MAXIM

Quad SPST CMOS Analog Switches

General Description

Maxim's MAX332, DG202 and DG212 are normally open, quad single-pole-single-throw (SPST) analog switches. These CMOS switches can be continuously operated with power supplies ranging from ±4.5V to ±18V. Maxim guarantees that the MAX332 and DG202/212 will not latch up if their power supplies are disconnected with input signals still connected.

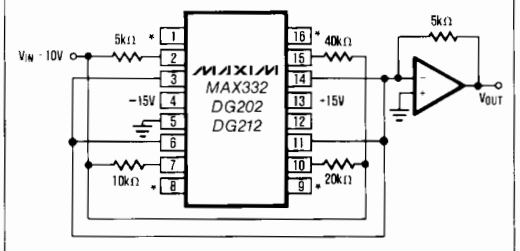
The MAX332 and DG202/DG212 are similar to the DG201 and DG211 except for inverted control inputs. All devices have guaranteed break-before-make switching as well as essentially constant on resistance over the analog signal range. All switches conduct current in either direction and add no offset to the output signal.

Compared to the original manufacturers products, Maxim's MAX332 and DG202/DG212 consume very little power, making them ideally suited for portable applications. Maxim has also eliminated the need for the third logic power supply (V_L), required when operating the original manufacturer's DG212, without sacrificing compatibility.

Applications

Analog Multiplexers
Programmable Gain Amplifiers
Communications Systems
Sample/Holds
Automatic Test Equipment
PBX, PABX

Typical Operating Circuit



Programmable Gain Amplifier

Note: *Pins 1, 8, 9 and 16 are logic control inputs.

Features

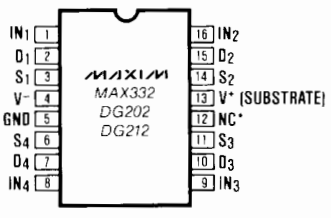
- **Improved 2nd Source! (See pages 3 and 5 for "MAXIM Advantage™")**
- **Guaranteed ±4.5V to ±18V Operation**
- **No V_L Supply Required**
- **Non-Latching with Supplies Turned-off and Input Signals Present**
- **CMOS and TTL Logic Compatible**
- **Monolithic, Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX332MJE	-55°C to +125°C	16 Lead CERDIP
DG202C/D	0°C to +70°C	Dice
DG202CJ	0°C to +70°C	16 Lead Plastic DIP
DG202CSE	0°C to +70°C	16 Lead Small Outline
DG202CK	0°C to +70°C	16 Lead CERDIP
DG202BSE	-25°C to +85°C	16 Lead Small Outline
DG202BK	-25°C to +85°C	16 Lead CERDIP
DG202AK	-55°C to +125°C	16 Lead CERDIP
DG212C/D	0°C to +70°C	Dice
DG212CJ	0°C to +70°C	16 Lead Plastic DIP
DG212CSE	0°C to +70°C	16 Lead Small Outline

Pin Configuration

Top View



LOGIC	SWITCH
0	OFF
1	ON

Note: *Pin 12 can be left open or connected to a logic supply voltage.

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG212)

V^+ to V^- 40V
V_{IN} to Ground ..... V^-, V^+
V_L to Ground ..... -0.3V, 25V
V_S or V_D to V^+ ..... 0, -40V
V_S or V_D to V^- 0, 40V
V^+ to Ground 25V
V^- to Ground ..... -25V
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1msec, 10% duty cycle max) 70mA

Storage Temperature ..... -65°C to +125°C
Operating Temperature ..... 0°C to +70°C
Power Dissipation (Note 1)
16 Pin Plastic DIP (Note 2) 470mW
16 Pin Small Outline (SE) (Note 3) 400mW

Note 1: Device mounted with all leads soldered to PC board.

Note 2: Derate 6.5mW/°C above +25°C.

Note 3: Derate 7mW/°C above +25°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 (DG212)

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

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	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} = 0.8V	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} = 2.4V			0.1	5.0	
			V_S = V_D = -14V, V_{IN} = 2.4V		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	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} = 0V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D(off)}$	V_D = 0V, V_{IN} = 0V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S(on)}$	V_D = V_S = 5V, V_{IN} = 0V, f = 1MHz			16		
	OFF Isolation (Note 7)	OIRR	V_{IN} = 0V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				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.

