

MAXIM

Quad SPST CMOS Analog Switches

MAX331/DG201A/DG211

General Description

The MAX331, DG201A and DG211 are normally closed, quad single-pole-single-throw (SPST) analog switches. These CMOS switches can be continuously operated with power supplies ranging from $\pm 4.5V$ to $\pm 18V$. Maxim guarantees that these switches will not latch-up if the power supplies are disconnected with input signals still connected.

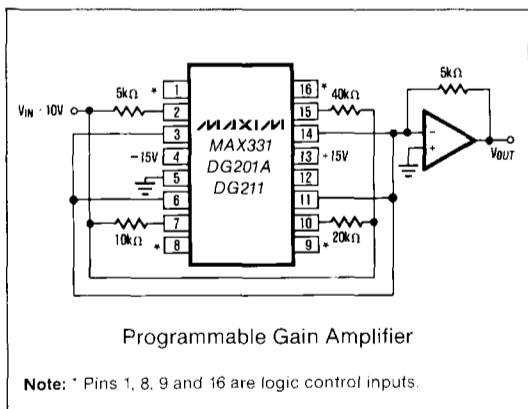
All three devices have guaranteed break-before-make switching. The MAX331 and DG201A differ with the DG211 primarily in switching speeds. The MAX331 and DG201A have a maximum turn-off time of 450ns and a maximum turn-on time of 600ns. The DG211 has a maximum turn-off time of 500ns and a maximum turn-on time of 1000ns.

Compared to the original manufacturer's products, Maxim's DG201A and DG211 consume significantly lower power, making them better suited for portable applications. By specifying the MAX331, the customer is guaranteed low power consumption units. Maxim has also eliminated the need for the third (V_L) power supply that is required for the operation of the original manufacturer's DG211.

Applications

- Winchester Disk Drives
- Test Equipment
- Communications Systems
- PBX, PABX
- Guidance and Control Systems
- Head up Displays
- Military Radios

Typical Operating Circuit



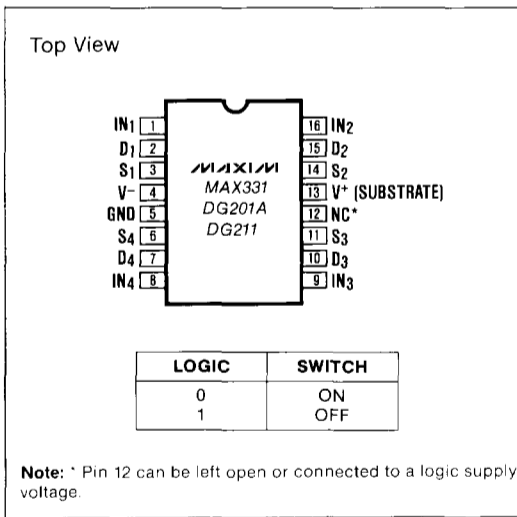
Features

- ◆ Improved 2nd Source! (See pages 3 and 5 for "MAXIM Advantage™")
- ◆ Guaranteed $\pm 4.5V$ to $\pm 18V$ Operation
- ◆ No V_L Supply Required
- ◆ Non-Latching with Supplies Turned-off and Input Signals Present
- ◆ CMOS and TTL Logic Compatible
- ◆ Monolithic, Low Power CMOS Design

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX331MJE	-55°C to +125°C	16 Lead CERDIP
DG201AAK	-55°C to +125°C	16 Lead CERDIP
DG201ABK	-25°C to +85°C	16 Lead CERDIP
DG201ACK	0°C to +70°C	16 Lead CERDIP
DG201ACJ	0°C to +70°C	16 Lead Plastic DIP
DG201ACSE	0°C to +70°C	16 Lead Small Outline
DG201C/D	0°C to +70°C	Dice
DG211CJ	0°C to +70°C	16 Lead Plastic DIP
DG211CSE	0°C to +70°C	16 Lead Small Outline
DG211C/D	0°C to +70°C	Dice

Pin Configuration



Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG211)

