High-Speed, Low-Glitch D/CMOS Analog Switches

DESCRIPTION

The DG611, DG612, DG613 feature high-speed low-capacitance lateral DMOS switches. Charge injection has been minimized to optimize performance in fast sample-and-hold applications.

Each switch conducts equally well in both directions when on and blocks up to 16 V_{p-p} when off. Capacitances have been minimized to ensure fast switching and low-glitch energy. To achieve such fast and clean switching performance, the DG611, DG612, DG613 are built on the Vishay Siliconix proprietary D/CMOS process. This process combines n-channel DMOS switching FETs with low-power CMOS control logic and drivers. An epitaxial layer prevents latchup.

The DG611 and DG612 differ only in that they respond to opposite logic levels. The versatile DG613 has two normally open and two normally closed switches. It can be given various configurations, including four SPST, two SPDT, one DPDT.

For additional information see Applications Note AN207.

FEATURES

- Fast switching - t_{ON}: 12 ns
- Low charge injection: ± 2 pC
- Wide bandwidth: 500 MHz
- 5 V CMOS logic compatible
- Low $R_{DS(on)}$: 18 Ω
- Low quiescent power : 1.2 nW
- Single supply operation

Pb-free Available

RoHS* COMPLIANT

BENEFITS

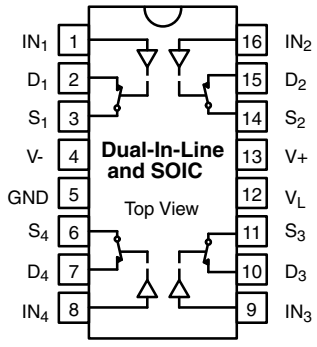
- Improved data throughput
- Minimal switching transients
- Improved system performance
- Easily interfaced
- Low insertion loss
- Minimal power consumption

APPLICATIONS

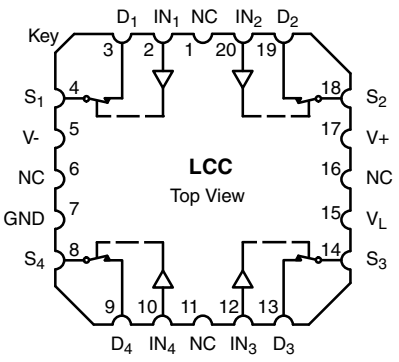
- Fast sample-and-holds
- Synchronous demodulators
- Pixel-rate video switching
- Disk/tape drives
- DAC deglitching
- Switched capacitor filters
- GaAs FET drivers
- Satellite receivers

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG611



DG611



Four SPST Switches per Package

TRUTH TABLE

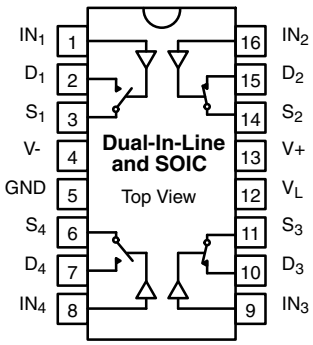
Logic	DG611	DG612
0	ON	OFF
1	OFF	ON

Logic “0” ≤ 1 V
Logic “1” ≥ 4 V

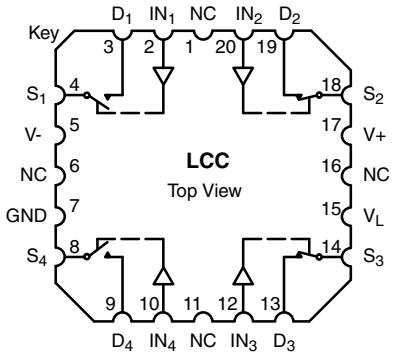
* Pb containing terminations are not RoHS compliant, exemptions may apply

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG613



DG613



Four SPST Switches per Package

TRUTH TABLE

Logic	SW_1, SW_4	SW_2, SW_3
0	OFF	ON
1	ON	OFF

Logic "0" ≤ 1 V
Logic "1" ≥ 4 V

ORDERING INFORMATION

Temp. Range	Package	Part Number
DG611, DG612		
- 40 °C to 85 °C	16-Pin Plastic DIP	DG611DJ DG611DJ-E3
		DG612DJ DG612DJ-E3
	16-Pin Narrow SOIC	DG611DY DG611DY-E3 DG611DY-T1 DG611DY-T1-E3
		DG612DY DG612DY-E3 DG612DY-T1 DG612DY-T1-E3
DG613		
- 40 °C to 85 °C	16-Pin Plastic DIP	DG613DJ DG613DJ-E3
	16-Pin Narrow SOIC	DG613DY DG613DY-E3 DG613DY-T1 DG613DY-T1-E3

ABSOLUTE MAXIMUM RATINGS

Parameter		Limit	Unit
V+ to V-		- 0.3 to 21	V
V+ to GND		- 0.3 to 21	
V- to GND		- 19 to 0.3	
V_L to GND		- 1 to (V+) + 1 or 20 mA, whichever occurs first	
V_{IN}[a]		(V-) - 1 to (V+) + 1 or 20 mA, whichever occurs first	
V_S, V_D[a]		(V-) - 0.3 to (V+) + 16 or 20 mA, whichever occurs first	
Continuous Current (Any Terminal)		± 30	mA
Current, S or D (Pulsed at 1 µs, 10 % Duty Cycle)		± 100	
Storage Temperature	CerDIP	- 65 to 150	°C
	Plastic	- 65 to 125	
Power Dissipation (Package)[b]	16-Pin Plastic DIP[c]	470	mW
	16-Pin Narrow SOIC[d]	600	
	16-Pin CerDIP[e]	900	
	20-Pin LCC[e]	900	

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 75 °C.
d. Derate 7.6 mW/°C above 75 °C.
e. Derate 12 mW/°C above 75 °C.

