Precision Monolithic Quad SPST CMOS Analog Switches

FEATURES

- 44-V Supply Max Rating
- ±15-V Analog Signal Range
- On-Resistance—$r_{DS(on)}$: 25 Ω
- Fast Switching—t_{ON}: 68 ns
- Ultra Low Power—P_D: 0.35 μW
- TTL, CMOS Compatible
- Single Supply Capability

BENEFITS

- Widest Dynamic Range
- Low Signal Errors and Distortion
- Break-Before-Make Switching Action
- Simple Interfacing

APPLICATIONS

- Precision Automatic Test Equipment
- Precision Data Acquisition
- Communication Systems
- Battery Powered Systems
- Computer Peripherals

DESCRIPTION

The DG411HS series of monolithic quad analog switches was designed to provide high speed, low error switching of precision analog signals. Combining low power (0.35 μW) with high speed (t_{ON}: 68 ns), the DG411HS family is ideally suited for portable and battery powered industrial and military applications.

To achieve high-voltage ratings and superior switching performance, the DG411HS series was built on Vishay Siliconix's high voltage silicon gate process. An epitaxial layer prevents latchup.

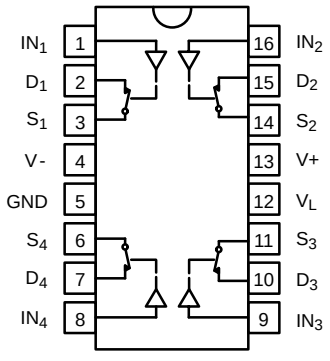
Each switch conducts equally well in both directions when on, and blocks input voltages up to the supply levels when off.

The DG411HS and DG412HS respond to opposite control logic as shown in the Truth Table. The DG413HS has two normally open and two normally closed switches.

