DG611A/DG612A/DG613A

Vishay Siliconix

1 pC Charge Injection, 100 pA Leakage, Quad SPST Switches

DESCRIPTION

The DG611A, DG612A and DG613A contain four independently selectable SPST switches. They offer improved performance over the industry standard DG611 series. The DG611A and DG612A have all switches normally closed and normally open respectively, while the DG613A has 2 normally open and 2 normally closed switches.

They are designed to operate from a 2.7 V to 12 V single supply or from ± 2.7 V to ± 5 V dual supplies and are fully specified at + 3 V, + 5 V and ± 5 V. All control logic inputs have guaranteed 2 V logic high limits when operating from + 5 V or ± 5 V supplies and 1.4 V when operating from a + 3 V supply.

The DG611A, DG612A and DG613A switches conduct equally well in both directions and offer rail to rail analog signal handling.

1 pC low charge injection, coupled with very low switch capacitance: 2 pF, fast switching speed: t_{on}/t_{off} 27 ns/16 ns and excellent 3 dB bandwidth: 720 MHz, make these products ideal for precision instrumentation, high-end data acquisition, automated test equipment and high speed communication applications.

Operation temperature is specified from - 40 °C to + 125 °C.

The DG611A, DG612A and DG613A are available in 16 lead SOIC, TSSOP and the space saving 1.8 x 2.6 mm miniQFN packages.

FEATURES

- Low charge injection (1 pC typ.)
- Leakage current < 0.25 nA at 85 °C
- Low switch capacitance (C_{soff} 2 pF typ.)
- Low $r_{DS(on)}$ - 115 Ω maximum
- Fully specified with single supply operation at 3 V, 5 V and dual supplies at ± 5 V
- Low voltage, 2.5 V CMOS/TTL compatible
- 720 MHz, 3 dB bandwidth
- Excellent isolation performance (62 dB at 10 MHz)
- Excellent crosstalk performance (90 dB at 10 MHz)
- Fully specified from - 40 °C to + 85 °C and - 40 °C to + 125 °C
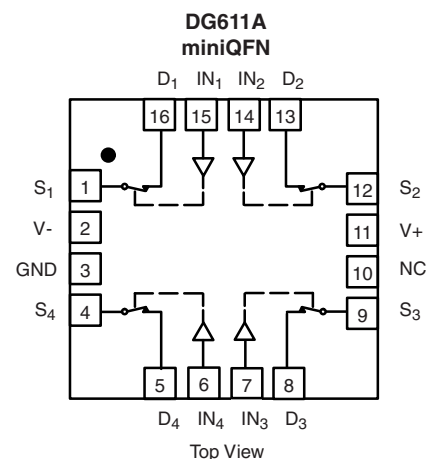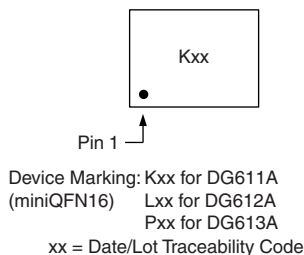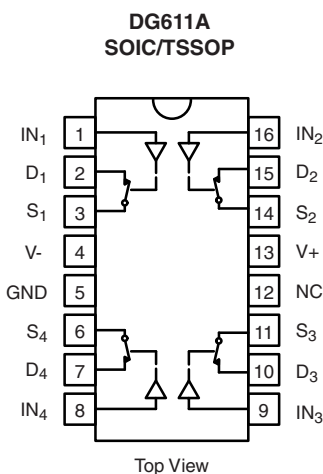- 16 lead SOIC, TSSOP and miniQFN package (1.8 x 2.6 mm)