RECOMMENDED OPERATING RANGE

Parameter	Limit	Unit
V+	5 to 21	V
V-	- 10 to 0	
V_L	4 to V+	
V_{IN}	0 to V_L	
V_{ANALOG}	V- to (V+) - 5	

SPECIFICATIONS[a]

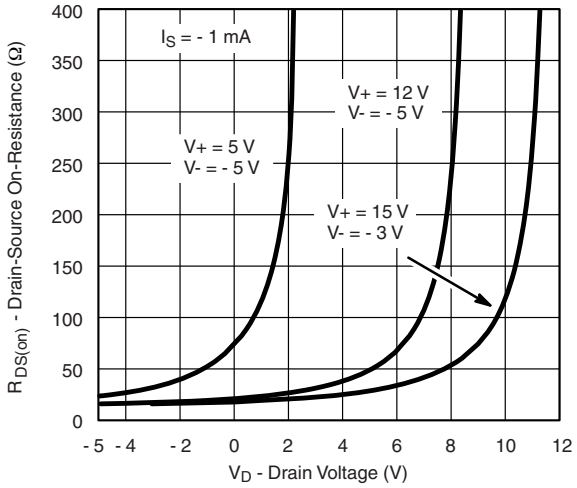
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 15 V, V- = - 3 V V_L = 5 V, V_{IN} = 4 V, 1 V[f]	Temp.[b]	Typ.[c]	A Suffix - 55 °C to 125 °C Min.[d]	A Suffix - 55 °C to 125 °C Max.[d]	D Suffix - 40 °C to 85 °C Min.[d]	D Suffix - 40 °C to 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}	V- = - 5 V, V+ = 12 V	Full		- 5	7	- 5	7	V
Switch On-Resistance	$R_{DS(on)}$	I_S = - 1 mA, V_D = 0 V	Room Full	18		45 60		45 60	Ω
Resistance Match Bet Ch.	$\Delta R_{DS(on)}$		Room	2					
Source Off Leakage	$I_{S(off)}$	V_S = 0 V, V_D = 10 V	Room Hot	± 0.001	- 0.25 - 20	0.25 20	- 0.25 - 20	0.25 20	nA
Drain Off Leakage Current	$I_{D(off)}$	V_S = 10 V, V_D = 0 V	Room Hot	± 0.001	- 0.25 - 20	0.25 20	- 0.25 - 20	0.25 20	
Switch On Leakage Current	$I_{D(on)}$	V_S = V_D = 0 V	Room Hot	± 0.001	- 0.4 - 40	0.4 40	- 0.4 - 40	0.4 40	
Digital Control									
Input Voltage High	V_{IH}		Full		4		4		V
Input Voltage Low	V_{IL}		Full			1		1	
Input Current	I_{IN}		Room Hot	0.005	- 1 - 20	1 20	- 1 - 20	1 20	µA
Input Capacitance	C_{IN}		Room	5					pF
Dynamic Characteristics									
Off State Input Capacitance	$C_{S(off)}$	V_S = 0 V	Room	3					pF
Off State Output Capacitance	$C_{D(off)}$	V_D = 0 V	Room	2					
On State Input Capacitance	$C_{S(on)}$	V_S = V_D = 0 V	Room	10					
Bandwidth	BW	R_L = 50 Ω	Room	500					MHz
Turn-On Time[e]	t_{ON}	R_L = 300 Ω, C_L = 3 pF V_S = ± 2 V, See test circuit, figure 2	Room	12		25		25	ns
Turn-Off Time[e]	t_{OFF}		Room	8		20		20	
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 75 pF V_S = ± 2 V, See test circuit, figure 2	Room Full	19		35 50		35 50	
Turn-Off Time	t_{OFF}		Room Full	16		25 35		25 35	
Charge Injection[e]	Q	C_L = 1 nF, V_S = 0 V	Room	4					pC
Ch. Injection Change[e,g]	ΔQ	C_L = 1 nF, $\|V_S\| \leq$ 3 V	Room	3		4		4	
Off Isolation[e]	OIRR	R_{IN} = 50 Ω, R_L = 50 Ω f = 5 MHz	Room	74					dB
Crosstalk[e]	X_{TALK}	R_{IN} = 10 Ω, R_L = 50 Ω f = 5 MHz	Room	87					
Power Supplies									
Positive Supply Current	I+	V_{IN} = 0 V or 5 V	Room Full	0.005		1 5		1 5	µA
Negative Supply Current	I-		Room Full	- 0.005	- 1 - 5		- 1 - 5		
Logic Supply Current	I_L		Room Full	0.005		1 5		1 5	
Ground Current	I_{GND}		Room Full	- 0.005	- 1 - 5		- 1 - 5		