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

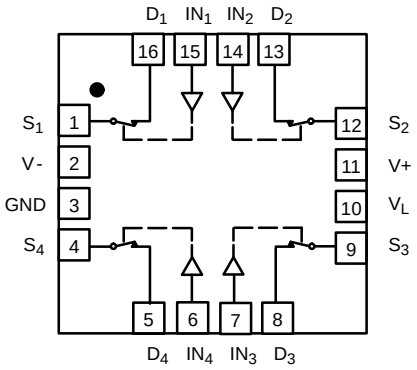
DG411HS

Dual-In-Line and SOIC



Top View

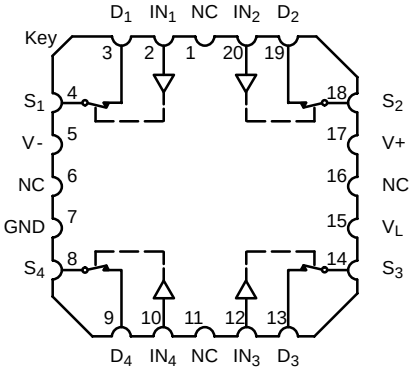
DG411HS
QFN16



Top View

DG411HS

LCC



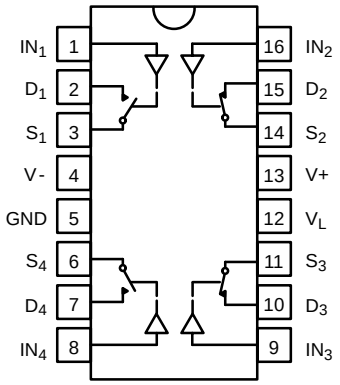
Top View

TRUTH TABLE		
Logic	**DG411HS**	**DG412HS**
0	ON	OFF
1	OFF	ON

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

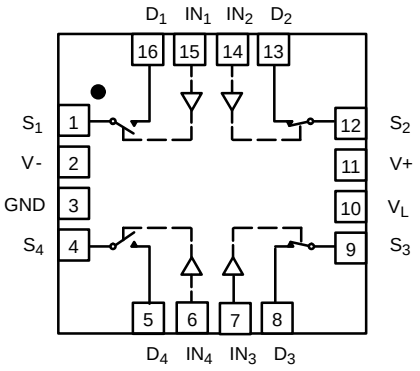
DG413HS

Dual-In-Line and SOIC



Top View

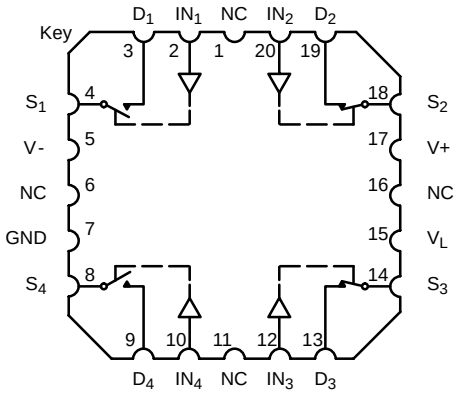
DG413HS
QFN16



Top View

DG413HS

LCC



Top View

TRUTH TABLE		
Logic	**SW_1, SW_4**	**SW_2, SW_3**
0	OFF	ON
1	ON	OFF

ORDERING INFORMATION		
Temp Range	**Package**	**Part Number**
DG411HS/412HS		
-40 to 85°C	16-Pin Plastic DIP	DG411HSDJ
		DG412HSDJ
	16-Pin Narrow SOIC	DG411HSDY
		DG412HSDY
	16-Pin QFN 4x4mm	DG411HSDN
		DG412HSDN
-55 to 125°C	16-Pin CerDIP	DG411HSAK, DG411HSAK/883
		DG412HSAK, DG412HSAK/883
	LCC-20	DG411HSAZ/883
DG413HS		
-40 to 85°C	16-Pin Plastic DIP	DG413HSDJ
	16-Pin Narrow SOIC	DG413HSDY
	16-Pin QFN 4x4mm	DG413HSDN
-55 to 125°C	16-Pin CerDIP	DG413HSAK, DG413HSAK/883
	LCC-20	

ABSOLUTE MAXIMUM RATINGS

V+ to V- . . . . . 44 V
GND to V- . . . . . 25 V
V_L . . . . . (GND -0.3 V) to (V+) +0.3 V
Digital Inputs[a], V_S, V_D . . . . . (V-) -2 V to (V+) +2 V or 30 mA, whichever occurs first
Continuous Current (Any Terminal) . . . . . 30 mA
Peak Current, S or D (Pulsed 1 ms, 10% Duty Cycle) . . . . . 100 mA
Storage Temperature (AK, AZ Suffix) . . . . . -65 to 150°C
(DJ, DY, DN Suffix) . . . . . -65 to 125°C
Power Dissipation (Package)[b]
16-Pin Plastic DIP[c] . . . . . 470 mW
16-Pin Narrow SOIC[d] . . . . . 600 mW
16-Pin CerDIP[e] . . . . . 900 mW
LCC-20[e] . . . . . 900 mW
16-Pin (4x4mm) QFN[f] . . . . . 1880 mW

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 6 mW/°C above 25°C
d. Derate 7.6 mW/°C above 75°C
e. Derate 12 mW/°C above 75°C
f. Derate 23.5 mW/°C above 70°C

SPECIFICATIONS[a]

