

General Description

The MAX4659/MAX4660 are medium voltage CMOS analog switches with a low on-resistance of 25Ω max specifically designed to handle large switch currents. With a switch capability of up to 200mA peak current and 150mA continuous current (MAX4660), and up to 150mA peak current and 75mA continuous current (MAX4659), these parts can switch loads as low as 50Ω . They can replace reed relays with a million times the speed and a virtually unlimited number of lifetime cycles. Normal power consumption is only 3mW, whether the switch is on or off. These parts are TTL/CMOS compatible and will switch any voltage within their power-supply range.

The devices are single-pole/double-throw (SPDT) switches. The MAX4659/MAX4660 contain one normally closed (NC) switch and one normally open (NO) switch.

The MAX4659/MAX4660s' power-supply range is from ±4.5V to ±20V for dual-supply operation and +9V to +40V for single-supply operation. These switches can operate from any combination of supplies, within a 40V V+ to V- range. They conduct equally well in either direction and can handle Rail-to-Rail® analog signals. The off-leakage current is only 1nA max at $T_A = +25$ °C. The MAX4659 is available in 8-pin µMAX and SO packages. The MAX4660 is available in thermally enhanced exposed paddle µMAX and SO packages.

Applications

Relay Replacement

Test Equipment

Communication Systems

xDSL Modems

PBX, PABX Systems

Audio Signal Routing

Audio Systems

PC Multimedia Boards

Redundant/Backup Systems

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

Features

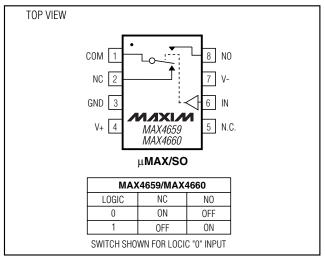
- ♦ High Continuous Current Handling 150mA Continuous Current (MAX4660) 75mA Continuous Current (MAX4659)
- **♦ High Peak Current Handling** 200mA Peak Current (MAX4660) 150mA Peak Current (MAX4659)
- ♦ 25Ω max On-Resistance (±15V Supplies)
- ♦ V_L Supply Not Required
- ♦ 1.5Ω max Ron Flatness (±15V Supplies)
- ♦ Rail-to-Rail Signal Handling
- ♦ +12V Single Supply or ±15V Dual-Supply Operation
- ♦ Pin Compatible with DG419, MAX319

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4659EUA	-40°C to +85°C	8 µMAX
MAX4659ESA	-40°C to +85°C	8 SO
MAX4660EUA	-40°C to +85°C	8 µMAX EP*
MAX4660ESA	-40°C to +85°C	8 SO EP*

^{*} Exposed paddle

Pin Configuration



MIXIM

Maxim Integrated Products 1

ABSOLUTE MAXIMUM RATINGS

V+ to GND	0.3V to +44V
V- to GND	
V+ to V	0.3V to +44V
All Other Pins to GND (Note 1) (V 0.3V) to	(V+ + 0.3V)
Continuous Current COM, NO, NC (MAX4660)	±150mA
Continuous Current COM, NO, NC (MAX4659)	
Continuous Current IN	±30mA
Peak Current COM, NO, NC	
MAX4660 (pulsed at 1ms, 10% duty cycle)	±200mA
MAX4659 (pulsed at 1ms, 10% duty cycle)	±150mA
Continuous Power Dissipation ($T_A = +70^{\circ}C$)	
8-Pin µMAX-EP (derate 10.3mW/°C above +70°	C)
MAX4660	825mW

8-Pin µMAX (derate 4.50mW/°C above 4 MAX4659	,
8-Pin SO-EP (derate 18.9mW/°C above MAX4660	,
8-Pin SO (derate 5.88mW/°C above +70 MAX4659	0°C)
Operating Temperature Ranges MAX4659/MAX4660	
Junction Temperature	+150°C
Storage Temperature Range Lead Temperature (soldering, 10s)	