SPECIFICATIONS FOR UNIPOLAR SUPPLIES[a]									
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 15 V, V- = - 3 V V_L = 5 V, V_{IN} = 4 V, 1 V[f]	Temp.[b]	Ty.p[c]	A Suffix - 55 °C to 125 °C Min.[d]	A Suffix - 55 °C to 125 °C Max.[d]	D Suffix - 40 °C to 85 °C Min.[d]	D Suffix - 40 °C to 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		0	7	0	7	V
Switch On-Resistance	$R_{DS(on)}$	I_S = - 1 mA, V_D = 1 V	Room	25		60		60	Ω
Dynamic Characteristics									
Turn-On Time[e]	t_{ON}	R_L = 300 Ω, C_L = 3 pF V_S = 2 V, See test circuit, figure 2	Room	15		30		30	ns
Turn-Off Time[e]	t_{OFF}		Room	10		25		25	ns

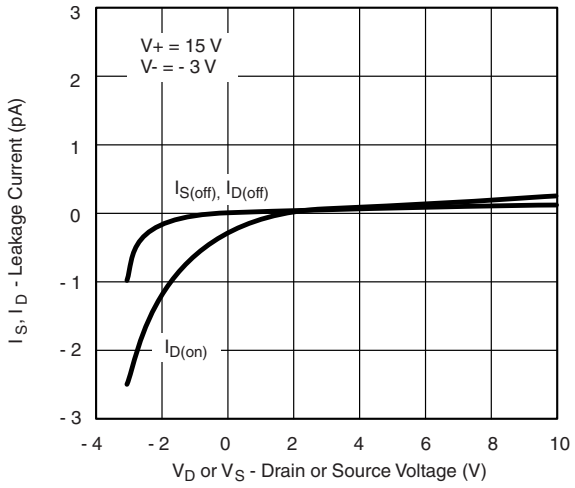
Notes:
a. Refer to PROCESS OPTION FLOWCHART.
b. Room = 25 °C, Full = as determined by the operating temperature suffix.
c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum.
e. Guaranteed by design, not subject to production test.
f. V_{IN} = input voltage to perform proper function.
g. $\Delta Q = |Q \text{ at } V_S = 3 \text{ V} - Q \text{ at } V_S = -3 \text{ V}|$.

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)

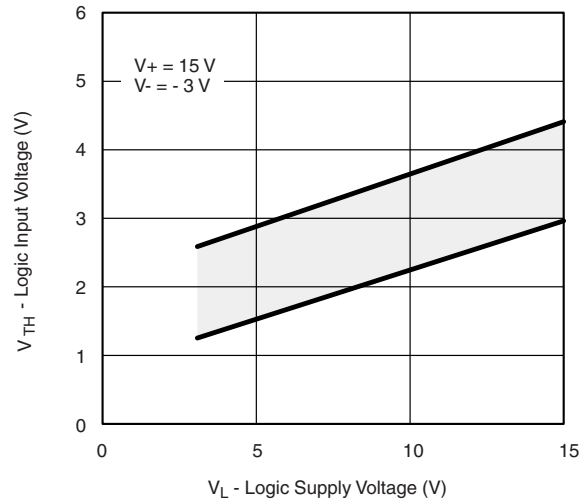


$R_{DS(on)}$ vs. V_D and Power Supply Voltages

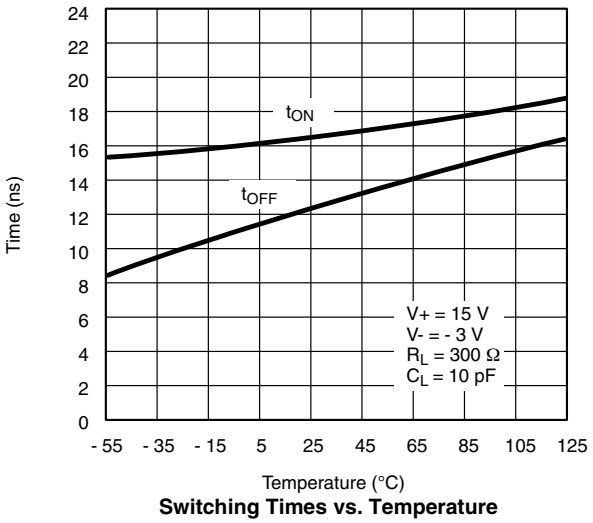


Leakage Current vs. Analog Voltage

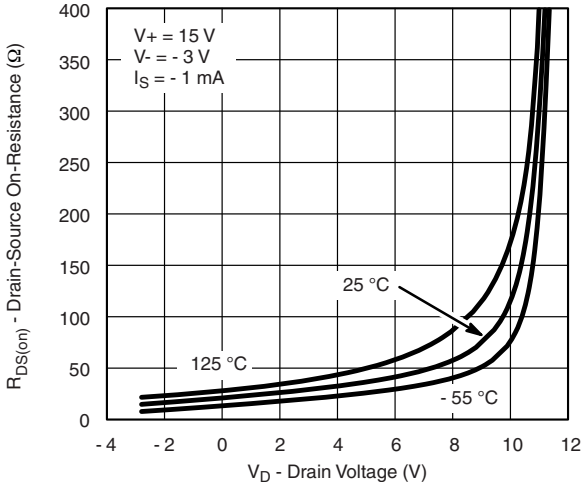
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