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Quad SPST CMOS Analog Switches

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

ABSOLUTE MAXIMUM RATINGS (DG212): This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (DG212): 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 MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	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} = 0.8V	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} = 2.4V			0.1	5.0	
			V_S = V_D = -14V, V_{IN} = 2.4V		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	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} = 0V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D(off)}$	V_D = 0V, V_{IN} = 0V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S(on)}$	V_D = V_S = 0V, V_{IN} = 5V, f = 1MHz			16		
	OFF Isolation (Note 8)	OIRR	V_{IN} = 0V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				90		
SUPPLY	**Positive Supply Current**	I^+	**V_{IN} = 0V and 2.4V**			**0.02**	**0.1**	mA
	Negative Supply Current	I^-				**0.00001**	**0.1**	
	Logic Supply Current	I_L				**0.0**	**0.0**	
	Power Supply Range for Continuous Operation	V_{OP}			**±4.5**		**±18**	V

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

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG202)

Voltages Referenced to V⁻
- V⁺ 44V
- GND 25V

Digital Inputs (Note 1), V_S, V_D ..... -2V, to (V^+ +2V) or 20mA, whichever occurs first

Current, Any Terminal Except S or D 30mA

Continuous Current, S or D 20mA

Peak Current, S or D (Pulsed at 1msec, 10% duty cycle max.) 70mA

Operating Temperature
- DG202 (A Suffix) ..... -55°C to +125°C
- (B Suffix) ..... -25°C to +85°C
- (C Suffix) ..... 0°C to +70°C
- MAX332MJE ..... -55°C to +125°C

Storage Temperature ..... -65°C to +150°C

Power Dissipation (Note 2)
- 16 Pin CERDIP (Note 3) 900mW
- 16 Pin Plastic DIP (Note 4) 470mW
- 16 Pin Small Outline (SE) (Note 5) 400mW

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- on Maxim's MAX332 and DG202 will be clamped by internal diodes, and are also internally current limited to 25mA.
Note 2: Device mounted with all leads soldered to PC board.
Note 3: Derate 12mW/°C above +75°C.
Note 4: Derate 6.5mW/°C above +25°C.
Note 5: Derate 7mW/°C above +25°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 (DG202)

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

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG202A MIN (Note 6)	DG202A TYP (Note 7)	DG202A MAX	LIMITS DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain OFF Leakage Current	$I_{D(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain ON Leakage Current (Note 8)	$I_{D(on)}$	V_S = -14V, V_{IN} = 2.4V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 2.4V		-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		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off}				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} = 0V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D(off)}$				5			5		
	Channel ON Capacitance	$C_{D(on)}$ + $C_{S(on)}$	V_D = V_S = 0V, V_{IN} = 5V			16			16		
	OFF Isolation		V_{IN} = 0V, Z_L = 75kΩ			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
SUPPLY	Positive Supply Current	I^+	All Channels ON or OFF			0.9	2		0.9	2	mA
	Negative Supply Current	I^-	All Channels ON or OFF		-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.

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Quad SPST CMOS Analog Switches

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

ABSOLUTE MAXIMUM RATINGS (MAX332, DG202): This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (MAX332, DG202): 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 MAX332/DG202A MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG202B,C MIN (Note 6)	TYP (Note 7)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 9)	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain ON Leakage Current (Note 8)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 2.4V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 2.4V		-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		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off_1}				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} = 0V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$				5			5		
	Channel ON Capacitance	$C_{D\ (on)}$ + $C_{S\ (on)}$	V_D = V_S = 0V, V_{IN} = 5V			16			16		
	OFF Isolation		V_{IN} = 0V, Z_L = 75kΩ			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
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.

Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (DG202)

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

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG202A MIN (Note 6)	DG202A TYP (Note 7)	DG202A MAX	LIMITS DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	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} = 0.8V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 2.4V				200			200	
			V_D = 14V, V_{IN} = 2.4V		-200			-200			
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0			-10			μA
			V_{IN} = 15V				-10			-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.

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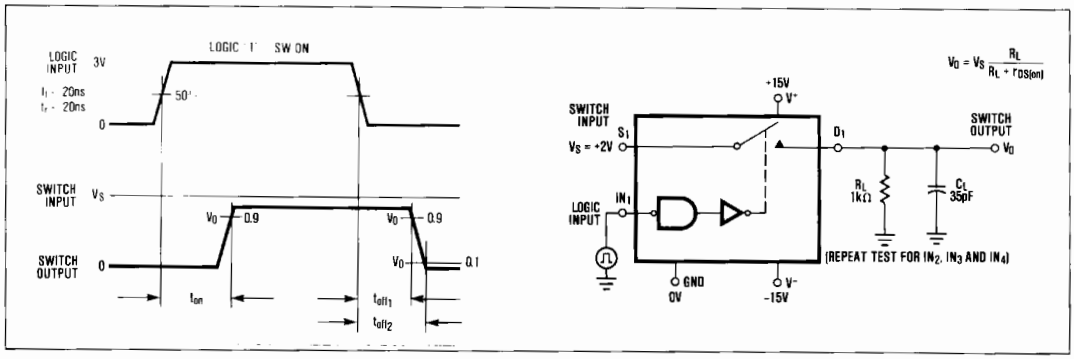
Switching Time Test Circuit

