

# MAXIM

## TTL Compatible CMOS Analog Switches

### General Description

Maxim's DG300-DG303 and DG300A-DG303A CMOS dual and quad analog switches combine low power operation with fast switching times and superior DC and AC switch characteristics. On resistance is less than 50Ω and is essentially constant over the analog signal range. Device specifications are ideal for battery powered circuitry.

These switches are available in a variety of formats as outlined below in the Pin Configurations section. The switch control logic inputs are fully TTL and CMOS compatible. Also featured are "break-before-make" switching and low charge injection.

Maxim's DG300-DG303 and DG300A-DG303A families are electrically compatible and pin compatible with the original manufacturer's devices. All devices will operate with power supplies ranging from ±5V to ±18V. Single supply operation is implemented by connecting V<sup>-</sup> to GND.

### Applications

- Portable Instruments
- Low Power Sample/Holds
- Power Supply Switching
- Programmable Gain Amplifiers
- SPDT and DPDT Functions
- Process Control and Telemetry

### Features

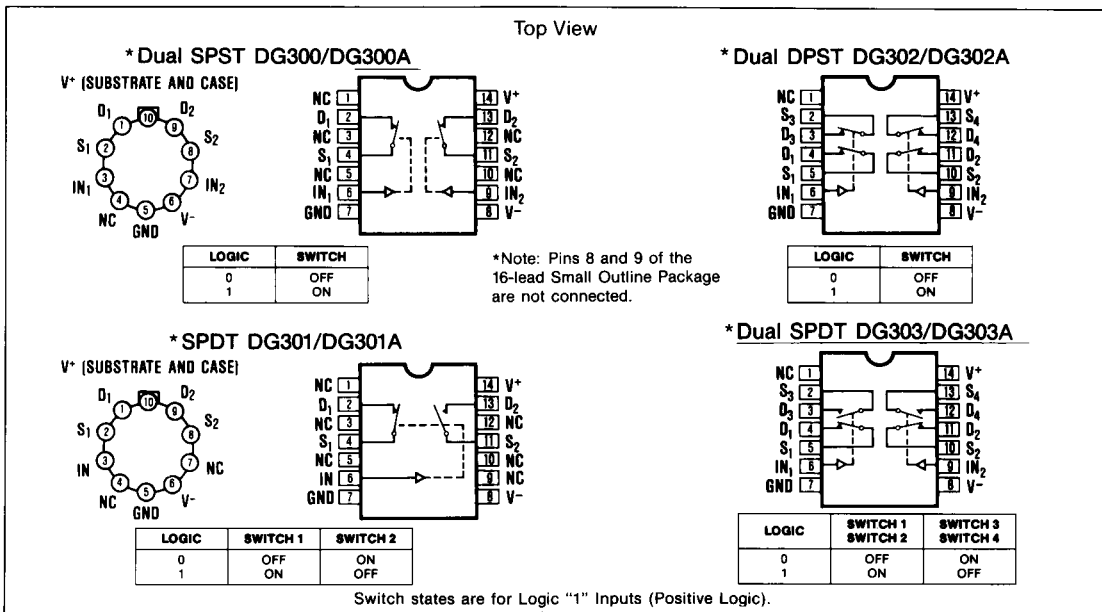
- ◆ Monolithic Low Power CMOS
- ◆ Latch-Up Proof Construction
- ◆ Fully Compatible 2nd Source
- ◆ Low On Resistance, <50Ω
- ◆ Fast Switching Time
- ◆ V<sup>+</sup> to V<sup>-</sup> Analog Signal Range
- ◆ Single Supply Capability

### Ordering Information

PART	TEMP. RANGE	PACKAGE
DG300C/D	0°C to +70°C	Dice
DG300CJ	0°C to +70°C	14 Lead Plastic DIP
DG300CWE	0°C to +70°C	16 Lead Wide SO
DG300CK	0°C to +70°C	14 Lead CERDIP
DG300BWE	-25°C to +85°C	16 Lead Wide SO
DG300BK	-25°C to +85°C	14 Lead CERDIP
DG300BA	-25°C to +85°C	10 Lead Metal Can
DG300AK	-55°C to +125°C	14 Lead CERDIP
DG300AA	-55°C to +125°C	10 Lead Metal Can

(Ordering information is continued at end of data sheet.)