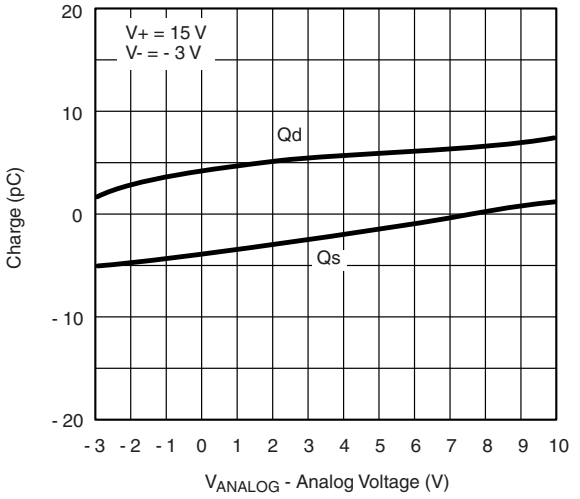
Input Switching Threshold vs. V_L



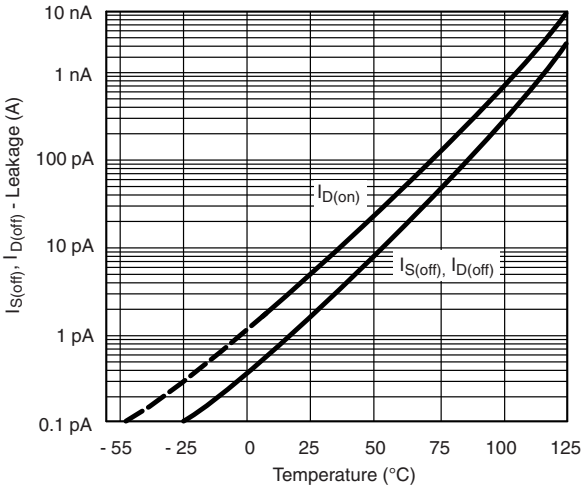
Switching Times vs. Temperature



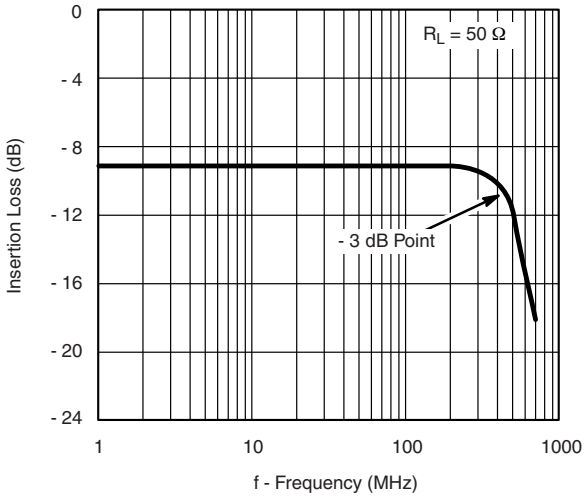
$R_{DS(on)}$ vs. V_D and Temperature



Charge Injection vs. Analog Voltage

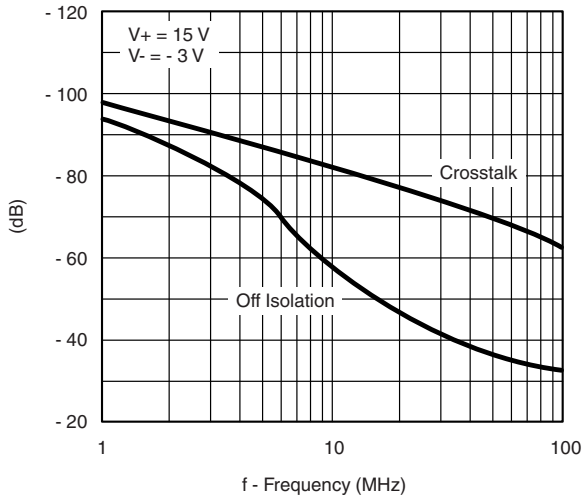


Leakage Currents vs. Temperature

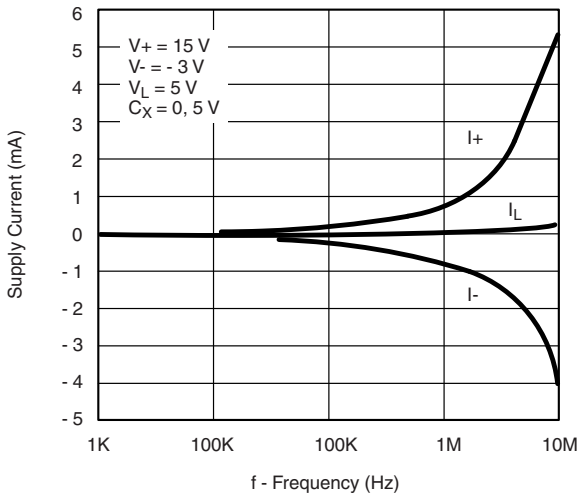


- 3 dB Bandwidth/Insertion Loss vs. Frequency

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Crosstalk and Off Isolation vs. Frequency



Supply Currents vs. Switching Frequency

SCHEMATIC DIAGRAM (Typical Channel)

