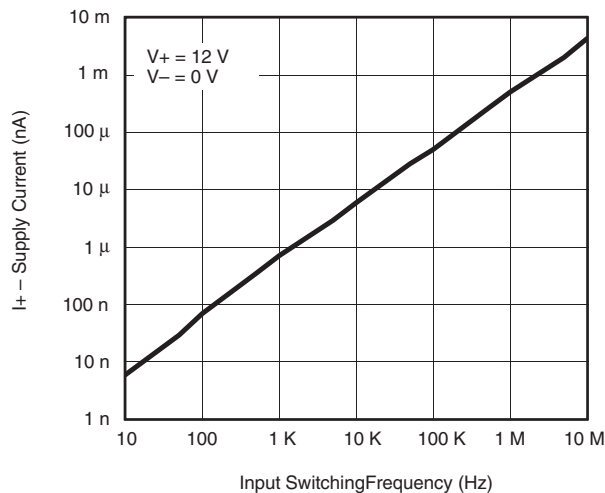
**Switching Threshold vs. Supply Voltage**



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

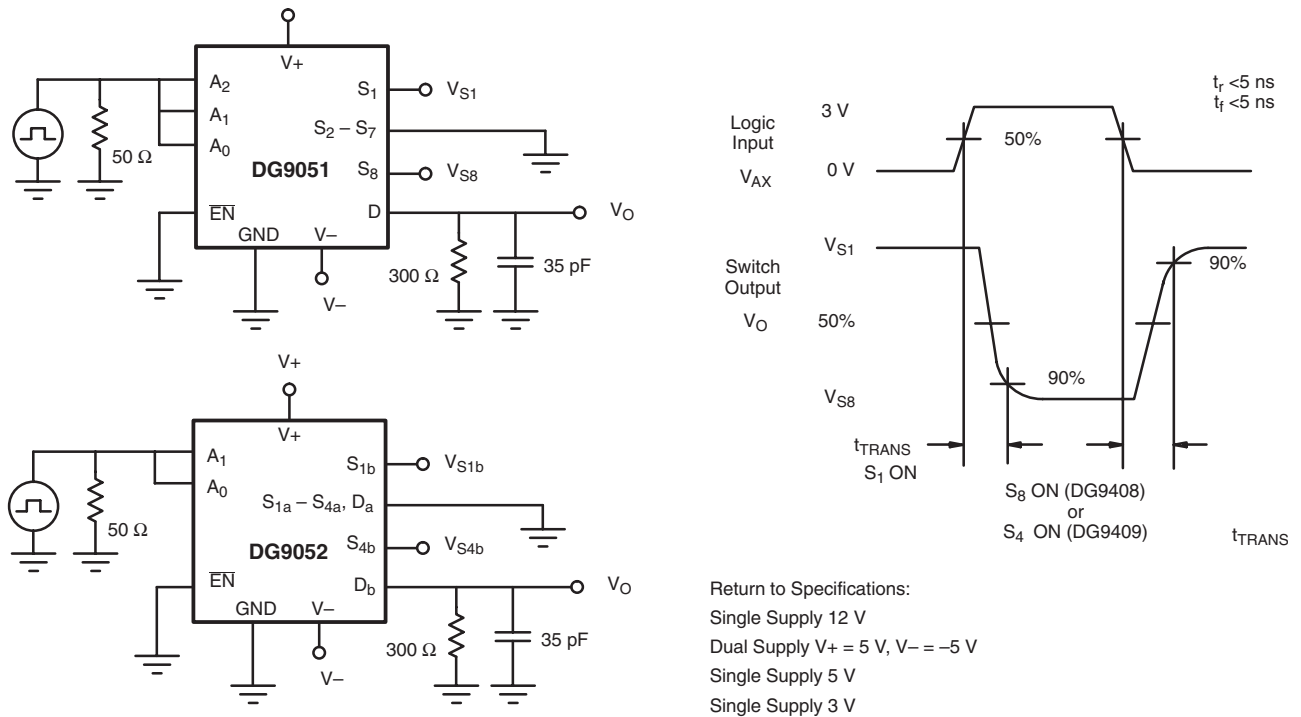
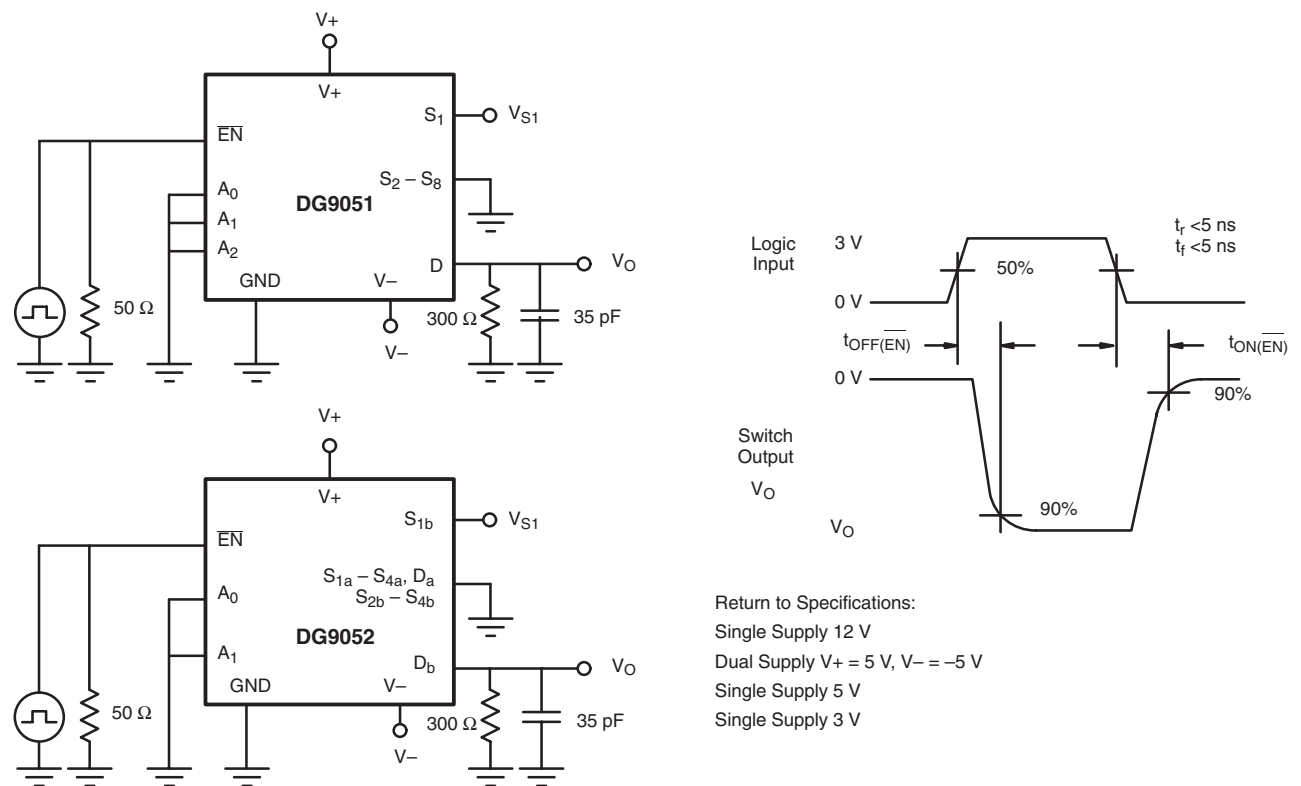