### Pin Configurations



DG300(A)/DG301(A)/DG302(A)/DG303(A)

## TTL Compatible CMOS Analog Switches

### ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V <sup>-</sup>	
V <sup>+</sup> (DG300-DG303)	36V
V <sup>+</sup> (DG300A-DG303A)	44V
GND	25V
Digital Inputs, V <sub>S</sub> , V <sub>D</sub> (Note 1)	-4V to (V <sup>+</sup> + 4V) or 30mA, whichever occurs first.
Current, Any Terminal Except S or D	30mA
Continuous Current, S or D	30mA
(Pulsed at 1msec, 10% duty cycle max)	100mA
Storage Temperature (A & B Suffix)	-85°C to 150°C
(C Suffix)	-65°C to 125°C

Operating Temperature (A Suffix)	-55°C to 125°C
(B Suffix)	-25°C to 85°C
(C Suffix)	0°C to 70°C
Lead Temperature (Soldering 10 sec.)	+300°C
Power Dissipation*	
Cerdip (K) (Derate 11mW/°C above 75°C)	825mW
Plastic DIP (J) (Derate 6.5mW/°C above 25°C)	470mW
Metal Can (A) (Derate 6mW/°C above 75°C)	450mW

\* Device mounted with all leads soldered or welded to PC board.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

### ELECTRICAL CHARACTERISTICS (V<sup>+</sup> = +15V, V<sup>-</sup> = -15V, GND = 0V, T<sub>A</sub> = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG300-DG303A DG300A-DG303AA			DG300-DG303B/C DG300A-DG303AB/C			UNITS	
				MIN (Note 2)	TYP (Note 3)	MAX	MIN (Note 2)	TYP (Note 3)	MAX		
SWITCH	Analog Signal Range	V <sub>ANALOG</sub>	I <sub>S</sub> = 10mA, V <sub>in</sub> = 0.8V or 4.0V	-15		15	-15		15	V	
	Drain-Source ON Resistance	r <sub>DS(on)</sub>	V <sub>in</sub> = 0.8V or 4.0V	I <sub>S</sub> = -10mA, V <sub>D</sub> = 10V		30	50		30	50	Ω
				I <sub>S</sub> = 10mA, V <sub>D</sub> = -10V		30	50		30	50	
	Source OFF Leakage Current	I <sub>S(off)</sub>		V <sub>S</sub> = 14V, V <sub>D</sub> = -14V		0.1	1		0.1	5	nA
	Drain OFF Leakage Current	I <sub>D(off)</sub>		V <sub>S</sub> = -14V, V <sub>D</sub> = 14V	-1	-0.1		-5	-0.1		
				V <sub>S</sub> = -14V, V <sub>D</sub> = 14V		0.1	1		0.1	5	
Drain ON Leakage Current	I <sub>D(on)</sub>	V <sub>D</sub> = V <sub>S</sub> = 14V		-1	-0.1		-5	-0.1			
		V <sub>D</sub> = V <sub>S</sub> = -14V		0.1	1		0.1	5			
INPUT	Input Current/Voltage High	I <sub>INH</sub>	V <sub>in</sub> = 5.0V	-1	-0.001		-1	-0.001		μA	
			V <sub>in</sub> = 15V		0.001	1		0.001	1		
	Input Current/Voltage Low	I <sub>INL</sub>	V <sub>in</sub> = 0V	-1	-0.001		-1	-0.001			
DYNAMIC	Turn-ON Time	t <sub>on</sub>	See Switching Time Test Circuit		150	300		150	300	ns	
	Turn-OFF Time	t <sub>off</sub>			130	250		130	250		
	Break-Before-Make Interval	t <sub>on</sub> -t <sub>off</sub>	See Break-Before-Make Time Test Circuit DG301(A)/DG303(A) Only		50			50			
	Charge Injection	Q	C <sub>L</sub> = 10nF, R <sub>gen</sub> = 0Ω, V <sub>gen</sub> = 0V		12			12		pC	
	Source OFF Capacitance	C <sub>S(off)</sub>	f = 1MHz, V <sub>in</sub> = 0.8V or 4.0V	V <sub>S</sub> = 0V		14			14	pF	
	Drain OFF Capacitance	C <sub>D(off)</sub>		V <sub>D</sub> = 0V		14			14		
	Channel ON Capacitance	C <sub>D(on)</sub> + C <sub>S(on)</sub>		V <sub>S</sub> = V <sub>D</sub> = 0V		40			40		
Input Capacitance	C <sub>in</sub>	f = 1MHz		V <sub>in</sub> = 0V		6			6		
			V <sub>in</sub> = 15V		7			7			
Off Isolation (Note 4)					62			62	dB		
Crosstalk (Channel to Channel)		V <sub>in</sub> = 0V, R <sub>L</sub> = 1kΩ V <sub>S</sub> = 1 V <sub>RMS</sub> , f = 500kHz			74			74			

(See Notes next page).

