

# MAXIM

## High Voltage CMOS/DMOS Analog Switches

MAX341/43/45/48

### General Description

The MAX341/43/45/48 are CMOS/DMOS analog switches intended for high voltage use as well as high reliability general purpose applications. The operating supply range is  $\pm 20\text{V}$  to  $\pm 50\text{V}$  or  $+20\text{V}$  to  $+60\text{V}$  when using a single power supply. Signal handling capability extends from the negative to the positive supply voltage, i.e. over a 100V peak-to-peak range with  $\pm 50\text{V}$  power supplies.

The switch control inputs can be driven with CMOS or other high level logic signals. All switches are normally closed, i.e. an input "0" level turns the switch ON. The MAX341 and MAX348 are dual SPST switches, the MAX343 is a dual SPDT switch, and the MAX345's configuration is dual DPST. The MAX348 is a reduced  $R_{ON}$  version of the MAX341.

Positive supply current for all devices is less than  $300\mu\text{A}$  and negative supply current is less than  $100\mu\text{A}$  with  $\pm 50\text{V}$  power supplies. When using a single power supply and logic input levels equal to the supply value, the power supply currents are less than  $20\mu\text{A}$ .

### Applications

Medical Ultrasound Equipment  
Automatic Test Equipment  
Diagnostic Systems  
48 Volt Telecom Systems  
Stepper and DC Motor Drivers

### Features

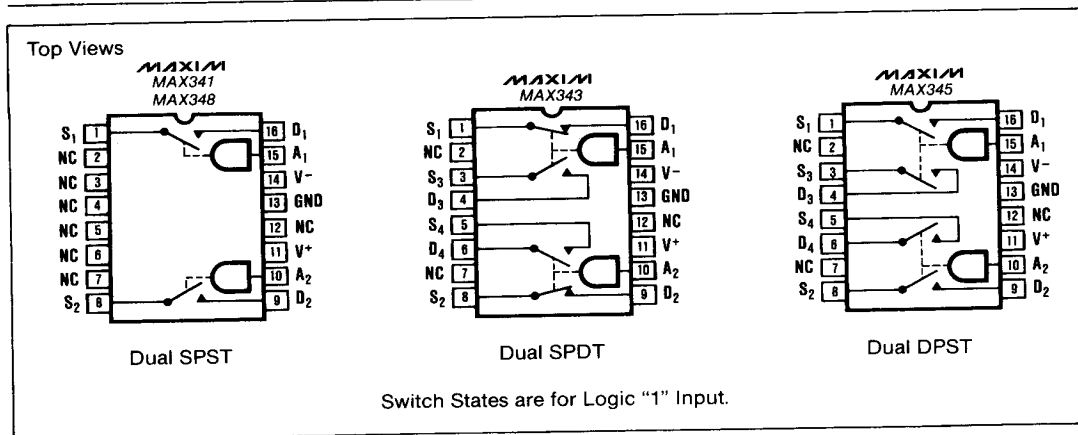
- ◆  $\pm 20\text{V}$  to  $\pm 50\text{V}$  and Single Supply Operation
- ◆  $R_{ON}$  Less than  $55\Omega$  (MAX348)
- ◆  $-70\text{dB}$  Typical OFF Isolation at  $1\text{MHz}$
- ◆ Input Voltage Range Includes Power Supplies
- ◆ 100V peak-to-peak Signal Handling Capability
- ◆ Guaranteed Break-Before-Make Operation
- ◆ Completely Latchup-Proof Construction

### Ordering Information

PART	TEMP RANGE	PACKAGE
MAX341C/D	$0^\circ\text{C}$ to $+70^\circ\text{C}$	Dice
MAX341CPE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Lead Plastic DIP
MAX341CWE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Lead Wide SO
MAX341EPE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Plastic DIP
MAX341EWE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Wide SO
MAX341EJE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Cerdip
MAX341MJE	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	16 Lead Cerdip
MAX343C/D	$0^\circ\text{C}$ to $+70^\circ\text{C}$	Dice
MAX343CPE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Lead Plastic DIP
MAX343CWE	$0^\circ\text{C}$ to $+70^\circ\text{C}$	16 Lead Wide SO
MAX343EPE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Plastic DIP
MAX343EWE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Wide SO
MAX343EJE	$-40^\circ\text{C}$ to $+85^\circ\text{C}$	16 Lead Cerdip
MAX343MJE	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	16 Lead Cerdip

(Ordering Information Continued on Last Page.)