**Charge Injection vs. Analog Voltage**

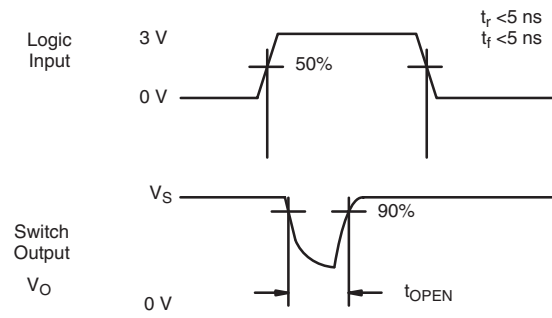
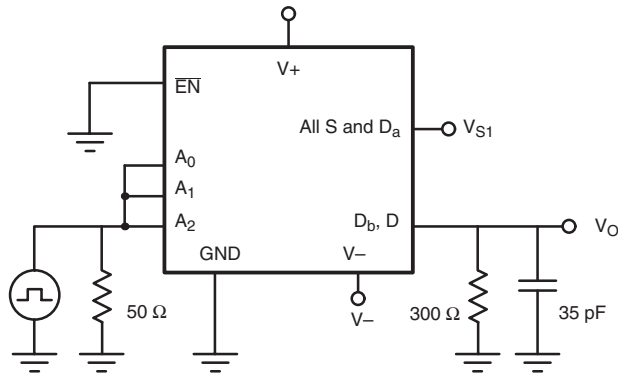


**Supply Current vs. Input Switching Frequency**



**TEST CIRCUITS**

**Figure 1. Transition Time**

**Figure 2. Enable Switching Time**

TEST CIRCUITS



Return to Specifications:  
 Single Supply 12 V  
 Dual Supply  $V_+ = 5\text{ V}$ ,  $V_- = -5\text{ V}$   
 Single Supply 5 V  
 Single Supply 3 V

