

MAXIM

Improved, Quad, SPST Analog Switches

DG411/DG412/DG413

General Description

Maxim's redesigned DG411/DG412/DG413 analog switches now feature low on-resistance matching between switches (3Ω max) and guaranteed on-resistance flatness over the signal range ($\Delta 4\Omega$ max). These low on-resistance switches conduct equally well in either direction. They guarantee low charge injection, low power consumption, and an ESD tolerance of 2000V minimum per Method 3015.7. The new design offers lower off leakage current over temperature (less than 5nA at +85°C).

The DG411/DG412/DG413 are quad, single-pole/single-throw (SPST) analog switches. The DG411 is normally closed (NC), and the DG412 is normally open (NO). The DG413 has two NC switches and two NO switches. Switching times are less than 150ns max for t_{ON} and less than 100ns max for t_{OFF} . These devices operate from a single +10V to +30V supply, or bipolar $\pm 4.5V$ to $\pm 20V$ supplies. Maxim's improved DG411/DG412/DG413 are fabricated with a 44V silicon-gate process.

Applications

Sample-and-Hold Circuits	Communication Systems
Test Equipment	Battery-Operated Systems
Heads-Up Displays	PBX, PABX
Guidance & Control Systems	Audio Signal Routing
Military Radios	

New Features

- ◆ Plug-In Upgrade for Industry-Standard DG411/DG412/DG413
- ◆ Improved $r_{DS(ON)}$ Match Between Channels (3Ω max)
- ◆ Guaranteed $r_{FLAT(ON)}$ Over Signal Range ($\Delta 4\Omega$)
- ◆ Improved Charge Injection (10pC max)
- ◆ Improved Off Leakage Current Over Temperature (<5nA at +85°C)
- ◆ Withstand Electrostatic Discharge (2000V min) per Method 3015.7

Existing Features

- ◆ Low $r_{DS(ON)}$ (35Ω max)
- ◆ Single-Supply Operation +10V to +30V
- ◆ Bipolar-Supply Operation $\pm 4.5V$ to $\pm 20V$
- ◆ Low Power Consumption ($35\mu W$ max)
- ◆ Rail-to-Rail Signal Handling
- ◆ TTL/CMOS-Logic Compatible

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
DG411CJ	0°C to +70°C	16 Plastic DIP
DG411CUE	0°C to +70°C	16 TSSOP
DG411CY	0°C to +70°C	16 Narrow SO
DG411C/D	0°C to +70°C	Dice*

Ordering Information continued at end of data sheet.
*Contact factory for dice specifications.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

DIP/SO/TSSOP

DG411	
LOGIC	SWITCH
0	ON
1	OFF

DIP/SO/TSSOP

DG412	
LOGIC	SWITCH
0	OFF
1	ON

DIP/SO/TSSOP

DG413		
LOGIC	SWITCHES 1, 4	SWITCHES 2, 3
0	OFF	ON
1	ON	OFF

SWITCHES SHOWN FOR LOGIC "0" INPUT

Improved, Quad, SPST Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-

V+	44V
GND	25V
V _L	(GND -0.3V) to (V+ +0.3V)
Digital Inputs, V _S , V _D (Note 1).....	(V- -2V) to (V+ +2V) or 30mA (whichever occurs first)
Continuous Current (any terminal)	30mA
Peak Current (pulsed at 1ms, 10% duty cycle max)	100mA

Continuous Power Dissipation (T_A = +70°C)

16-Pin Plastic DIP (derate 10.53mW/°C above +70°C) ..	842mW
16-Pin Narrow SO (derate 8.70mW/°C above +70°C) ..	696mW
16-Pin CERDIP (derate 10.00mW/°C above +70°C)	800mW
16-Pin TSSOP (derate 6.7mW/°C above +70°C)	457mW

Operating Temperature Ranges

DG41_C_	0°C to +70°C
DG41_D_	-40°C to +85°C
DG41_AK_	-55°C to +125°C

Storage Temperature Range

.....	-65°C to +150°C
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Lead Temperature (soldering, 10sec)

.....	+300°C
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Note 1: Signals on S, D, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current rating.

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.

ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = 15V, V- = -15V, V_L = 5V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS			
SWITCH									
Analog Signal Range	V _{ANALOG}	(Note 3)	-15		15	V			
Drain-Source On-Resistance	r _{DS(ON)}	V+ = 13.5V, V- = -13.5V, V _D = ±8.5V, I _S = -10mA	T _A = +25°C	C, D	17	45	Ω		
				A	17	30			
			T _A = T _{MIN} to T _{MAX}			45			
On-Resistance Match Between Channels (Note 4)	Δr _{DS(ON)}	V+ = 15V, V- = -15V, V _D = ±10V, I _S = -10mA	T _A = +25°C			3	Ω		
				T _A = T _{MIN} to T _{MAX}				5	
On-Resistance Flatness (Note 4)	r _{FLAT(ON)}	V+ = 15V, V- = -15V, V _D = ±5V, 0V, I _S = -10mA	T _A = +25°C			4	Ω		
				T _A = T _{MIN} to T _{MAX}				6	
Source-Off Leakage Current (Note 7)	I _{S(OFF)}	V+ = 16.5V, V- = -16.5V, V _D = ±15.5V, V _S = ±15.5V	T _A = +25°C	C, D, A	-0.25	-0.10	0.25	nA	
				T _A = T _{MIN} to T _{MAX}	C, D	-5			5
					A	-10			10
Drain-Off Leakage Current (Note 7)	I _{D(OFF)}	V+ = 16.5V, V- = -16.5V, V _D = ±15.5V, V _S = ±15.5V	T _A = +25°C	C, D, A	-0.25	-0.10	0.25	nA	
				T _A = T _{MIN} to T _{MAX}	C, D	-5			5
					A	-10			10
Drain-On Leakage Current (Note 7)	I _{D(ON)} + I _{S(ON)}	V+ = 16.5V, V- = -16.5V, V _D = ±15.5V, V _S = ±15.5V	T _A = +25°C	C, D, A	-0.4	-0.1	0.4	nA	
				T _A = T _{MIN} to T _{MAX}	C, D	-20			20
					A	-40			40

Improved, Quad, SPST Analog Switches

DG411/DG412/DG413

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = 15V, V- = -15V, VL = 5V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP (Note 2)	MAX	UNITS	
INPUT							
Input Current with Input Voltage High	I _{INH}	IN = 2.4V, all others = 0.8V	-0.500	0.005	0.500	μA	
Input Current with Input Voltage Low	I _{INL}	IN = 0.8V, all others = 2.4V	-0.500	0.005	0.500	μA	
SUPPLY							
Power-Supply Range			±4.5		±20.0	V	
Positive Supply Current	I+	All channels on or off, V+ = 16.5V, V- = -16.5V, VIN = 0V or 5V	TA = +25°C	-1	0.0001	1	μA
			TA = TMIN to TMAX	-5		5	
Negative Supply Current	I-	All channels on or off, V+ = 16.5V, V- = -16.5V, VIN = 0V or 5V	TA = +25°C	-1	-0.0001	1	μA
			TA = TMIN to TMAX	-5		5	
Logic Supply Current	IL	All channels on or off, V+ = 16.5V, V- = -16.5V, VIN = 0V or 5V	TA = +25°C	-1	0.0001	1	μA
			TA = TMIN to TMAX	-5		5	
Ground Current	IGND	All channels on or off, V+ = 16.5V, V- = -16.5V, VIN = 0V or 5V	TA = +25°C	-1	-0.0001	1	μA
			TA = TMIN to TMAX	-5		5	
DYNAMIC							
Turn-On Time	t _{ON}	VD = ±10V, Figure 2	TA = +25°C	110	175	ns	
			TA = TMIN to TMAX		220		
Turn-Off Time	t _{OFF}	VD = ±10V, Figure 2	TA = +25°C	100	145	ns	
			TA = TMIN to TMAX		160		
Break-Before-Make Time Delay	t _D	DG413 only, RL = 300Ω, CL = 35pF, Figure 3	TA = +25°C	25		ns	
Charge Injection (Note 3)	Q	CL = 1.0nF, VGEN = 0V, RGEN = 0Ω, Figure 4	TA = +25°C	5	10	pC	
Off Isolation (Note 5)	OIRR	RL = 50Ω, CL = 5pF, f = 1MHz, Figure 5	TA = +25°C	68		dB	
Crosstalk (Note 6)		RL = 50Ω, CL = 5pF, f = 1MHz, Figure 6	TA = +25°C	85		dB	
Source-Off Capacitance	CS(OFF)	f = 1MHz, Figure 7	TA = +25°C	9		pF	
Drain-Off Capacitance	CD(OFF)	f = 1MHz, Figure 7	TA = +25°C	9		pF	
Drain-On Capacitance	CD(ON) + CS(ON)	f = 1MHz, Figure 8	TA = +25°C	35		pF	