### Pin Configurations



12

MAXIM  
MAXIM is a registered trademark of Maxim Integrated Products.

Maxim Integrated Products 12-25

# High Voltage CMOS/DMOS Analog Switches

## ABSOLUTE MAXIMUM RATINGS

V <sup>+</sup> to V <sup>-</sup> Voltage	+120V
V <sup>+</sup> to GND Voltage	+65V
Digital Input Voltage	V <sup>-</sup> to V <sup>+</sup>
Input Current	
S and D	+200mA
All pins except S and D	±30mA
Lead Temperature (Soldering 10 sec)	+300°C
Storage Temperature	-65°C to +150°C

Operating Temperature Range	
MAX34XC	0°C to +70°C
MAX34XE	-40°C to +85°C
MAX34XM	-55°C to +125°C
Power Dissipation (16 pin packages)	
CERDIP (derate 10mW/°C above +75°C)	750mW
Plastic DIP (derate 7.35mW/°C above +75°C)	550mW
Small Outline (derate 9mW/°C above +75°C)	680mW

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 at these or any other conditions above those indicated in the operations section of the specifications is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(Over Temperature, V<sup>+</sup> = +50V, V<sup>-</sup> = -50V, GND = 0V unless otherwise indicated)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Analog Signal Range	V <sub>S</sub> , V <sub>D</sub>		V <sup>+</sup>		V <sup>-</sup>	V
Channel ON Resistance MAX341/43/45 MAX341/43/45 MAX348 MAX348	R <sub>ON</sub>	V <sub>S</sub> = ±50V, I <sub>S</sub> = 10mA T <sub>A</sub> = +25°C Over Temp. T <sub>A</sub> = +25°C Over Temp.		80 35	110 160 55 80	Ω
ON Resistance Match	ΔR <sub>ON</sub>	V <sub>S</sub> = ±50V, I <sub>S</sub> = 10mA		7		%
OFF Leakage Current (Figure 7)	I <sub>D(OFF)</sub> , I <sub>S(OFF)</sub>	V <sub>S</sub> = ±50V, V <sub>D</sub> = ±50V T <sub>A</sub> = +25°C Over Temp.		10 1000	50 5000	nA
ON Output Leakage Current (Figure 8)	I <sub>D(ON)</sub> , I <sub>S(ON)</sub>	V <sub>S</sub> = V <sub>D</sub> = ±50V T <sub>A</sub> = +25°C Over Temp.		10 1000	60 5000	nA
Input Low Threshold	V <sub>AL</sub>				3.5	V
Input High Threshold	V <sub>AH</sub>		12			V
Input Current (Logic)	I <sub>A</sub>	V <sub>A</sub> = 0V to +15V		0.1	10	μA
Turn-On Time (Figure 9)	t <sub>ON</sub>	T <sub>A</sub> = +25°C Over Temp.		0.5	1.0 1.5	μs
Turn-Off Time (Figure 9)	t <sub>OFF</sub>	T <sub>A</sub> = 25°C Over Temp.		0.4	0.75 1.0	μs
OFF Isolation (Figure 4)	ISO <sub>OFF</sub>	T <sub>A</sub> = +25°C, 1MHz, R <sub>L</sub> = 75Ω		-70		dB
Channel-Channel Crosstalk (Figure 5)	ISO <sub>X</sub>	T <sub>A</sub> = +25°C, 1MHz, R <sub>L</sub> = 75Ω		-75		dB
Channel Input Capacitance OFF State, C to Gnd OFF State, C to Out ON State, C to Gnd	C <sub>S(OFF)</sub> , C <sub>SD(OFF)</sub> , C <sub>S(ON)</sub>	T <sub>A</sub> = +25°C, V <sub>S</sub> = 0V		17 1 38		pF
Charge Injection (Figure 6)	Q	V <sub>S</sub> = +50V V <sub>S</sub> = 0V V <sub>S</sub> = -50V		100 240 480		pC
Supply Current V <sup>+</sup> Current	I <sup>+</sup>	T <sub>A</sub> = +25°C Over Temp.		200	300 600	μA
Supply Current V <sup>-</sup> Current	I <sup>-</sup>	T <sub>A</sub> = +25°C Over Temp.		40 55	100 200	μA
Supply Voltage Range Split Supplies Single Supply		GND = 0V V <sup>-</sup> = GND = 0V	±20 +20		±50 +60	V

