19-2424; Rev 2; 5/06

MAXIM

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers



## General Description

The MAX4238/MAX4239 are low-noise, low-drift, ultra-high precision amplifiers that offer near-zero DC offset and drift through the use of patented autocorrelating zeroing techniques. This method constantly measures and compensates the input offset, eliminating drift over time and temperature and the effect of 1/f noise. Both devices feature rail-to-rail outputs, operate from a single 2.7V to 5.5V supply, and consume only 600µA. An active-low shutdown mode decreases supply current to 0.1µA.

The MAX4238 is unity-gain stable with a gain-bandwidth product of 1MHz, while the decompensated MAX4239 is stable with $A_V \geq 10V/V$ and a GBWP of 6.5MHz. The MAX4238/MAX4239 are available in 8-pin narrow SO, 6-pin TDFN and SOT23 packages.

## Applications

Thermocouples

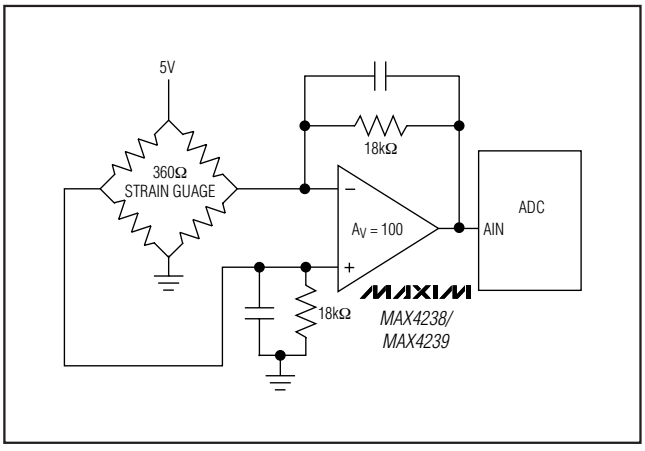
Strain Gauges

Electronic Scales

Medical Instrumentation

Instrumentation Amplifiers

## Typical Application Circuit




## Features

- **Ultra-Low, 0.1µV Offset Voltage**
  **2.0µV (max) at +25°C**
  **2.5µV (max) at -40°C to +85°C**
  **3.5µV (max) at -40°C to +125°C**
- **Low 10nV/ºC Drift**
- **Specified over the -40ºC to +125ºC Automotive Temperature Range**
- **Low Noise: 1.5µ$V_{P-P}$ from DC to 10Hz**
- **150dB $A_{VOL}$, 140dB PSRR, 140dB CMRR**
- **High Gain-Bandwidth Product**
  **1MHz (MAX4238)**
  **6.5MHz (MAX4239)**
- **0.1µA Shutdown Mode**
- **Rail-to-Rail Output ($R_L$ = 1kΩ)**
- **Low 600µA Supply Current**
- **Ground-Sensing Input**
- **Single 2.7V to 5.5V Supply Voltage Range**
- **Available in a Space-Saving 6-Pin SOT23 and TDFN Packages**

## Ordering Information

| PART | PIN-PACKAGE | TOP MARK | PKG CODE |
|---|---|---|---|
| **MAX4238**AUT-T | 6 SOT23-6 | AAZZ | U6F-6 |
| MAX4238ASA | 8 SO | — | S8-4 |
| MAX4238ATT+T | 6 TDFN-EP* | +ANG | T633-2 |
| **MAX4239**AUT-T | 6 SOT23-6 | ABAA | U6F-6 |
| MAX4239ASA | 8 SO | — | S8-4 |
| MAX4239ATT+T | 6 TDFN-EP* | +ANH | T633-2 |

***Note:*** *All devices are specified over the -40°C to +125°C operating temperature range.*

*+Denotes lead-free package.*

**EP = Exposed paddle.*

## Selector Guide

| PART | MINIMUM STABLE GAIN | GAIN BANDWIDTH (MHz) |
|---|---|---|
| MAX4238 | 1V/V | 1 |
| MAX4239 | 10V/V | 6.5 |

***Pin Configurations appear at end of data sheet.***

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

## ABSOLUTE MAXIMUM RATINGS

Power-Supply Voltage ($V_{CC}$ to GND).....6V
All Other Pins .....(GND - 0.3V) to ($V_{CC}$ + 0.3V)
Output Short-Circuit Duration
(OUT shorted to $V_{CC}$ or GND) .....Continuous
Continuous Power Dissipation ($T_A$ = +70°C)
6-Pin Plastic SOT23
(derate 9.1mW/°C above +70°C) .....727mW
8-Pin Plastic SO (derate 5.88mW/°C above +70°C).....471mW
6-Pin TDFN-EP (derate 18.2mW above +70°C).....1454mW
Operating Temperature Range .....-40°C to +125°C
Junction Temperature .....+150°C
Storage Temperature Range.....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