V ⁺ to V ⁻	40V	Storage Temperature	-65°C to +125°C
V _{IN} to Ground	V ⁻ , V ⁺	Operating Temperature	0°C to +70°C
V _I to Ground	-0.3V, 25V	Power Dissipation (Note 1)	
V _S or V _D to V ⁺	0, -40V	16 Pin Plastic DIP (Note 2)	470mW
V _S or V _D to V ⁻	0, 40V	16 Pin Small Outline (SE) (Note 3)	400mW
V ⁺ to Ground	25V		
V ⁻ to Ground	-25V	Note 1: Device mounted with all leads soldered to PC board.	
Current, Any Terminal Except S or D	30mA	Note 2: Derate 6.5mW/°C above +25°C.	
Continuous Current, S or D	20mA	Note 3: Derate 7mW/°C above +25°C.	
Peak Current, S or D	70mA		
(Pulsed at 1msec, 10% duty cycle max)			

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 (DG211)

(V⁺ = +15V, V⁻ = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS			UNITS
				MIN (Note 4)	TYP (Note 5)	MAX	
SWITCH	Analog Signal Range	V _{ANALOG}		-15		15	V
	Drain-Source ON Resistance	r _{DS(on)}	V _D = ±10V, V _{IN} = 0.8V, I _S = 1mA		115	175	Ω
	Source OFF Leakage Current	I _{S(off)}	V _{IN} = 2.4V	V _S = 14V, V _D = -14V	0.01	5.0	nA
				V _S = -14V, V _D = 14V	-5.0	-0.02	
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 2.4V	V _S = 14V, V _D = -14V	0.01	5.0	
			V _S = -14V, V _D = 14V	-5.0	-0.02		
	Drain ON Leakage Current (Note 6)	I _{D(on)}	V _S = V _D = 14V, V _{IN} = 0.8V		0.1	5.0	μA
			V _S = V _D = -14V, V _{IN} = 0.8V	-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V	-1.0	-0.0004		μA
	Input Current With Input Voltage Low	I _{INL}	V _{IN} = 15V		0.003	1.0	
DYNAMIC	Turn-ON Time	t _{ON}	See Switching Time Test Circuit		460	1000	ns
	Turn-OFF Time	t _{OFF1}	V _S = 2V, R _L = 1kΩ, C _L = 35pF		360	500	
		t _{OFF2}			450		
	Source OFF Capacitance	C _{S(off)}	V _S = 0V, V _{IN} = 5V, f = 1MHz		5		pF
	Drain OFF Capacitance	C _{D(off)}	V _D = 0V, V _{IN} = 5V, f = 1MHz		5		
	Channel ON Capacitance	C _{D-S(on)}	V _D = V _S = 0V, V _{IN} = 0V, f = 1MHz		16		dB
	OFF Isolation (Note 7)	OIRR	V _{IN} = 5V, R _L = 1kΩ, C _L = 15pF		70		
Crosstalk (Channel to Channel)	CCRR	V _S = 1VRMS, f = 100kHz		90			
SUPPLY	Positive Supply Current	I ⁺	V _{IN} = 0V and 2.4V		0.35	0.48	mA
	Negative Supply Current	I ⁻			0.30	0.48	
	Logic Supply Current	I _L			0.5	1.2	

Note 4: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 5: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 6: I_{D(on)} is leakage from driver into "ON" switch.

Note 7: OFF Isolation = 20 log $\frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = output.

The electrical characteristics above are a reproduction of a portion of Siliconix's copyrighted 1985 data book. This information does not constitute any representation by Maxim that Siliconix's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.



Quad SPST CMOS Analog Switches

- ◆ Significantly Reduced Power Consumption
- ◆ Third (Logic) Supply Not Required
- ◆ Fault Protected