Improved, Quad, SPST Analog Switches

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = 12V, V- = 0V, VL = 5V, GND = 0V, VINH = 2.4V, VINL = 0.8V, TA = TMIN to TMAX, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
SWITCH							
Analog Signal Range	VANALOG	(Note 3)		0		12	V
Drain-Source On Resistance	rDS(ON)	V+ = 10.8V, VD = 3.8V, IS = -10mA	TA = +25°C		40	80	Ω
			TA = TMIN to TMAX			100	
SUPPLY							
Positive Supply Current	I+	All channels on or off, V+ = 13.2V, VIN = 0V or 5V	TA = +25°C	-1	0.0001	1	μA
			TA = TMAX	-5		5	
Negative Supply Current	I-	All channels on or off, V+ = 13.2V, VIN = 0V or 5V	TA = +25°C	-1	0.0001	1	μA
			TA = TMAX	-5		5	
Logic Supply Current	IL	All channels on or off, VL = 5.25V, VIN = 0V or 5V	TA = +25°C	-1	0.0001	1	μA
			TA = TMAX	-5		5	
Ground Current	IGND	All channels on or off, VL = 5.25V, VIN = 0V or 5V	TA = +25°C	-1	-0.0001	1	μA
			TA = TMAX	-5		5	
DYNAMIC							
Turn-On Time	tON	VS = 8V, Figure 2	TA = +25°C		175	250	ns
			TA = TMIN to TMAX			315	
Turn-Off Time	tOFF	VS = 8V, Figure 2	TA = +25°C		95	125	ns
			TA = TMIN to TMAX			140	
Break-Before-Make Time Delay	tD	DG413 only, RL = 300Ω, CL = 35pF, Figure 3	TA = +25°C		25		ns
Charge Injection (Note 3)	Q	CL = 1.0nF, VGEN = 0V, RGEN = 0V, Figure 4	TA = +25°C		5	10	pC

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.

Note 3: Guaranteed by design.

Note 4: $\Delta R_{ON} = \Delta R_{ON\ max} - \Delta R_{ON\ min}$. On-resistance match between channels and flatness are guaranteed only with bipolar-supply operation. Flatness is defined as the difference between the maximum and minimum value of on resistance as measured at the extremes of the specified analog signal range.

Note 5: Off Isolation = 20 log (VD/VS), VD = output, VS = input to off switch. See Figure 5.

Note 6: Between any two switches. See Figure 6.

Note 7: Leakage parameters IS(OFF), ID(OFF), and ID(ON) are 100% tested at the maximum rated hot temperature and guaranteed by correlation at +25°C.

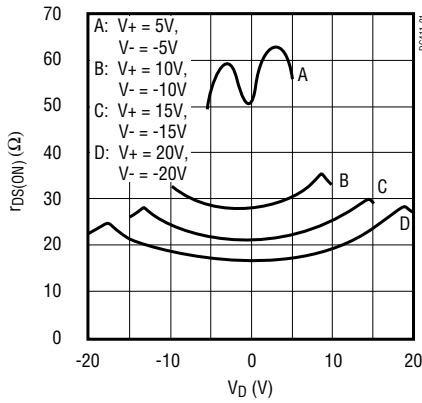
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Typical Operating Characteristics

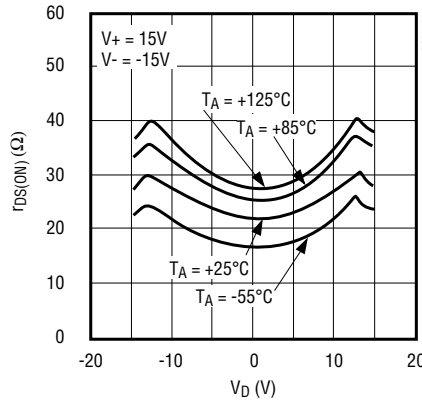
($T_A = +25^\circ\text{C}$, unless otherwise noted.)