# High Voltage CMOS/DMOS Analog Switches

MAX341/43/45/48

## Detailed Description

### Analog Signal Range

The MAX341 family's analog signal range is equal to the power supply value, up to  $\pm 50V$  with split power supplies and  $+60V$  with a single power supply ( $V^-$  connected to GND). An ON switch is also capable of passing up to  $0.5A$  on a peak current basis. Maximum continuous current is limited only by the package power dissipation (see Absolute Maximum Ratings)

### ON Resistance

The ON resistance of the MAX341 series switches is typically  $40\Omega$ .  $R_{ON}$  does, however, increase as the switch voltage ( $V_S$ ) approaches  $V^+$ . For example, with  $\pm 50V$  supplies and a  $+50V$  analog signal,  $R_{ON}$  will be typically less than  $100\Omega$  ( $50\Omega$  for the MAX348), and  $45\Omega$  ( $25\Omega$  for the MAX348) for  $-50V$  signals. With  $\pm 50V$  power supplies, and  $\pm 40V$  switch voltages,  $R_{ON}$  is about  $40\Omega$  for the  $+40V$  case and  $30\Omega$  for the  $-40V$  case. ON resistance can be reduced and current handling capacity can be increased by connecting switches in parallel. This is especially useful in power switching applications. Table 1 and the graph in the Typical Characteristics section further describe the relation between  $R_{ON}$  and  $V^+$ .

Table 1: ON Resistance

$V^+/V^-$	$R_{ON}$ AT $V_S = V^+$	$R_{ON}$ AT $V_S = V^-$
$+20V/-20V$	$127\Omega$	$39\Omega$
$+30V/-30V$	$105\Omega$	$36\Omega$
$+40V/-40V$	$92\Omega$	$32\Omega$
$+50V/-50V$	$84\Omega$	$30\Omega$
$+40V/GND$	$127\Omega$	$39\Omega$
$+60V/GND$	$105\Omega$	$36\Omega$

**Note:**

Typical  $R_{ON}$  for the MAX348 is approximately one half of the above values.

### Power Supply Current

The maximum supply current for  $V^+$  and  $V^-$  at  $25^\circ C$  is  $300\mu A$  and  $100\mu A$  respectively. However, the positive supply current ( $I^+$ ) is partly dependent on the input logic level and can be reduced if control signals of a larger amplitude than  $0V$  and  $+15V$  are used. If the control inputs swing to within  $4V$  of  $V^+$  and  $V^-$  then  $I^+$  drops to a typical value of  $20\mu A$ .

### Control Inputs

$15V$  logic level inputs are required to turn switches on or off, but the control inputs can also accept levels up to  $V^+$  and  $V^-$ . A input greater than  $12V$  constitutes a "1" state (switch OFF), and an input less than  $3.5V$  will constitute a "0" state (switch ON).

Standard TTL logic can be used with MAX341 series switches if a level shifter such as the MC14504 is used to drive the control inputs as shown in in figure 1. Open collector drivers, with external pull-up resistors, can be used in a similar fashion as well.

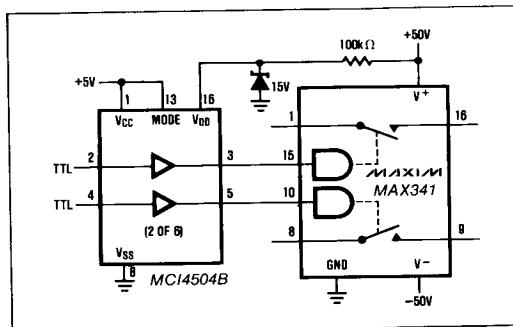


Figure 1. Using TTL Control Levels.