ABSOLUTE MAXIMUM RATINGS (DG211) This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (DG211): Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V⁺ = +15V, V⁻ = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS			UNITS
				MIN (Note 4)	TYP (Note 5)	MAX	
SWITCH	Analog Signal Range	V _{ANALOG}		-15		15	V
	Drain-Source ON Resistance	r _{DS(on)}	V _D = ±10V, V _{IN} = 0.8V, I _S = 1mA		115	175	Ω
	Source OFF Leakage Current	I _{S(off)}	V _{IN} = 2.4V V _S = 14V, V _D = -14V V _S = -14V, V _D = 14V	-5.0	0.01	5.0	nA
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 2.4V V _S = 14V, V _D = -14V V _S = -14V, V _D = 14V	-5.0	0.01	5.0	
	Drain ON Leakage Current (Note 6)	I _{D(on)}	V _S = V _D = 14V, V _{IN} = 0.8V V _S = V _D = -14V, V _{IN} = 0.8V	-5.0	0.1	5.0	
INPUT	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V V _{IN} = 15V	-1.0	-0.0004	1.0	μA
	Input Current With Input Voltage Low	I _{INL}	V _{IN} = 0V	-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t _{on}	See Switching Time Test Circuit V _S = 2V, R _L = 1kΩ, C _L = 35pF		460	1000	ns
	Turn-OFF Time	t _{off1}			360	500	
		t _{off2}			450		
	Source OFF Capacitance	C _{S(off)}	V _S = 0V, V _{IN} = 5V, f = 1MHz		5		pF
	Drain OFF Capacitance	C _{D(off)}	V _D = 0V, V _{IN} = 5V, f = 1MHz		5		
	Channel ON Capacitance	C _{D+S(on)}	V _D = V _S = 0V, V _{IN} = 0V, f = 1MHz		16		
OFF Isolation (Note 8)	OIRR				70	dB	
	CCRR (Channel to Channel)	V _{IN} = 5V, R _L = 1kΩ, C _L = 15pF, V _S = 1VRMS, f = 100kHz			90		
SUPPLY	Positive Supply Current	I ⁺	V _{IN} = 0V and 2.4V		0.02	0.1	mA
	Negative Supply Current	I ⁻			0.01	0.1	
	Logic Supply Current	I _L			0.0	0.0	
	Power Supply Range for Continuous Operation	V _{OP}			±4.5		

Note 8: Electrical characteristics, such as ON Resistance, will change when power supplies, other than ±15V, are used.

MAX331/DG201A/DG211

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (MAX331, DG201A)

Voltages Referenced to V ⁻	Storage Temperature	-65°C to +150°C
V ⁺	Power Dissipation (Note 2)	
GND	16 Pin CERDIP (Note 3)	900mW
Digital Inputs (Note 1), V _S , V _D	16 Pin Plastic DIP (Note 4)	470mW
or 20mA, whichever occurs first	16 Pin Small Outline (SE) (Note 5)	400mW
Current, Any Terminal Except S or D	Note 1: Signals on S _x , D _x , or I _{Nx} exceeding V ⁺ or V ⁻ on Maxim's MAX331 and DG201A will be clamped by internal diodes, and are also internally current limited to 25mA.	
30mA	Note 2: Device mounted with all leads soldered to PC board.	
Continuous Current, S or D	Note 3: Derate 12mW/°C above +75°C.	
20mA	Note 4: Derate 6.5mW/°C above +25°C.	
Peak Current, S or D	Note 5: Derate 7mW/°C above +25°C.	
(Pulsed at 1msec, 10% duty cycle max.)		
70mA		
Operating Temperature		
DG201A (A Suffix)		
-55°C to +125°C		
(B Suffix)		
-25°C to +85°C		
(C Suffix)		
0°C to +70°C		
MAX331MJE		
-55°C to +125°C		

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 (DG201A)

(V⁺ = -15V, V⁻ = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS				UNITS
				DG201AA		DG201AB,C		
				MIN	TYP	MAX	MIN	
	Analog Signal Range	V _{ANALOG}		-15	15	-15	15	V
SWITCH	Drain-Source ON Resistance	r _{DS(on)}	V _D = ±10V, V _{IN} = 0.8V, I _S = 1mA	115	175	115	200	Ω
	Source OFF Leakage Current	I _{S(off)}	V _{IN} = 2.4V V _S = 14V, V _D = -14V V _S = -14V, V _D = 14V	0.01	1.0	0.01	5.0	nA
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 2.4V V _S = 14V, V _D = -14V V _S = -14V, V _D = 14V	0.01	1.0	0.01	5.0	
	Drain ON Leakage Current (Note 8)	I _{D(on)}	V _S = -14V, V _{IN} = 0.8V V _D = 14V, V _{IN} = 0.8V	-1.0	-0.15	-5.0	-0.15	
	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V V _{IN} = 15V	-1.0	-0.0004	-1.0	-0.0004	
Input Current With Input Voltage Low	I _{INL}	V _{IN} = 0V	-1.0	-0.0004	-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t _{on}	See Switching Time Test Circuit	480	600	480	600	ns
	Turn-OFF Time	t _{off1}		370	450	370	450	
	Charge Injection	Q	C _L = 1000pF, V _{GEN} = 0V, R _{GEN} = 0Ω	20		20		pC
	Source OFF Capacitance	C _{S(off)}	V _S = 0V, V _{IN} = 5V	5		5		pF
	Drain OFF Capacitance	C _{D(off)}	f = 140kHz	5		5		
	Channel ON Capacitance	C _{D(on)} + C _{S(on)}	V _D = V _S = 0V, V _{IN} = 0V	16		16		
	OFF Isolation		V _{IN} = 5V, Z _L = 75Ω	70		70		
Crosstalk (Channel to Channel)		V _S = 2.0V, f = 100kHz	90		90		dB	
SUPPLY	Positive Supply Current	I ⁺	All Channels ON or OFF	0.9	2	0.9	2	mA
	Negative Supply Current	I ⁻		-1	-0.3	-1	-0.3	

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 8: I_{D(on)} is leakage from driver into "ON" switch.

