

MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

General Description

The MAX44269 is an ultra-small and low-power dual comparator ideal for battery-powered applications such as cell phones, notebooks, and portable medical devices that have extremely aggressive board space and power constraints. The comparator is available in a miniature 1.3mm x 1.3mm, 9-bump WLP package, making it the industry's smallest dual comparator.

The IC can be powered from supply rails as low as 1.8V and up to 5.5V. It requires just 0.5µA of typical supply current per comparator. It has a rail-to-rail input structure and a unique output stage that limits supply current surges while switching. This design also minimizes overall power consumption under dynamic conditions. The IC has open-drain outputs, making it suitable for mixed voltage systems. The IC also features internal filtering to provide high RF immunity. It operates over a -40°C to +85°C temperature.

Applications

- Smartphones
- Notebooks
- Two-Cell Battery-Powered Devices
- Battery-Operated Sensors
- Ultra-Low-Power Systems
- Portable Medical Mobile Accessories

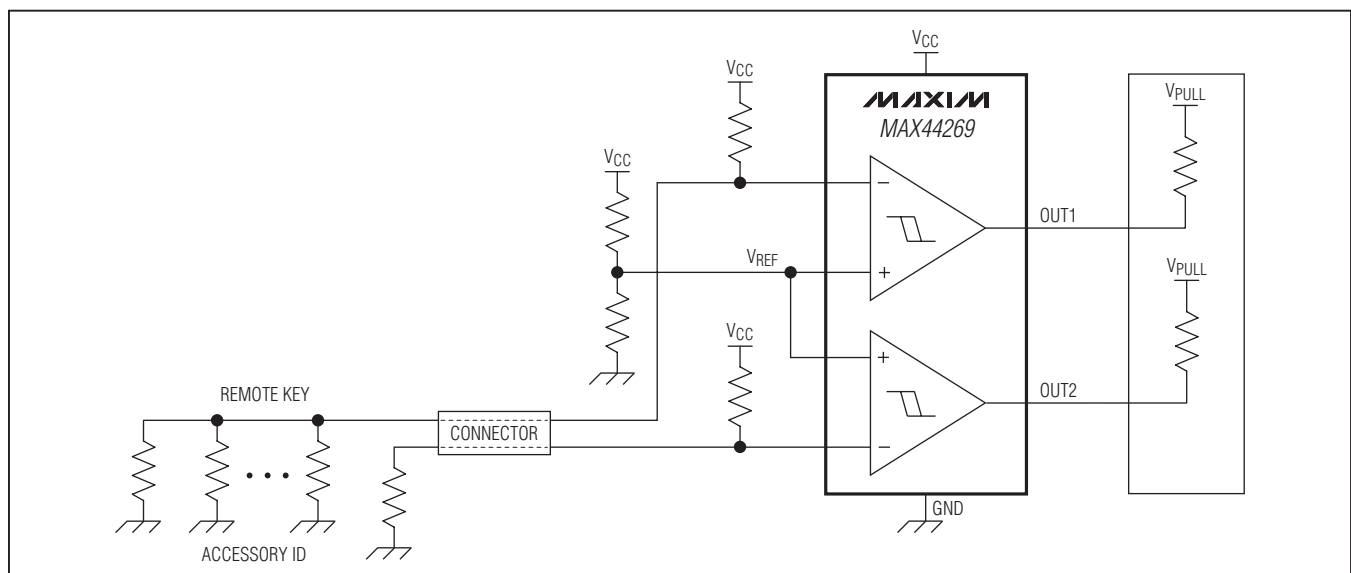
Features

- ◆ Ultra-Low Power Consumption
 - ✦ 0.5µA per Comparator
- ◆ Ultra-Small 1.3mm x 1.3mm WLP Package
- ◆ Guaranteed Operation Down to $V_{CC} = 1.8V$
- ◆ Input Common-Mode Voltage Range Extends 200mV Beyond-the-Rails
- ◆ 6V Tolerant Inputs Independent of Supply
- ◆ Open-Drain Outputs
- ◆ Internal Filters Enhance RF Immunity
- ◆ Crowbar-Current-Free Switching
- ◆ Internal Hysteresis for Clean Switching
- ◆ No Output Phase Reversal for Overdriven Inputs

Ordering Information appears at end of data sheet.