DG411/DG412/DG413

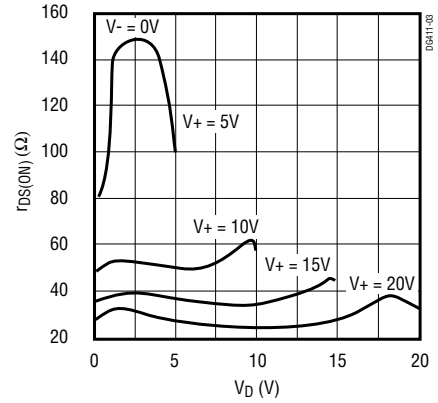
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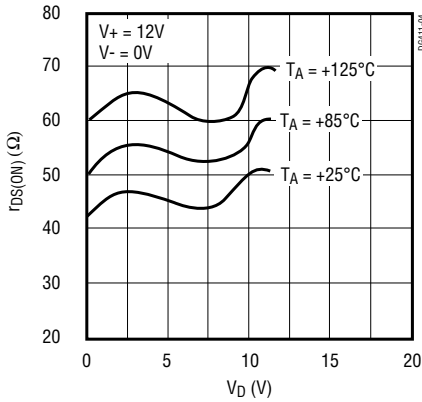
ON-RESISTANCE vs. V_D AND TEMPERATURE



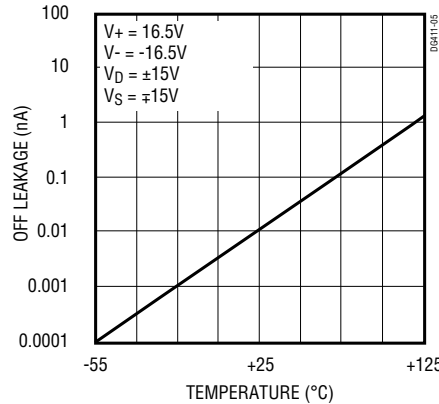
ON-RESISTANCE vs. V_D AND TEMPERATURE (SINGLE SUPPLY)



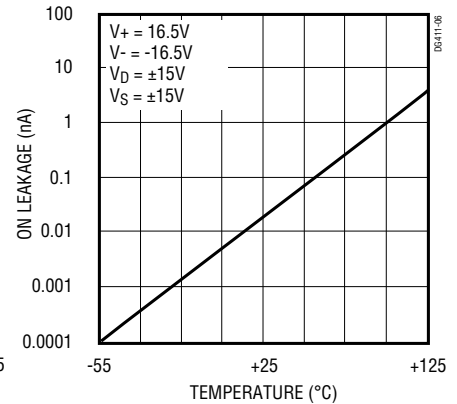
ON-RESISTANCE vs. V_D (SINGLE SUPPLY)



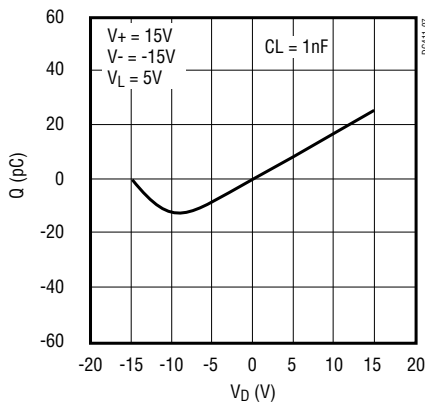
OFF LEAKAGE CURRENTS vs. TEMPERATURE



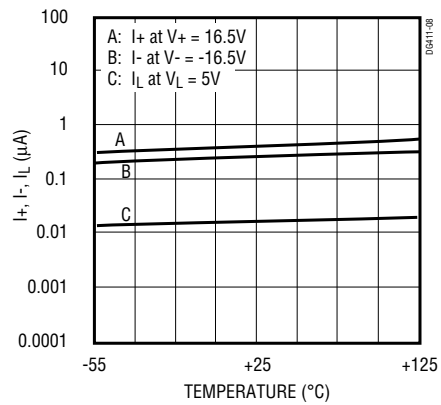
ON LEAKAGE CURRENTS vs. TEMPERATURE



CHARGE INJECTION vs. ANALOG VOLTAGE



SUPPLY CURRENT vs. TEMPERATURE



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Timing Diagrams/Test Circuits

