Precision 8-Ch/Dual 4-Ch Low Voltage Analog Multiplexers

DESCRIPTION

The DG408L, DG409L are low voltage pin-for-pin compatible companion devices to the industry standard DG408, DG409 with improved performance.

Using BiCMOS wafer fabrication technology allows the DG408L, DG409L to operate on single and dual supplies. Single supply voltage ranges from 3 V to 12 V while dual supply operation is recommended with ± 3 V to ± 6 V.

The DG408L 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 (A_0, A_1, A_2). The DG409L 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 (A_0, A_1). Break-before-make switching action to protect against momentary crosstalk between adjacent channels.

The DG408L, DG409L provides lower on-resistance, faster switching time, lower leakage, less power consumption and higher off-Isolation than the DG408, DG409.

FEATURES

- Pin-for-pin compatibility with DG408, DG409
- 2.7 V to 12 V single supply or ± 3 V to ± 6 V dual supply operation
- Lower on-resistance: $R_{DS(on)}$ - 17 Ω typ.
- Fast switching: t_{ON} - 38 ns, t_{OFF} - 18 ns
- Break-before-make guaranteed
- Low leakage: $I_{S(off)}$ - 0.2 nA max.
- Low charge injection: 1 pC
- TTL, CMOS, LV logic (3 V) compatible
- 82 dB off-isolation at 1 MHz
- 2000 V ESD protection (HBM)
- Compliant to RoHS directive 2002/95/EC

Pb-free Available

RoHS* COMPLIANT

BENEFITS

- High accuracy
- Single and dual power rail capacity
- Wide operating voltage range
- Simple logic interface

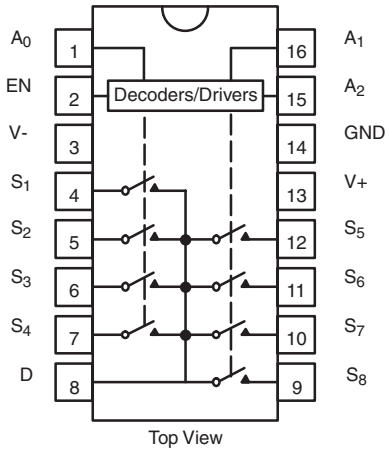
APPLICATIONS

- Data acquisition systems
- Battery operated equipment
- Portable test equipment
- Sample and hold circuits
- Communication systems
- SDSL, DSLAM
- Audio and video signal routing

FUNCTIONAL BLOCK DIAGRAMS AND PIN CONFIGURATIONS

DG408L

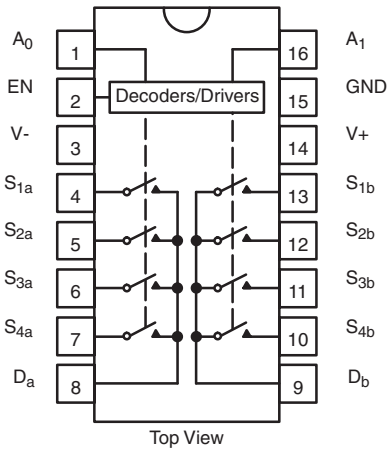
Dual-In- Line, SOIC and TSSOP



Top View

DG409L

Dual-In- Line, SOIC and TSSOP



Top View

* Pb containing terminations are not RoHS compliant, exemptions may apply

TRUTH TABLE DG408L				
A_2	A_1	A_0	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 DG409L			
A_1	A_0	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" = $V_{AL} \leq 0.8$ V
Logic "1" = $V_{AH} \geq 2.4$ V
X = Do not Care

For low and high voltage levels for V_{AX} and V_{EN} consult “Digital Control” parameters for specific V+ operation.

ORDERING INFORMATION DG408L		
Temp. Range	Package	Part Number
- 40 °C to 85 °C	16-Pin SOIC	DG408LDY DG408LDY-E3 DG408LDY-T1 DG408LDY-T1-E3
	16-Pin TSSOP	DG408LDQ DG408LDQ-E3 DG408LDQ-T1 DG408LDQ-T1-E3

ORDERING INFORMATION DG409L		
Temp. Range	Package	Part Number
- 40 °C to 85 °C	16-Pin SOIC	DG409LDY DG409LDY-E3 DG409LDY-T1 DG409LDY-T1-E3
	16-Pin TSSOP	DG409LDQ DG409LDQ-E3 DG409LDQ-T1 DG409LDQ-T1-E3

ABSOLUTE MAXIMUM RATINGS			
Parameter		Limit	Unit
Voltage Referenced V+ to V-		14	V
GND		7	
Digital Inputs[a], V_S, V_D		(V-) - 0.3 to (V) + 0.3	
Current (Any Terminal)		30	mA
Peak Current, S or D (Pulsed at 1 ms, 10 % Duty Cycle Max.)		100	
Storage Temperature	(A Suffix)	- 65 to 150	°C
	(D Suffix)	- 65 to 125	
Power Dissipation (Package)[b]	16-Pin Plastic TSSOP[c]	650	mW
	16-Pin Narrow SOIC[c]	600	
	16-Pin CerDIP[d]	900	
	LCC-20[e]	750	

Notes:
a. Signals on S_X, DX, A_X, or EN 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 7.6 mW/°C above 75 °C.
d. Derate 12 mW/°C above 75 °C.
e. Derate 10 mW/°C above 75 °C.