Note 1: Signals on NO, NC, COM, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward-diode 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_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Notes 2, 6)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS	
ANALOG SWITCH								
Analog Signal Range VCOM, VNO, VNC			V-		V+	V		
On-Resistance	R _{ON}	I _{COM} = 50mA;	+25°C		18	25	Ω	
On resistance	11010	V_{NO} or $V_{NC} = \pm 10V$	T _{MIN} to T _{MAX}			30	22	
On-Resistance Matching	ΔRON	I _{COM} = 50mA;	+25°C		0.4	1.2	Ω	
Between Channels	ZHON	V_{NO} or $V_{NC} = \pm 10V$	T _{MIN} to T _{MAX}			1.5	_ 12	
On-Resistance Flatness	D=: += (0.1)	I _{COM} = 50mA;	+25°C		0.5	1.5	1.5	
(Note 3)	RFLAT (ON)	V_{NO} or $V_{NC} = -5V$, 0, +5V	T _{MIN} to T _{MAX}			2	Ω	
NO or NC Off-Leakage	I _{NO(OFF)} or	V _{COM} = -14.5V, +14.5V; V _{NO}	+25°C	-1	0.01	1	n 1	
Current (Note 4)	INC(OFF)	or $V_{NC} = +14.5V$, $-14.5V$	T_{MIN} to T_{MAX}	-10		10	nA	
COM On-Leakage	ICOM(ON)	$V_{COM} = +14.5V, -14.5V;$ V_{NO} or $V_{NC} = +14.5V,$	+25°C	-2	0.02	2	nA	
Current (Note 4)	ICOM(ON)	-14.5V, or floating	T _{MIN} to T _{MAX}	-20		20		
DYNAMIC CHARACTERISTICS	3							
Transition Time		V_{NO} or $V_{NC} = 10V$;	+25°C		85	150		
Hansilion hine	ttrans	$R_L = 300\Omega$, $C_L = 35pF$; Figure 3	T _{MIN} to T _{MAX}			200	ns	
Break-Before-Make Delay	tbbm	V_{NO} or $V_{NC} = 10V$; $R_L = 300\Omega$,	+25°C	10	20		ns	
Broak Boloro Wake Bolay	rDDIVI	$C_L = 35pF$, Figure 3		5				

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

 $(V+=+15V, V-=-15V, V_{IH}=2.4V, V_{IL}=0.8V, T_A=T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A=+25^{\circ}C$.) (Notes 2, 6)

PARAMETER	SYMBOL	CONDITIONS	TA	MIN	TYP	MAX	UNITS
Charge Injection	Ю	$V_{GEN} = 0$, $R_{GEN} = 0$, $C_L = 1$ nF, Figure 4	+25°C		1.5		рС
-3dB Bandwidth	BW		+25°C		225		MHz
Off-Isolation (Note 5)	VISO	$f = 1MHz$, $R_L = 50\Omega$, Figure 5	+25°C		-70		dB
Total Harmonic Distortion	THD	$f = 20$ Hz to 20 kHz, $V_{N_} = 5$ Vp-p, $R_L = 600\Omega$	+25°C		0.005		%
Crosstalk	VCROSS	$R_L = 50\Omega$, $C_L = 5pF$, $f = 1MHz$, Figure 6	+25°C		-76		dB
NO or NC Off-Capacitance	C _{NO(OFF)} , C _{NC(OFF)}	f = 1MHz, Figure 7	+25°C		6		pF
COM On-Capacitance	C _{COM} (ON)	f = 1MHz, Figure 8	+25°C		25		рF
DIGITAL I/O							
Input Logic High	VIH		T _{MIN} to T _{MAX}	2.4			V
Input Logic Low	VIL		T _{MIN} to T _{MAX}			0.8	V
Input Leakage Current	I _{IN}	$V_{IN} = 0.8V \text{ or } 2.4V$	T _{MIN} to T _{MAX}	-1		1	μΑ
POWER SUPPLY							
Power-Supply Range			T _{MIN} to T _{MAX}	±4.5		±20	V
Positive Supply Current	1+	$V_{IN} = 0$ or $5V$, $V_{N} = 3V$, $I_{SWITCH} = 100$ mA, $MAX4660$; $I_{SWITCH} = 50$ mA, $MAX4659$	+25°C		135	200	μΑ
i ositive Supply Current	IT		T _{MIN} to T _{MAX}			300	μΑ
No seating Councils Councils			+25°C		30	50	
Negative Supply Current	l-	MAX4660; ISWITCH = 50mA, MAX4659	T _{MIN} to T _{MAX}			75	μΑ
Ground Current		V _{IN} = 0 or 5V, V _N = 3V, I _{SWITCH} = 100mA, MAX4660; I _{SWITCH} = 50mA, MAX4659	+25°C		100	175	
	IGND		T _{MIN} to T _{MAX}			225	μΑ