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## ELECTRICAL CHARACTERISTICS (Continued)

(V<sup>+</sup> = +15V, V<sup>-</sup> = -15V, GND = 0V, T<sub>A</sub> = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG300-DG303A DG300A-DG303AA			DG300-DG303B/C DG300A-DG303AB/C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
SUPPLY	Positive Supply Current	I <sup>+</sup>	V <sub>in</sub> = 4V (One Input) (All Others = 0)	0.23	0.5		0.23	0.5	mA	
	Negative Supply Current	I <sup>-</sup>		-10	-0.001		-10	-0.001		
	Positive Supply Current	I <sup>+</sup>	V <sub>in</sub> = 0.8V (All Inputs)	0.001	10		0.001	10	μA	
	Negative Supply Current	I <sup>-</sup>		-10	-0.001		-10	-0.001		

## ELECTRICAL CHARACTERISTICS (Over Temperature)

(V<sup>+</sup> = +15V, V<sup>-</sup> = -15V, GND = 0V, T<sub>A</sub> = Over Temperature Range, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG300-DG303A DG300A-DG303AA			DG300-DG303B/C DG300A-DG303AB/C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
SWITCH	Analog Signal Range	V <sub>ANALOG</sub>	I <sub>S</sub> = 10mA, V <sub>in</sub> = 0.8V or 4.0V	-15	15		-15	15	V	
	Drain-Source ON Resistance	r <sub>DS(on)</sub>	I <sub>S</sub> = -10mA, V <sub>D</sub> = 10V		75			75	Ω	
				I <sub>S</sub> = 10mA, V <sub>D</sub> = -10V		75				75
	Source OFF Leakage Current	I <sub>S(off)</sub>	V <sub>in</sub> = 0.8V or V <sub>in</sub> = 4.0V	V <sub>S</sub> = 14V, V <sub>D</sub> = -14V		100			100	nA
				V <sub>S</sub> = -14V, V <sub>D</sub> = 14V	-100			-100		
	Drain OFF Leakage Current	I <sub>D(off)</sub>	V <sub>in</sub> = 0.8V or V <sub>in</sub> = 4.0V	V <sub>S</sub> = -14V, V <sub>D</sub> = 14V		100			100	
				V <sub>S</sub> = 14V, V <sub>D</sub> = -14V	-100			-100		
Drain ON Leakage Current	I <sub>D(on)</sub>	V <sub>in</sub> = 0.8V or 4.0V	V <sub>D</sub> = V <sub>S</sub> = 14V		100			100		
			V <sub>D</sub> = V <sub>S</sub> = -14V	-200				-200		
INPUT	Input Current/ Voltage High	I <sub>INH</sub>	V <sub>in</sub> = 5.0V	-1			-10		μA	
			V <sub>in</sub> = 15V		1			10		
	Input Current/ Voltage Low	I <sub>INL</sub>	V <sub>in</sub> = 0V	-1			-10		μA	
SUPPLY	Positive Supply Current	I <sup>+</sup>	V <sub>in</sub> = 4V (One Input) (All Others = 0)		1			1	mA	
	Negative Supply Current	I <sup>-</sup>			-100			-200		
	Positive Supply Current	I <sup>+</sup>	V <sub>in</sub> = 0.8V (All Inputs)		100			200	μA	
	Negative Supply Current	I <sup>-</sup>			-100			-200		

**Note 1:** Signals on S<sub>x</sub>, D<sub>x</sub>, or I<sub>Nx</sub> exceeding V<sup>+</sup> or V<sup>-</sup> will be clamped by internal diodes. Limit diode forward current to maximum current ratings.