## Applications

### Flying Capacitor Input

A "flying capacitor" differential to single-ended converter takes advantage of the MAX343's wide input voltage range, which allows large common mode inputs to be rejected. As shown in Figure 2, a capacitor is alternately charged by the differential input signal and then is connected to an op-amp or A-to-D input. An instrumentation amplifier is not required since the output signal can be referenced to ground. Sample-hold operation is also built in to the design and the MAX343's break-before-make operation ensures that the output sees only the differential portion of the input signal. A similar approach can also be used for single-ended to differential signal conversion as well.

### Parallel Switches

In designs where power switching ability is needed, any of the MAX341 series switches can be connected in parallel to increase current handling capability and reduce ON resistance. Applications such as ultrasonics, RF power, and DC motor drive are areas where this is often important. A MAX348 is shown in a parallel configuration in figure 3. The resulting SPST switch has a typical  $R_{ON}$  of  $12\Omega$  ( $5\Omega$  for signals more than  $10V$  below  $V^+$ ) and can handle pulsed loads of up to  $0.5$  Amps. With  $\pm 50V$  power supplies, the peak-to-peak signal range is still  $100V$  and  $10MHz$  signals can be switched while maintaining typically  $-50dB$  of isolation.

12

MAXIM

12-27

# High Voltage CMOS/DMOS Analog Switches

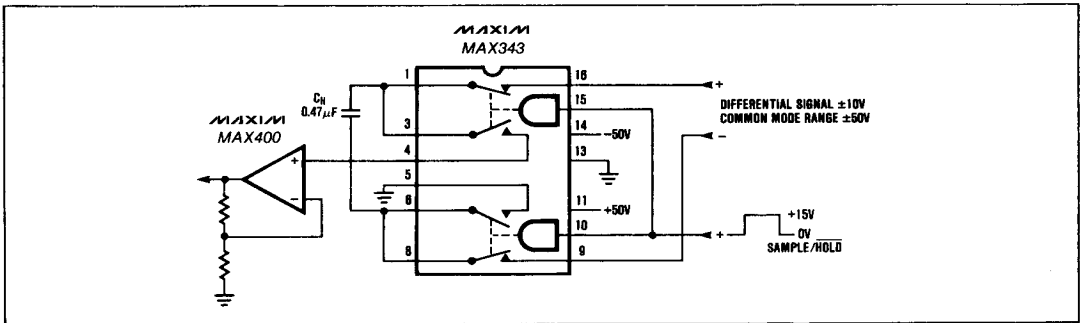


Figure 2. Flying Capacitor Differential to Single-Ended Converter with ±50V Common-Mode Range.

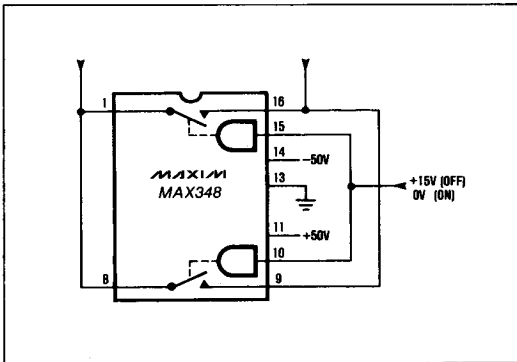


Figure 3. Minimum R<sub>ON</sub> (5 to 10Ω typ.) High Voltage Switch.

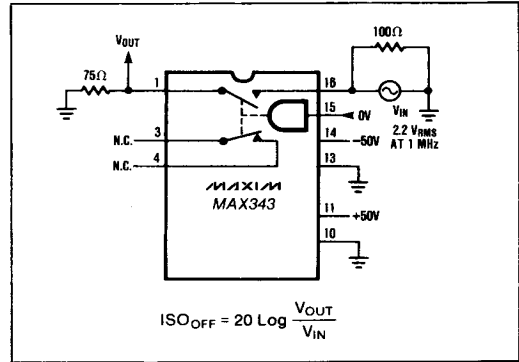


Figure 4. OFF Isolation Test Circuit.