For related parts and recommended products to use with this part, refer to www.maxim-ic.com/MAX44269.related.

Typical Application Circuit



1.3mm x 1.3mm, Low-Power Dual Comparator

ABSOLUTE MAXIMUM RATINGS

| | | | |
|---|--------------|---|-----------------|
| V _{CC} to GND..... | -0.3V to +6V | Output Short-Circuit Duration (OUT_)..... | Continuous |
| INA+, INA-, INB+, INB- to GND..... | -0.3V to +6V | Operating Temperature Range..... | -40°C to +85°C |
| Continuous Input Current into Any Pin..... | ±20mA | Storage Temperature Range..... | -65°C to +150°C |
| Maximum Power Dissipation | | Junction Temperature..... | +150°C |
| (derate 11.9mW/°C at T _A = +70°C)..... | 952mW | Lead Temperature (soldering, 10s)..... | +300°C |
| Output Voltage to GND (OUT_)..... | -0.3V to +6V | Soldering Temperature (reflow)..... | +260°C |
| Output Current (OUT_)..... | ±50mA | | |

PACKAGE THERMAL CHARACTERISTICS (Note 1)

WLP

Junction-to-Ambient Thermal Resistance (θ_{JA})84°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maxim-ic.com/thermal-tutorial.

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

(V_{CC} = 5V, V_{GND} = 0V, V_{IN-} = V_{IN+} = 1.2V, R_{PULLUP} = 100kΩ to V_{CC}, T_A = -40°C to +85°C. Typical values are at T_A = +25°C, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|------------------------------|-------------------|---|--------------------------------|------|------------------------|-------|----|
| DC CHARACTERISTICS | | | | | | | |
| Input-Referred Hysteresis | V _{HYS} | (V _{GND} - 0.2V) ≤ V _{CM} ≤ (V _{CC} + 0.2V) (Note 3) | | 4 | 6 | mV | |
| Input Offset Voltage | V _{OS} | V _{GND} - 0.2V ≤ V _{CM} ≤ V _{CC} + 0.2V (Note 4) | T _A = +25°C | | 0.15 | 5 | mV |
| | | | -40°C ≤ T _A ≤ +85°C | | | 10 | |
| Input Bias Current | I _B | T _A = +25°C | | 0.15 | | nA | |
| | | T _A = -40°C to +85°C | | 0.2 | | | |
| Output-Voltage Swing Low | V _{OL} | V _{CC} = 1.8V, I _{SINK} = 1mA | T _A = +25°C | | 105 | 200 | mV |
| | | | -40°C ≤ T _A ≤ +85°C | | 300 | | |
| | | V _{CC} = 5V, I _{SINK} = 6mA | T _A = +25°C | | 285 | 350 | |
| | | | -40°C ≤ T _A ≤ +85°C | | 450 | | |
| Input Voltage Range | V _{CM} | Inferred from V _{OS} test | V _{GND} - 0.2V | | V _{CC} + 0.2V | V | |
| Output Short-Circuit Current | I _{SC} | Sinking, V _{OUT} = V _{CC} | V _{CC} = 1.8V | | 3 | | mA |
| | | | V _{CC} = 5V | | 30 | | |
| Output Leakage Current | I _{LEAK} | V _{CC} = 5.5V, V _{OUT} = 5.5V | | | 0.2 | | nA |

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1.3mm x 1.3mm, Low-Power Dual Comparator

ELECTRICAL CHARACTERISTICS (continued)