SPECIFICATIONS Single Supply 12 V									
Parameter	**Symbol**	**Test Conditions Unless Otherwise Specified** V+ = 12 V, ± 10 %, V- = 0 V V_{EN} = 0.8 V or 2.4 V[f]	**Temp.[b]**	**Typ.[d]**	**A Suffix** - 55 °C to 125 °C **Min.[c]**	**A Suffix** - 55 °C to 125 °C **Max.[c]**	**D Suffix** - 40 °C to 85 °C **Min.[c]**	**D Suffix** - 40 °C to 85 °C **Max.[c]**	**Unit**
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	12	0	12	V
Drain-Source On-Resistance	$R_{DS(on)}$	V_D = 10.8 V, V_D = 2 V or 9 V, I_S = 10 mA Sequence Each Switch On	Room Full	17		29 38		29 35	Ω
$R_{DS(on)}$ Matching Between Channels[g]	ΔR_{DS}	V_D = 10.8 V, V_D = 2 V or 9 V I_S = 10 mA	Room	1		3		3	
On-Resistance Flatness[i]	$R_{FLAT(on)}$		Room	3		7		7	
Switch Off Leakage Current	$I_{S(off)}$	V_{EN} = 0 V, V_D = 11 V or 1 V V_S = 1 V or 11 V	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
	$I_{D(off)}$		Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Channel On Leakage Current	$I_{D(on)}$	V_S = V_D = 1 V or 11 V	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Digital Control									
Logic High Input Voltage	V_{INH}		Full		2.4		2.4		V
Logic Low Input Voltage	V_{INL}		Full			0.8		0.8	
Input Current	I_{IN}	V_{AX} = V_{EN} = 2.4 V or 0.8 V	Full		- 1.5	1.5	- 1	1	µA
Dynamic Characteristics									
Transition Time	t_{TRANS}	V_{S1} = 8 V, V_{S8} = 0 V, (DG408L) V_{S1b} = 8 V, V_{S4b} = 0 V, (DG409L) See Figure 2	Room Full	30		60 68		60 65	ns
Break-Before-Make Time	t_{OPEN}	$V_{S(all)}$ = V_{DA} = 5 V See Figure 4	Room Full	11	1		1		
Enable Turn-On Time	$t_{ON(EN)}$	V_{AX} = 0 V, V_{S1} = 5 V (DG408L) V_{AX} = 0 V, V_{S1b} = 5 V (DG409L) See Figure 3	Room Full	38		55 60		55 60	
Enable Turn-Off Time	$t_{OFF(EN)}$		Room Full	18		25 35		25 30	
Charge Injection[e]	Q	C_L = 1 nF, V_{GEN} = 0 V, R_{GEN} = 0 Ω	Room	1		5		5	pC
Off Isolation[e, h]	OIRR	f = 100 kHz, R_L = 1 kΩ	Room	- 70					dB
Crosstalk[e]	X_{TALK}		Room	- 82					
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz, V_S = 0 V, V_{EN} = 0 V	Room	7					pF
Drain Off Capacitance[e]	$C_{D(off)}$	f = 1 MHz, V_D = 2.4 V, V_{EN} = 0 V	Room	20					
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 2.4 V (DG409L only)	Room	31					
Power Supplies									
Power Supply Range	V+				3	12	3	12	V
Power Supply Current	I+	V_{EN} = V_A = 0 V or 5 V	Room	0.2		0.7		0.7	mA

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_{IN} = input voltage to perform proper function.
g. $\Delta R_{DS(on)}$ = $R_{DS(on)}$ Max - $R_{DS(on)}$ Min.
h. Worst case isolation occurs on Channel 4 do to proximity to the drain pin.
i. $R_{DS(on)}$ flatness is measured as the difference between the minimum and maximum measured values across a defined Analog signal.

SPECIFICATIONS Dual Supply V+ = 5 V, V = 5 V									
		Test Conditions Unless Otherwise Specified V+ = 5 V, ± 10 %, V- = - 5 V, V- = 0 V V_{EN} = 0.6 V or 2.4 V[f]			**A Suffix** - 55 °C to 125 °C		**D Suffix** - 40 °C to 85 °C		
Parameter	**Symbol**		**Temp.[b]**	**Typ.[d]**	**Min.[c]**	**Max.[c]**	**Min.[c]**	**Max.[c]**	**Unit**
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		- 5	5	- 5	5	V
Drain-Source On-Resistance	$R_{DS(on)}$	V_D = ± 3.5 V, I_S = 10 mA Sequence Each Switch On	Room Full	20		40 50		40 50	Ω
Switch Off Leakage Current[a]	$I_{S(off)}$	V+ = 5.5 , V- = 5.5 V V_{EN} = 0 V, V_D = ± 4.5 V, V_S = 4.5 V ∓	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
	$I_{D(off)}$		Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Channel On Leakage Current[a]	$I_{D(on)}$	V+ = 5.5 V, V- = - 5.5 V V_{EN} = 2.4 V, V_D = ± 4.5 V, V_S = 4.5 V ∓	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Digital Control									
Logic High Input Voltage	V_{INH}		Full		2.4		2.4		V
Logic Low Input Voltage	V_{INL}		Full			0.6		0.6	
Input Current[a]	I_{IN}	V_{AX} = V_{EN} = 2.4 V or 0.6 V	Full		- 1.5	1.5	- 1	1	µA
Dynamic Characteristics									
Transition Time[e]	t_{TRANS}	V_{S1} = 3.5 V, V_{S8} = - 3.5 V, (DG408L) V_{S1b} = 3.5 V, V_{S4b} = - 3.5 V, (DG409L) See Figure 2	Room Full	30		60 78		60 65	ns
Break-Before-Make Time[e]	t_{OPEN}	$V_{S(all)}$ = V_{DA} = 3.5 V See Figure 4	Room Full	8	1		1		
Enable Turn-On Time[e]	$t_{ON(EN)}$	V_{AX} = 0 V, V_{S1} = 3.5 V (DG408L) V_{AX} = 0 V, V_{S1b} = 3.5 V (DG409L) See Figure 3	Room Full	25		55 68		55 60	
Enable Turn-Off Time[e]	$t_{OFF(EN)}$		Room Full	20		40 50		40 45	
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz, V_S = 0 V, V_{EN} = 0 V	Room	6					pF
Drain Off Capacitance[e]	$C_{D(off)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 0 V	Room	15					
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 2.4 V	Room	29					

Notes:
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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_{IN} = input voltage to perform proper function.
g. $\Delta R_{DS(on)} = R_{DS(on)}$ max. - $R_{DS(on)}$ min.
h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.
i. $R_{DS(on)}$ flatness is measured as the difference between the minimum and maximum measured values across a defined analog signal.