*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

(2.7V ≤ $V_{CC}$ ≤ 5.5V, $V_{CM}$ = GND = 0V, $V_{OUT}$ = $V_{CC}$/2, $R_L$ = 10kΩ connected to $V_{CC}$/2, $\overline{SHDN}$ = $V_{CC}$, **$T_A$ = +25°C**, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | (Note 1) | | | 0.1 | 2 | µV |
| Long-Term Offset Drift | | | | | 50 | | nV/1000hr |
| Input Bias Current | $I_B$ | (Note 2) | | | 1 | | pA |
| Input Offset Current | $I_{OS}$ | (Note 2) | | | 2 | | pA |
| Peak-to-Peak Input Noise Voltage | $e_{nP-P}$ | $R_S$ = 100Ω, 0.01Hz to 10Hz | | | 1.5 | | $µV_{P-P}$ |
| Input Voltage-Noise Density | $e_n$ | f = 1kHz | | | 30 | | $NV/\sqrt{Hz}$ |
| Common-Mode Input Voltage Range | $V_{CM}$ | Inferred from CMRR test | | GND - 0.1 | | $V_{CC}$ - 1.3 | V |
| Common-Mode Rejection Ratio | CMRR | -0.1V ≤ $V_{CM}$ ≤ $V_{CC}$ - 1.3V (Note 1) | | 120 | 140 | | dB |
| Power-Supply Rejection Ratio | PSRR | 2.7V ≤ $V_{CC}$ ≤ 5.5V (Note 1) | | 120 | 140 | | dB |
| Large-Signal Voltage Gain | $A_{VOL}$ | 0.05V ≤ $V_{OUT}$ ≤ $V_{CC}$ - 0.05V (Note 1) | $R_L$ = 10kΩ | 125 | 150 | | dB |
| | | 0.1V ≤ $V_{OUT}$ ≤ $V_{CC}$ - 0.1V (Note 1) | $R_L$ = 1kΩ | 125 | 145 | | |
| Output Voltage Swing | $V_{OH}/V_{OL}$ | $R_L$ = 10kΩ | $V_{CC}$ - $V_{OH}$ | | 4 | 10 | mV |
| | | | $V_{OL}$ | | 4 | 10 | |
| | | $R_L$ = 1kΩ | $V_{CC}$ - $V_{OH}$ | | 35 | 50 | |
| | | | $V_{OL}$ | | 35 | 50 | |
| Output Short-Circuit Current | | To either supply | | | 40 | | mA |
| Output Leakage Current | | 0 ≤ $V_{OUT}$ ≤ $V_{CC}$, $\overline{SHDN}$ = GND (Note 2) | | | 0.01 | 1 | µA |
| Slew Rate | | $V_{CC}$ = 5V, $C_L$ = 100pF, $V_{OUT}$ = 2V step | MAX4238 | | 0.35 | | V/µs |
| | | | MAX4239 | | 1.6 | | |
| Gain-Bandwidth Product | GBWP | $R_L$ = 10kΩ, $C_L$ = 100pF, measured at f = 100kHz | MAX4238 | | 1 | | MHz |
| | | | MAX4239 | | 6.5 | | |
| Minimum Stable Closed-Loop Gain | | $R_L$ = 10kΩ, $C_L$ = 100pF, phase margin = 60° | MAX4238 | | 1 | | V/V |
| | | | MAX4239 | | 10 | | |

## ELECTRICAL CHARACTERISTICS (continued)

(2.7V ≤ $V_{CC}$ ≤ 5.5V, $V_{CM}$ = GND = 0V, $V_{OUT}$ = $V_{CC}$/2, $R_L$ = 10kΩ connected to $V_{CC}$/2, $\overline{SHDN}$ = $V_{CC}$, **$T_A$ = +25°C**, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Maximum Closed-Loop Gain | | $R_L$ = 10kΩ, $C_L$ = 100pF, phase margin = 60° | MAX4238 | | 1000 | | V/V |
| | | | MAX4239 | | 6700 | | |
| Settling Time | | -1V step | 0.1% (10 bit) | | 0.5 | | ms |
| | | | 0.025% (12 bit) | | 1.0 | | |
| | | | 0.006% (14 bit) | | 1.7 | | |
| | | | 0.0015% (16 bit) | | 2.3 | | |
| Overload Recovery Time | | $A_V$ = 10 (Note 4) | 0.1% (10 bit) | | 3.3 | | ms |
| | | | 0.025% (12 bit) | | 4.1 | | |
| | | | 0.006% (14 bit) | | 4.9 | | |
| | | | 0.0015% (16 bit) | | 5.7 | | |
| Startup Time | | $A_V$ = 10 | 0.1% (10 bit) | | 1.8 | | ms |
| | | | 0.025% (12 bit) | | 2.6 | | |
| | | | 0.006% (14 bit) | | 3.4 | | |
| | | | 0.0015% (16 bit) | | 4.3 | | |
| Supply Voltage Range | $V_{CC}$ | Inferred by PSRR test | | 2.7 | | 5.5 | V |
| Supply Current | $I_{CC}$ | $\overline{SHDN}$ = $V_{CC}$, no load, $V_{CC}$ = 5.5V | | | 600 | 850 | µA |
| | | $\overline{SHDN}$ = GND, $V_{CC}$ = 5.5V | | | 0.1 | 1 | |
| Shutdown Logic-High | $V_{IH}$ | | | 2.2 | | | V |
| Shutdown Logic-Low | $V_{IL}$ | | | | | 0.8 | V |
| Shutdown Input Current | | 0V ≤ $V_{\overline{SHDN}}$ ≤ $V_{CC}$ | | | 0.1 | 1 | µA |