Parameter	Symbol	Test Conditions Unless Specified V+ = 15 V, V- = -15 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V[f]	Temp[b]	Typ[c]	A Suffix -55 to 125°C Min[d]	A Suffix -55 to 125°C Max[d]	D Suffix -40 to 85°C Min[d]	D Suffix -40 to 85°C Max[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		-15	15	-15	15	V
Drain-Source On-Resistance	$r_{DS(on)}$	V+ = 13.5 V, V- = -13.5 V I_S = -10 mA, V_D = ±8.5 V	Room Full	25		35 45		35 45	Ω
Switch Off Leakage Current	$I_{S(off)}$	V+ = 16.5, V- = -16.5 V V_D = ±15.5 V, V_S = ∓15.5 V	Room Full	±0.1	-0.25 -20	0.25 20	-0.25 -5	0.25 5	nA
	$I_{D(off)}$		Room Full	±0.1	-0.25 -20	0.25 20	-0.25 -5	0.25 5	
Channel On Leakage Current	$I_{D(on)}$	V+ = 16.5 V, V- = -16.5 V V_S = V_D = ±15.5 V	Room Full	±0.1	-0.4 -40	0.4 40	-0.4 -10	0.4 10	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.8 V	Full	0.005	-0.5	0.5	-0.5	0.5	µA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 2.4 V	Full	0.005	-0.5	0.5	-0.5	0.5	
Input Capacitance[e]	C_{IN}	f = 1 MhZ	Room	5					pF
Dynamic Characteristics									
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = ±10 V See Figure 2	Room Full	68		105 127		105 116	ns
Turn-Off Time	t_{OFF}		Room Full	42		80 94		80 90	
Break-Before-Make Time Delay	t_D	DG413HS Only, V_S = 10 V R_L = 300 Ω, C_L = 35 pF	Room	20					
Charge Injection	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room	22					pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room	-91					dB
Channel-to-Channel Cross-talk[e]	X_{TALK}		Room	-88					
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room	12					pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room	12					
Channel On Capacitance[e]	$C_{D(on)}$		Room	30					
Power Supplies									
Positive Supply Current	I+	V+ = 16.5, V- = -16.5 V V_{IN} = 0 or 5 V	Room Full	0.0001		1 5		1 5	µA
Negative Supply Current	I-		Room Full	-0.0001	-1 -5		-1 -5		
Logic Supply Current	I_L		Room Full	0.0001		1 5		1 5	
Ground Current	I_{GND}		Room Full	-0.0001	-1 -5		-1 -5		

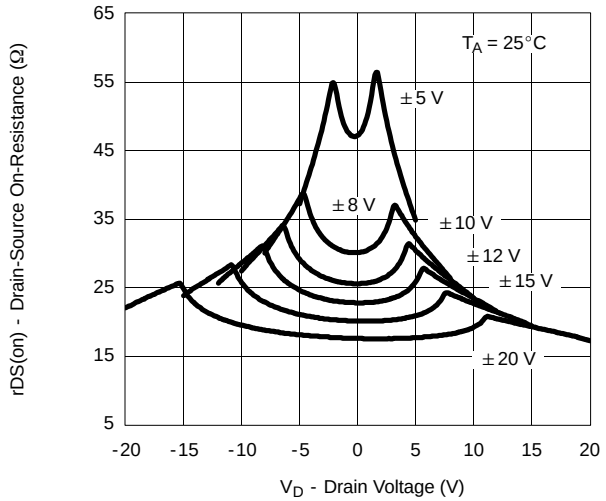
SPECIFICATIONS[a] FOR UNIPOLAR SUPPLIES

Parameter	Symbol	Test Conditions Unless Specified V+ = 12 V, V- = 0 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V[f]	Temp[b]	Typ[c]	A Suffix -55 to 125°C Min[d]	A Suffix -55 to 125°C Max[d]	D Suffix -40 to 85°C Min[d]	D Suffix -40 to 85°C Max[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full			12		12	V
Drain-Source On-Resistance	$r_{DS(on)}$	V+ = 10.8 V, I_S = -10 mA V_D = 3 V, 8 V	Room Full	49		80 100		80 100	Ω
Dynamic Characteristics									
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = 8 V, See Figure 2	Room Hot	95		140 180		140 160	ns
Turn-Off Time	t_{OFF}		Room Hot	36		70 79		70 74	
Break-Before-Make Time Delay	t_D	DG413HS Only, V_S = 8 V, R_L = 300 Ω, C_L = 35 pF	Room	60					
Charge Injection	Q	V_g = 6 V, R_g = 0 Ω, C_L = 1 nF	Room	60					pC
Power Supplies									
Positive Supply Current	I+	V+ = 13.2, V_{IN} = 0 or 5 V	Room Hot	0.0001		1 5		1 5	µA
Negative Supply Current	I-		Room Hot	-0.0001	-1 -5		-1 -5		
Logic Supply Current	I_L		Room Hot	0.0001		1 5		1 5	
Ground Current	I_{GND}		Room Hot	-0.0001	-1 -5		-1 -5		