SPECIFICATIONS Single Supply 5 V									
		Test Conditions Unless Otherwise Specified V+ = 5 V, ± 10 %, V- = 0 V V_{EN} = 0.6 V or 2.4 V[f]			**A Suffix** - 55 °C to 125 °C		**D Suffix** - 40 °C to 85 °C		
Parameter	**Symbol**		**Temp.[b]**	**Typ.[d]**	**Min.[c]**	**Max.[c]**	**Min.[c]**	**Max.[c]**	**Unit**
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	5	0	5	V
Drain-Source On-Resistance	$R_{DS(on)}$	V+ = 4.5 V, V_D or V_S = 1 V or 3.5 V, I_D = 5 mA	Room Full	35		49 62		40 62	Ω
$R_{DS(on)}$ Matching Between Channels[g]	ΔR_{DS}	V+ = 4.5 V, V_D = 1 V or 3.5 V, I_S = 5 mA	Room	1.5		3		3	Ω
On-Resistance Flatness[i]	$R_{FLAT(on)}$		Room			4		4	Ω
Switch Off Leakage Current[a]	$I_{S(off)}$	V+ = 5.5 V, V_S = 1 V or 4 V V_D = 4 V or 1 V	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
	$I_{D(off)}$		Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
Channel On Leakage Current[a]	$I_{D(on)}$	V+ = 5.5 V, V_D = V_S = 1 V or 4 V Sequence Each Switch On	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
Digital Control									
Logic High Input Voltage	V_{INH}	V+ = 5 V	Full		2.4		2.4		V
Logic Low Input Voltage	V_{INL}		Full			0.6		0.6	V
Input Current[a]	I_{IN}	V_{AX} = V_{EN} = 2.4 V or 0.6 V	Full		- 1.5	1.5	- 1	1	µA
Dynamic Characteristics									
Transition Time[e]	t_{TRANS}	V_{S1} = 3.5 V, V_{S8} = 0 V, (DG408L) V_{S1b} = 3.5 V, V_{S4b} = 0 V, (DG409L) See Figure 2	Room Full	44		125 138		125 135	ns
Break-Before-Make Time[e]	t_{OPEN}	$V_{S(all)}$ = V_{DA} = 3.5 V, See Figure 4	Room Full	17	1		1		ns
Enable Turn-On Time[e]	$t_{ON(EN)}$	V_{AX} = 0 V, V_{S1} = 3.5 V (DG408L) V_{AX} = 0 V, V_{S1b} = 3.5 V (DG409L) See Figure 3	Room Full	43		60 70		60 65	ns
Enable Turn-Off Time[e]	$t_{OFF(EN)}$		Room Full	26		45 60		45 50	ns
Charge Injection[e]	Q	C_L = 1 nF, R_{GEN} = 0 Ω, V_{GEN} = 0 Ω	Room	1		5		5	pC
Off Isolation[e, h]	OIRR	f = 100 kHz, R_L = 1 kΩ	Room	- 70					dB
Crosstalk[e]	X_{TALK}		Room	- 80					dB
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz, V_S = 0 V, V_{EN} = 0 V	Room	8					pF
Drain Off Capacitance[e]	$C_{D(off)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 0 V	Room	21					pF
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 2.4 V (DG409L only)	Room	32					pF

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 datasheet.
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_{IN} = input voltage to perform proper function.
g. $\Delta R_{DS(on)}$ = $R_{DS(on)}$ max. - $R_{DS(on)}$ min.
h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.
i. $R_{DS(on)}$ flatness is measured as the difference between the minimum and maximum measured values across a defined analog signal.