APPLICATIONS

- Precision instrumentation
- Medical instrumentation
- Automated test equipment
- High speed communications applications
- High-end data acquisition
- Sample and hold applications
- Sample and hold systems
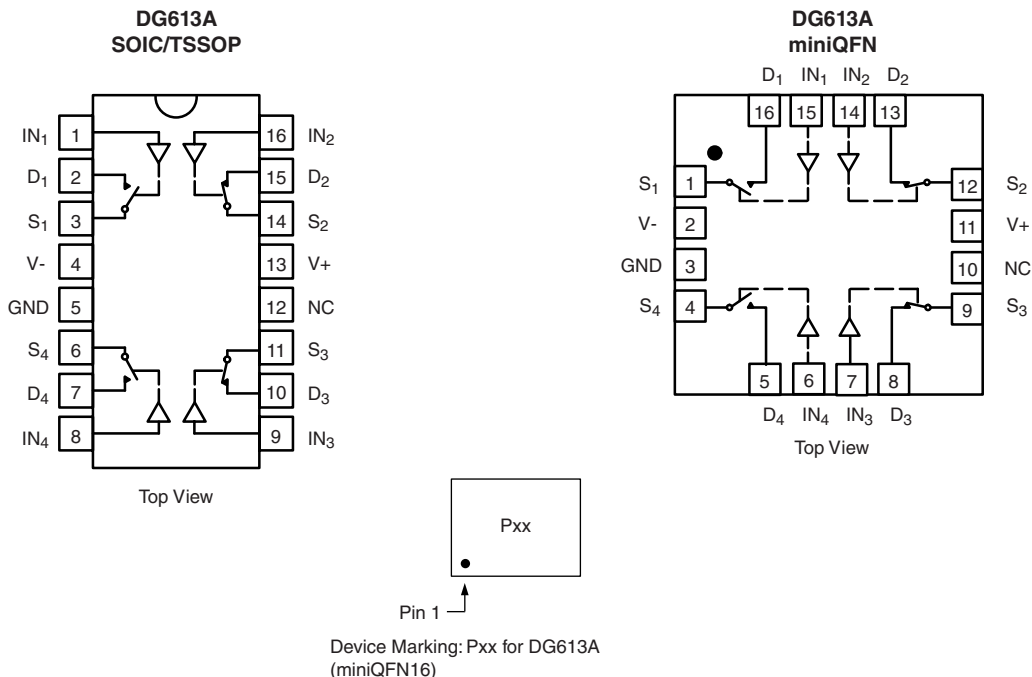
RoHS COMPLIANT

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG611A SOIC/TSSOP

Top View

Device Marking: Kxx for DG611A
(miniQFN16)   Lxx for DG612A
               Pxx for DG613A
xx = Date/Lot Traceability Code

DG611A miniQFN

Top View

TRUTH TABLE

Logic	DG611A	DG612A
0	ON	OFF
1	OFF	ON

DG611A/DG612A/DG613A

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FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG613A
SOIC/TSSOP

IN$_1$	1	16	IN$_2$
D$_1$	2	15	D$_2$
S$_1$	3	14	S$_2$
V-	4	13	V+
GND	5	12	NC
S$_4$	6	11	S$_3$
D$_4$	7	10	D$_3$
IN$_4$	8	9	IN$_3$

Top View

DG613A
miniQFN

Top View

Device Marking: Pxx for DG613A
(miniQFN16)

TRUTH TABLE

Logic	SW$_1$, SW$_4$	SW$_2$, SW$_3$
0	OFF	ON
1	ON	OFF

ORDERING INFORMATION

Temp. Range	Package	Part Number
DG611A/612A/613A		
- 40 °C to 125 °C[a]	16-Pin TSSOP	DG611AEQ-T1-E3 DG612AEQ-T1-E3 DG613AEQ-T1-E3
	16-Pin Narrow SOIC	DG611AEY-T1-E3 DG612AEY-T1-E3 DG613AEY-T1-E3
	16-Pin miniQFN	DG611AEN-T1-E4 DG612AEN-T1-E4 DG613AEN-T1-E4

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

ABSOLUTE MAXIMUM RATINGS T_A = 25 °C, unless otherwise noted

Parameter		Limit	Unit
V+ to V-		14	V
GND to V-		7	
Digital Inputs[a], V_S, V_D		(V-) - 0.3 V to (V+) + 0.3 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	
Storage Temperature		- 65 to 150	°C
Power Dissipation (Package)[b]	16-Pin TSSOP[c]	450	mW
	16-Pin miniQFN[d]	525	
	16-Pin Narrow SOIC[e]	640	
Thermal Resistance (Package)[b]	16-Pin TSSOP	178	°C/W
	16-Pin miniQFN	152	
	16-Pin Narrow SOIC	125	

Notes:
a. Signals on SX, DX, or INX 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 5.6 mW/°C above 70 °C.
d. Derate 6.6 mW/°C above 70 °C.
e. Derate 8.0 mW/°C above 70 °C.
f. Manual soldering with iron is not recommended for leadless components. The miniQFN-16 is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper lip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.