ELECTRICAL CHARACTERISTICS—Single Supply

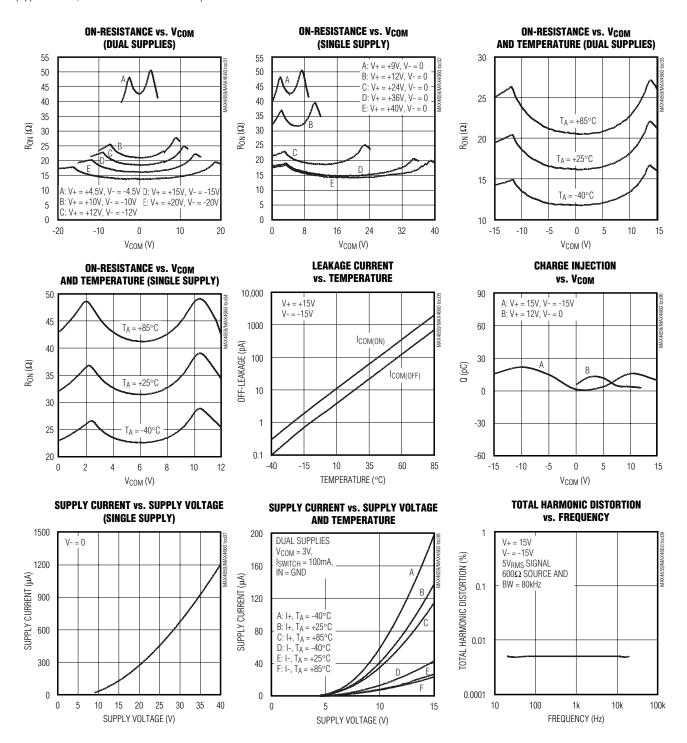
 $(V+=+12V, V-=0, V_{IH}=2.4V, V_{IL}=0.8V, T_A=T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A=+25^{\circ}C$.) (Notes 2, 6)

PARAMETER	ARAMETER SYMBOL CONDITIONS		TA	MIN	TYP	MAX	UNITS	
ANALOG SWITCH								
Analog Signal Range	VIN		T _{MIN} to T _{MAX}	0		V+	V	
On-Resistance	Ron	I _{COM} = 25mA;	+25°C		38	50	Ω	
Ori-nesistarice	UON	V_{NO} or $V_{NC} = +10V$	T _{MIN} to T _{MAX}			60	22	
On-Resistance Matching	ADa.	I _{COM} = 25mA;	+25°C		0.4	2	Ω	
Between Channels	ΔRon	V_{NO} or $V_{NC} = \pm 10V$	T _{MIN} to T _{MAX}			2.5	22	
On-Resistance Flatness	RFLAT (ON)	$I_{COM} = 25mA;$ V _{NO} or V _{NC} = +2V, +6V,	+25°C		4	7	Ω	
(Note 3)	I LAT (ON)	+10V	T _{MIN} to T _{MAX}			9		
DYNAMIC CHARACTERISTICS							1	
Transition Time	trouse	V_{NO} or V_{NC} = 10V; R_L = 300 Ω ; C_L = 35pF, Figure 2	+25°C		120	200	ns	
Transmon nine	ttrans		T _{MIN} to T _{MAX}			250		
Break-Before-Make Delay	t _{BBM}	V_{NO} or V_{NC} = 10V; R_L = 300 Ω ; C_L = 35pF, Figure 2	+25°C	20	50		ns	
Diean-Deloie-Mane Delay	regivi		T _{MIN} to T _{MAX}	10				
Charge Injection	Q	$V_{GEN} = 0$, $R_{GEN} = 0$, $C_L = 1$ nF, Figure 4	+25°C		1		рС	
POWER SUPPLY								
Power-Supply Range	V+			+9		+40	V	
Positive Supply Current	l+	V _{IN} = 0 or 12V, V _N _ = 3V; I _{SWITCH} = 50mA, MAX4660;	+25°C		50	100	- μΑ	
		I _{SWITCH} = 25mA, MAX4659	T _{MIN} to T _{MAX}			125		
т означе опрріу Оппені		V _{IN} = 5V, V _N = 3V; ISWITCH = 50mA, MAX4660;	+25°C		70	125	μ/\	
		ISWITCH = 25mA, MAX4659	T _{MIN} to T _{MAX}			150		