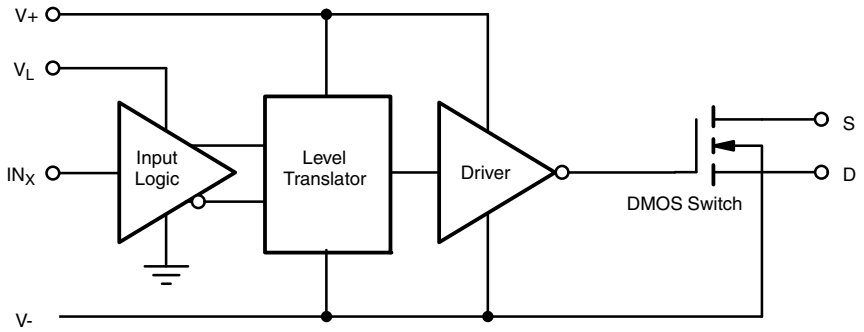
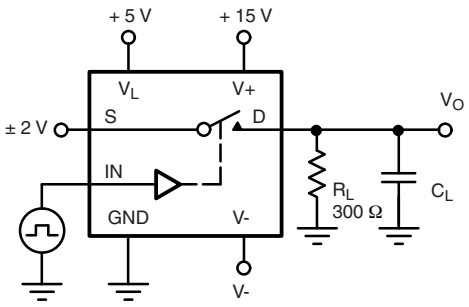


Figure 1.

TEST CIRCUITS



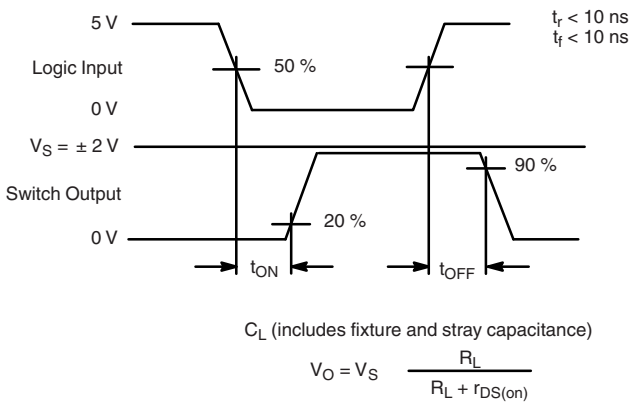


Figure 2. Switching Time

TEST CIRCUITS

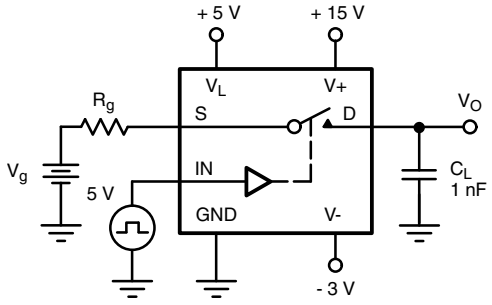


Figure 3. Charge Injection

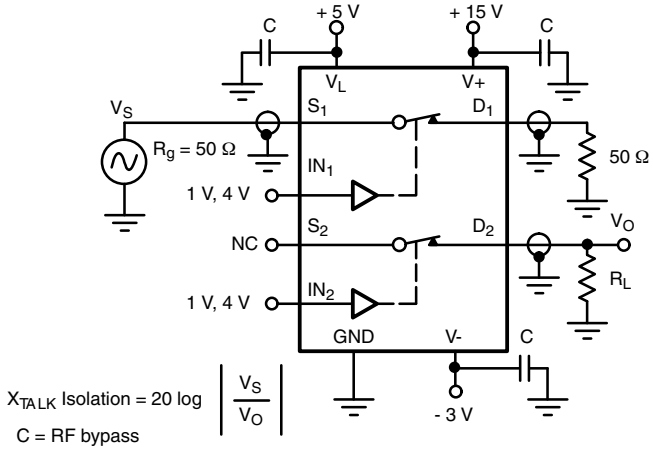


Figure 4. Crosstalk

APPLICATIONS

High-Speed Sample-and-Hold

In a fast sample-and-hold application, the analog switch characteristics are critical. A fast switch reduces aperture uncertainty. A low charge injection eliminates offset (step) errors. A low leakage reduces droop errors. The CLC111, a fast input buffer, helps to shorten acquisition and settling times. A low leakage, low dielectric absorption hold capacitor must be used. Polycarbonate, polystyrene and polypropylene are good choices. The JFET output buffer reduces droop due to its low input bias current.
(see figure 5.)

Pixel-Rate Switch

Windows, picture-in-picture, title overlays are economically generated using a high-speed analog switch such as the DG613. For this application the two video sources must be sync locked. The glitch-less analog switch eliminates halos. (see figure 6.)

GaAs FET Drivers

Figure 7 illustrates a high-speed GaAs FET driver. To turn the GaAs FET on 0 V are applied to its gate via S_1, whereas to turn it off, - 8 V are applied via S_2. This high-speed, low-power driver is especially suited for applications that require a large number of RF switches, such as phased array radars.