Parameter	Symbol	Test Conditions Unless Specified $V+ = +5$ V, $V- = -5$ V $V_{IN} = 2.0$ V, 0.8 V[a]	Temp.[b]	Typ.[c]	-40 to 125 °C Min.[d]	-40 to 125 °C Max.[d]	-40 to 85 °C Min.[d]	-40 to 85 °C Max.[d]	Unit
SPECIFICATIONS FOR DUAL SUPPLIES $V+ = +5$ V, $V- = -5$ V									
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		-5	5	-5	5	V
On-Resistance	r_{ON}	$I_S = 1$ mA, $V_D = -3$ V, 0 V, $+3$ V	Room Full	72		115 160		115 140	Ω
On-Resistance Match	Δr_{ON}	$I_S = 1$ mA, $V_D = \pm 3$ V	Room Full	0.7		4 6.5		4 5.5	Ω
On-Resistance Flatness	$r_{FLATNESS}$	$I_S = 1$ mA, $V_D = -3$ V, 0 V, $+3$ V	Room Full	25		40 60		40 55	Ω
Switch Off Leakage Current	$I_{S(off)}$	$V+ = 5.5$ V, $V- = -5.5$ V $V_D = +4.5$ V/-4.5 V $V_S = -4.5$ V/$+4.5$ V	Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	nA
	$I_{D(off)}$		Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	
Switch On Leakage Current	$I_{D(on)}$	$V+ = 5.5$ V, $V- = -5.5$ V $V_D = V_S = \pm 4.5$ V	Room Full	± 0.02	- 0.1 - 6	0.1 6	- 0.1 - 0.25	0.1 0.25	nA
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.8 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	μA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 2.0 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	
Input Capacitance[e]	C_{IN}	f = 1 MHz	Room	2					pF
Dynamic Characteristics									
Turn-On Time	t_{ON}	$R_L = 300$ Ω, $C_L = 35$ pF $V_S = \pm 3$ V, see Figure 1	Room Full	27		55 90		55 75	ns
Turn-Off Time	t_{OFF}		Room Full	16		35 50		35 45	ns
Break-Before-Make Time Delay	t_{BBM}	DG613A only, $V_S = 3$ V $R_L = 300$ Ω, $C_L = 35$ pF	Room Full	15	2		2		ns
Charge Injection[e]	Q	$V_g = 0$ V, $R_g = 0$ Ω, $C_L = 1$ nF	Room	1					pC
Off Isolation[e]	OIRR	$R_L = 50$ Ω, $C_L = 5$ pF f = 10 MHz	Room	- 62					dB
Channel-to-Channel Crosstalk[e]	X_{TALK}		Room	- 90					
3 dB Bandwidth[e]	BW	$R_L = 50$ Ω, $C_L = 5$ pF	Room	720					MHz
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz; $V_S = 0$ V	Room	2					pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room	3					
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz; $V_S = V_D = 0$ V	Room	9					
Total Harmonic Distortion[e]	THD	Signal = 1 V_{RMS}, 20 Hz to 20 kHz, $R_L = 600$ Ω	Room	0.01					%
Power Supplies									
Power Supply Current	I+	$V+ = +5$ V, $V- = -5$ V $V_{IN} = 0$ or 5 V	Room Full	0.001		0.1 1		0.1 1	μA
Negative Supply Current	I-		Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		μA
Ground Current	I_{GND}		Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		

SPECIFICATIONS FOR UNIPOLAR SUPPLIES V+ = + 5 V, V- = 0 V

Parameter	Symbol	Test Conditions Unless Specified V+ = + 5 V, V- = 0 V V_{IN} = 2.0 V, 0.8 V[a]	Temp.[b]	Typ.[c]	- 40 to 125 °C Min.[d]	Max.[d]	- 40 to 85 °C Min.[d]	Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	5	0	5	V
On-Resistance	r_{ON}	V+ = + 5 V, V- = 0 V I_S = 1 mA, V_D = + 3.5 V	Room Full	139		180 235		180 215	Ω
On-Resistance Match	Δr_{ON}	V+ = + 5 V, V- = 0 V, I_S = 1 mA, V_D = + 3.5 V	Room Full	1		6 10		6 9	Ω
On-Resistance Flatness	$r_{FLATNESS}$	V+ = + 5 V, V- = 0 V, I_S = 1 mA, V_D = 0 V, + 3.5 V	Room Full	56		80 120		80 110	Ω
Switch Off Leakage Current	$I_{S(off)}$	V+ = 5.5 V, V- = 0 V V_D = 4.5 V/1 V V_S = 1 V/4.5 V	Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	nA
	$I_{D(off)}$		Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	
Switch On Leakage Current	$I_{D(on)}$	V+ = 5.5 V, V- = 0 V $V_D = V_S$ = 1 V/4.5 V	Room Full	± 0.02	- 0.1 - 6	0.1 6	- 0.1 - 0.25	0.1 0.25	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.8 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 2.0 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	
Input Capacitance[e]	C_{IN}	f = 1 MHz	Room	2					pF
Dynamic Characteristics									
Turn-On Time[e]	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = 3 V, see Figure 1	Room Full	33		60 100		60 90	ns
Turn-Off Time[e]	t_{OFF}		Room Full	16		35 50		35 45	
Break-Before-Make[e] Time Delay	t_{BBM}	DG613A only, V_S = 3 V R_L = 300 Ω, C_L = 35 pF	Room Full	19	2		2		
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Full	2.3					pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF f = 10 MHz	Room	- 61					dB
Channel-to-Channel Crosstalk[e]	X_{TALK}		Room	- 90					
3 dB Bandwidth[e]	BW	R_L = 50 Ω, C_L = 5 pF	Room	675					MHz
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz; V_S = 0 V	Room	3					pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room	5					
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz; $V_S = V_D$ = 0 V	Room	9					
Power Supplies									
Power Supply Current	I+		Room Full	0.001		0.1 1		0.1 1	µA
Negative Supply Current	I-	V_{IN} = 0 or 5 V	Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		
Ground Current	I_{GND}		Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		