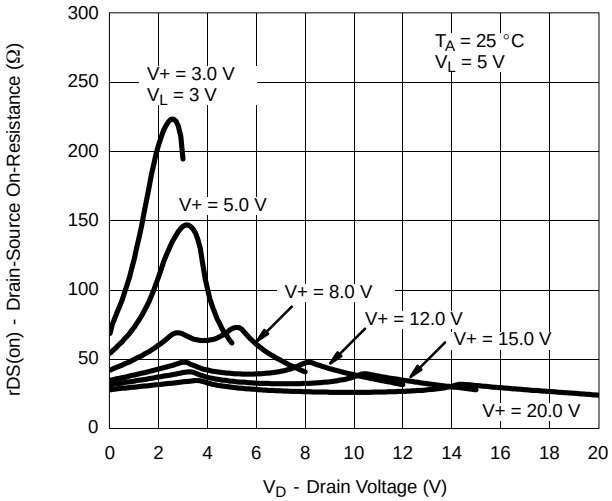
Notes:
a. Refer to PROCESS OPTION FLOWCHART.
b. Room = 25°C, Full = as determined by the operating temperature suffix.
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
e. Guaranteed by design, not subject to production test.
f. V_{IN} = input voltage to perform proper function.

TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

On-Resistance vs. V_D and Dual Supply Voltage

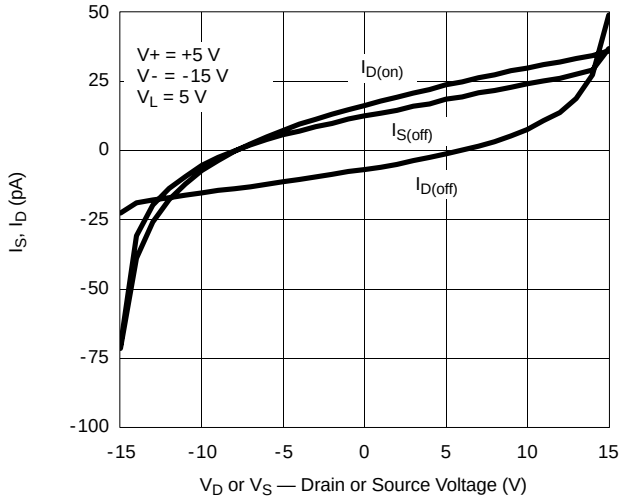