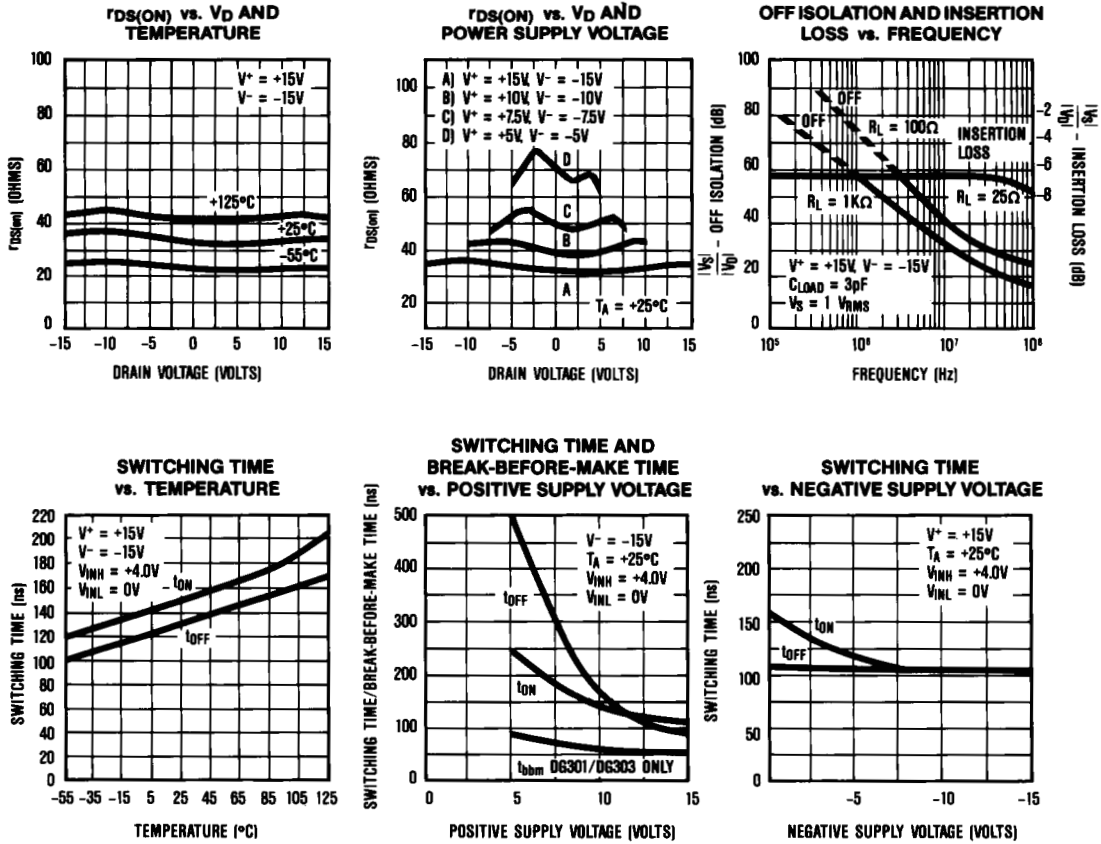
**Note 2:** The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum is used in this data sheet.

**Note 3:** Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

**Note 4:** OFF isolation = 20 log  $\frac{V_S}{V_D}$ , V<sub>S</sub> = input to OFF switch, V<sub>D</sub> = Output.

# TTL Compatible CMOS Analog Switches

## Typical Operating Characteristics



## Test Circuits

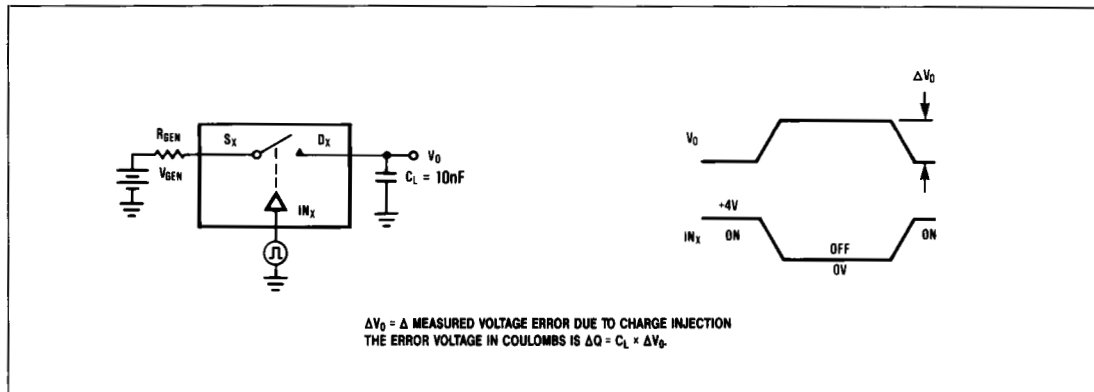


Figure 1. Charge Injection Test Circuit.