DG611A/DG612A/DG613A

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SPECIFICATIONS FOR UNIPOLAR SUPPLIES   V+ = + 3 V, V- = 0 V

| Parameter	Symbol	Test Conditions Unless Specified V+ = + 3 V, V- = 0 V V_{IN} = 1.4 V, 0.6 V[a]	Temp.[b]	Typ.[c]	- 40 to 125 °C Min.[d]	- 40 to 125 °C Max.[d]	- 40 to 85 °C Min.[d]	- 40 to 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	3	0	3	V
On-Resistance	r_{ON}	I_S = 1 mA, V_D = + 1.5 V	Room Full	195		235 300		235 280	Ω
Switch Off Leakage Current	$I_{S(off)}$	V+ = 3.3 V, V- = 0 V V_D = 3 V/0.3 V V_S = 0.3 V/3 V	Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	nA
Switch Off Leakage Current	$I_{D(off)}$		Room Full	± 0.02	- 0.1 - 2	0.1 2	- 0.1 - 0.25	0.1 0.25	nA
Switch On Leakage Current	$I_{D(on)}$	V+ = 3.3 V, V- = 0 V $V_D = V_S$ = 0.3 V/3 V	Room Full	± 0.02	- 0.1 - 6	0.1 6	- 0.1 - 0.25	0.1 0.25	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.6 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 1.4 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Capacitance[e]	C_{IN}	f = 1 MHz	Room	2					pF
Dynamic Characteristics									
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF V_S = 2 V, see Figure 1	Room Full	87		125 180		125 170	ns
Turn-Off Time	t_{OFF}		Room Full	33		55 65		55 60	ns
Break-Before-Make Time Delay	t_{BBM}	DG613 only, V_S = 2 V R_L = 300 Ω, C_L = 35 pF	Room Full	60	10		10		
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room	2.3					pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF f = 10 MHz	Room	- 60					dB
Channel-to-Channel Crosstalk[e]	X_{TALK}		Room	- 90					dB
3 dB Bandwidth[e]	BW	R_L = 50 Ω, C_L = 5 pF	Room	550					MHz
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz; V_S = 0 V	Room	5					pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room	6					pF
Drain On Capacitance[e]	$C_{D(on)}$	f = 1 MHz; $V_S = V_D$ = 0 V	Room	9					
Power Supplies									
Power Supply Current	I+		Room Full	0.001		0.1 1		0.1 1	µA
Negative Supply Current	I-	V_{IN} = 0 or 3 V	Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		µA
Ground Current	I_{GND}		Room Full	- 0.001	- 0.1 - 1		- 0.1 - 1		µA