On-Resistance vs. V_D and Unipolar Supply Voltage

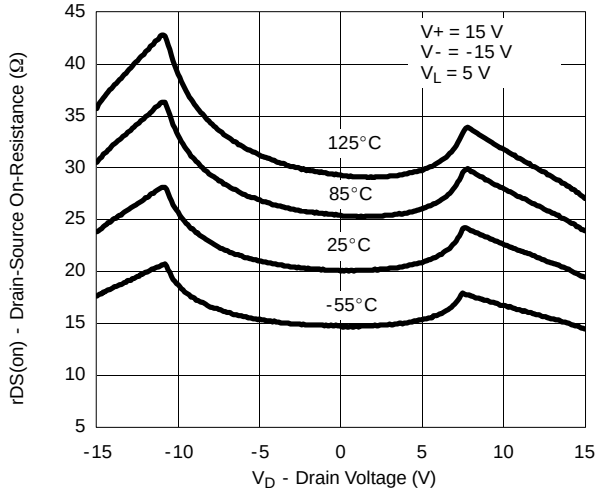


TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

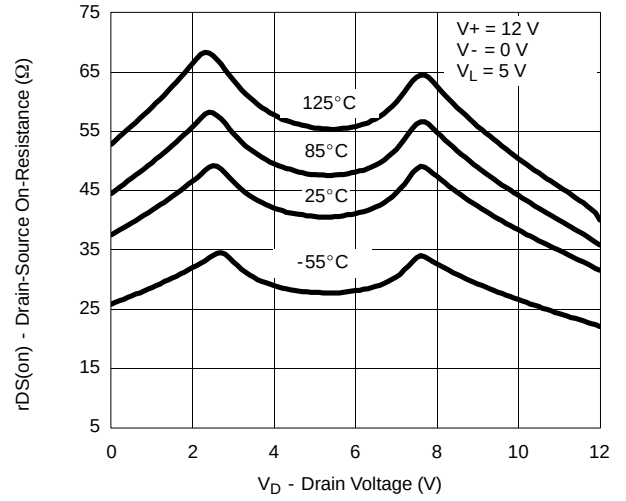
Leakage Current vs. Analog Voltage



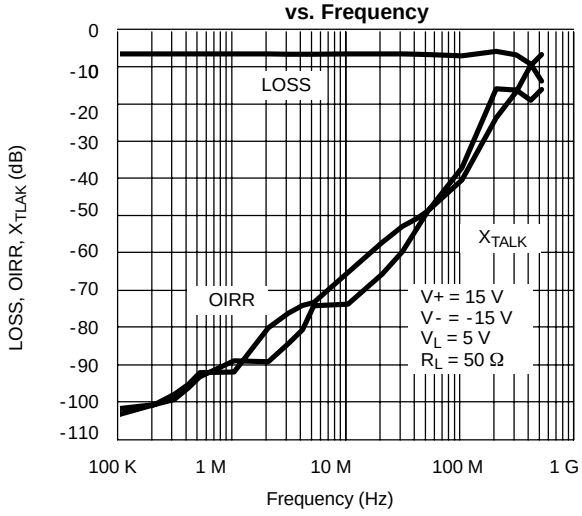
On-Resistance vs. V_D and Temperature



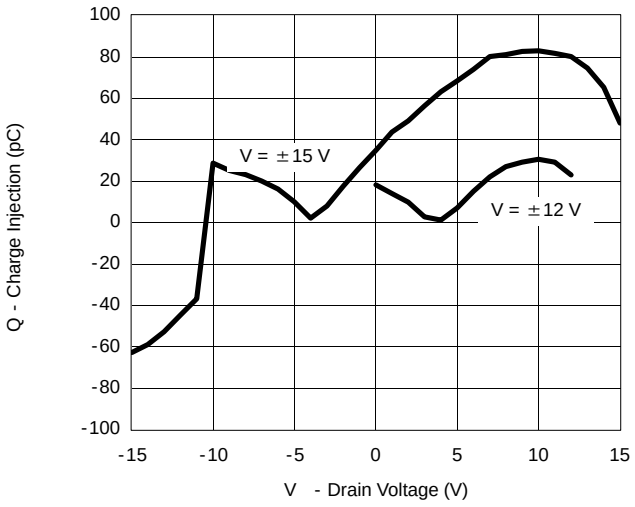
On-Resistance vs. V_D and Temperature



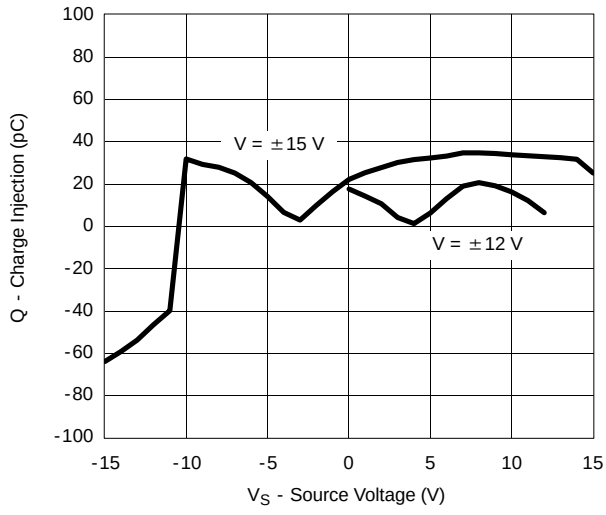
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