- Note 2: The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.
- **Note 3:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
- Note 4: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at $T_A = +25$ °C.
- Note 5: Off-isolation = 20log₁₀ [V_{COM} / (V_{NC} or V_{NO})], V_{COM} = output, V_{NC} or V_{NO} = input to off switch.
- Note 6: -40°C specifications are guaranteed by design.

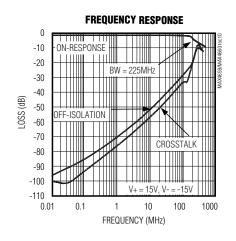
Typical Operating Characteristics

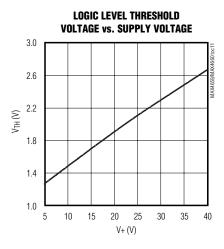
 $(T_A = +25^{\circ}C, \text{ unless otherwise noted.})$

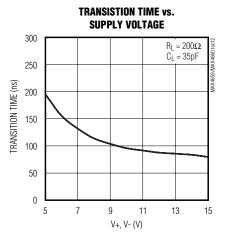


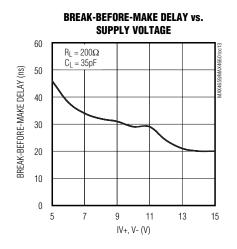
Typical Operating Characteristics (continued)

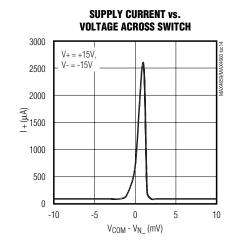
 $(T_A = +25^{\circ}C, \text{ unless otherwise noted.})$











Pin Description

PIN	NAME	FUNCTION		
1	COM	Analog Switch Common		
2	NC Normally Closed Switch Terminal. NC is connected to COM when IN is low.			
3	3 GND Ground			
4	V+	Positive Supply Voltage Input		
5 N.C. No		No Connection		
6 IN		Digital Control Input		
7	7 V- Negative Supply Voltage Input			
8	NO	Normally Open Switch Terminal. NO is connected to COM when IN is high.		

Detailed Description

The MAX4659/MAX4660 are single, single-pole/double-throw (SPDT) CMOS analog switches. The CMOS switch construction provides rail-to-rail signal handling while consuming very little power. The switch is controlled by a TTL/CMOS level compatible digital input. The MAX4659/MAX4660 have a normally open switch and a normally closed switch.

These devices can be operated with either single power supplies or dual power supplies. Operation at up to ±20V supplies allows users a wide switching dynamic range. Additionally, asymmetrical operation is possible to tailor performance to a particular application.

These switches have been specifically designed to handle high switch currents, up to 200mA peak current and 150mA continuous currents. In order to do this, a new technique is used to drive the body of the output N-channel device. (Note: The basic switch between the input, NC/NO terminal and the output common terminal consists of an N-channel MOSFET and a P-channel MOSFET in parallel.) The standard method limits operation to approximately a 600mV drop across the switch. More than 600mV causes an increase in Idon leakage current (due to the turn-on of on-chip parasitic diodes), and an increase in V+ supply current. With this new sensing method, there is no limitation to the voltage drop across the switch. Current and voltage are limited only by the power dissipation rating of the package and the absolute maximum ratings of the switch.

When the analog input voltage drop is approximately 7mV there is an increase in power supply current from 90µA to 2mA (typ) within a 1mV to 7mV range, caused by the new sensing/driving circuitry.