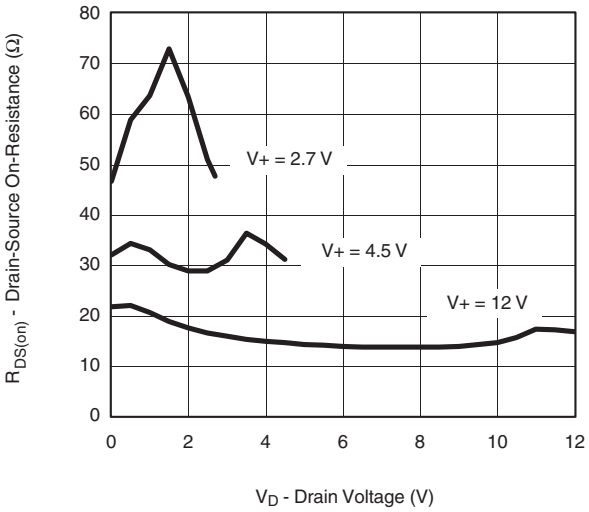
SPECIFICATIONS Single Supply 3 V

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 3 V, ± 10 %, V- = 0 V V_{EN} = 0.4 V or 2.0 V[f]	Temp.[b]	Typ.[d]	A Suffix - 55 °C to 125 °C Min.[c]	A Suffix - 55 °C to 125 °C Max.[c]	D Suffix - 40 °C to 85 °C Min.[c]	D Suffix - 40 °C to 85 °C Max.[c]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	3	0	3	V
Drain-Source On-Resistance	$R_{DS(on)}$	V+ = 2.7 V, V_D = 0.5 or 2.2 V, I_S = 5 mA	Room Full	60		80 105		80 100	Ω
Switch Off Leakage Current[a]	$I_{S(off)}$	V+ = 3.3 V, V_S = 2 or 1 V, V_D = 1 or 2 V	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	nA
	$I_{D(off)}$		Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Channel On Leakage Current[a]	$I_{D(on)}$	V+ = 3.3 V, V_D = V_S = 1 or 2 V Sequence Each Switch On	Room Full		- 1 - 15	1 15	- 1 - 10	1 10	
Digital Control									
Logic High Input Voltage	V_{INH}		Full		2		2		V
Logic Low Input Voltage	V_{INL}		Full			0.4		0.4	
Input Current[a]	I_{IN}	V_{AX} = V_{EN} = 2.4 V or 0.4 V	Full		- 1.5	1.5	- 1	1	µA
Dynamic Characteristics									
Transition Time	t_{TRANS}	V_{S1} = 1.5 V, V_{S8} = 0 V, (DG408L) V_{S1b} = 1.5 V, V_{S4b} = 0 V, (DG409L) See Figure 2	Room Full	75		150 175		150 175	ns
Break-Before-Make Time	t_{OPEN}	$V_{S(all)}$ = V_{DA} = 1.5 V, See Figure 4	Room Full	32	1		1		
Enable Turn-On Time	$t_{ON(EN)}$	V_{AX} = 0 V, V_{S1} = 1.5 V (DG408L) V_{AX} = 0 V, V_{S1b} = 1.5 V (DG409L) See Figure 3	Room Full	70		95 115		95 105	
Enable Turn-Off Time	$t_{OFF(EN)}$		Room Full	55		100 115		100 105	
Charge Injection[e]	Q	C_L = 1 nF, R_{GEN} = 0 Ω, V_{GEN} = 0 V	Room	0.4		5		5	pC
Off Isolation[e, h]	OIRR	R_L = 1 kΩ, f = 100 kHz	Room	- 70					dB
Crosstalk[e]	X_{TALK}		Room	- 79					
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz, V_S = 0 V, V_{EN} = 0 V	Room	8					pF
Drain Off Capacitance[e]	$C_{D(off)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 0 V	Room	19					
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz, V_D = 0 V, V_{EN} = 2 V (DG409L only)	Room	33					

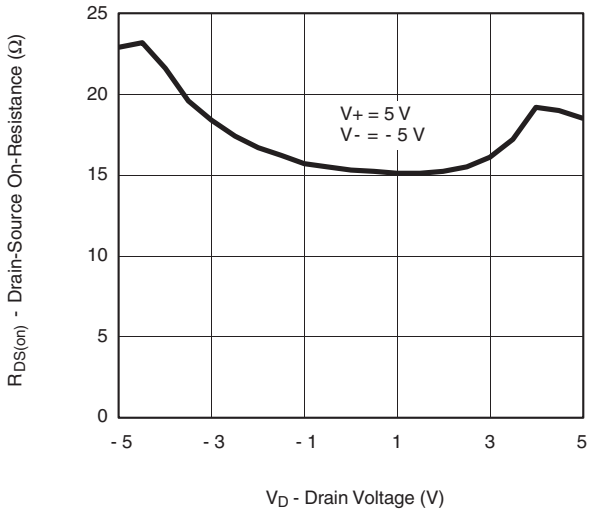
Notes:
a. Leakage parameters are guaranteed by worst case test condition and not subject to production test.
b. Room = 25 °C, full = as determined by the operating temperature suffix.
c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet.
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_{IN} = input voltage to perform proper function.
g. $\Delta R_{DS(on)} = R_{DS(on)}$ max. - $R_{DS(on)}$ min.
h. Worst case isolation occurs on channel 4 do to proximity to the drain pin.
i. $R_{DS(on)}$ 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.

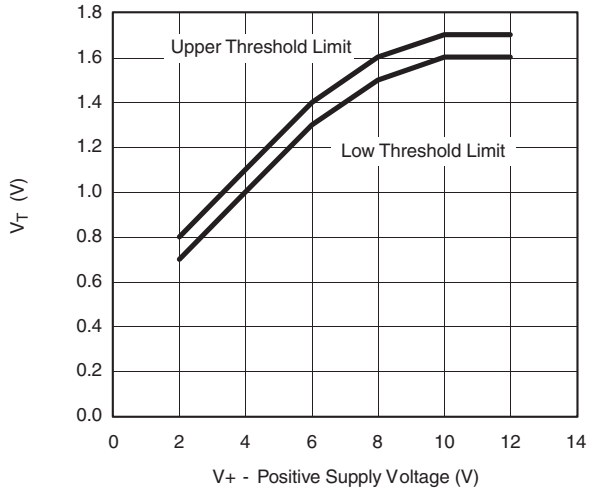
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