Charge Injection vs. Analog Voltage

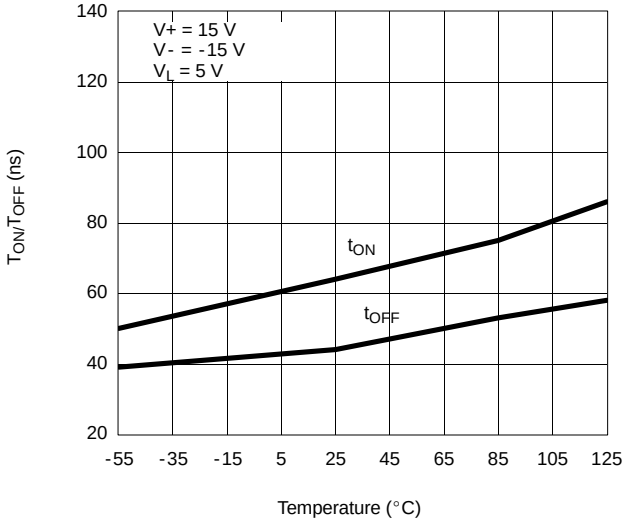


Charge Injection vs. Analog Voltage

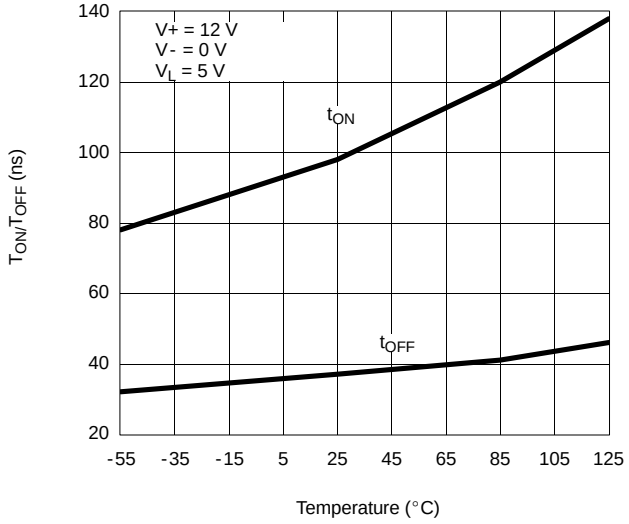


TYPICAL CHARACTERISTICS (25°C UNLESS NOTED)

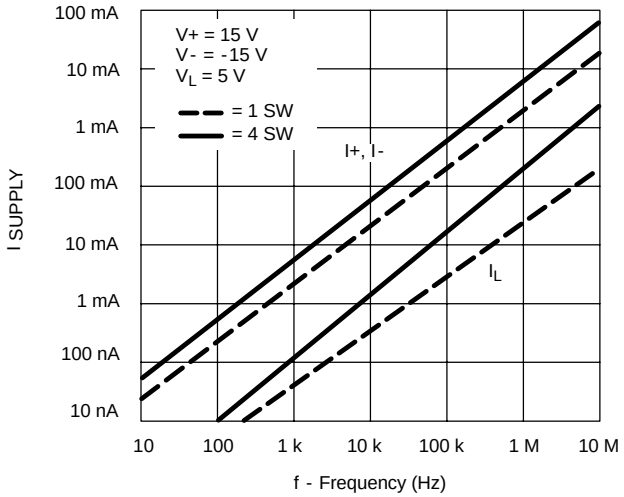
Switching Time vs. Temperature



Switching Time vs. Temperature



Supply Current vs. Input Switching Frequency



SCHEMATIC DIAGRAM (TYPICAL CHANNEL)