Notes:
a. V_{IN} = 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.
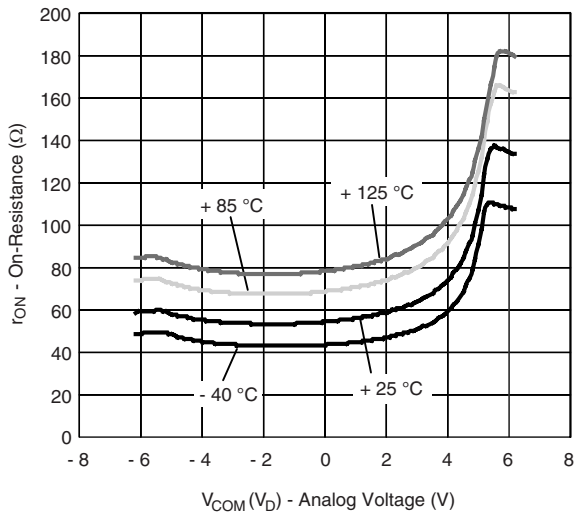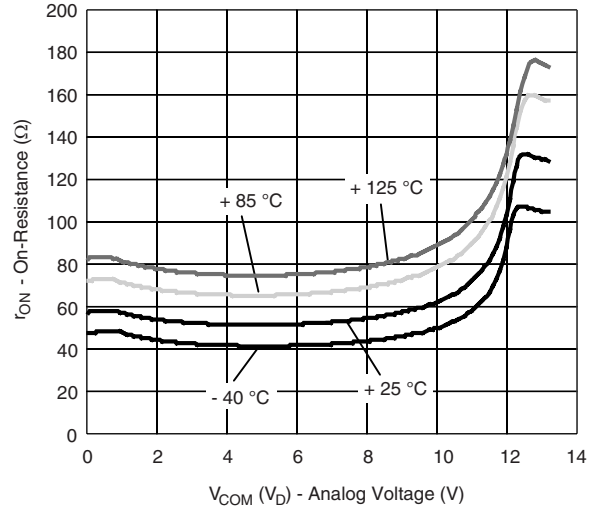
TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted
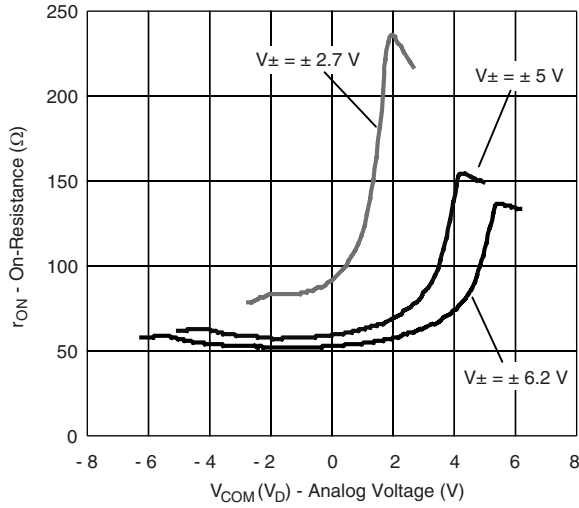
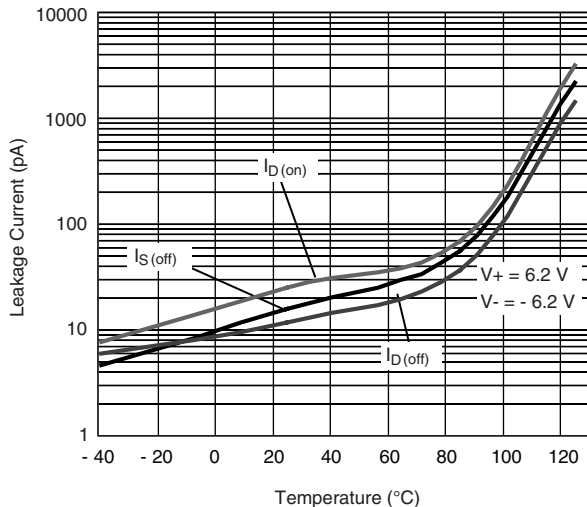**On-Resistance vs. V_D (Dual Supply)**
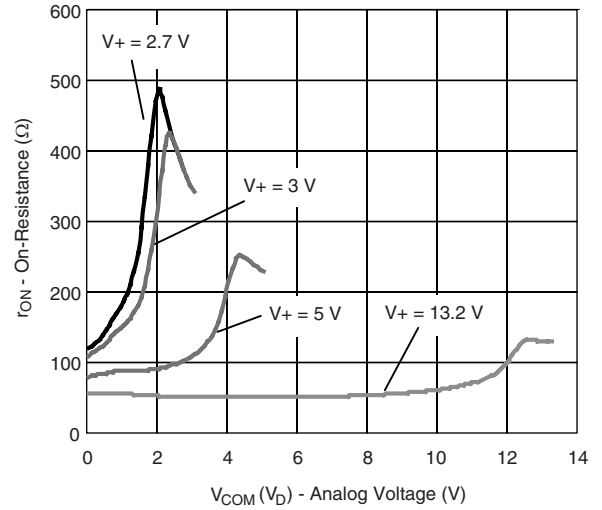
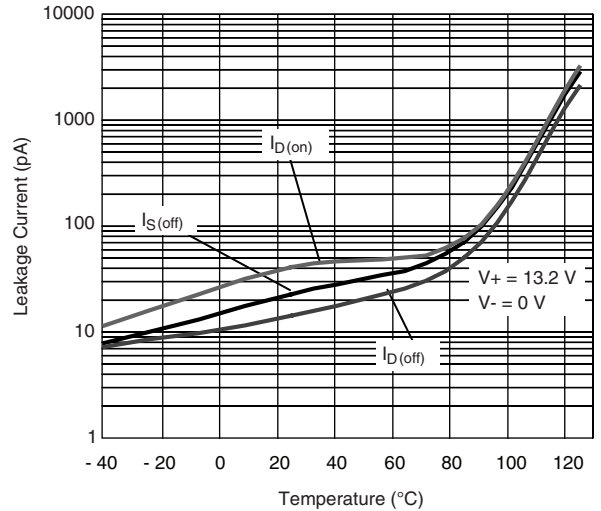**On-Resistance vs. V_D (Single Supply)**