DG411/DG412/DG413

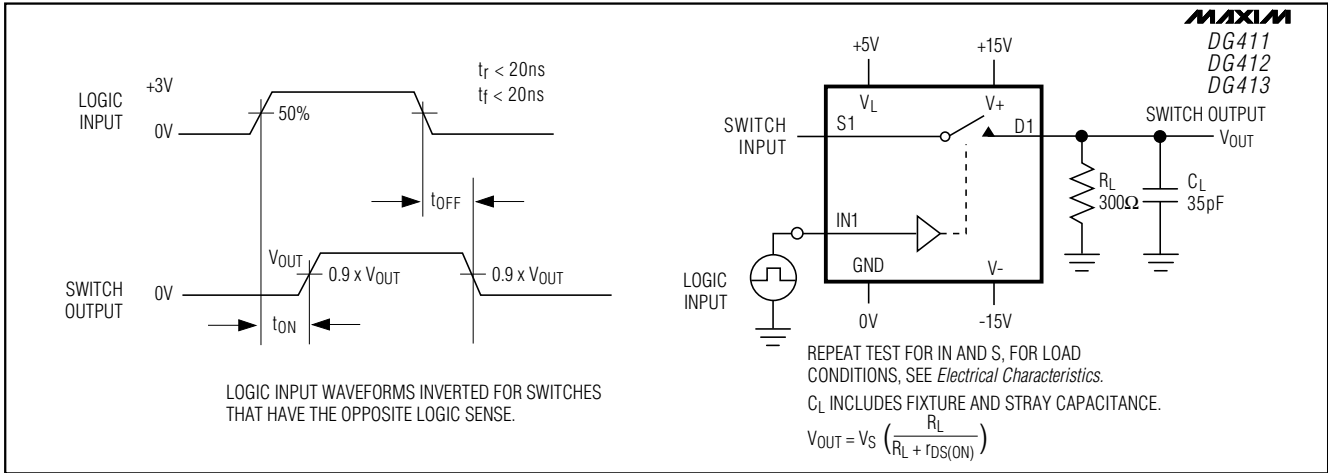


Figure 2. Switching-Time

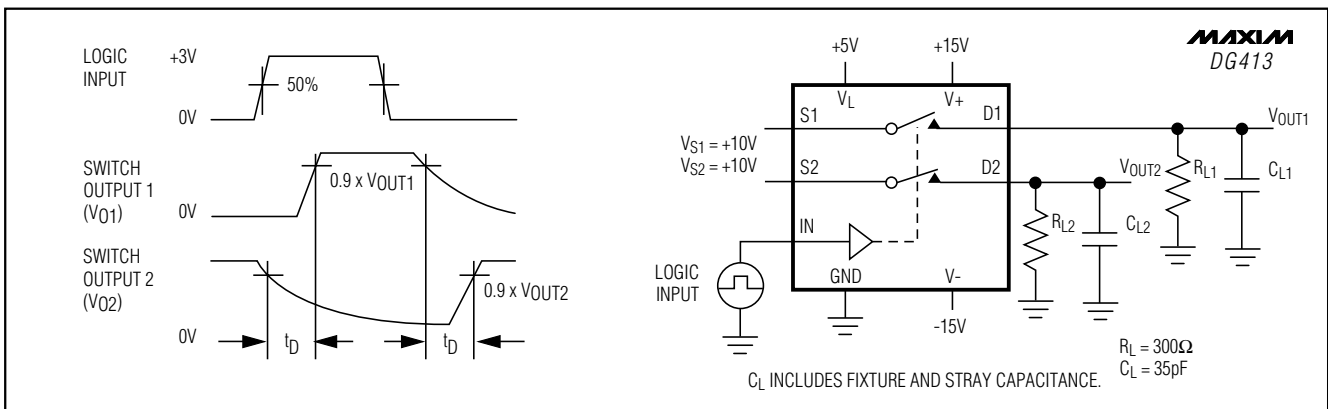


Figure 3. DG413 Break-Before-Make

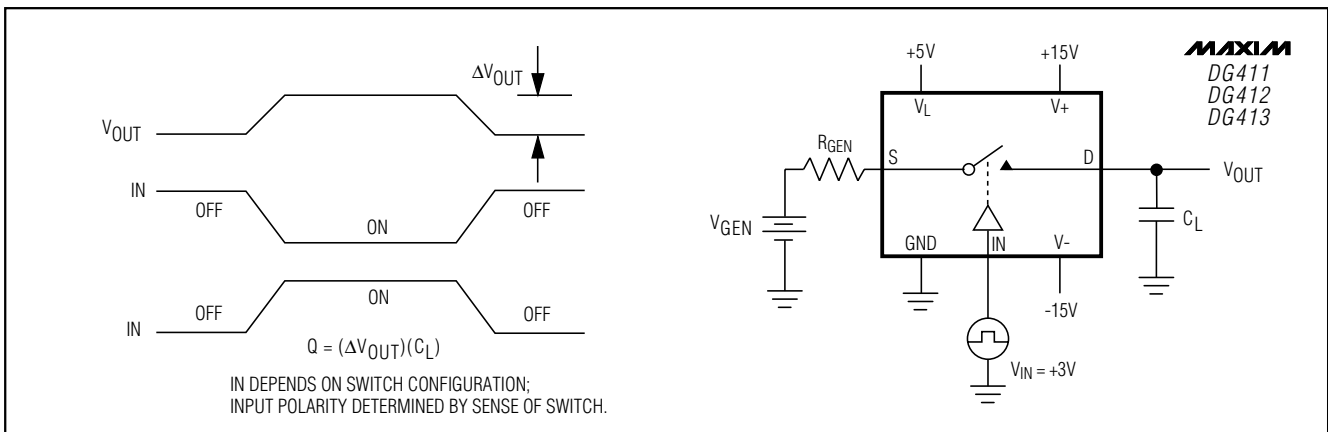


Figure 4. Charge-Injection

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Timing Diagrams/Test Circuits (continued)