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

## ELECTRICAL CHARACTERISTICS

(2.7V ≤ $V_{CC}$ ≤ 5.5V, $V_{CM}$ = GND = 0V, $V_{OUT}$ = $V_{CC}$/2, $R_L$ = 10kΩ connected to $V_{CC}$/2, $\overline{SHDN}$ = $V_{CC}$, **$T_A$ = -40°C to +125°C**, unless otherwise noted.) (Note 5)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Input Offset Voltage | $V_{OS}$ | (Note 1) | $T_A$ = -40°C to +85°C | | | 2.5 | µV |
| | | | $T_A$ = -40°C to +125°C | | | 3.5 | |
| Input Offset Drift | $TCV_{OS}$ | (Note 1) | | | 10 | | nV/°C |
| Common-Mode Input Voltage Range | $V_{CM}$ | Inferred from CMRR test | | GND - 0.05 | | $V_{CC}$ - 1.4 | V |
| Common-Mode Rejection Ratio | CMRR | GND - 0.05V ≤ $V_{CM}$ ≤ $V_{CC}$ - 1.4V (Note 1) | $T_A$ = -40°C to +85°C | 115 | | | dB |
| | | | $T_A$ = -40°C to +125°C | 90 | | | |
| Power-Supply Rejection Ratio | PSRR | 2.7V ≤ $V_{CC}$ ≤ 5.5V (Note 1) | | 120 | | | dB |
| Large-Signal Voltage Gain | $A_{VOL}$ | $R_L$ = 10kΩ, 0.1V ≤ $V_{OUT}$ ≤ $V_{CC}$ - 0.1V (Note 1) | $T_A$ = -40°C to +85°C | 125 | | | dB |
| | | | $T_A$ = -40°C to +125°C | 95 | | | |
| | | $R_L$ = 1kΩ (Note 1) | 0.1V ≤ $V_{OUT}$ ≤ $V_{CC}$ - 0.1V, $T_A$ = -40°C to +85°C | 120 | | | dB |
| | | | 0.2V ≤ $V_{OUT}$ ≤ $V_{CC}$ - 0.2V, $T_A$ = -40°C to +125°C | 80 | | | |
| Output Voltage Swing | $V_{OH}/V_{OL}$ | $R_L$ = 10kΩ | $V_{CC}$ - $V_{OH}$ | | | 20 | mV |
| | | | $V_{OL}$ | | | 20 | |
| | | $R_L$ = 1kΩ | $V_{CC}$ - $V_{OH}$ | | | 100 | |
| | | | $V_{OL}$ | | | 100 | |
| Output Leakage Current | | 0V ≤ $V_{OUT}$ ≤ $V_{CC}$, $\overline{SHDN}$ = GND (Note 3) | | | | 2 | µA |
| Supply Voltage Range | $V_{CC}$ | Inferred by PSRR test | | 2.7 | | 5.5 | V |
| Supply Current | $I_{CC}$ | $\overline{SHDN}$ = $V_{CC}$, no load, $V_{CC}$ = 5.5V | | | | 900 | µA |
| | | $\overline{SHDN}$ = GND, $V_{CC}$ = 5.5V | | | | 2 | |
| Shutdown Logic High | $V_{IH}$ | | | 2.2 | | | V |
| Shutdown Logic Low | $V_{IL}$ | | | | | 0.7 | V |
| Shutdown Input Current | | 0V ≤ $V_{\overline{SHDN}}$ ≤ $V_{CC}$ | | | | 2 | µA |

**Note 1**: Guaranteed by design. Thermocouple and leakage effects preclude measurement of this parameter during production testing. Devices are screened during production testing to eliminate defective units.

**Note 2**: IN+ and IN- are gates to CMOS transistors with typical input bias current of 1pA. CMOS leakage is so small that it is impractical to test and guarantee in production. Devices are screened during production testing to eliminate defective units.

**Note 3**: Leakage does not include leakage through feedback resistors.

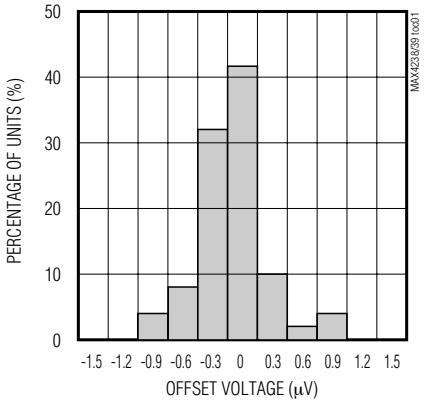
**Note 4**: Overload recovery time is the time required for the device to recover from saturation when the output has been driven to either rail.

**Note 5**: Specifications are 100% tested at $T_A$ = +25°C, unless otherwise noted. Limits over temperature are guaranteed by design.

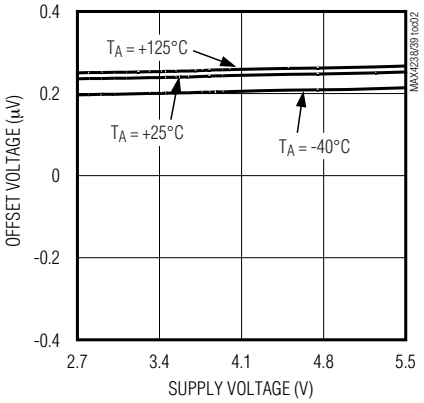
## Typical Operating Characteristics

($V_{CC}$ = 5V, $V_{CM}$ = 0V, $R_L$ = 10kΩ connected to $V_{CC}/2$, $\overline{SHDN}$ = $V_{CC}$, $T_A$ = +25°C, unless otherwise noted.)