_Applications Information

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings can cause permanent damage to the devices. First, connect GND, followed by V+, V-, and the remaining pins. If power-supply sequencing is not possible, add two small-signal diodes (D1, D2) in series with

supply pins (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V. The protection diode for the negative supply is not required when V- is connected to GND.

Off-Isolation at High Frequencies

In 50Ω systems, the high-frequency on-response of these parts extends from DC to above 100MHz, with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor and off-isolation decreases with increasing frequency. This effect is more pronounced with higher source and load impedances. Above 5MHz, circuit board layout becomes critical. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors.

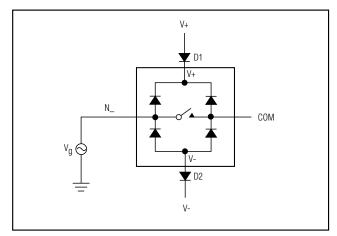


Figure 1. Overvoltage Protection Using Blocking Diodes

Test Circuits/Timing Diagrams

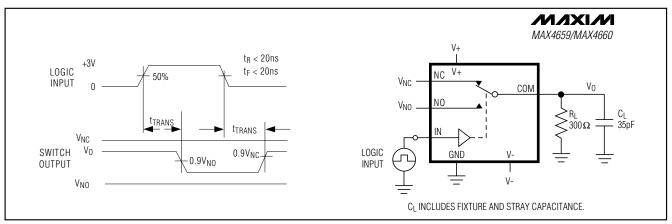


Figure 2. Functional Diagram

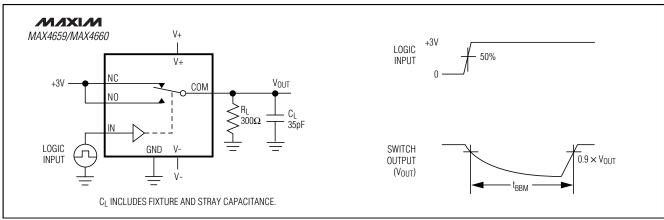


Figure 3. Break-Before-Make Time

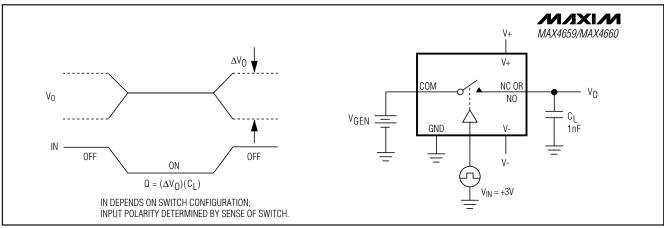


Figure 4. Charge Injection

Test Circuits/Timing Diagrams (continued)