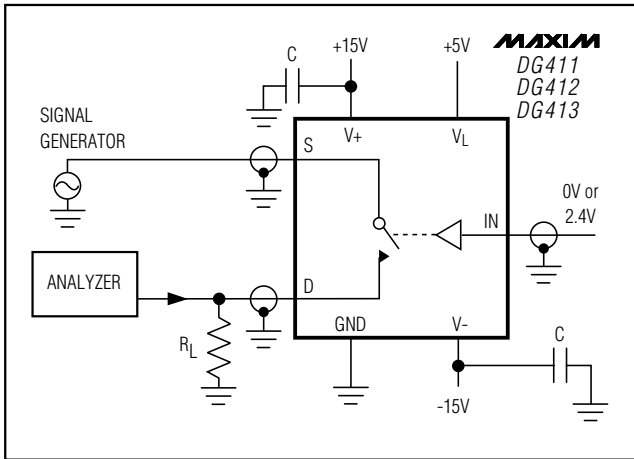


Figure 5. Off-Isolation

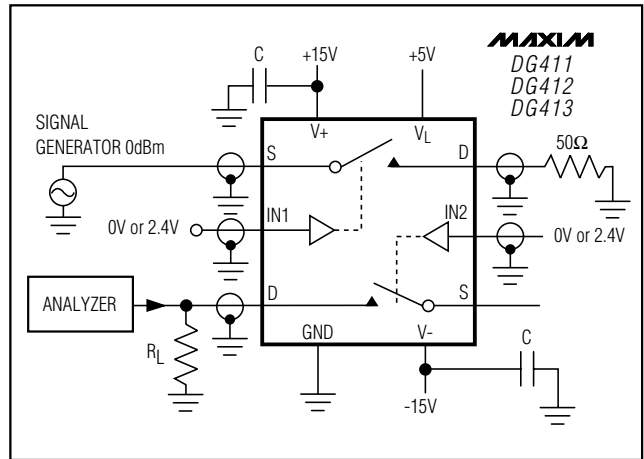


Figure 6. Crosstalk

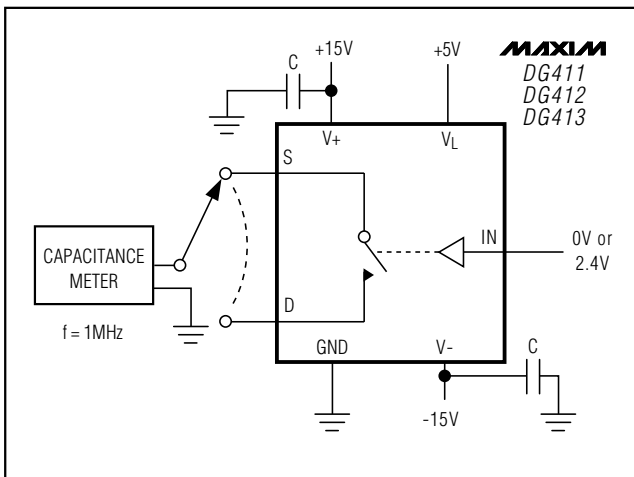


Figure 7. Channel-Off Capacitance

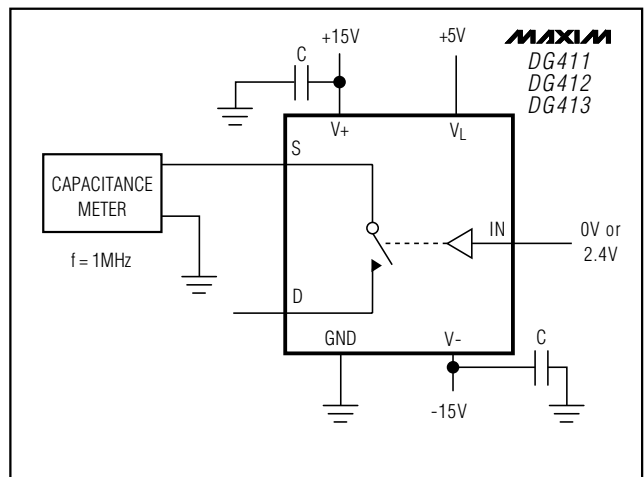


Figure 8. Channel-On Capacitance

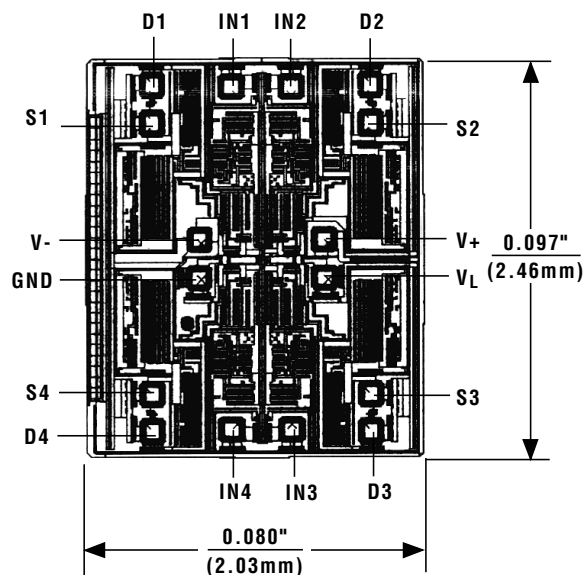
Improved, Quad, SPST Analog Switches

DG411/DG412/DG413

Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
DG411DJ	-40°C to +85°C	16 Plastic DIP
DG411DY	-40°C to +85°C	16 Narrow SO
DG411DK	-40°C to +85°C	16 CERDIP
DG411AK	-55°C to +125°C	16 CERDIP**
DG412CJ	0°C to +70°C	16 Plastic DIP
DG412CUE	0°C to +70°C	16 TSSOP