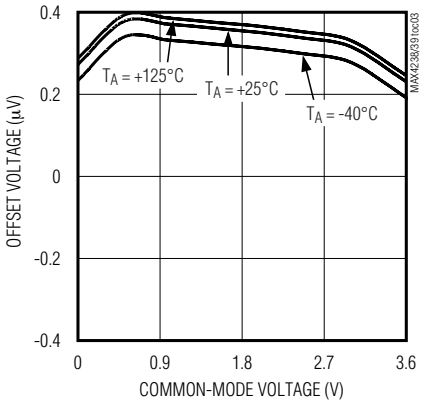
**INPUT OFFSET DISTRIBUTION**



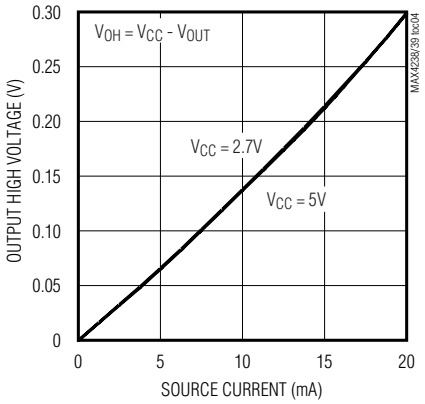

**OFFSET VOLTAGE vs. SUPPLY VOLTAGE**



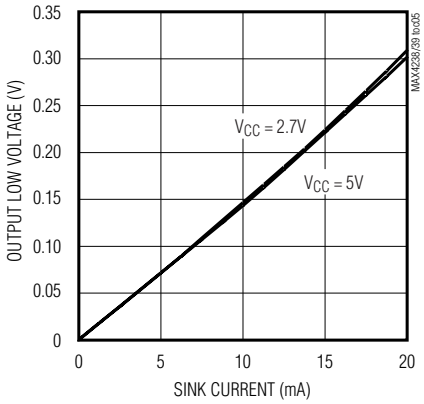

**OFFSET VOLTAGE vs. COMMON-MODE VOLTAGE**



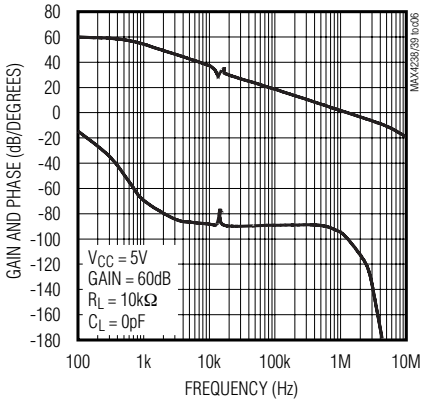

**OUTPUT HIGH VOLTAGE vs. OUTPUT SOURCE CURRENT**



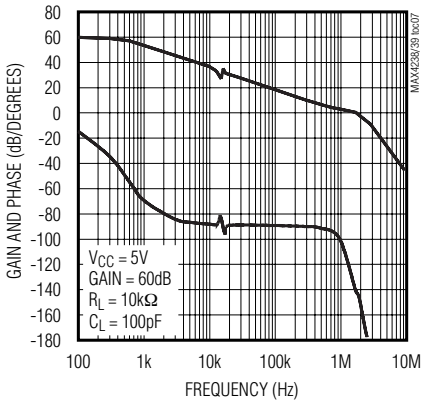

**OUTPUT LOW VOLTAGE vs. OUTPUT SINK CURRENT**



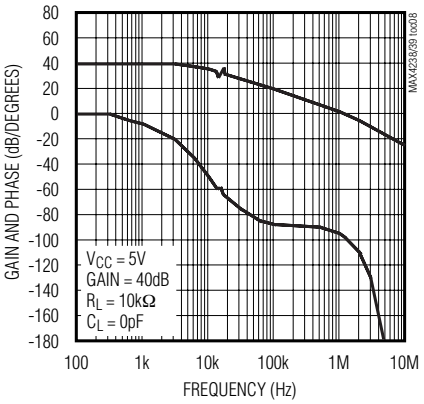

**MAX4238 GAIN AND PHASE vs. FREQUENCY**



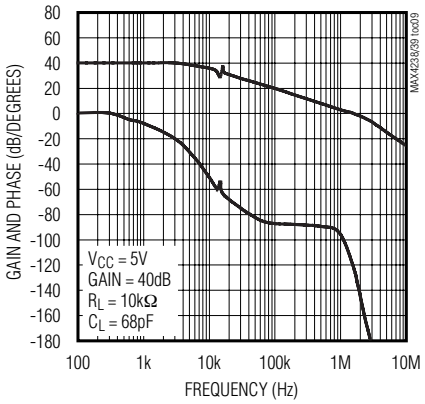

**MAX4238 GAIN AND PHASE vs. FREQUENCY**




**MAX4238 GAIN AND PHASE vs. FREQUENCY**




**MAX4238 GAIN AND PHASE vs. FREQUENCY**

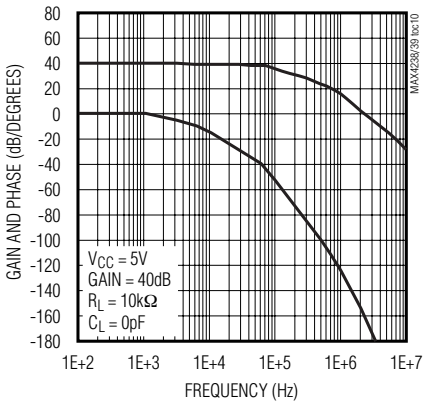


# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

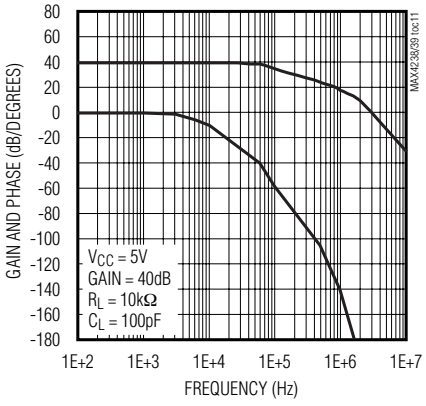
## Typical Operating Characteristics (continued)

($V_{CC}$ = 5V, $V_{CM}$ = 0V, $R_L$ = 10kΩ connected to $V_{CC}/2$, $\overline{SHDN}$ = $V_{CC}$, $T_A$ = +25°C, unless otherwise noted.)

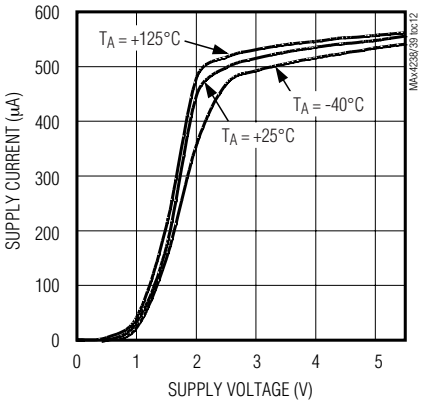
**MAX4239**
**GAIN AND PHASE vs. FREQUENCY**