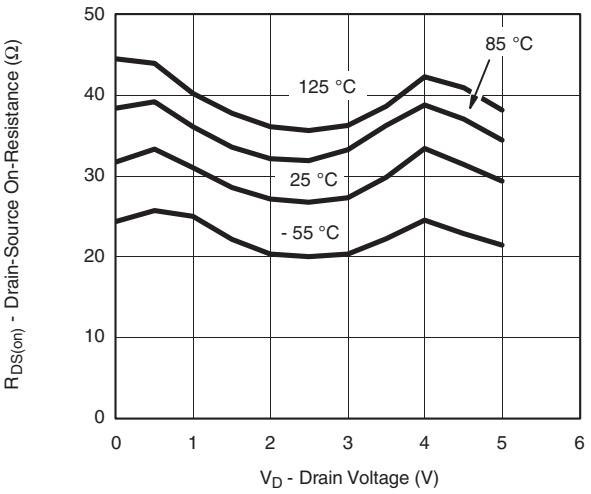
$R_{DS(on)}$ vs. V_D and Power Supply



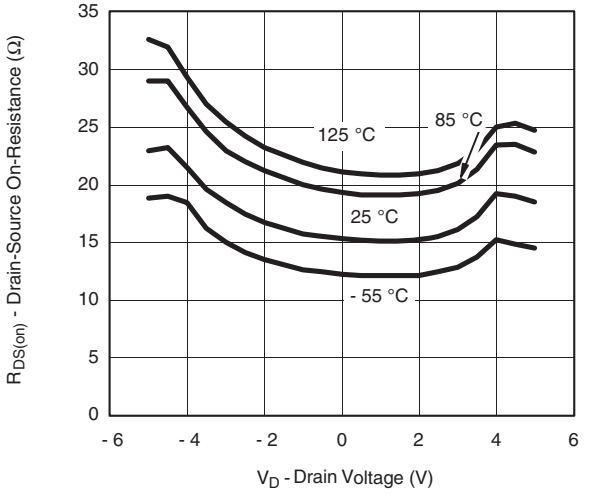
$R_{DS(on)}$ vs. V_D and Power Supply



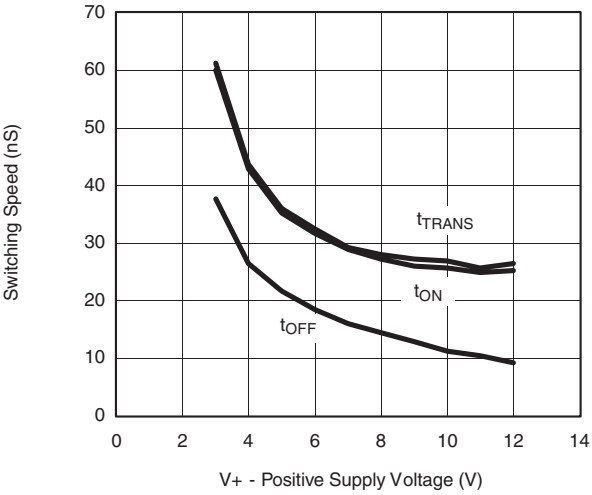
Input Threshold vs. V+ Supply Voltage



$R_{DS(on)}$ vs. V_D and Temperature

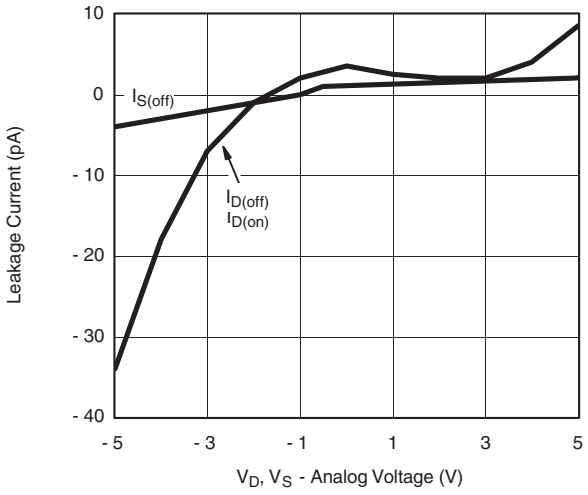


$R_{DS(on)}$ vs. V_D and Temperature

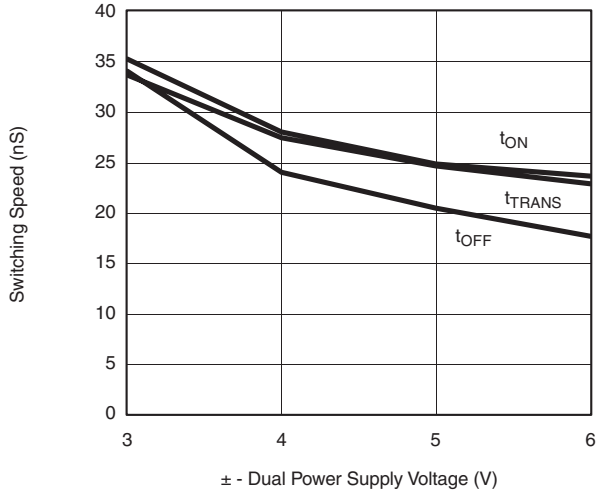


Switching Time vs. Positive Supply Voltage

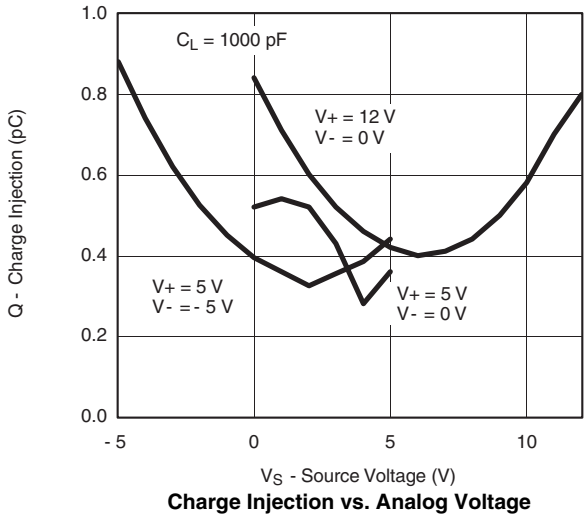
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