($V_{CC} = 5V$, $V_{GND} = 0V$, $V_{IN-} = V_{IN+} = 1.2V$, $R_{PULLUP} = 100k\Omega$ to V_{CC} , $T_A = -40^\circ C$ to $+85^\circ C$. Typical values are at $T_A = +25^\circ C$, unless otherwise noted.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-----------|---|-----|-----|------|---------|
| AC CHARACTERISTICS | | | | | | |
| Propagation Delay High to Low (Note 5) | t_{PHL} | Input overdrive = $\pm 100mV$, $V_{CC} = 5V$ | | 5 | | μs |
| | | Input overdrive = $\pm 100mV$, $V_{CC} = 1.8V$ | | 7 | | |
| | | Input overdrive = $\pm 20mV$, $V_{CC} = 5V$ | | 8 | | |
| | | Input overdrive = $\pm 20mV$, $V_{CC} = 1.8V$ | | 12 | | |
| Propagation Delay Low to High (Note 5) | t_{PLH} | Input overdrive = $\pm 100mV$, $V_{CC} = 5V$ | | 34 | | μs |
| | | Input overdrive = $\pm 100mV$, $V_{CC} = 1.8V$ | | 12 | | |
| | | Input overdrive = $\pm 20mV$, $V_{CC} = 5V$ | | 35 | | |
| | | Input overdrive = $\pm 20mV$, $V_{CC} = 1.8V$ | | 12 | | |
| Fall Time | t_F | $C_{LOAD} = 15pF$ | | 0.2 | | μs |
| POWER SUPPLY | | | | | | |
| Supply Voltage Range | V_{CC} | Guaranteed from PSRR tests | 1.8 | | 5.5 | V |
| Power-Supply Rejection Ratio | PSRR | $V_{CC} = 1.8V$ to $5.5V$ | 60 | 80 | | dB |
| Supply Current per Comparator | I_{CC} | $V_{CC} = 1.8V$, $T_A = +25^\circ C$ | | 0.4 | 0.75 | μA |
| | | $V_{CC} = 5V$, $T_A = +25^\circ C$ | | 0.5 | 0.85 | |
| | | $V_{CC} = 5V$, $-40^\circ C \leq T_A \leq +85^\circ C$ | | | 1 | |
| Power-Up Time | t_{ON} | | | 1 | | ms |

Note 2: All devices are 100% production tested at $T_A = +25^\circ C$. Temperature limits are guaranteed by design.

Note 3: Hysteresis is the input voltage difference between the two switching points.

Note 4: V_{OS} is the average of the positive and negative trip points minus V_{REF} .

Note 5: Overdrive is defined as the voltage above or below the switching points.

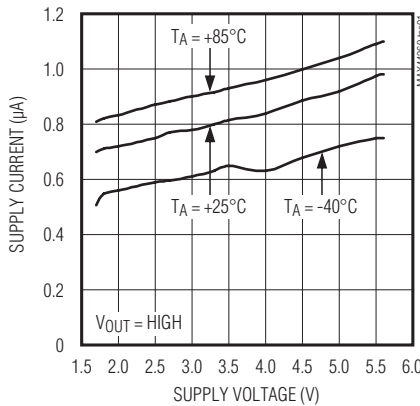
MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

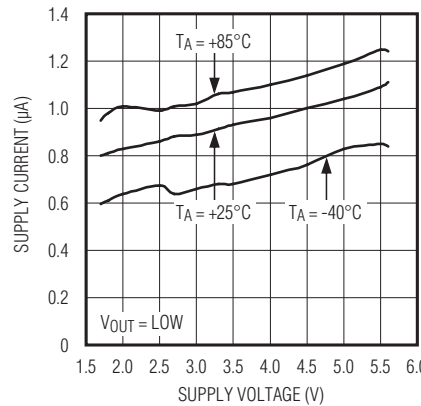
Typical Operating Characteristics

($V_{CC} = 5V$, $V_{GND} = 0V$, $V_{IN-} = V_{IN+} = 1.2V$, $R_{PULLUP} = 100k\Omega$ to V_{CC} , $T_A = -40^\circ C$ to $+85^\circ C$. Typical values are at $T_A = +25^\circ C$, unless otherwise noted. All devices are 100% production tested at $T_A = +25^\circ C$. Temperature limits are guaranteed by design.)