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## Test Circuits (Continued)

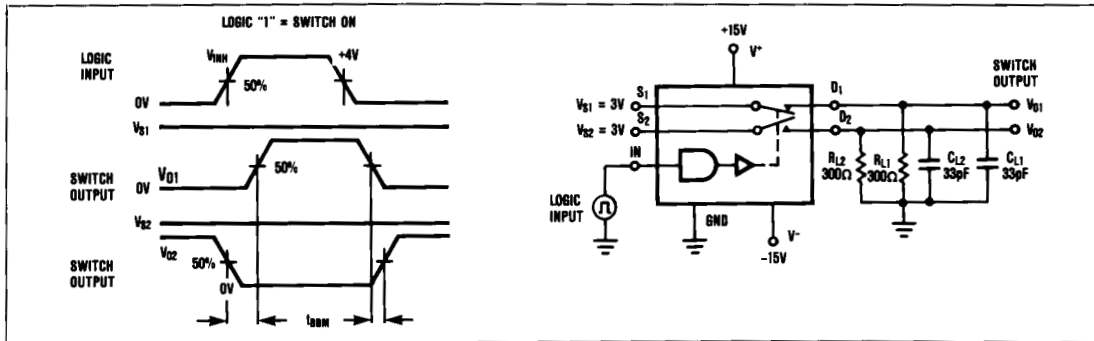


Figure 2. Break-Before-Make Time Test Circuit SPDT (DG301(A), DG303(A)).

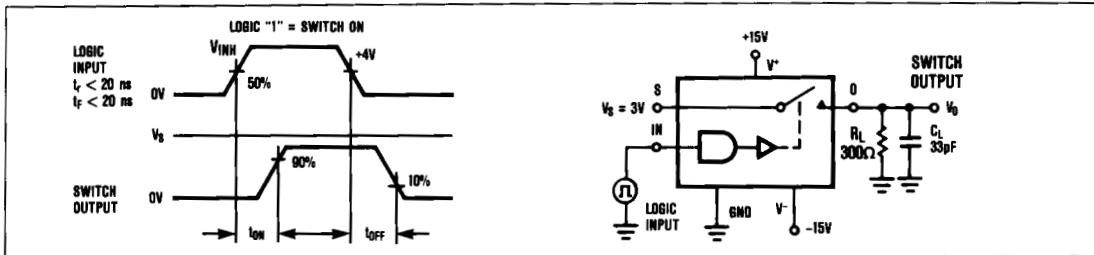


Figure 3. Switching Time Test Circuit.

## Application Information

All DG300 family switches will operate with  $\pm 5$  to  $\pm 15$ V power supplies. They can also be used with single ended power supplies ranging from +10V to +30V where the  $V^-$  terminal is connected to ground. In either case analog signals ranging from  $V^+$  to  $V^-$  can be switched.

The on resistance variation with analog signal and supply voltage is shown in the Typical Operating Characteristics graphs. The temperature coefficient of  $R_{ON}$  is typically 0.5%/°C. Typical on resistance matching from channel to channel is 10%. In addition, Table 1 outlines some typical parameters for single supply operation.

Table 1. Typical Single Supply Parameters

	$V^+$ SUPPLY VOLTAGE ( $V^- = 0V$ )			
	+10V	+15V	+20V	+30V
Switching Time ( $R_L = 1k\Omega$ )				
$t_{ON}$	190ns	150ns	110ns	70ns
$t_{OFF}$	40ns	40ns	40ns	40ns
On Resistance				
$V_{SIGNAL} = +1V$	71 $\Omega$	51 $\Omega$	42 $\Omega$	31 $\Omega$
$V_{SIGNAL} = V^+/2$	77 $\Omega$	54 $\Omega$	43 $\Omega$	30 $\Omega$
$V_{SIGNAL} = V^+$	84 $\Omega$	63 $\Omega$	54 $\Omega$	43 $\Omega$
Input Logic Levels	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.5V

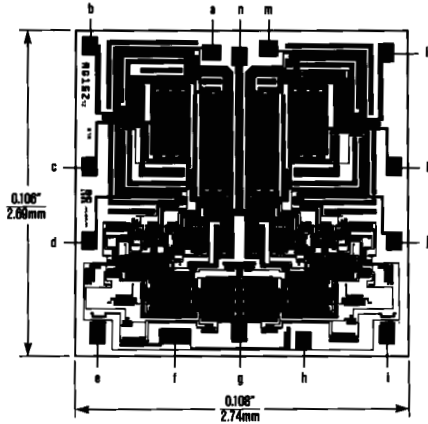
The charge injection test circuit is shown in Figure 1. Table 2 lists the typical injected charge for DG300 series switches with various input voltages.