On-Resistance vs. Temperature (Dual Supply)

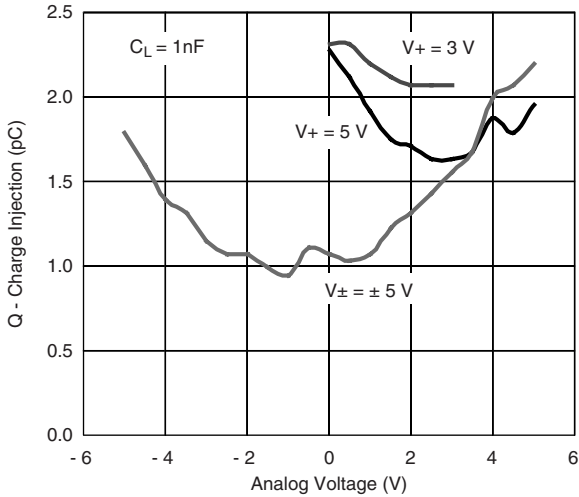**On-Resistance vs. Temperature (Single Supply)**

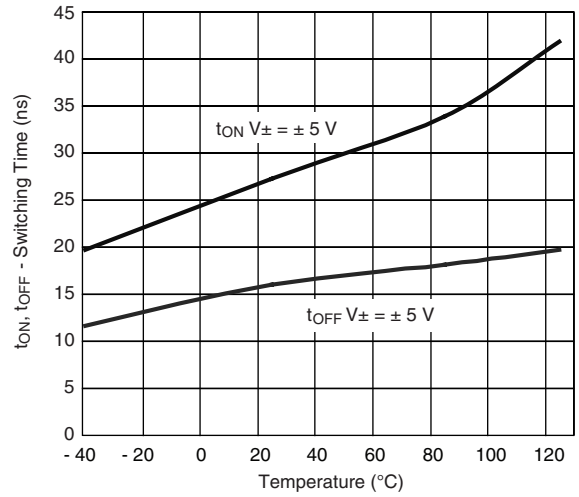**Leakage Current vs. Temperature**
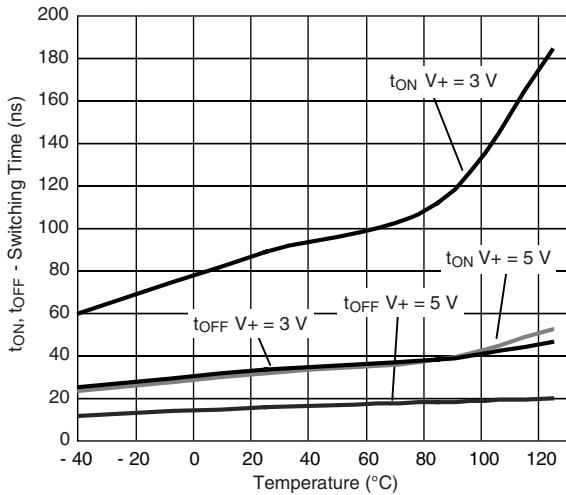
Leakage Current vs. Temperature

TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted

Charge Injection vs. Analog Voltage
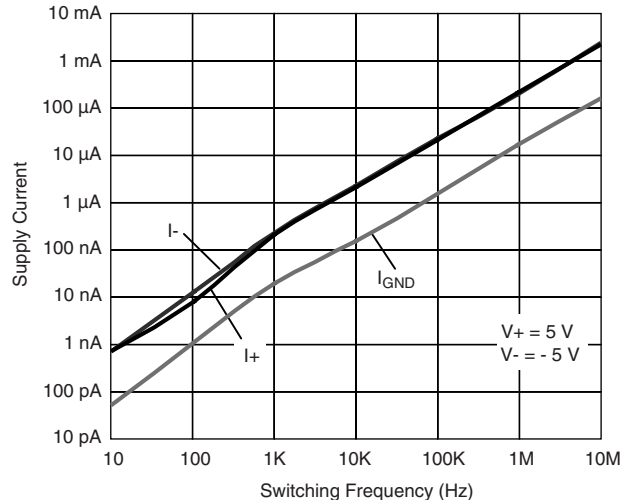
Switching Time vs. Temperature (Dual Supply)