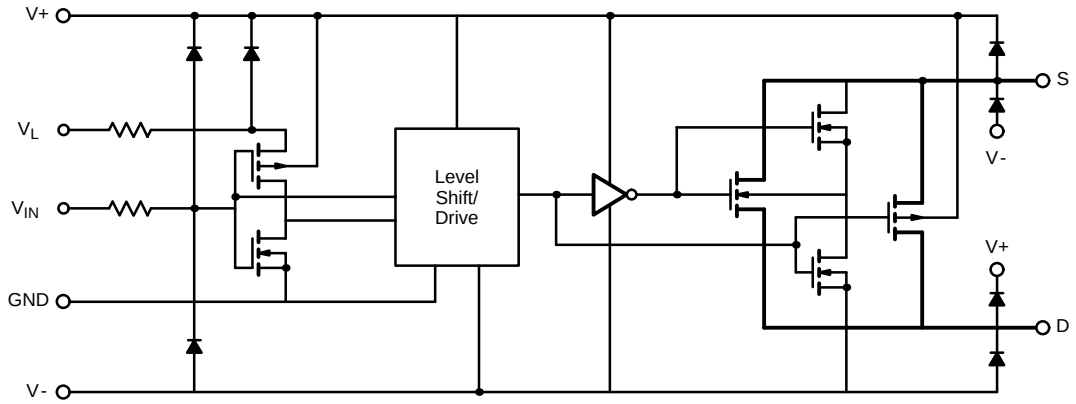
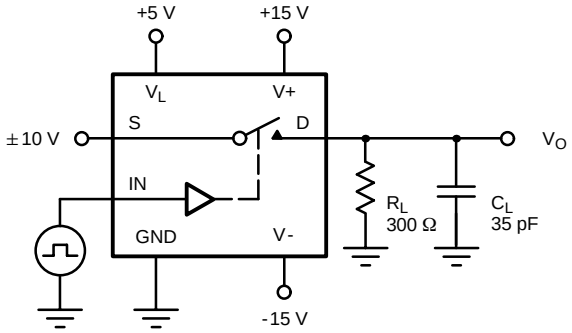


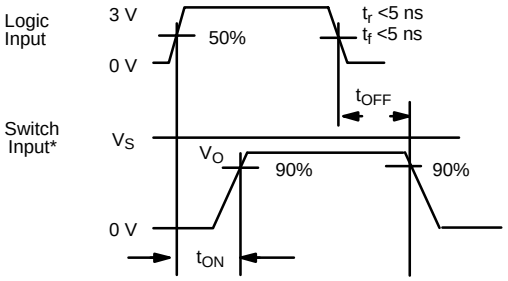
FIGURE 1.

TEST CIRCUITS



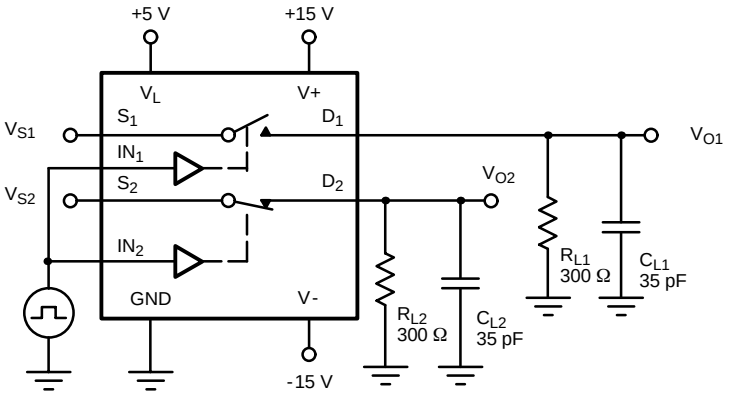
C_L (includes fixture and stray capacitance)

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



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

FIGURE 2. Switching Time



C_L (includes fixture and stray capacitance)

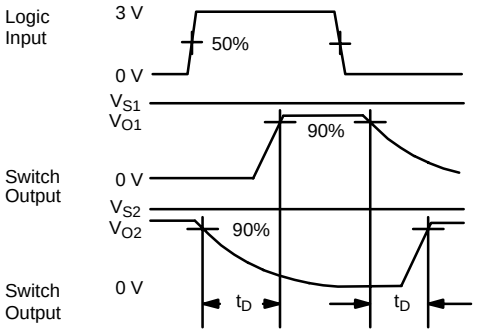
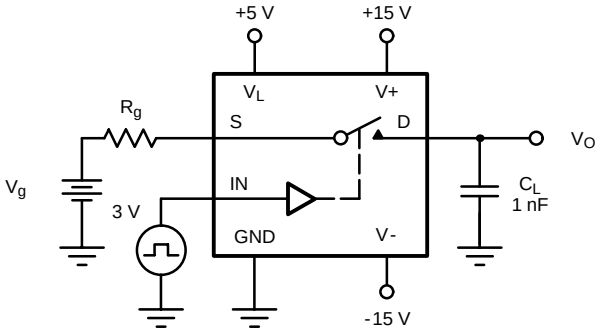