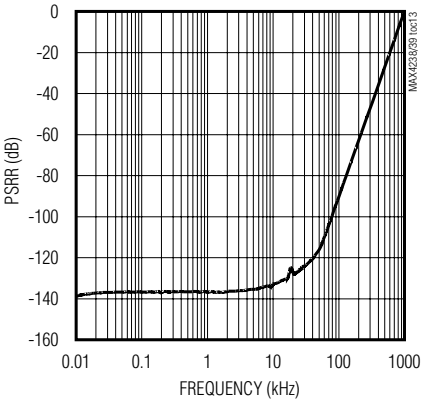

**MAX4239**
**GAIN AND PHASE vs. FREQUENCY**



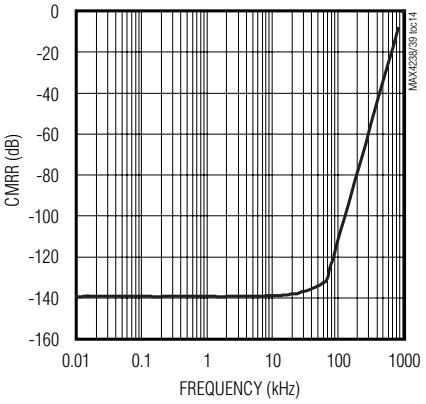

**SUPPLY CURRENT vs. SUPPLY VOLTAGE**



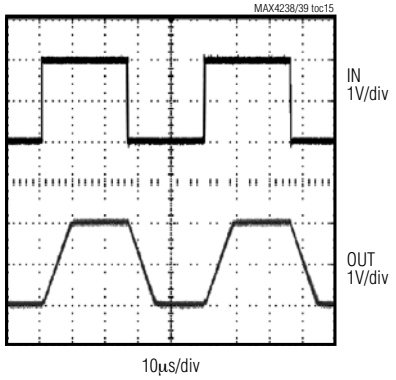

**POWER-SUPPLY REJECTION RATIO vs. FREQUENCY**




**COMMON-MODE REJECTION RATIO vs. FREQUENCY**

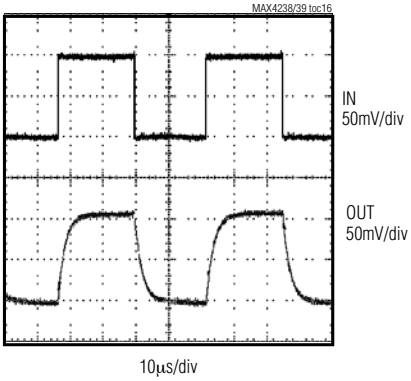



**MAX4238**
**LARGE-SIGNAL TRANSIENT RESPONSE**



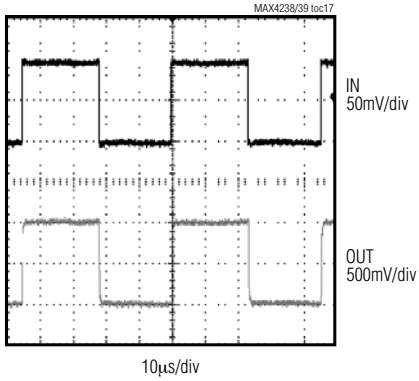

AV = 1V/V
RL = 2kΩ
CL = 100pF

**MAX4238**
**SMALL-SIGNAL TRANSIENT RESPONSE**



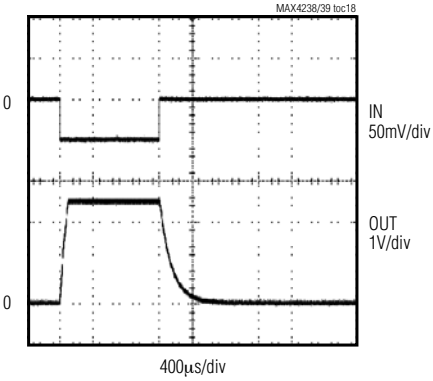

AV = 1V/V
RL = 2kΩ
CL = 100pF

**MAX4239**
**SMALL-SIGNAL TRANSIENT RESPONSE**




AV = 10V/V
RL = 2kΩ
CL = 100pF

**OVERVOLTAGE RECOVERY TIME**



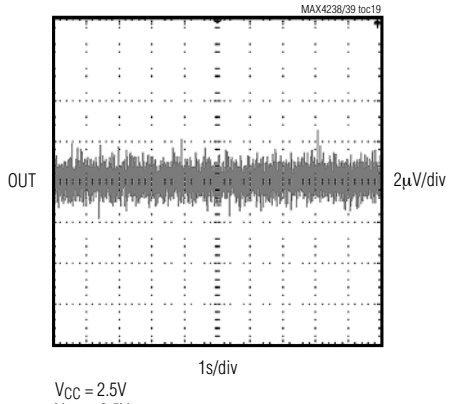

AV = 100V/V
RL = 10kΩ
VCC = 2.5V
VEE = -2.5V

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

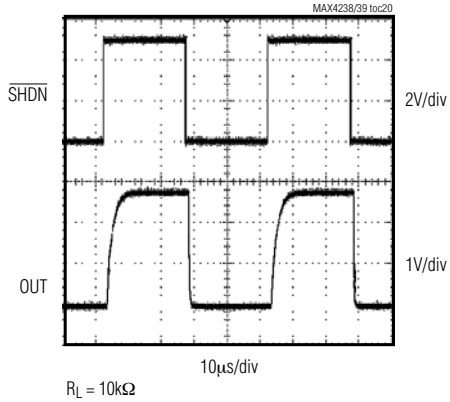
## Typical Operating Characteristics (continued)

($V_{CC}$ = 5V, $V_{CM}$ = 0V, $R_L$ = 10kΩ connected to $V_{CC}/2$, $\overline{SHDN}$ = $V_{CC}$, $T_A$ = +25°C, unless otherwise noted.)

**DC TO 10Hz NOISE**




**SHUTDOWN WAVEFORM**




## Pin Description

| PIN | | | NAME | FUNCTION |
|---|---|---|---|---|
| TDFN | SOT23 | SO | | |
| 1 | 1 | 6 | OUT | Amplifier Output |
| 2 | 2 | 4 | GND | Ground |
| 3 | 3 | 3 | IN+ | Noninverting Input |
| 4 | 4 | 2 | IN- | Inverting Input |
| 5 | 5 | 1 | $\overline{SHDN}$ | Shutdown Input. Active-low shutdown, connect to $V_{CC}$ for normal operation. |
| 6 | 6 | 7 | $V_{CC}$ | Positive Power Supply |
| — | — | 5, 8 | N.C. | No Connection. Not internally connected. |
| EP | — | — | EP | Exposed Pad. Connect EP to GND. |

## Detailed Description

The MAX4238/MAX4239 are high-precision amplifiers that have less than 2.5µV of input-referred offset and low 1/f noise. These characteristics are achieved through a patented autozeroing technique that samples and cancels the input offset and noise of the amplifier. The pseudorandom clock frequency varies from 10kHz to 15kHz, reducing intermodulation distortion present in chopper-stabilized amplifiers.