Switching Time vs. Temperature (Single Supply)
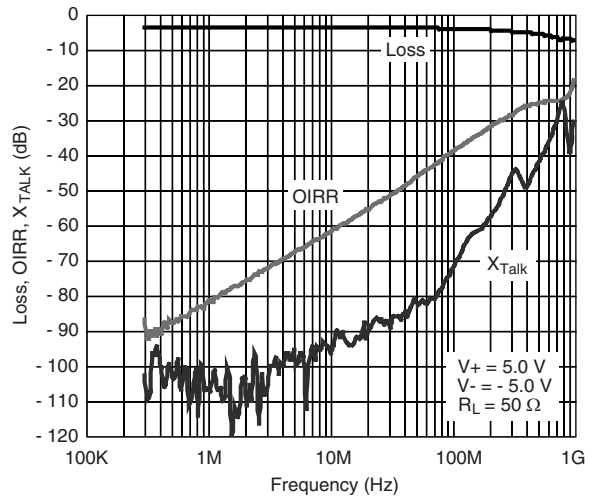
**Insertion Loss, Off-Isolation, Crosstalk
vs. Frequency**
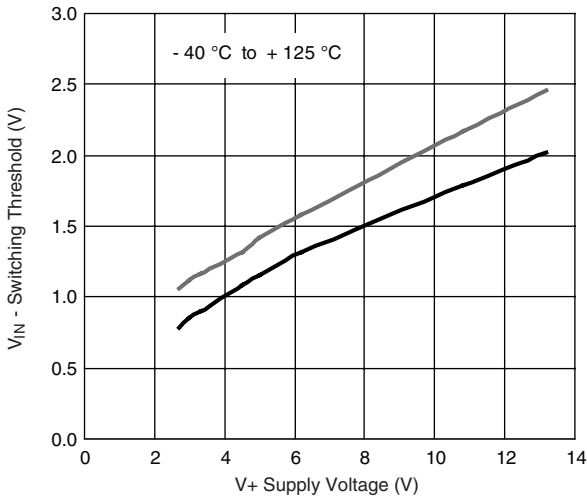
Switching Threshold vs. Supply Voltage
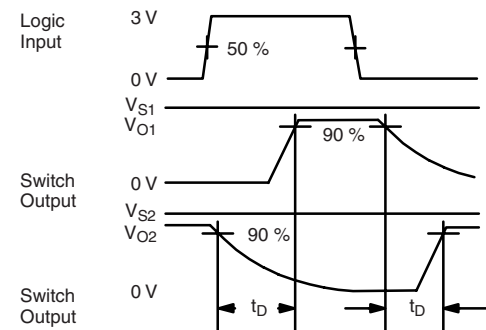
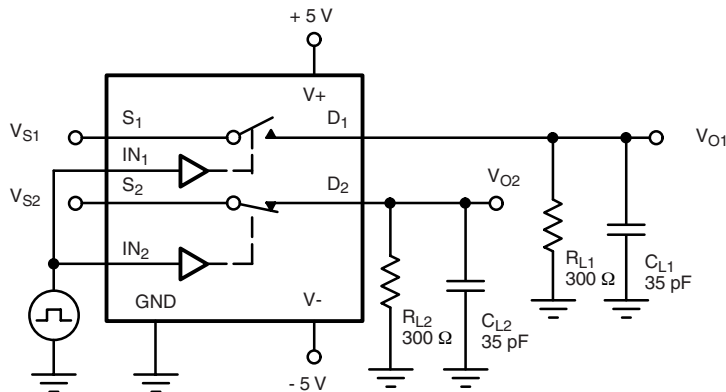**Supply Current vs. Switching Frequency**

TEST CIRCUITS
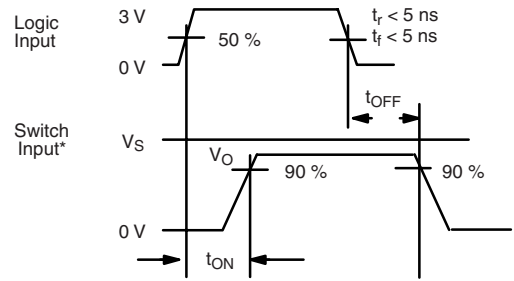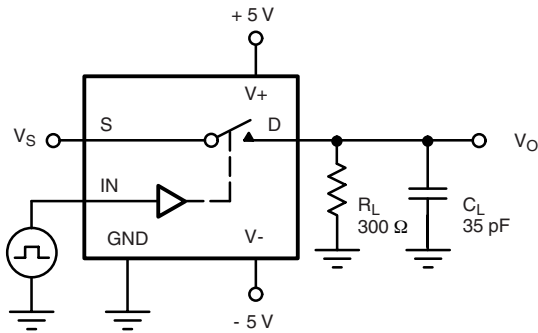
C_L (includes fixture and stray capacitance)