The electrical characteristics above are a reproduction of a portion of Siliconix's copyrighted 1985 data book. This information does not constitute any representation by Maxim that Siliconix's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.



Quad SPST CMOS Analog Switches

- ◆ Significantly Reduced Power Consumption
- ◆ Lower Input Current Over Temperature
- ◆ No Input Current Spike

ABSOLUTE MAXIMUM RATINGS (MAX331, DG201A) This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (MAX331, DG201A): Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V⁺ = +15V, V⁻ = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS				UNITS
				MAX331/DG201AA		DG201AB,C		
				MIN	TYP	MAX	MIN	
	Analog Signal Range	V _{ANALOG}		-15	15	-15	15	V
SWITCH	Drain-Source ON Resistance (Note 9)	r _{DS(on)}	V _D = ±10V, V _{IN} = 0.8V, I _S = 1mA	115	175	115	200	Ω
	Source OFF Leakage Current	I _{S(off)}	V _{IN} = 2.4V	V _S = 14V, V _D = -14V		0.01 1.0		nA
			V _S = -14V, V _D = 14V		-1.0 -0.02			
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 2.4V	V _S = 14V, V _D = -14V		0.01 1.0		
			V _S = -14V, V _D = 14V		-1.0 -0.02			
Drain ON Leakage Current (Note 8)	I _{D(on)}		V _S = -14V, V _{IN} = 0.8V	0.1	1.0	0.1	5.0	nA
			V _D = 14V, V _{IN} = 0.8V	-1.0	-0.15	-5.0	-0.15	
INPUT	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V	-1.0	-0.0004	-1.0	-0.0004	μA
			V _{IN} = 15V	0.003	1.0	0.003	1.0	
	Input Current With Input Voltage Low	I _{INL}	V _{IN} = 0V	-1.0	-0.0004	-1.0	-0.0004	μA
DYNAMIC	Turn-ON Time	t _{on}	See Switching Time Test Circuit	480	600	480	600	ns
	Turn-OFF Time	t _{off1}		370	450	370	450	
	Charge Injection	Q	C _L = 1000pF, V _{GEN} = 0V, R _{GEN} = 0Ω	20		20		pC
	Source OFF Capacitance	C _{S(off)}	V _S = 0V, V _{IN} = 5V	5		5		pF
	Drain OFF Capacitance	C _{D(off)}	f = 140kHz	5		5		
	Channel ON Capacitance	C _{D(on)} + C _{S(on)}		V _D = V _S = 0V, V _{IN} = 0V	16		16	
	OFF Isolation		V _{IN} = 5V, Z _L = 75Ω	70		70		
Crosstalk (Channel to Channel)		V _S = 2.0V, f = 100kHz	90		90		dB	
SUPPLY	Positive Supply Current	I ⁺	All Channels ON or OFF	0.02	0.1	0.02	0.1	mA
	Negative Supply Current	I ⁻	All Channels ON or OFF	-0.1	-0.01	-0.1	-0.01	
	Power Supply Range for Continuous Operation	V _{OP}		±4.5	±18	±4.5	±18	V

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 8: I_{D(on)} is leakage from driver into "ON" switch.

Note 9: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V, are used.

MAX331/DG201A/DG211

Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (DG201A)

(V⁺ = +15V, V⁻ = -15V, GND = 0V, T_A = Full Operating Temperature Range)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS						UNITS
			DG201AA			DG201AB,C			
			MIN	TYP	MAX	MIN	TYP	MAX	
Analog Signal Range	V _{ANALOG}		-15		15	-15		15	V
Drain-Source ON Resistance	r _{DS(on)}	V _D = ±10V, V _{IN} = 0.8V, I _S = 1mA			250			250	Ω
Source OFF Leakage Current	I _{S(off)}	V _{IN} = 2.4V			100			100	nA
Drain OFF Leakage Current	I _{D(off)}	V _S = 14V, V _D = -14V							
		V _S = -14V, V _D = 14V	-100			-100			
Drain ON Leakage Current (Note 10)	I _{D(on)}	V _S = 14V, V _D = -14V			100			100	
		V _S = -14V, V _D = 14V	-100			-100			
Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V			-1.0			-10	μA
		V _{IN} = 15V						-10	
Input Current With Input Voltage Low	I _{INL}	V _{IN} = 0V			-10			-10	