DG412CY	0°C to +70°C	16 Narrow SO
DG412C/D	0°C to +70°C	Dice*
DG412DJ	-40°C to +85°C	16 Plastic DIP
DG412DY	-40°C to +85°C	16 Narrow SO
DG412DK	-40°C to +85°C	16 CERDIP
DG412AK	-55°C to +125°C	16 CERDIP**
DG413CJ	0°C to +70°C	16 Plastic DIP
DG413CUE	0°C to +70°C	16 TSSOP
DG413CY	0°C to +70°C	16 Narrow SO
DG413C/D	0°C to +70°C	Dice*
DG413DJ	-40°C to +85°C	16 Plastic DIP
DG413DY	-40°C to +85°C	16 Narrow SO
DG413DK	-40°C to +85°C	16 CERDIP
DG413AK	-55°C to +125°C	16 CERDIP**

Chip Topography



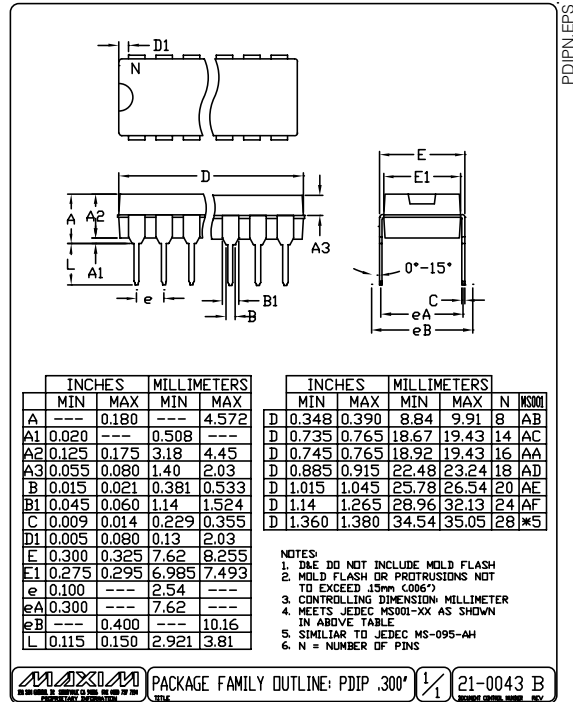
TRANSISTOR COUNT: 136
SUBSTRATE CONNECTED TO V+

* Contact factory for dice specifications.