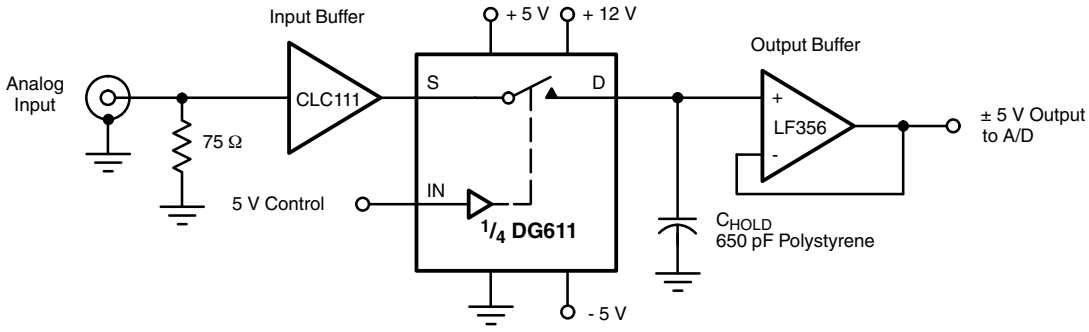


Figure 5. High-Speed Sample-and-Hold

APPLICATIONS

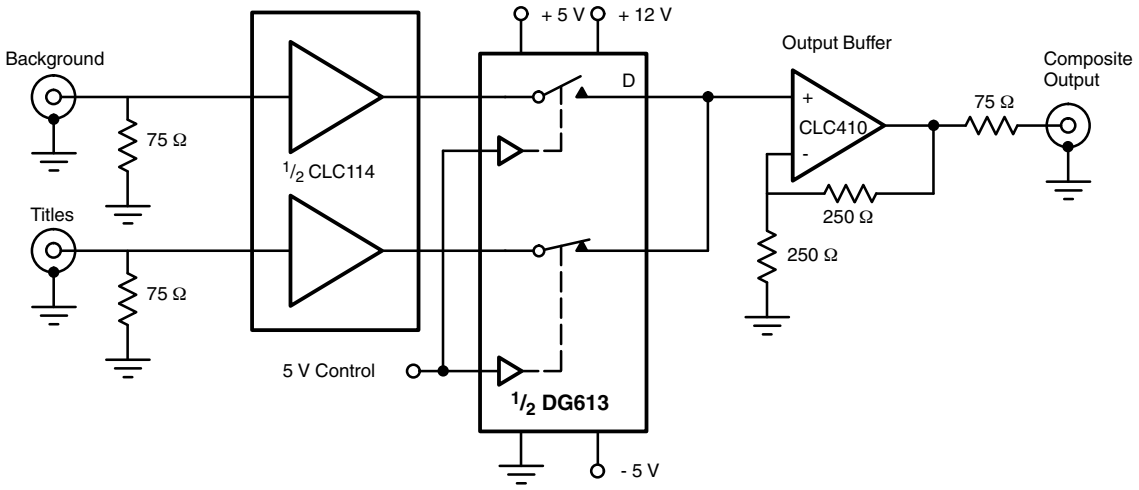


Figure 6. A Pixel-Rate Switch Creates Title Overlays

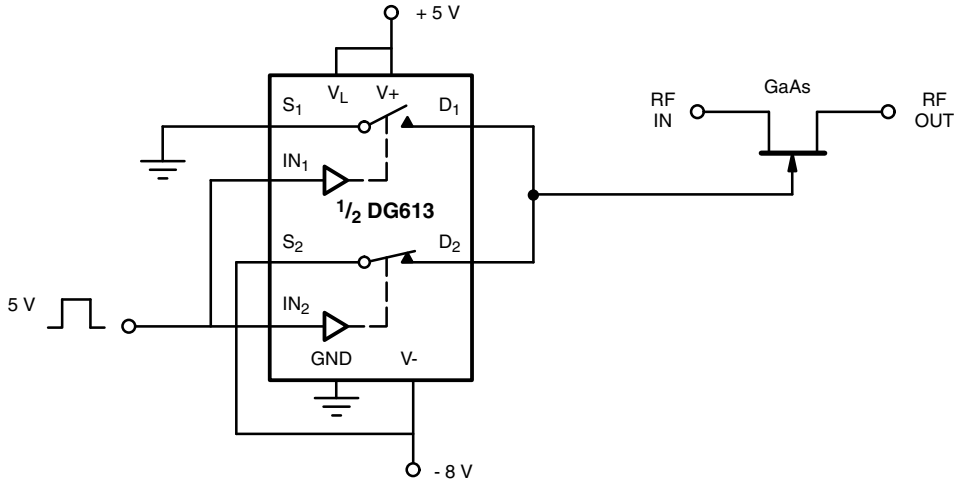


Figure 7. A High-Speed GaAs FET Driver that Saves Power

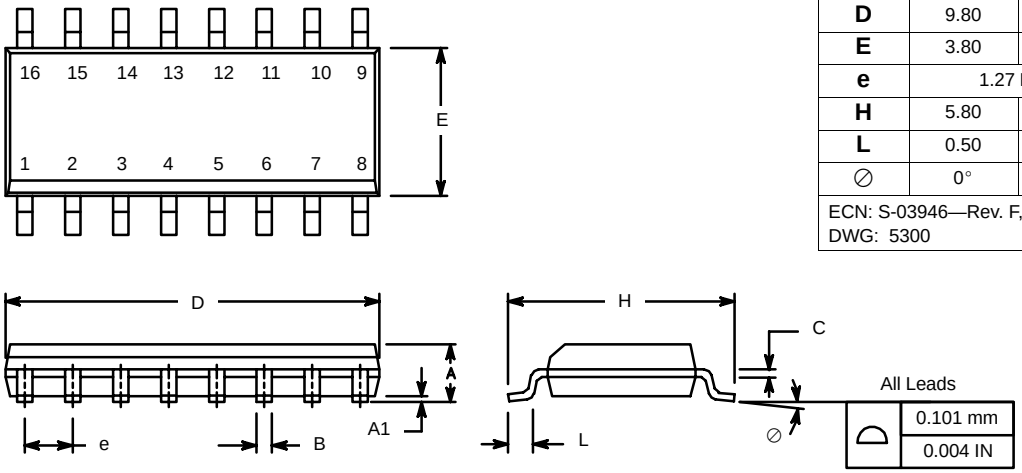
Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?70057.