Figure 3. Break-Before-Make Interval

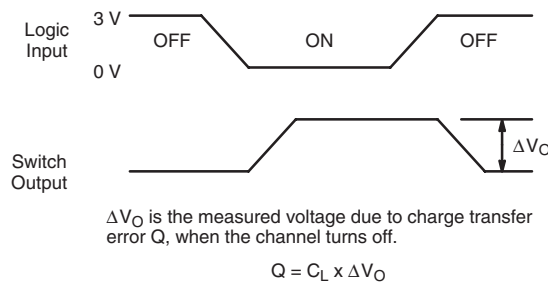
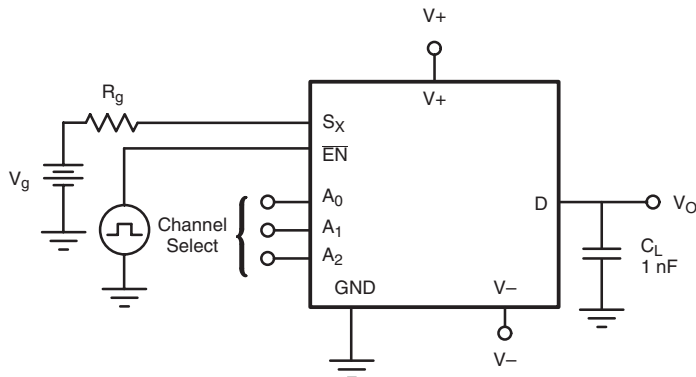


Figure 4. Charge Injection

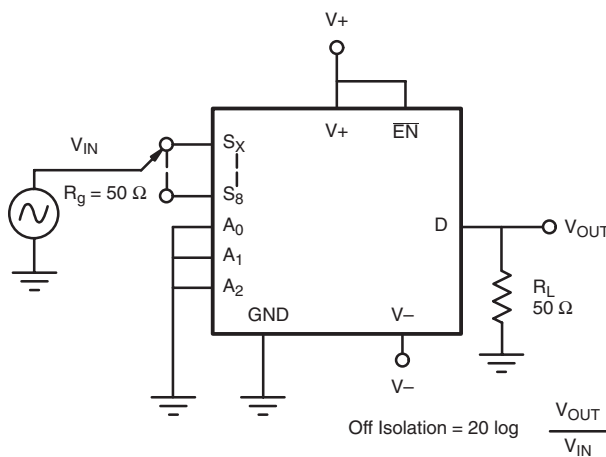


Figure 5. Off Isolation

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

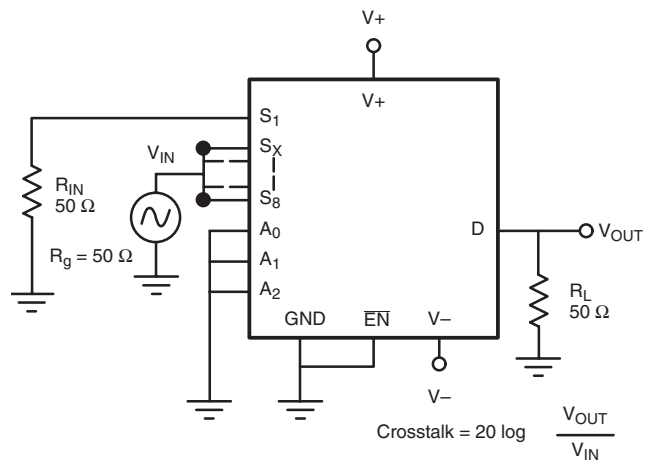
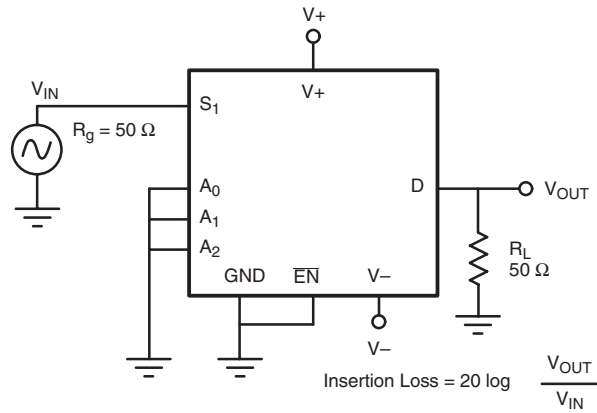
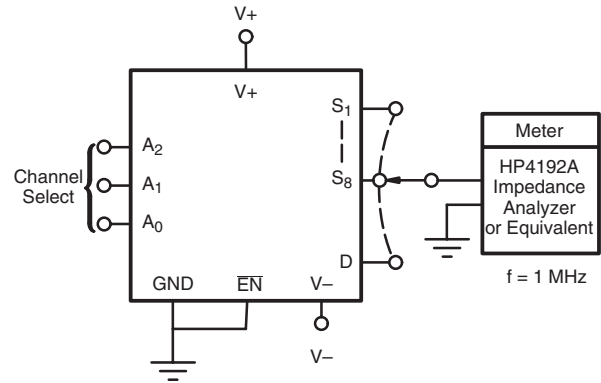


Figure 6. Crosstalk

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

**TEST CIRCUITS**

**Figure 7. Insertion Loss**

**Figure 8. Source Drain Capacitance**

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