**Contact factory for availability and processing to MIL-STD-883B.

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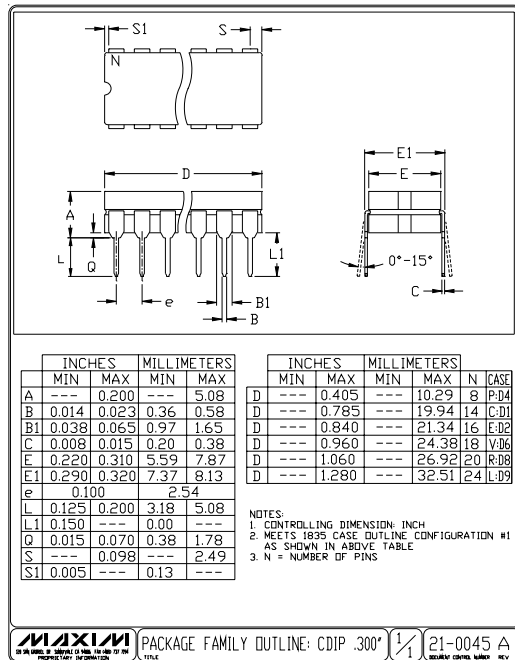
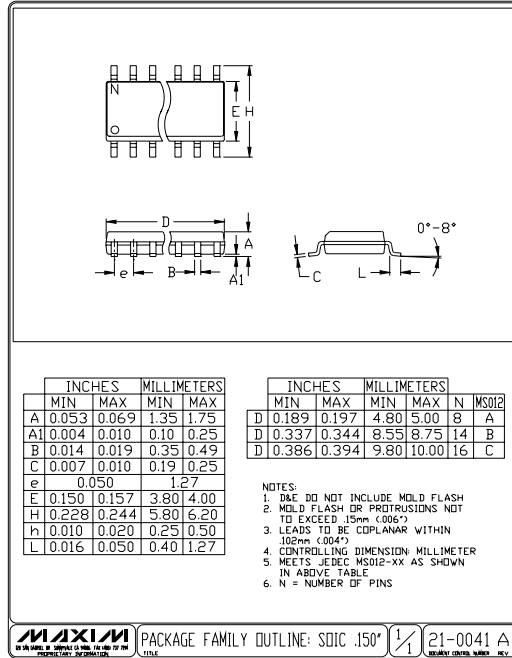
Package Information



Improved, Quad, SPST Analog Switches

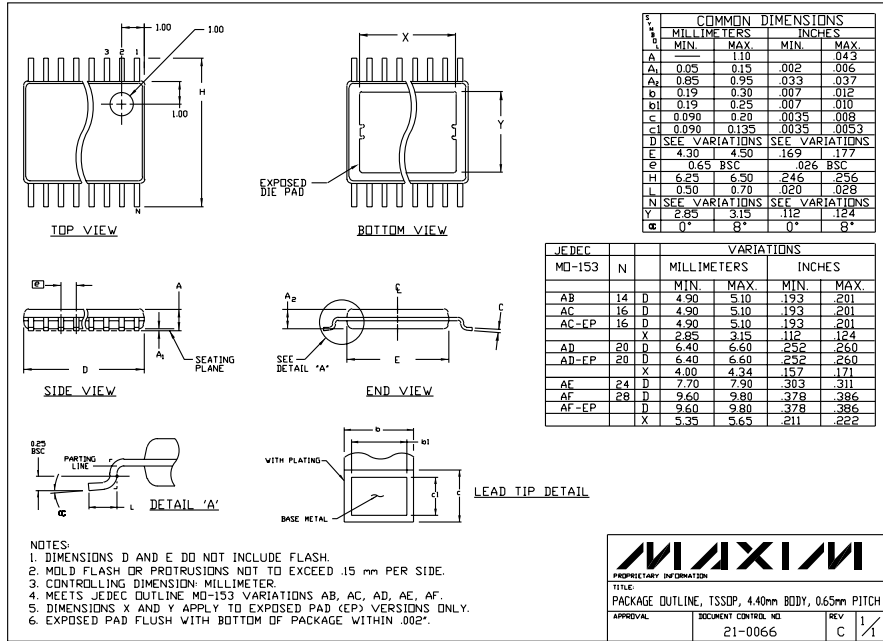
Package Information (continued)

DG411/DG412/DG413



Improved, Quad, SPST Analog Switches

Package Information (continued)



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

12 _____ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 (408) 737-7600**