Table 2. Charge Injection ( $\pm 15V$  Supplies)

ANALOG INPUT	INJECTED Q
+10V	4pC
+5V	8pC
0V	12pC
-5V	8pC
-10V	5pC

## TTL Compatible CMOS Analog Switches

### Chip Topography



DIE PAD	DG300 DG300A	DG301 DG301A	DG302/303 DG302A/303A
a	N.C.	N.C.	S3
b	D1	D1	D3
c	D1	S1	D1
d	S1	IN1	S1
e	IN1	IN1	IN1
f	V <sup>+</sup>	V <sup>+</sup>	V <sup>+</sup>
g	GND	GND	GND
h	V <sup>-</sup>	V <sup>-</sup>	V <sup>-</sup>
i	IN2	GND	IN2
j	S2	V <sup>-</sup>	S2
k	D2	S2	D2
l	D2	D2	D4
m	N.C.	N.C.	S4
n	V <sup>+</sup>	V <sup>+</sup>	V <sup>+</sup>

### Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DG300AC/D	0°C to +70°C	Dice
DG300ACJ	0°C to +70°C	14 Lead Plastic DIP
DG300ACWE	0°C to +70°C	16 Lead Wide SO
DG300ACK	0°C to +70°C	14 Lead CERDIP
DG300ABWE	-25°C to +85°C	16 Lead Wide SO
DG300ABK	-25°C to +85°C	14 Lead CERDIP
DG300ABA	-25°C to +85°C	10 Lead Metal Can
DG301C/D	0°C to +70°C	Dice
DG301CJ	0°C to +70°C	14 Lead Plastic DIP
DG301CWE	0°C to +70°C	16 Lead Wide SO
DG301CK	0°C to +70°C	14 Lead CERDIP
DG301BWE	-25°C to +85°C	16 Lead Wide SO
DG301BK	-25°C to +85°C	14 Lead CERDIP
DG301BA	-25°C to +85°C	10 Lead Metal Can
DG301AK	-55°C to +125°C	14 Lead CERDIP
DG301AA	-55°C to +125°C	10 Lead Metal Can
DG301AC/D	0°C to +70°C	Dice
DG301ACJ	0°C to +70°C	14 Lead Plastic DIP
DG301ACWE	0°C to +70°C	16 Lead Wide SO
DG301ACK	0°C to +70°C	14 Lead CERDIP
DG301ABWE	-25°C to +85°C	16 Lead Wide SO
DG301ABK	-25°C to +85°C	14 Lead CERDIP
DG301ABA	-25°C to +85°C	10 Lead Metal Can
DG302C/D	0°C to +70°C	Dice
DG302CJ	0°C to +70°C	14 Lead Plastic DIP

PART	TEMP. RANGE	PACKAGE
DG302CWE	0°C to +70°C	16 Lead Wide SO
DG302CK	0°C to +70°C	14 Lead CERDIP
DG302BWE	-25°C to +85°C	16 Lead Wide SO
DG302BK	-25°C to +85°C	14 Lead CERDIP
DG302AK	-55°C to +125°C	14 Lead CERDIP
DG302AC/D	0°C to +70°C	Dice
DG302ACJ	0°C to +70°C	14 Lead Plastic DIP
DG302ACWE	0°C to +70°C	16 Lead Wide SO
DG302ACK	0°C to +70°C	14 Lead CERDIP
DG302ABWE	-25°C to +85°C	16 Lead Wide SO
DG302ABK	-25°C to +85°C	14 Lead CERDIP
DG303C/D	0°C to +70°C	Dice
DG303CJ	0°C to +70°C	14 Lead Plastic DIP
DG303CWE	0°C to +70°C	16 Lead Wide SO
DG303CK	0°C to +70°C	14 Lead CERDIP
DG303BWE	-25°C to +85°C	16 Lead Wide SO
DG303BK	-25°C to +85°C	14 Lead CERDIP
DG303AK	-55°C to +125°C	14 Lead CERDIP
DG303AC/D	0°C to +70°C	Dice
DG303ACJ	0°C to +70°C	14 Lead Plastic DIP
DG303ACWE	0°C to +70°C	16 Lead Wide SO
DG303ACK	0°C to +70°C	14 Lead CERDIP
DG303ABWE	-25°C to +85°C	16 Lead Wide SO
DG303ABK	-25°C to +85°C	14 Lead CERDIP