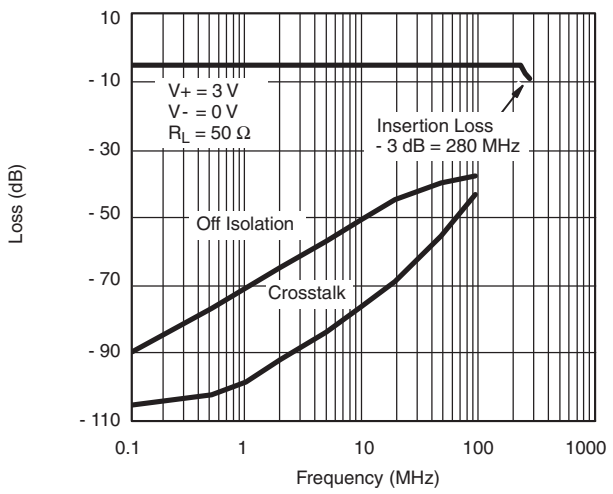
Leakage Current vs. Analog Voltage



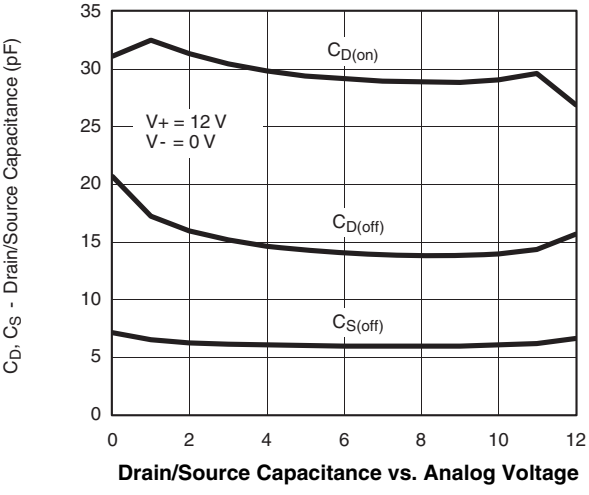
Switching Time vs. Dual Power Supply Voltage



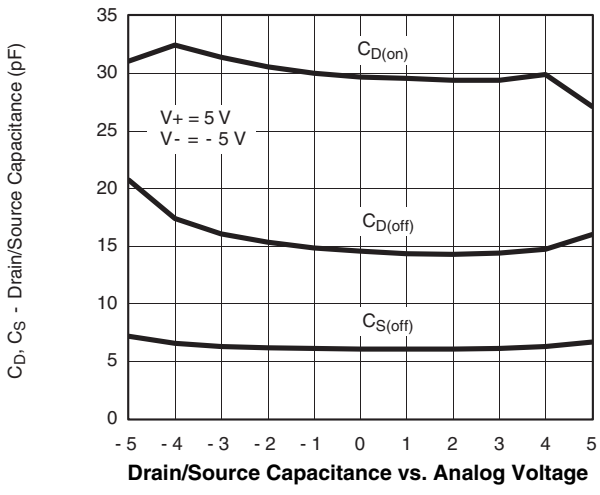
Charge Injection vs. Analog Voltage



Insertion Loss, Off Isolation and Crosstalk vs. Frequency (Single Supply)



Drain/Source Capacitance vs. Analog Voltage



Drain/Source Capacitance vs. Analog Voltage

SCHEMATIC DIAGRAM Typical Channel

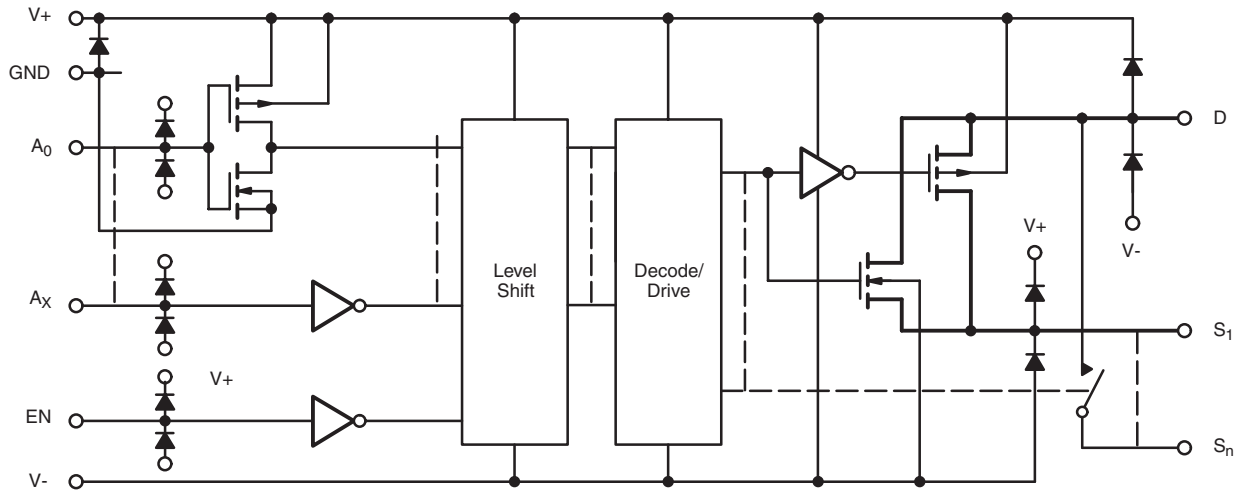
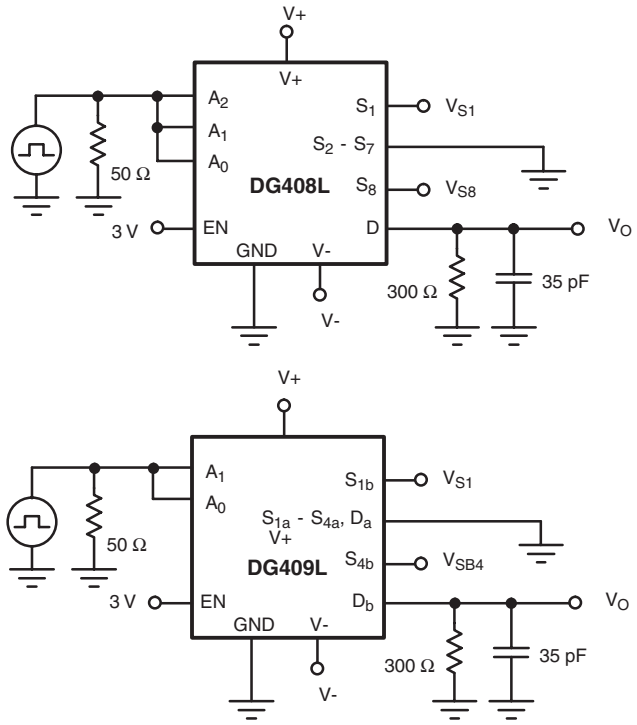


Figure 1.