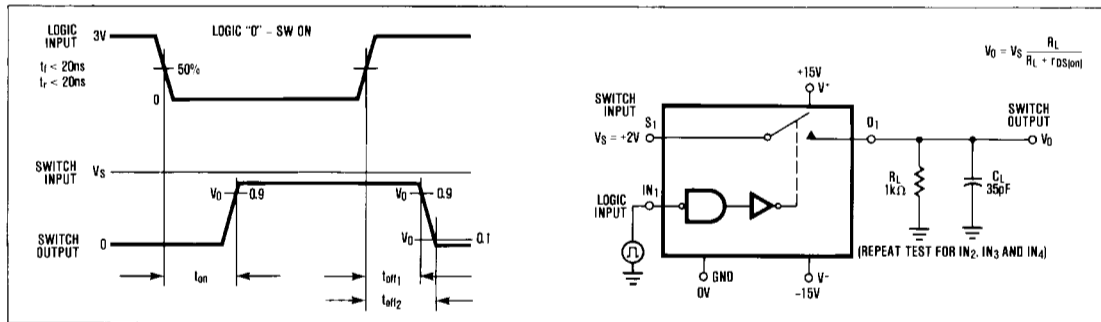
Note 10: I_{D(on)} is leakage from driver into "ON" switch.

The electrical characteristics above are a reproduction of a portion of Siliconix's copyrighted 1985 data book. This information does not constitute any representation by Maxim that Siliconix's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.

Switching Time Test Circuit

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_O may be +ve or -ve as per switching times test circuit.

V_O is the steady state output with switch on. Feed-through via gate capacitance may result in spikes at leading and trailing edge of output waveform.



Typical R_{DS(ON)} vs. Power Supplies for Maxim's MAX331, DG201A and DG211

POWER SUPPLIES	R _{DS(ON)} AT ANALOG SIGNAL LEVEL					
	-5V	+5V	-10V	+10V	-15V	+15V
±5V	350Ω	380Ω				
±10V			165Ω	250Ω		
±15V			125Ω	160Ω	135Ω	155Ω



Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (MAX331, DG201A):

($V^+ = +15V$, $V^- = -15V$, GND = 0V, T_A = full operating temperature range)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS						UNITS
				MAX331/DG201AA			DG201AB,C			
				MIN	TYP	MAX	MIN	TYP	MAX	
SWITCH	Analog Signal Range	V_{ANALOG}		-15		15	-15		15	V
	Drain-Source ON Resistance (Note 11)	$r_{DS(on)}$	$V_D = \pm 10V$, $V_{IN} = 0.8V$, $I_S = 1mA$			250			250	Ω
	Source OFF Leakage Current	$I_{S(off)}$	$V_{IN} = 2.4V$	$V_S = 14V$, $V_D = -14V$			100		100	nA
			$V_S = -14V$, $V_D = 14V$	-100			-100			
	Drain OFF Leakage Current	$I_{D(off)}$	$V_{IN} = 2.4V$	$V_S = 14V$, $V_D = -14V$			100		100	
			$V_S = -14V$, $V_D = 14V$	-100			-100			
INPUT	Drain ON Leakage Current (Note 10)	$I_{D(on)}$	$V_S = -14V$, $V_{IN} = 0.8V$			200			200	nA
			$V_D = 14V$, $V_{IN} = 0.8V$	-200			-200			
INPUT	Input Current With Input Voltage High	I_{INH}	$V_{IN} = 2.4V$	-1.0			-1.0			μA
			$V_{IN} = 15V$			1.0		1.0		
	Input Current With Input Voltage Low	I_{INL}	$V_{IN} = 0V$	-1.0			-1.0			

Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.

Note 11: Electrical characteristics, such as ON Resistance, will change when power supplies other than $\pm 15V$, are used.

Protecting Against Fault Conditions

Fault conditions occur when power supplies are turned off when input signals are still present or when over voltages occur at the inputs during normal operation. In either case, source-to-body diodes can be forward biased and conduct current from the signal source. If this current is required to be kept to low (μA) levels then the addition of external protection diodes is recommended.

