

MAXIM

Quad SPST CMOS Analog Switches

MAX332/DG202/DG212

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 $\pm 18V$. Maxim guarantees that the MAX332 and DG202/212 will not latch up if their power supplies are disconnected with input signals still connected.

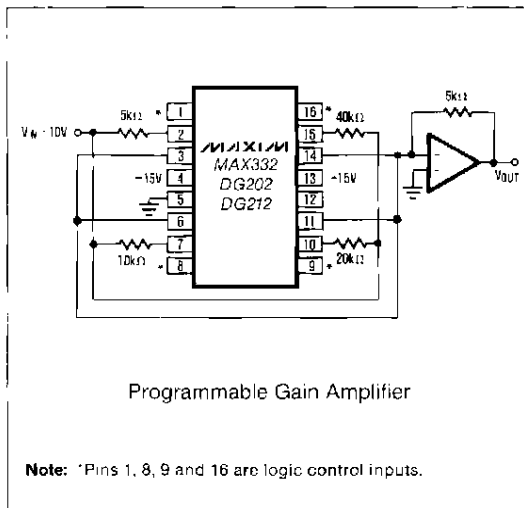
The MAX332 and DG202/DG212 are similar to the DG201 and DG211 except for inverted control inputs. All devices have guaranteed break-before-make switching as well as essentially constant on resistance over the analog signal range. All switches conduct current in either direction and add no offset to the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



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	70mA
(Pulsed at 1msec, 10% duty cycle max)	

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, $T_A = +25^\circ C$, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS			UNITS
				MIN (Note 4)	TYP (Note 5)	MAX	
SWITCH	Analog Signal Range	$V_{ANA,CG}$		15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	$V_D = \pm 10V$, $V_{IN} = 2.4V$, $I_S = 1mA$		115	175	Ω
	Source OFF Leakage Current	$I_{S(off)}$	$V_{IN} = 0.8V$ $V_S = -14V$, $V_D = -14V$ $V_S = -14V$, $V_D = 14V$	-5.0	0.01	5.0	nA
	Drain OFF Leakage Current	$I_{D(off)}$	$V_{IN} = 0.8V$ $V_S = 14V$, $V_D = -14V$ $V_S = -14V$, $V_D = 14V$	-5.0	0.01	5.0	
	Drain ON Leakage Current (Note 6)	$I_{D(on)}$	$V_S = V_D = -14V$, $V_{IN} = 2.4V$ $V_S = V_D = 14V$, $V_{IN} = 2.4V$	-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		
	Turn-ON Time	t_{on}	See Switching Time Test Circuit $V_S = 2V$, $R_L = 1k\Omega$, $C_L = 35pF$		460	1000	ns
DYNAMIC	Turn-OFF Time	t_{off1} t_{off2}			360	500	
	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+SIGN}	$V_D = V_S = 5V$, $V_{IN} = 0V$, $f = 1MHz$		16		
	OFF Isolation (Note 7)	OIRR	$V_{IN} = 0V$, $R_L = 1k\Omega$, $C_L = 15pF$ $V_S = 1VRMS$, $f = 100kHz$		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			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} = 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 V _S = -14V, V _D = 14V	-5.0	-0.02		nA
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 0.8V, V _S = 14V, V _D = -14V 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 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 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		
	Turn-ON Time	t _{on}	See Switching Time Test Circuit V _S = 2V, R _L = 1kΩ, C _L = 35pF		460	1000	ns
DYNAMIC	Turn-OFF Time	t _{off1} t _{off2}			360	500	
	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
SUPPLY	Crosstalk (Channel to Channel)	CCRR			90		
	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

MAX332/DG202/DG212

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 I_{NX} 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						UNITS
					DG202A			DG202B,C			
					MIN (Note 6)	TYP (Note 7)	MAX	MIN (Note 6)	TYP (Note 7)	MAX	
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 V _S = -14V, V _D = 14V	0.01	1.0		0.01	5.0	nA	
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 0.8V	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} = 2.4V V _D = 14V, V _{IN} = 2.4V	0.1	1.0		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	-0.0004	μA	
	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						UNITS
					MAX332/DG202A			DG202B,C			
					MIN	TYP	MAX	MIN	TYP	MAX	
					(Note 6)	(Note 7)		(Note 6)	(Note 7)		
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 _{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} = 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.

MAX332/DG202/DG212

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						UNITS
					DG202A			DG202B,C			
					MIN (Note 6)	TYP (Note 7)	MAX	MIN (Note 6)	TYP (Note 7)	MAX	
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 V _S = -14V, V _D = 14V			100			100	nA
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 0.8V	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 _{IN} = 2.4V V _D = 14V, V _{IN} = 2.4V				200			200	
	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V V _{IN} = 15V				-1.0			-10	
INPUT	Input Current With Input Voltage Low	I _{INL}	V _{IN} = 0V				-10			-10	μA

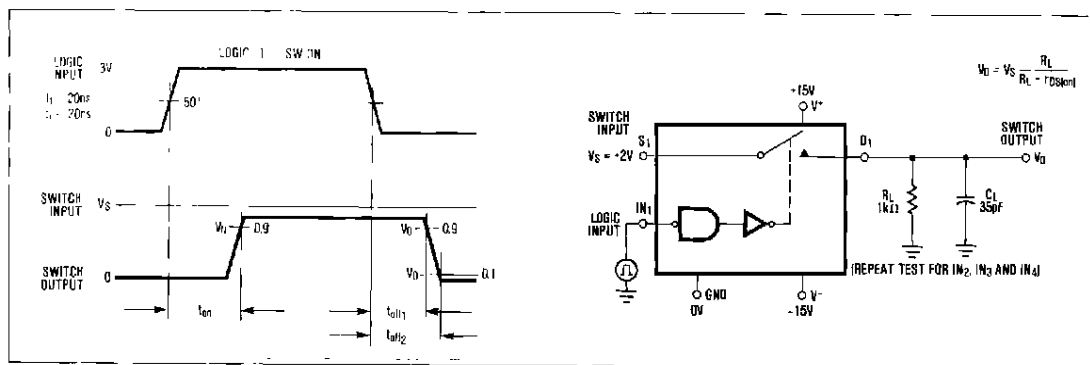
Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.