### Offset Error Sources

To achieve very low offset, several sources of error common to autozero-type amplifiers need to be considered. The first contributor is the settling of the sampling capacitor. This type of error is independent of input-source impedance, or the size of the external gain-setting resistors. Maxim uses a patented design technique to avoid large changes in the voltage on the sampling capacitor to reduce settling time errors.

The second error contributor, which is present in both autozero and chopper-type amplifiers, is the charge injection from the switches. The charge injection appears as current spikes at the input, and combined with the impedance seen at the amplifier's input, contributes to input offset voltage. Minimize this feedthrough by reducing the size of the gain-setting resistors and the input-source impedance. A capacitor in parallel with the feedback resistor reduces the amount of clock feedthrough to the output by limiting the closed-loop bandwidth of the device.

The design of the MAX4238/MAX4239 minimizes the effects of settling and charge injection to allow specification of an input offset voltage of 0.1µV (typ) and less than 2.5µV over temperature (-40°C to +85°C).

### 1/f Noise

1/f noise, inherent in all semiconductor devices, is inversely proportional to frequency. 1/f noise increases 3dB/octave and dominates amplifier noise at lower frequencies. This noise appears as a constantly changing voltage in series with any signal being measured. The MAX4238/MAX4239 treat 1/f noise as a slow varying offset error, inherently canceling the 1/f noise.

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

### Output Overload Recovery

Autozeroing amplifiers typically require a substantial amount of time to recover from an output overload. This is due to the time it takes for the null amplifier to correct the main amplifier to a valid output. The MAX4238/MAX4239 require only 3.3ms to recover from an output overload (see *Electrical Characteristics* and *Typical Operating Characteristics*).

### Shutdown

The MAX4238/MAX4239 feature a low-power (0.1µA) shutdown mode. When $\overline{SHDN}$ is pulled low, the clock stops and the device output enters a high-impedance state. Connect $\overline{SHDN}$ to $V_{CC}$ for normal operation.

## Applications Information

### Minimum and Maximum Gain Configurations

The MAX4238 is a unity-gain stable amplifier with a gain-bandwidth product (GBWP) of 1MHz. The MAX4239 is decompensated for a GBWP of 6.5MHz and is stable with a gain of 10V/V. Unlike conventional operational amplifiers, the MAX4238/MAX4239 have a maximum gain specification. To maintain stability, set the gain of the MAX4238 between $A_V$ = 1000V/V to 1V/V, and set the gain of the MAX4239 between $A_V$ = 6700V/V and 10V/V.

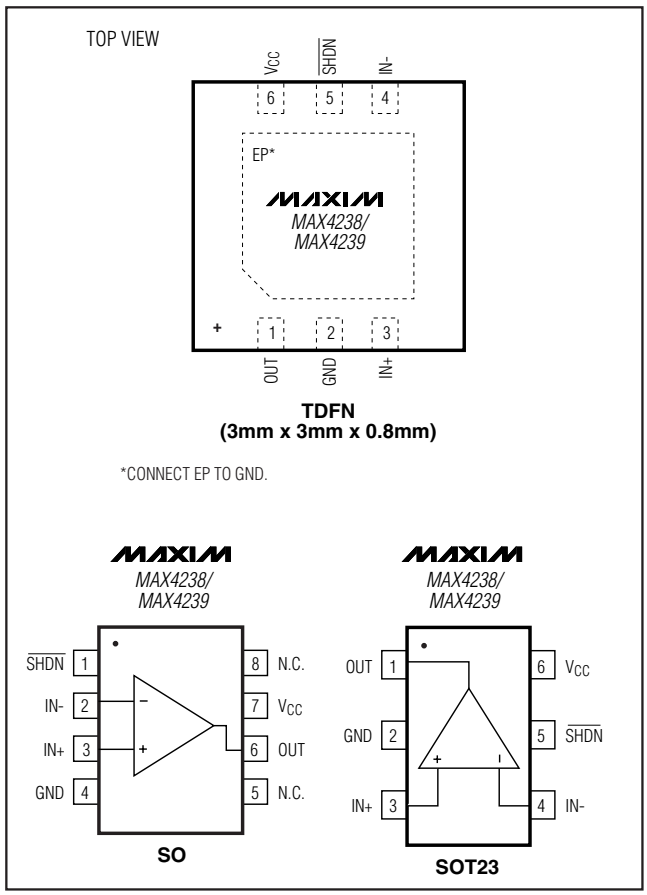
### ADC Buffer Amplifier

The low offset, fast settling time, and 1/f noise cancellation of the MAX4238/MAX4239 make these devices ideal for ADC buffers. The MAX4238/MAX4239 are well suited for low-speed, high-accuracy applications such as strain gauges (see *Typical Application Circuit*).

### Error Budget Example

When using the MAX4238/MAX4239 as an ADC buffer, the temperature drift should be taken into account when determining the maximum input signal. With a typical offset drift of 10nV/°C, the drift over a 10°C range is 100nV. Setting this equal to 1/2LSB in a 16-bit system yields a full-scale range of 13mV. With a single 2.7V supply, an acceptable closed-loop gain is $A_V$ = 200. This provides sufficient gain while maintaining headroom.

## Pin Configurations




## Chip Information

TRANSISTOR COUNT: 821

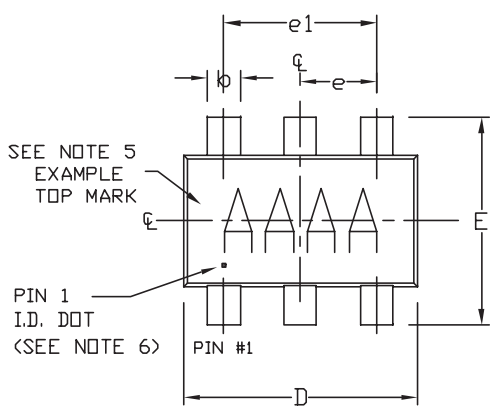
PROCESS: BiCMOS

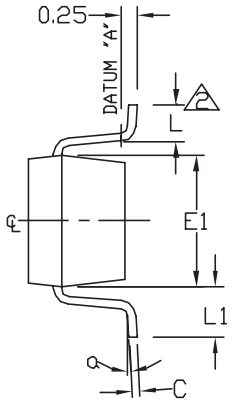
# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