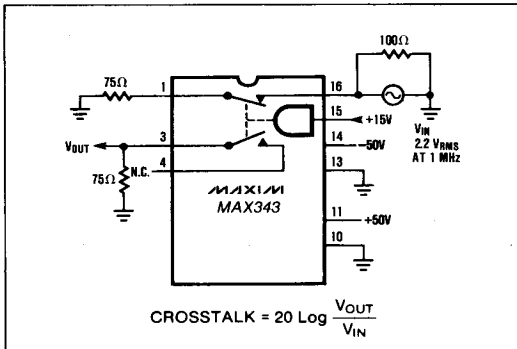


Figure 5. Channel-Channel Crosstalk Test Circuit.

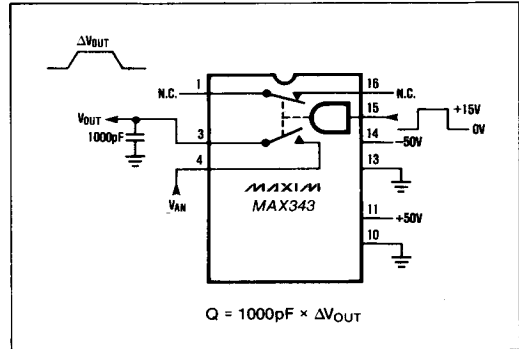


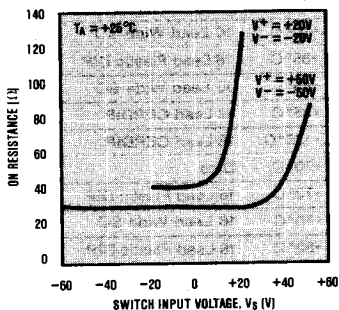
Figure 6. Charge Injection Test Circuit.

# High Voltage CMOS/DMOS Analog Switches

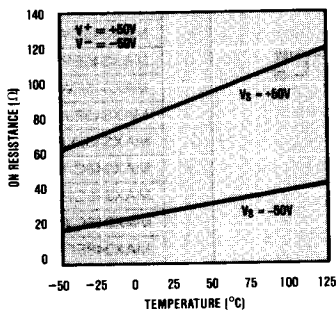
## Typical Operating Characteristics

MAX341/43/45/48

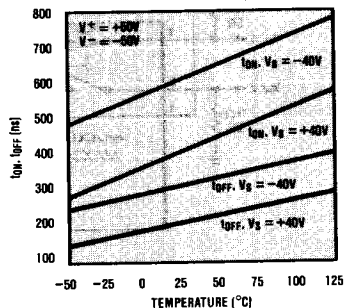
ON RESISTANCE vs.  
SWITCH INPUT VOLTAGE



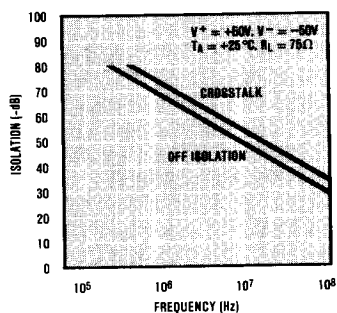
ON RESISTANCE vs.  
TEMPERATURE



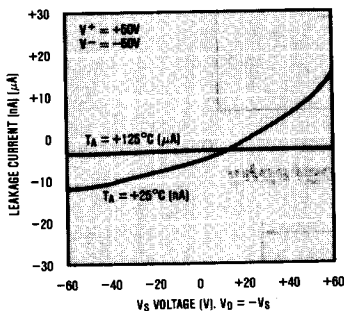
SWITCHING TIME vs.  
TEMPERATURE



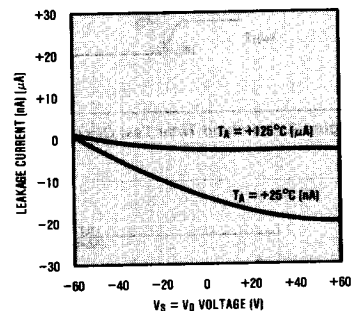
OFF ISOLATION AND  
CROSSTALK vs. FREQUENCY