TEST CIRCUITS



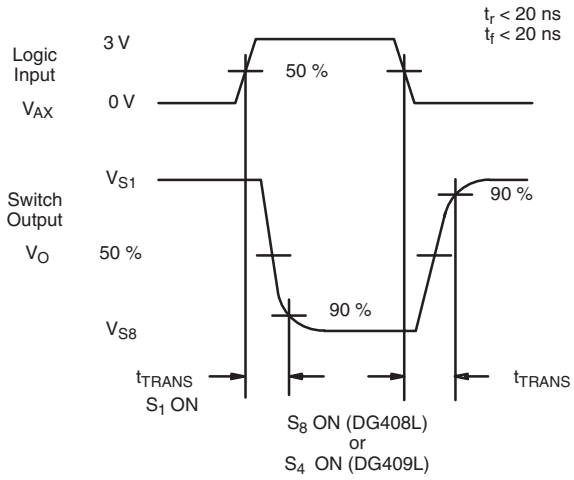


Figure 2. Transition Time

TEST CIRCUITS

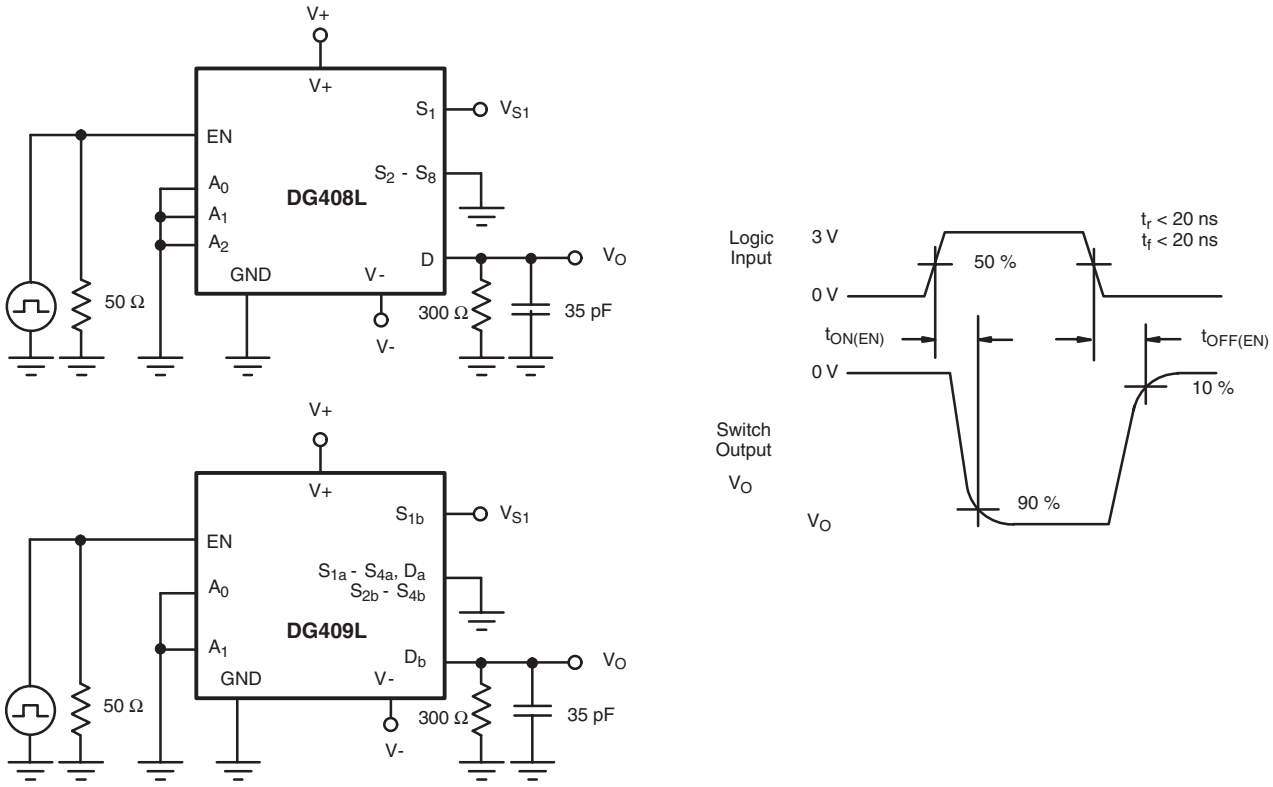


Figure 3. Enable Switching Time

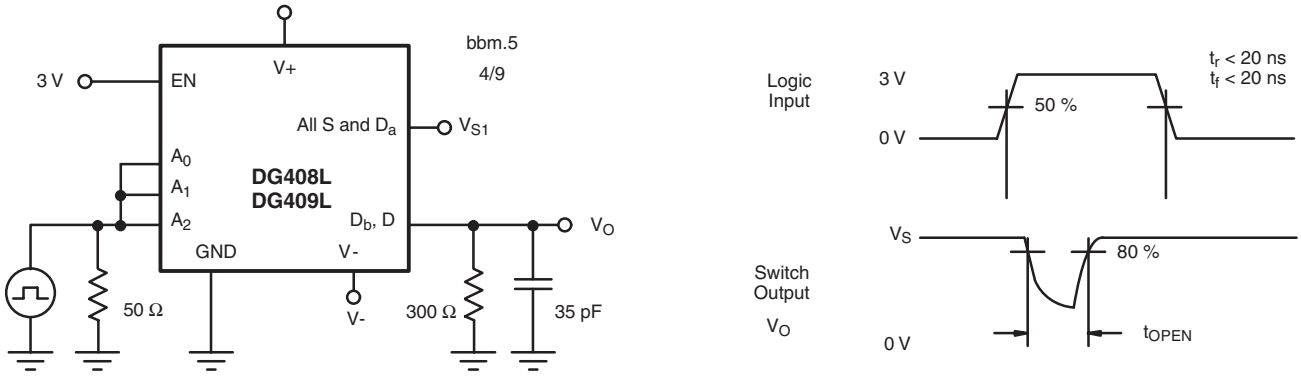


Figure 4. Break-Before-Make Interval

TEST CIRCUITS

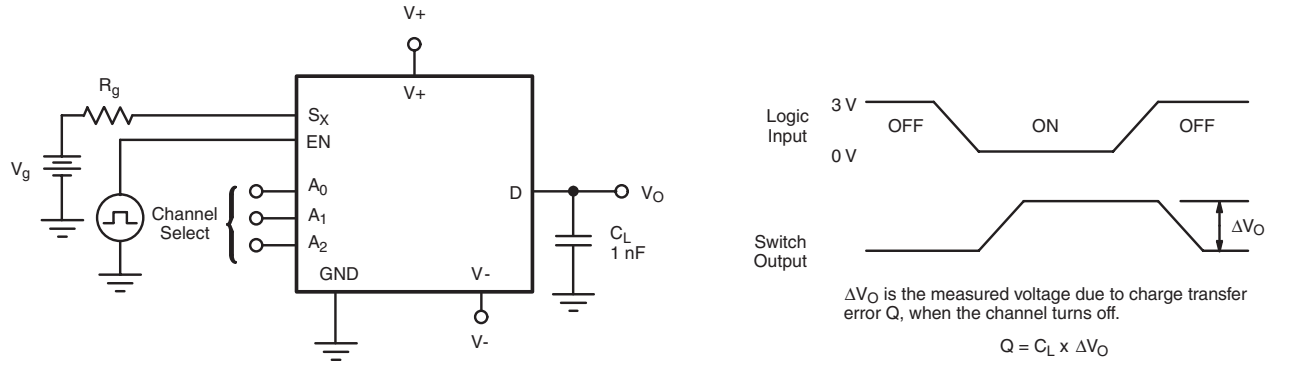


Figure 5. Charge Injection