SOIC (NARROW): 16-LEAD

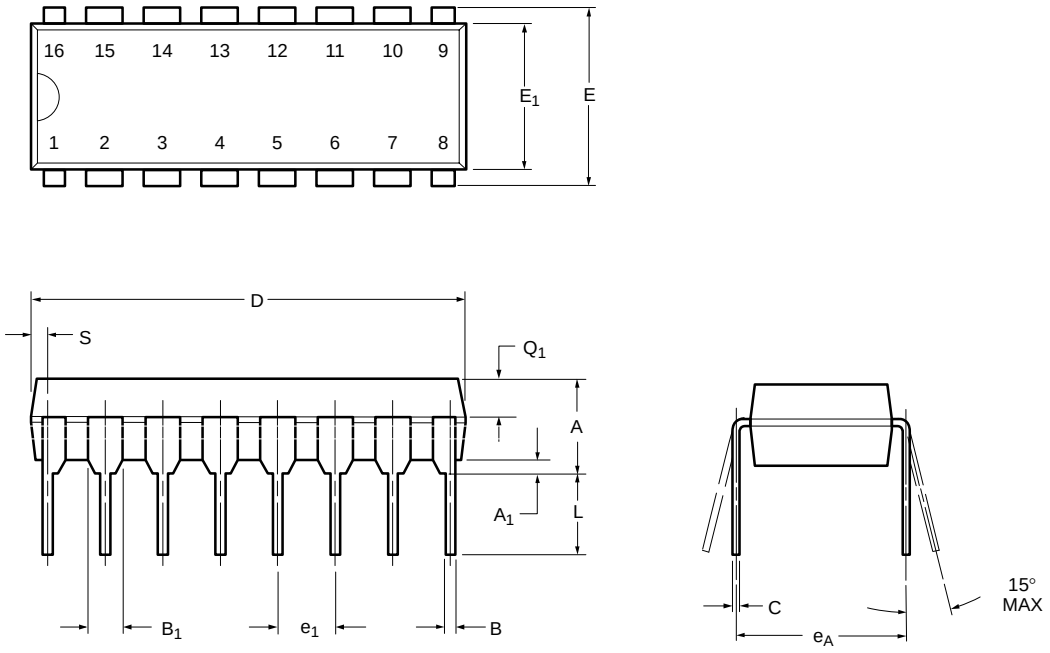
JEDEC Part Number: MS-012

Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A_1	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
⊘	0°	8°	0°	8°