To provide protection for over-voltages up to 20V above the supplies, a 1N4001 or 1N914 type diode should be placed in series with the positive and negative supplies as shown in Fig. 1. The addition of these diodes will reduce the analog signal range to 1 volt below the positive supply and 1 volt above the negative supply.

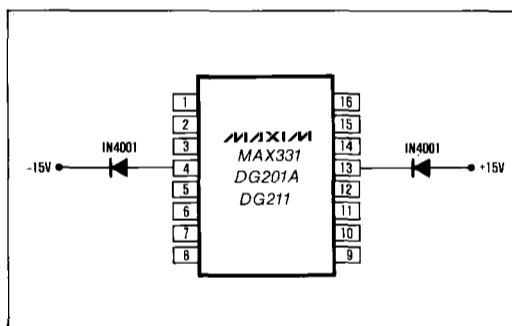


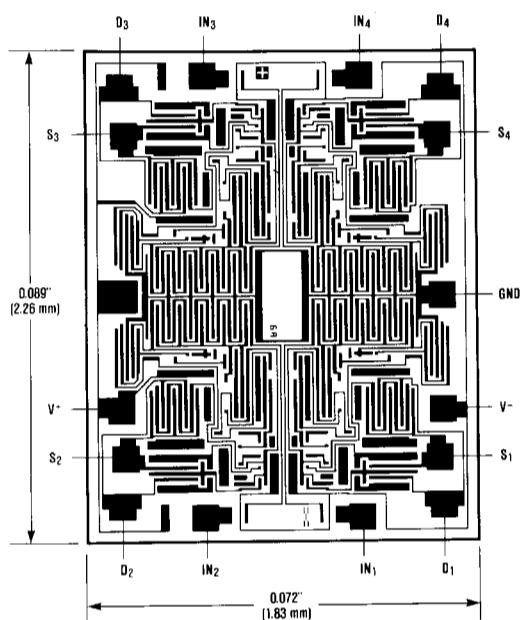
Figure 1. Protection Against Fault Conditions

MAX331/DG201A/DG211

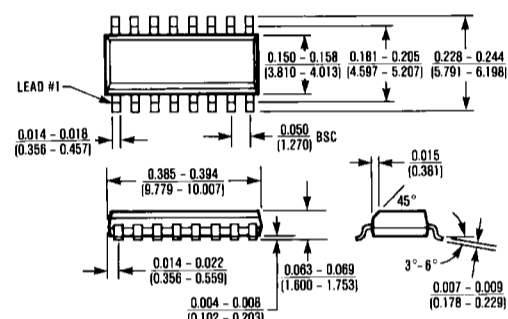
Quad SPST CMOS Analog Switches

MAX331/DG201A/DG211

Chip Topography

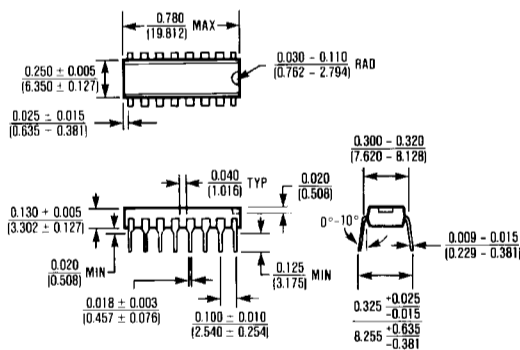


Package Information



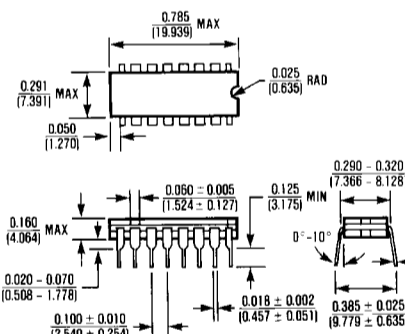
16 Lead Small Outline (SE)

$\theta_{JA} = 110^{\circ}\text{C/W}$
 $\theta_{JC} = 60^{\circ}\text{C/W}$



16 Lead Plastic DIP

$\theta_{JA} = 135^{\circ}\text{C/W}$
 $\theta_{JC} = 65^{\circ}\text{C/W}$



16 Lead Cerdip

$\theta_{JA} = 100^{\circ}\text{C/W}$
 $\theta_{JC} = 60^{\circ}\text{C/W}$

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.

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

© 1995 Maxim Integrated Products

Printed USA

MAXIM is a registered trademark of Maxim Integrated Products.