# TTL Compatible CMOS Analog Switches

## Package Information

DG300(A)/DG301(A)/DG302(A)/DG303(A)

**Plastic DIP  
PLASTIC  
DUAL-IN-LINE  
PACKAGE  
(0.300 in.)**

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	-	0.200	-	5.08
A1	0.015	-	0.38	-
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.016	0.022	0.41	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.012	0.20	0.30
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100	-	2.54	-
eA	0.300	-	7.62	-
eB	-	0.400	-	10.16
L	0.115	0.150	2.92	3.81

PKG.	DIM	PINS	INCHES		MILLIMETERS	
			MIN	MAX	MIN	MAX
P	D	8	0.348	0.390	8.84	9.91
P	D	14	0.735	0.765	18.67	19.43
P	D	16	0.745	0.765	18.92	19.43
P	D	18	0.885	0.915	22.48	23.24
P	D	20	1.015	1.045	25.78	26.54
N	D	24	1.14	1.265	28.96	32.13

21-0043A

**Wide SO  
SMALL-OUTLINE  
PACKAGE  
(0.300 in.)**

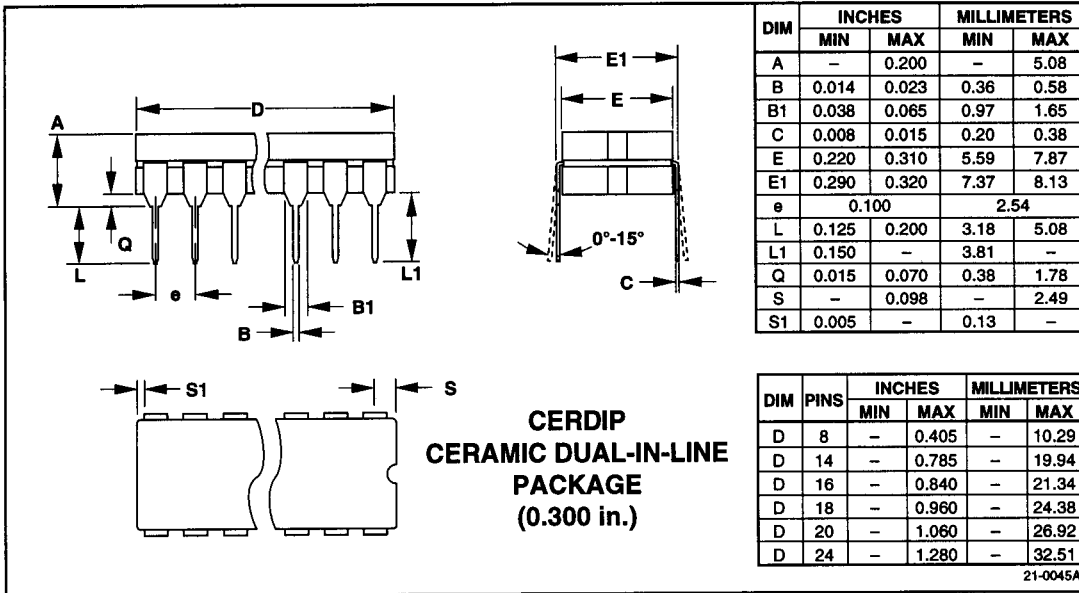
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
E	0.291	0.299	7.40	7.60
e	0.050		1.27	
H	0.394	0.419	10.00	10.65
L	0.016	0.050	0.40	1.27

DIM	PINS	INCHES		MILLIMETERS	
		MIN	MAX	MIN	MAX
D	16	0.398	0.413	10.10	10.50
D	18	0.447	0.463	11.35	11.75
D	20	0.496	0.512	12.60	13.00
D	24	0.598	0.614	15.20	15.60
D	28	0.697	0.713	17.70	18.10

21-0042A

# TTL Compatible CMOS 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.

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