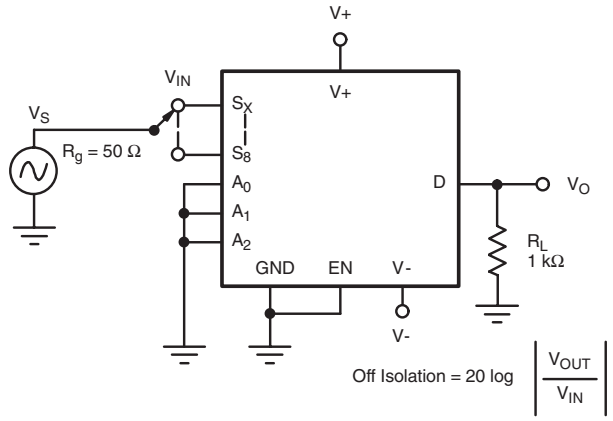


Figure 6. Off Isolation

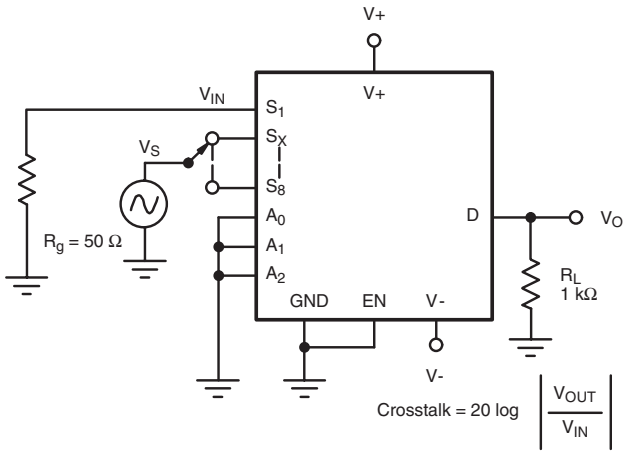


Figure 7. Crosstalk

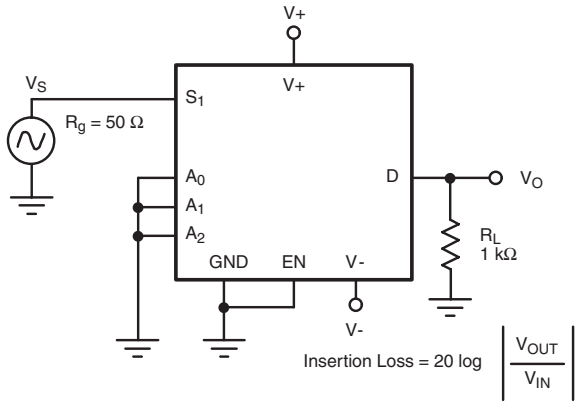


Figure 8. Insertion Loss

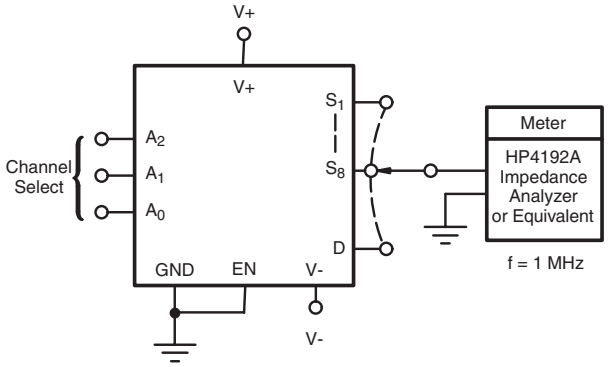


Figure 9. Source Drain Capacitance

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