## Package Information

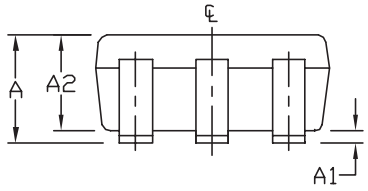
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

6LSOT.EPS




| SYMBOL | MIN | MAX |
|---|---|---|
| A | 0.90 | 1.45 |
| A1 | 0.00 | 0.15 |
| A2 | 0.90 | 1.30 |
| b | 0.35 | 0.50 |
| C | 0.08 | 0.20 |
| D | 2.80 | 3.00 |
| E | 2.60 | 3.00 |
| E1 | 1.50 | 1.75 |
| L | 0.35 | 0.60 |
| L1 | 0.60 REF. | |
| e1 | 1.90 BSC. | |
| e | 0.95 BSC. | |
| a | 0° | 10° |




NOTES:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. FOOT LENGTH MEASURED AT INTERCEPT POINT BETWEEN DATUM A & LEAD SURFACE.
3. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & METAL BURR. MOLD FLASH, PROTRUSION OR METAL BURR SHOULD NOT EXCEED 0.25 MM.
4. PACKAGE OUTLINE INCLUSIVE OF SOLDER PLATING.
5. PIN 1 IS LOWER LEFT PIN WHEN READING TOP MARK FROM LEFT TO RIGHT. (SEE EXAMPLE TOP MARK)
6. PIN 1 I.D. DOT IS 0.3 MM Ø MIN. LOCATED ABOVE PIN 1.
7. MEETS JEDEC MO178, VARIATION AB.
8. SOLDER THICKNESS MEASURED AT FLAT SECTION OF LEAD BETWEEN 0.08mm AND 0.15mm FROM LEADTIP.
9. LEAD TO BE COPLANAR WITHIN 0.1 MM.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, SOT 6L BODY

| APPROVAL | DOCUMENT CONTROL NO. | REV. | |
|---|---|---|---|
| | 21-0058 | G | 1/1 |

# Ultra-Low Offset/Drift, Low-Noise, Precision SOT23 Amplifiers

## Package Information (continued)

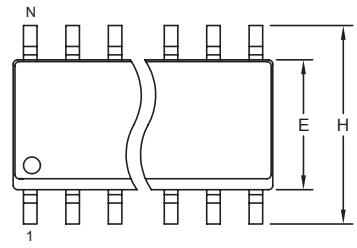
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SOICN .EPS

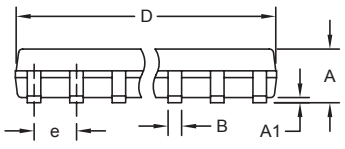
| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.053 | 0.069 | 1.35 | 1.75 |
| A1 | 0.004 | 0.010 | 0.10 | 0.25 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.007 | 0.010 | 0.19 | 0.25 |
| e | 0.050 BSC | | 1.27 BSC | |
| E | 0.150 | 0.157 | 3.80 | 4.00 |
| H | 0.228 | 0.244 | 5.80 | 6.20 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

VARIATIONS:

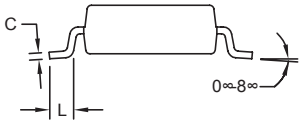
| | INCHES | | MILLIMETERS | | | |
|---|---|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX | N | MS012 |
| D | 0.189 | 0.197 | 4.80 | 5.00 | 8 | AA |
| D | 0.337 | 0.344 | 8.55 | 8.75 | 14 | AB |
| D | 0.386 | 0.394 | 9.80 | 10.00 | 16 | AC |




TOP VIEW




FRONT VIEW




SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

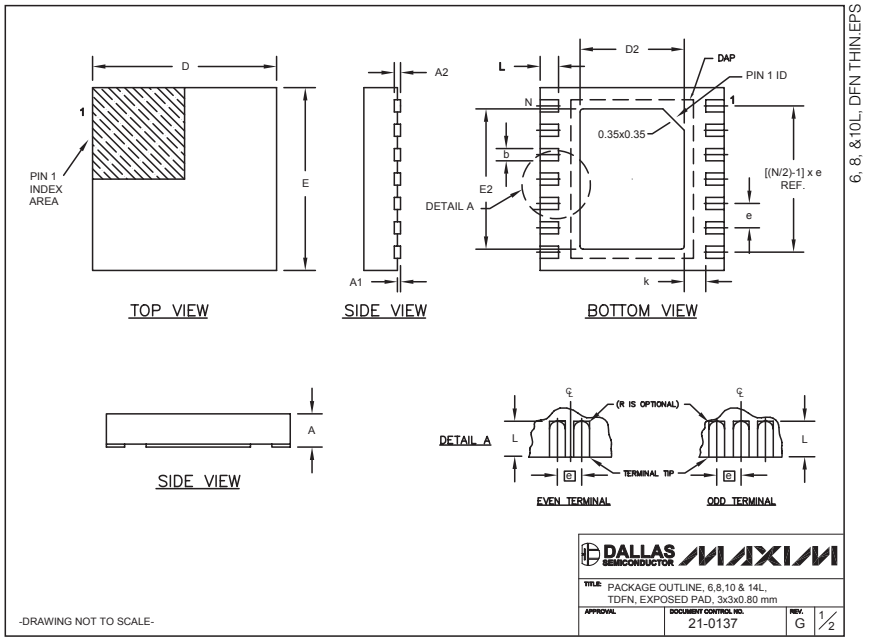
TITLE:

PACKAGE OUTLINE, .150" SOIC

| APPROVAL | DOCUMENT CONTROL NO. | REV. | |
|---|---|---|---|
| | 21-0041 | B | 1/1 |

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)




| COMMON DIMENSIONS | | |
|---|---|---|
| SYMBOL | MIN. | MAX. |
| A | 0.70 | 0.80 |
| D | 2.90 | 3.10 |
| E | 2.90 | 3.10 |
| A1 | 0.00 | 0.05 |
| L | 0.20 | 0.40 |
| k | 0.25 MIN. | |
| A2 | 0.20 REF. | |

| PACKAGE VARIATIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PKG. CODE | N | D2 | E2 | e | JEDEC SPEC | b | [(N/2)-1] x e | DOWNBONDS ALLOWED |
| T633-1 | 6 | 1.50±0.10 | 2.30±0.10 | 0.95 BSC | MO229 / WEEA | 0.40±0.05 | 1.90 REF | NO |
| T633-2 | 6 | 1.50±0.10 | 2.30±0.10 | 0.95 BSC | MO229 / WEEA | 0.40±0.05 | 1.90 REF | NO |
| T833-1 | 8 | 1.50±0.10 | 2.30±0.10 | 0.65 BSC | MO229 / WEEC | 0.30±0.05 | 1.95 REF | NO |
| T833-2 | 8 | 1.50±0.10 | 2.30±0.10 | 0.65 BSC | MO229 / WEEC | 0.30±0.05 | 1.95 REF | NO |
| T833-3 | 8 | 1.50±0.10 | 2.30±0.10 | 0.65 BSC | MO229 / WEEC | 0.30±0.05 | 1.95 REF | YES |
| T1033-1 | 10 | 1.50±0.10 | 2.30±0.10 | 0.50 BSC | MO229 / WEED-3 | 0.25±0.05 | 2.00 REF | NO |
| T1433-1 | 14 | 1.70±0.10 | 2.30±0.10 | 0.40 BSC | - - - - | 0.20±0.05 | 2.40 REF | YES |
| T1433-2 | 14 | 1.70±0.10 | 2.30±0.10 | 0.40 BSC | - - - - | 0.20±0.05 | 2.40 REF | NO |

NOTES:
1. ALL DIMENSIONS ARE IN mm. ANGLES IN DEGREES.
2. COPLANARITY SHALL NOT EXCEED 0.08 mm.
3. WARPAGE SHALL NOT EXCEED 0.10 mm.
4. PACKAGE LENGTH/PACKAGE WIDTH ARE CONSIDERED AS SPECIAL CHARACTERISTIC(S).
5. DRAWING CONFORMS TO JEDEC MO229, EXCEPT DIMENSIONS "D2" AND "E2", AND T1433-1 & T1433-2.
6. "N" IS THE TOTAL NUMBER OF LEADS.
7. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM
TITLE: PACKAGE OUTLINE, 6,8,10 & 14L, TDFN, EXPOSED PAD, 3x3x0.80 mm
APPROVAL
DOCUMENT CONTROL NO. 21-0137
REV. G
2/2

***MAX4238/MAX4239 Package Code: T633-2***

*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.*

# MAX4238

## Part Number Table

Notes:

1. See the MAX4238 QuickView Data Sheet for further information on this product family or download the MAX4238 full data sheet (PDF, 388kB).
2. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
3. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See full data sheet or Part Naming Conventions.
5. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

| Part Number | Free Sample | Buy Direct | Package: TYPE PINS SIZE DRAWING CODE/VAR * | Temp | RoHS/Lead-Free? Materials Analysis |
|---|---|---|---|---|---|
| MAX4238ASA | Sample | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8-4* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4238ASA-T | | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8-4* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4238ASA+ | Sample | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8+4* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4238ASA+T | | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8+4* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4238AUT+ | Sample | Buy | | -40°C to +125°C | RoHS/Lead-Free: Yes |
| MAX4238AUT+T | | Buy | | -40°C to +125°C | RoHS/Lead-Free: Yes |

| | | | | | |
|---|---|---|---|---|---|
| MAX4238AUT#G16 | Sample | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6FH-6* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4238AUT | Sample | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6F-6* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4238AUT#TG16 | | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6FH-6* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4238AUT-T | | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6F-6* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4238AUT-TG16 | | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6F-6* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4238ATT+ | Sample | Buy | THIN QFN (Dual);6 pin;3X3X0.8mm<br>Dwg: 21-0137I (PDF)<br>Use pkgcode/variation: T633+2* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4238ATT+T | | Buy | THIN QFN (Dual);6 pin;3X3X0.8mm<br>Dwg: 21-0137I (PDF)<br>Use pkgcode/variation: T633+2* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |

Didn't Find What You Need?

# MAX4239

## Part Number Table

Notes:

1. See the MAX4239 QuickView Data Sheet for further information on this product family or download the MAX4239 full data sheet (PDF, 388kB).
2. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
3. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See full data sheet or Part Naming Conventions.
5. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

| Part Number | Free Sample | Buy Direct | Package: TYPE PINS SIZE DRAWING CODE/VAR * | Temp | RoHS/Lead-Free? Materials Analysis |
|---|---|---|---|---|---|
| MAX4239ASA | Sample | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8-4* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4239ASA-T | | Buy | | -40°C to +125°C | RoHS/Lead-Free: No |
| MAX4239ASA+ | Sample | Buy | SOIC;8 pin;.150"<br>Dwg: 21-0041B (PDF)<br>Use pkgcode/variation: S8+4* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4239ASA+T | | Buy | | -40°C to +125°C | RoHS/Lead-Free: Yes |
| MAX4239AUT#TG16 | | Buy | | -40°C to +125°C | RoHS/Lead-Free: No |
| MAX4239AUT | Sample | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF) | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |

| | | | | | |
|---|---|---|---|---|---|
| | | | Use pkgcode/variation: U6F-6* | | |
| MAX4239AUT-T | | Buy | SOT-23;6 pin;<br>Dwg: 21-0058I (PDF)<br>Use pkgcode/variation: U6F-6* | -40°C to +125°C | RoHS/Lead-Free: No<br>Materials Analysis |
| MAX4239ATT+T | | Buy | THIN QFN (Dual);6 pin;3X3X0.8mm<br>Dwg: 21-0137I (PDF)<br>Use pkgcode/variation: T633+2* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |
| MAX4239ATT+ | Sample | Buy | THIN QFN (Dual);6 pin;3X3X0.8mm<br>Dwg: 21-0137I (PDF)<br>Use pkgcode/variation: T633+2* | -40°C to +125°C | RoHS/Lead-Free: Yes<br>Materials Analysis |

Didn't Find What You Need?