ECN: S-03946—Rev. F, 09-Jul-01
DWG: 5300

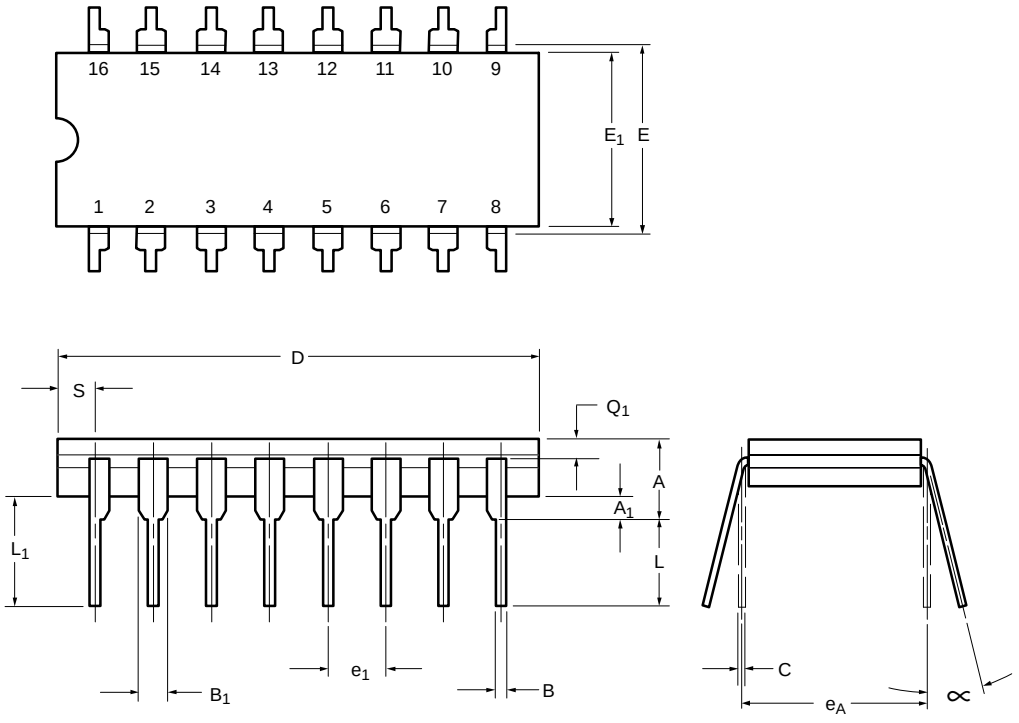


PDIP: 16-LEAD



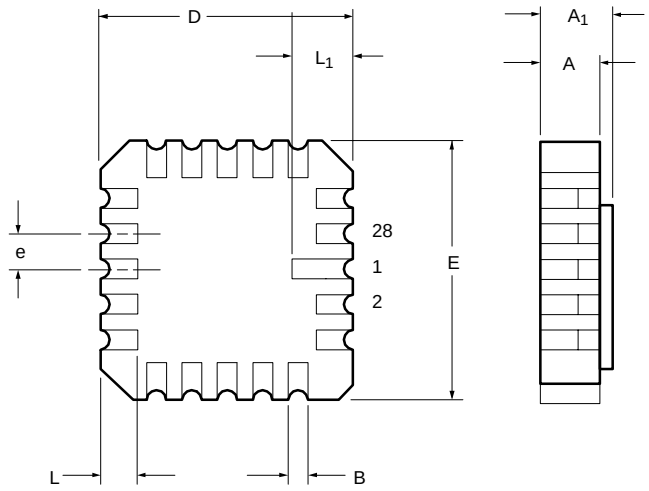
Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	3.81	5.08	0.150	0.200
A_1	0.38	1.27	0.015	0.050
B	0.38	0.51	0.015	0.020
B_1	0.89	1.65	0.035	0.065
C	0.20	0.30	0.008	0.012
D	18.93	21.33	0.745	0.840
E	7.62	8.26	0.300	0.325
E_1	5.59	7.11	0.220	0.280
e_1	2.29	2.79	0.090	0.110
e_A	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
Q_1	1.27	2.03	0.050	0.080
S	0.38	1.52	.015	0.060
ECN: S-03946—Rev. D, 09-Jul-01 DWG: 5482				

CERDIP: 16-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	4.06	5.08	0.160	0.200
A_1	0.51	1.14	0.020	0.045
B	0.38	0.51	0.015	0.020
B_1	1.14	1.65	0.045	0.065
C	0.20	0.30	0.008	0.012
D	19.05	19.56	0.750	0.770
E	7.62	8.26	0.300	0.325
E_1	6.60	7.62	0.260	0.300
e_1	2.54 BSC		0.100 BSC	
e_A	7.62 BSC		0.300 BSC	
L	3.18	3.81	0.125	0.150
L_1	3.81	5.08	0.150	0.200
Q_1	1.27	2.16	0.050	0.085
S	0.38	1.14	0.015	0.045
∝	0°	15°	0°	15°
ECN: S-03946—Rev. G, 09-Jul-01 DWG: 5403				

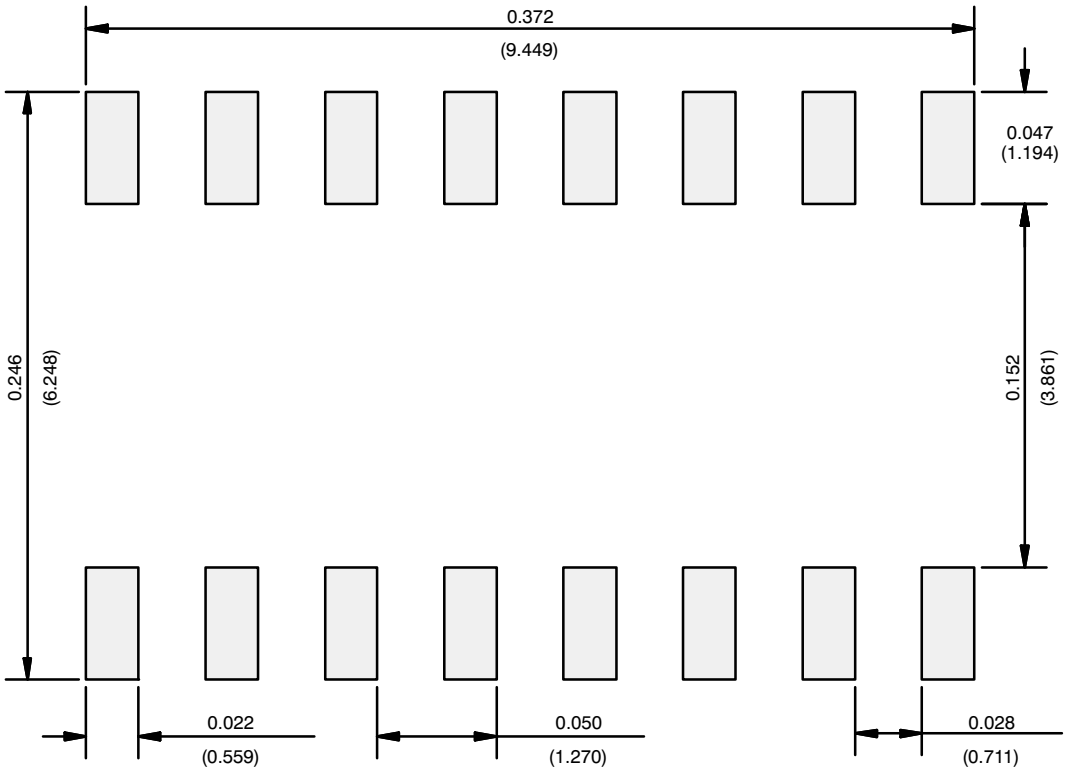
20-LEAD LCC



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.37	2.24	0.054	0.088
A_1	1.63	2.54	0.064	0.100
B	0.56	0.71	0.022	0.028
D	8.69	9.09	0.342	0.358
E	8.69	9.09	0.442	0.358
e	1.27 BSC		0.050 BSC	
L	1.14	1.40	0.045	0.055
L_1	1.96	2.36	0.077	0.093

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DWG: 5321

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

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