OFF LEAKAGE vs.  
SWITCH VOLTAGE



ON LEAKAGE vs.  
SWITCH VOLTAGE



## Test Circuits

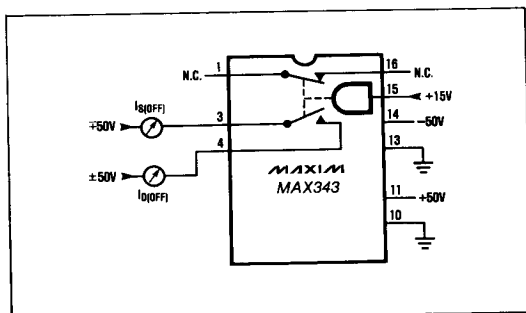


Figure 7. OFF Leakage Test Circuit.

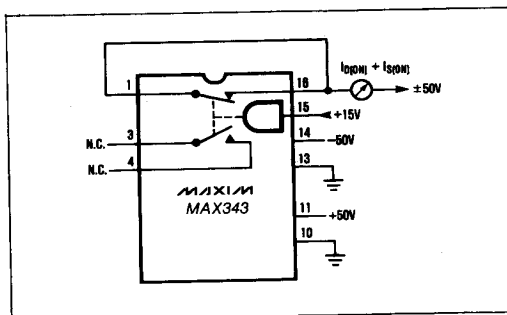


Figure 8. ON Leakage Test Circuit.

MAXIM

# High Voltage CMOS/DMOS Analog Switches

## Test Circuit

## Ordering Information (continued)

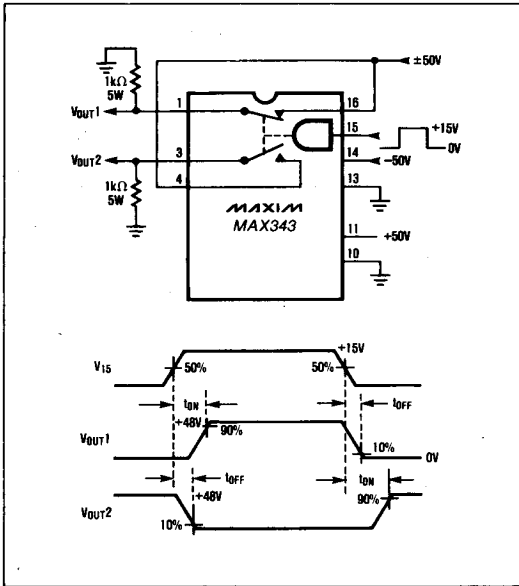
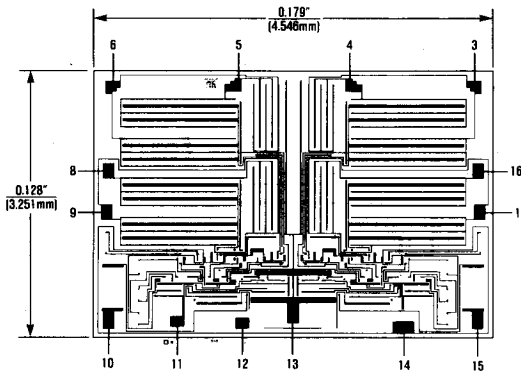


Figure 9. Switching Time Test Circuit.

PART	TEMP. RANGE	PACKAGE
MAX345C/D	0°C to +70°C	Dice
MAX345CPE	0°C to +70°C	16 Lead Plastic DIP
MAX345CWE	0°C to +70°C	16 Lead Wide SO
MAX345EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX345EWE	-40°C to +85°C	16 Lead Wide SO
MAX345EJE	-40°C to +85°C	16 Lead Cerdip
MAX345MJE	-55°C to +125°C	16 Lead Cerdip
MAX348C/D	0°C to +70°C	Dice
MAX348CPE	0°C to +70°C	16 Lead Plastic DIP
MAX348CWE	0°C to +70°C	16 Lead Wide SO
MAX348EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX348EWE	-40°C to +85°C	16 Lead Wide SO
MAX348EJE	-40°C to +85°C	16 Lead Cerdip
MAX348MJE	-55°C to +125°C	16 Lead Cerdip

## Chip Topography



See Pin Configurations for pin functions.

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.