FIGURE 3. Break-Before-Make (DG413HS)



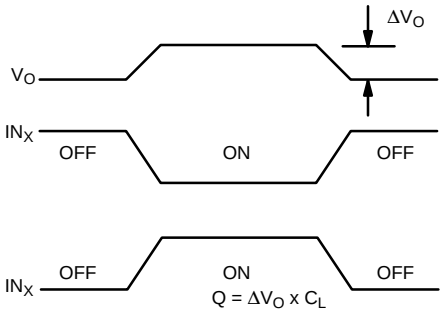


FIGURE 4. Charge Injection

TEST CIRCUITS

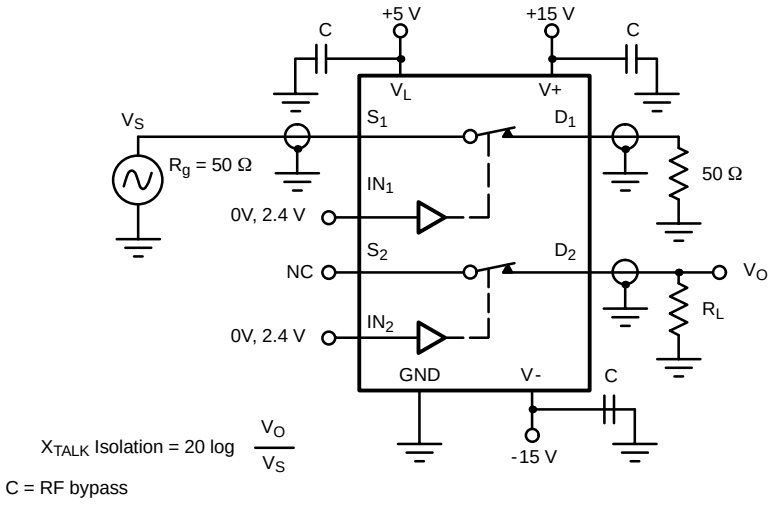


FIGURE 5. Crosstalk

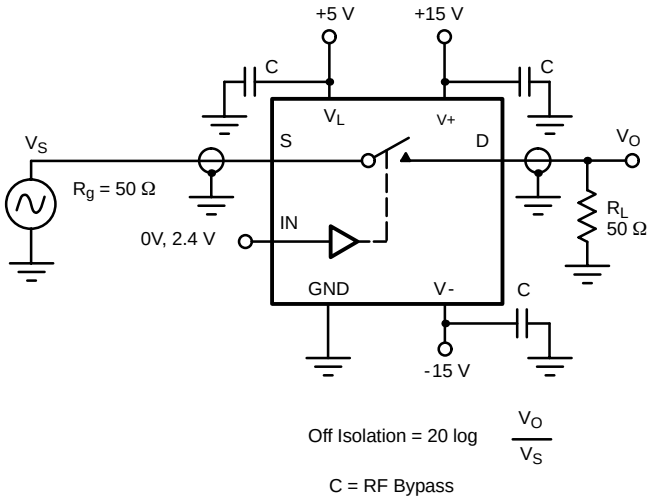


FIGURE 6. Off Isolation

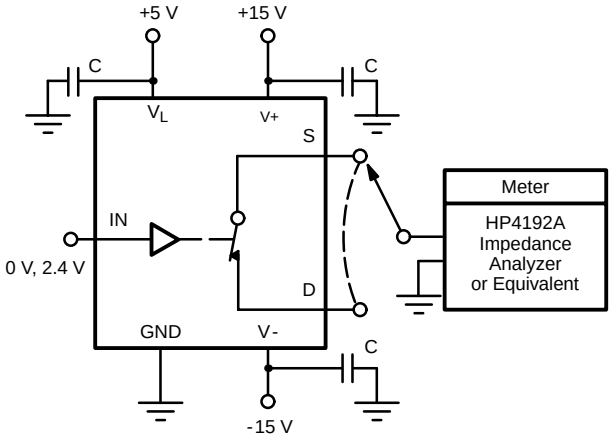


FIGURE 7. Source/Drain Capacitances