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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. 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 MAX332, DG202/DG212

POWER SUPPLIES	$R_{DS(ON)}$ AT ANALOG SIGNAL LEVEL					
	-5V	+5V	-10V	+10V	-15V	+15V
$\pm 5V$	350 Ω	380 Ω				
$\pm 10V$			165 Ω	250 Ω		
$\pm 15V$			125 Ω	160 Ω	135 Ω	155 Ω



Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (MAX332, DG202):

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

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS						UNITS
					MAX332/DG202A			DG202B.C			
					MIN	TYP	MAX	MIN	TYP	MAX	
					(Note 6)	(Note 7)		(Note 6)	(Note 7)		
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 V _S = -14V, V _D = 14V			100			100	nA
	Drain OFF Leakage Current	I _{D(off)}	V _{IN} = 0.8V	V _S = 14V, V _D = -14V V _S = -14V, V _D = 14V	-100		100	-100		100	
	Drain ON Leakage Current (Note 10)	I _{D(on)}	V _S = -14V, V _{IN} = 2.4V V _D = 14V, V _{IN} = 2.4V				200			200	
					-200			-200			
INPUT	Input Current With Input Voltage High	I _{INH}	V _{IN} = 2.4V V _{IN} = 15V		-1.0		1.0	-1.0		1.0	μA
	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.

MAX332/DG202/DG212

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.

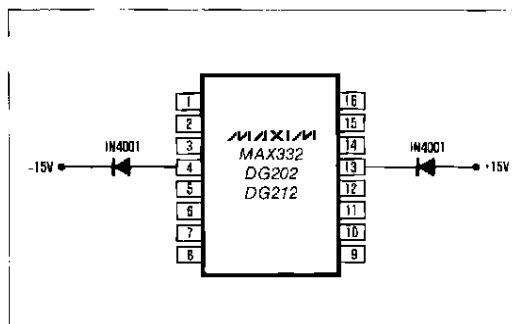
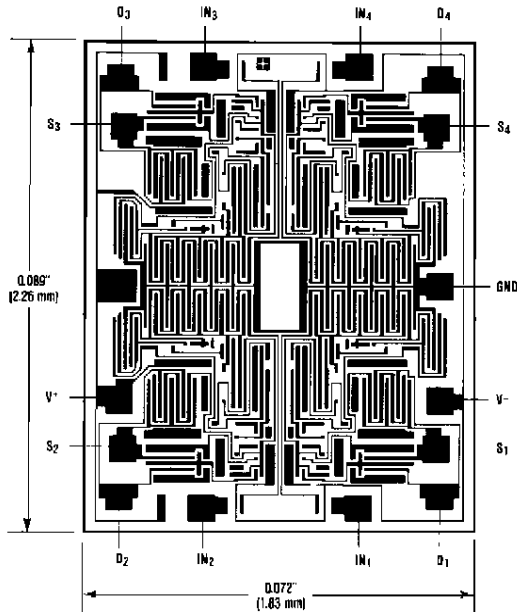


Figure 1. Protection Against Fault Conditions

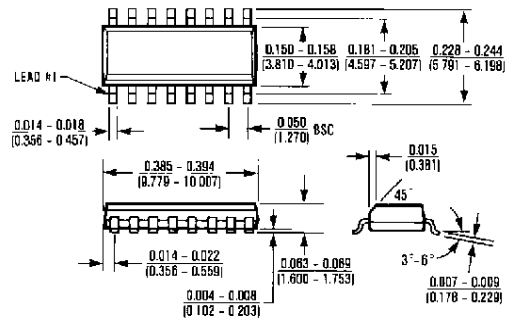
Quad SPST CMOS Analog Switches

MAX332/DG202/DG212

Chip Topography



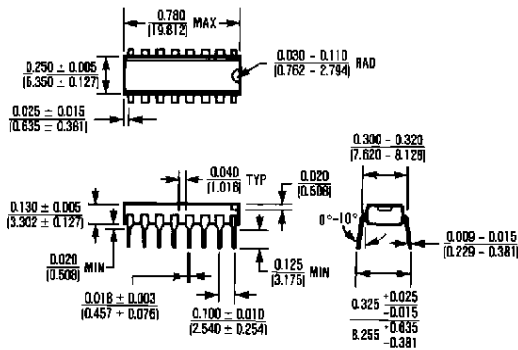
Package Information



16 Lead Small Outline (SE)

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

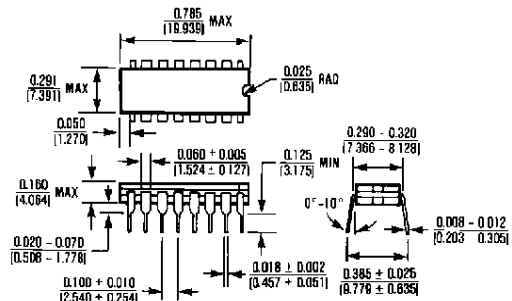
$$\theta_{JC} = 60^{\circ}\text{C/W}$$



16 Lead Plastic DIP

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

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



16 Lead Cerdip

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

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

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