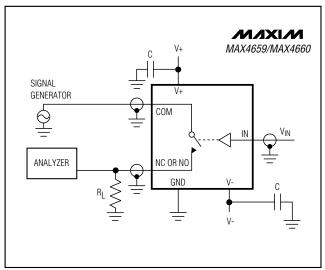


Figure 5. Off-Isolation

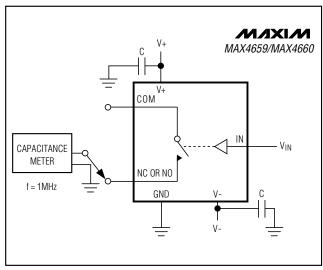


Figure 7. Channel Off-Capacitance

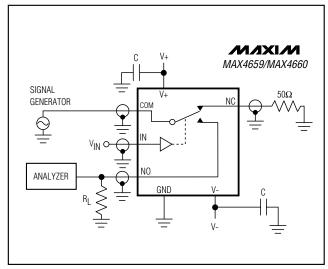


Figure 6. Crosstalk

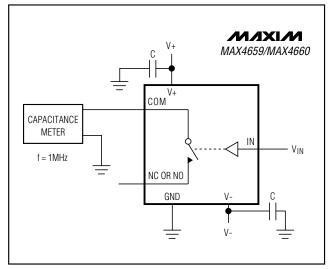
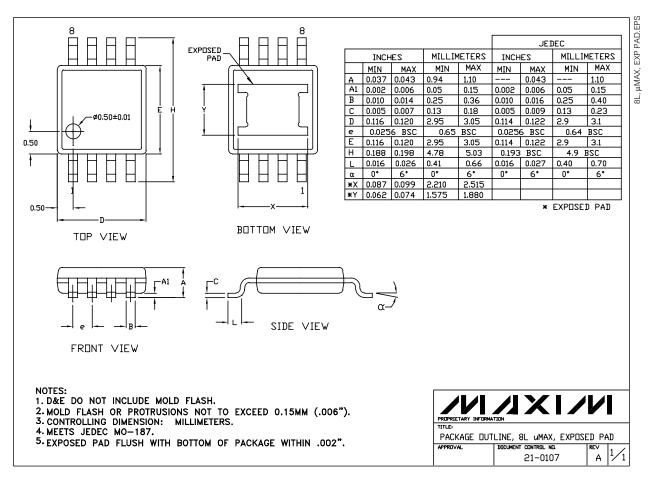


Figure 8. Channel On-Capacitance

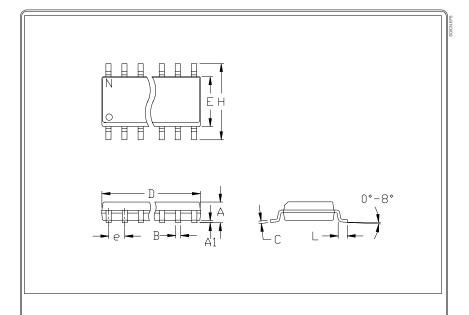
Chip Information

TRANSISTOR COUNT: 45 PROCESS: CMOS

Package Information



Package Information (continued)



		0.053 0.069 1.35 1.75 0.004 0.010 0.10 0.25 0.014 0.019 0.35 0.49				
	INC	HES	MILLIM	IETERS		
	MIN	MAX	MIN	MAX		
Α	0.053	0.069	1.35	1.75		
A1	0.004	0.010	0.10	0.25		
В	0.014	0.019	0.35	0.49		
С	0.007	0.010	0.19	0.25		
е	0.050		1.27			
Ε	0.150	0.157	3.80	4.00		
Н	0.228	0.244	5.80	6.20		
h	0.010	0.020	0.25	0.50		
L	0.016	0.050	0.40	1.27		

		INCHES MIN MAX		MILLIM			
				MIN	MAX	Z	MS012
	D	0.189	0.197	4.80	5.00	8	Α
ĺ	D	0.337	0.344	8.55	8.75	14	В
	D	0.386	0.394	9.80	10.00	16	С

- NOTES:

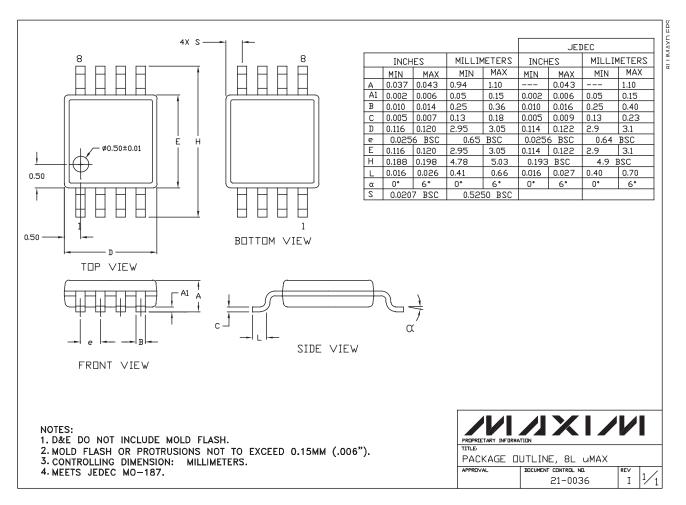
 1. D&E DO NOT INCLUDE MOLD FLASH
 2. MOLD FLASH DR PROTRUSIONS NOT
 TO EXCEED .15mm (.006")
 3. LEADS TO BE COPLANAR WITHIN
 .102mm (.004")
 4. CONTROLLING DIMENSION: MILLIMETER
 5. MEETS JEDEC MSO12-XX AS SHOWN
 IN ABOVE TABLE
 6. N = NUMBER OF PINS



PACKAGE FAMILY DUTLINE: SDIC ,150"



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.