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

V_O is the steady state output with switch on. Feedthrough 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 MAX332, DG202/DG212

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

ELECTRICAL CHARACTERISTICS (MAX332, DG202):

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

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MAX332/DG202A MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG202B,C MIN (Note 6)	TYP (Note 7)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 11)	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	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} = 0.8V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D(on)}$	V_S = -14V, V_{IN} = 2.4V				200			200	
			V_D = 14V, V_{IN} = 2.4V		-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 ±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.

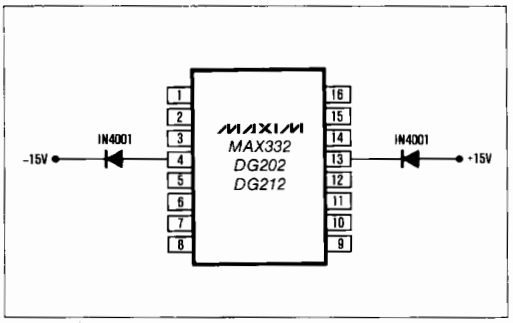
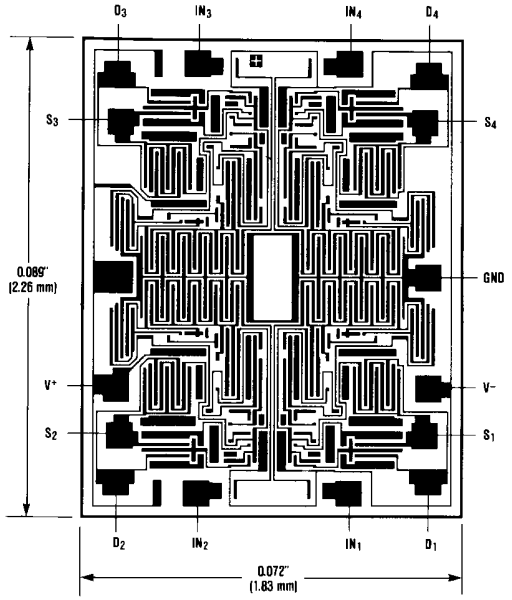


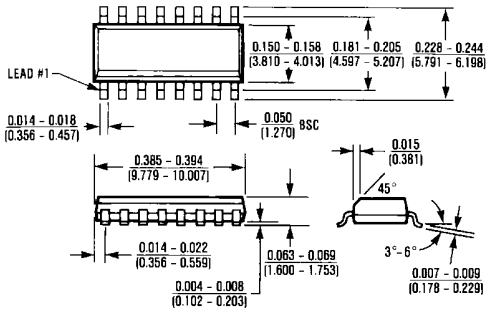
Figure 1. Protection Against Fault Conditions

Quad SPST CMOS Analog Switches

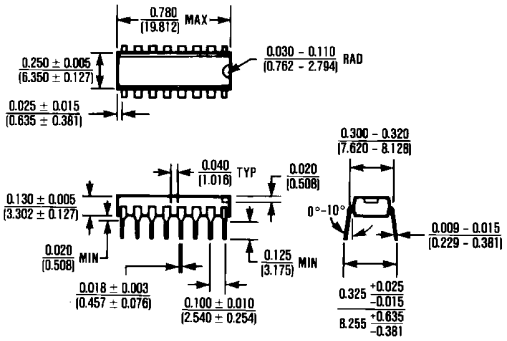
Chip Topography



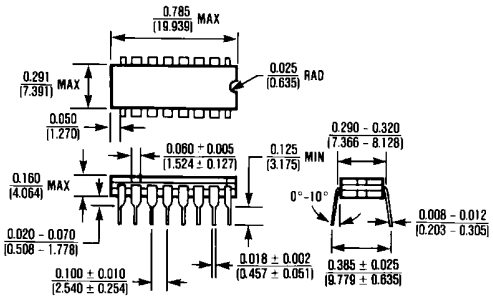
Package Information



16 Lead Small Outline (SE)
θ_{JA} = 110°C/W
θ_{JC} = 60°C/W



16 Lead Plastic DIP
θ_{JA} = 135°C/W
θ_{JC} = 65°C/W



16 Lead CERDIP
θ_{JA} = 100°C/W
θ_{JC} = 60°C/W