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

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

Figure 1. Switching Time

C_L (includes fixture and stray capacitance)
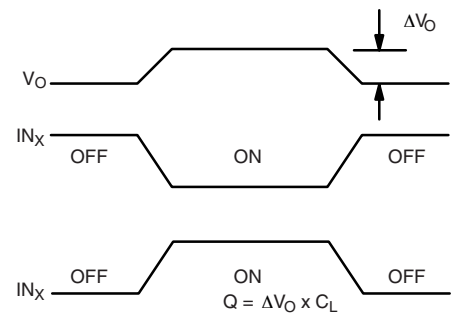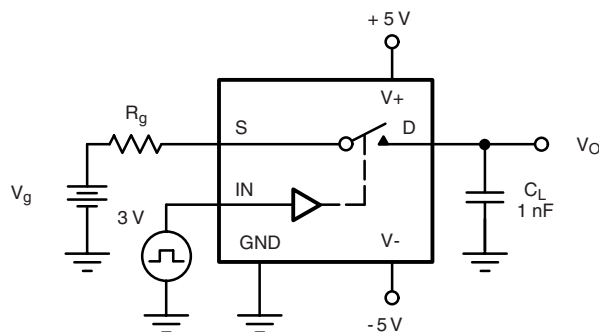
Figure 2. Break-Before-Make (DG613A)

$Q = \Delta V_O \times C_L$

Figure 3. Charge Injection

DG611A/DG612A/DG613A

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TEST CIRCUITS

$$X_{TALK} \text{ Isolation} = 20 \log \frac{V_O}{V_S}$$

C = RF bypass

Figure 4. Crosstalk

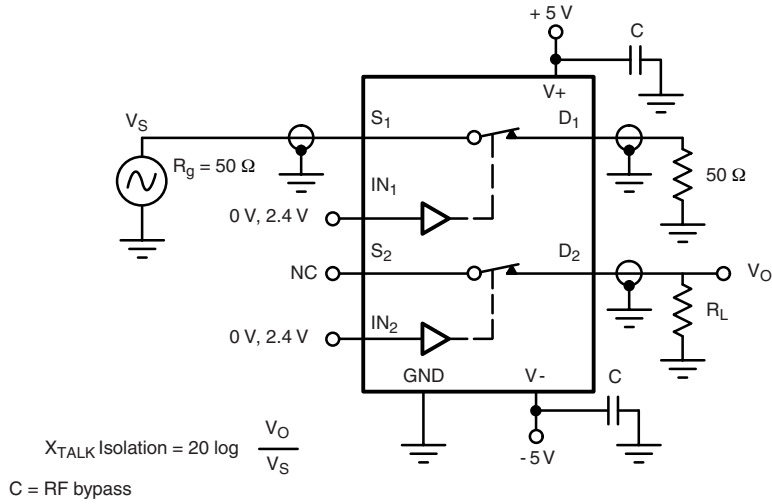$$\text{Off Isolation} = 20 \log \frac{V_O}{V_S}$$
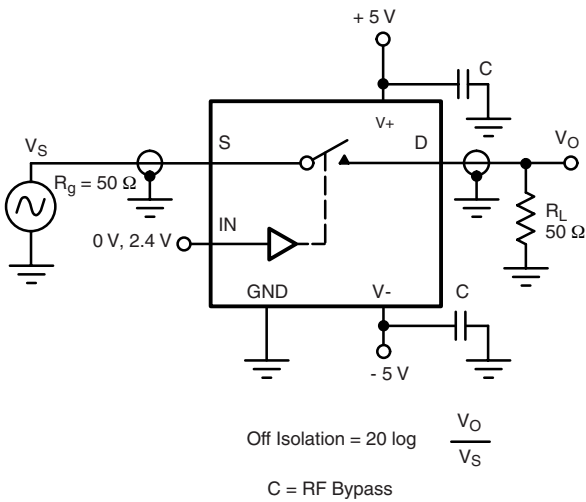
C = RF Bypass

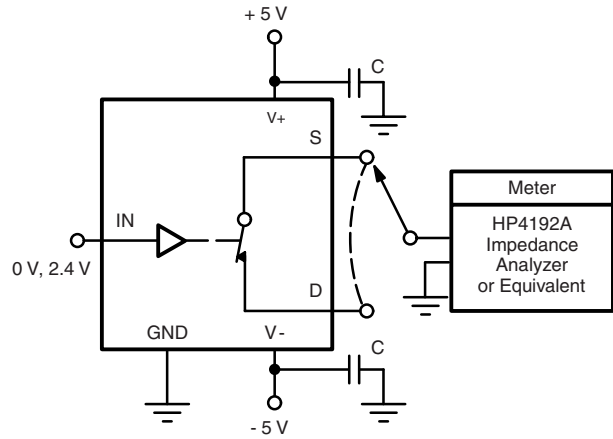**Figure 5. Off-Isolation**

Figure 6. Source/Drain Capacitances

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see http://www.vishay.com/ppg?69904.

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