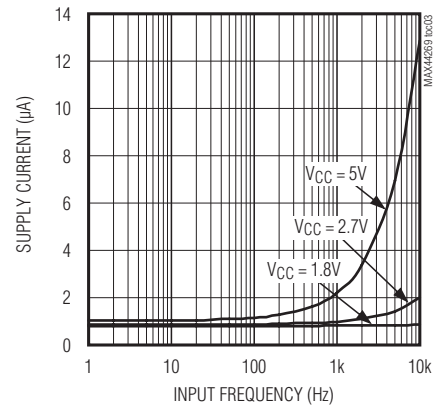
SUPPLY CURRENT vs. SUPPLY VOLTAGE



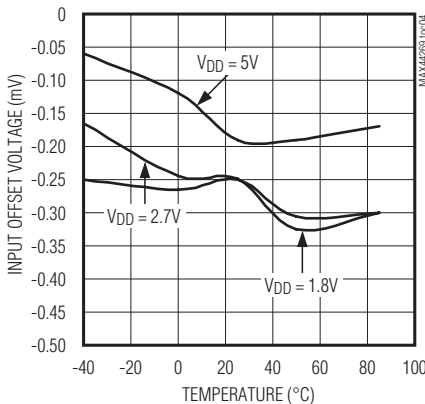
SUPPLY CURRENT vs. SUPPLY VOLTAGE



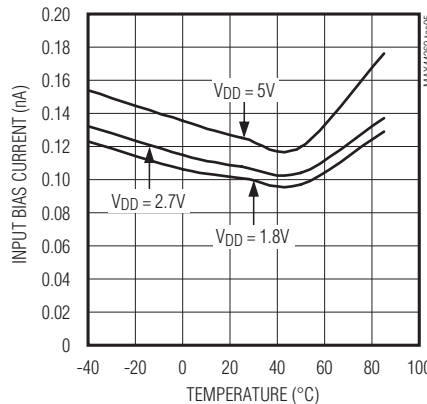
SUPPLY CURRENT vs. TRANSITION FREQUENCY (V_{OVERDRIVE} = 20mV)



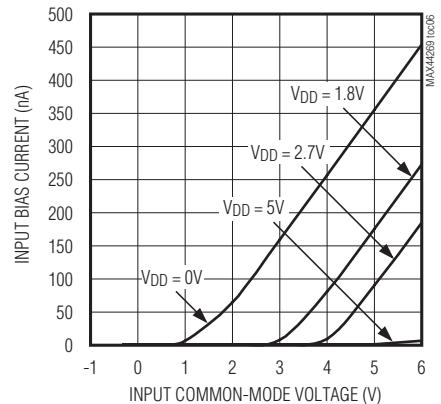
INPUT OFFSET VOLTAGE vs. TEMPERATURE



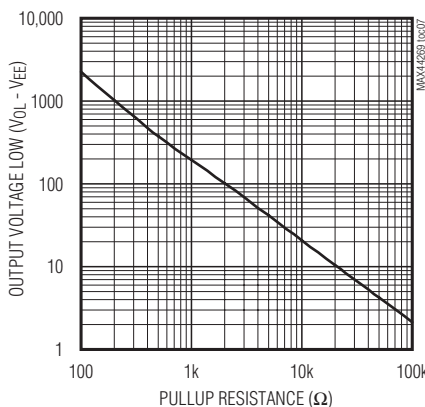
INPUT BIAS CURRENT vs. TEMPERATURE



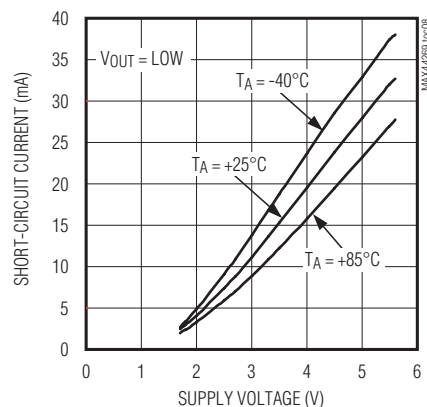
INPUT BIAS CURRENT vs. COMMON-MODE VOLTAGE



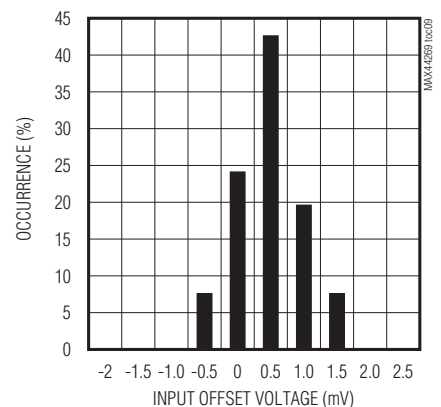
OUTPUT-VOLTAGE LOW vs. PULLUP RESISTANCE



SHORT-CIRCUIT CURRENT vs. SUPPLY VOLTAGE



INPUT OFFSET VOLTAGE HISTOGRAM



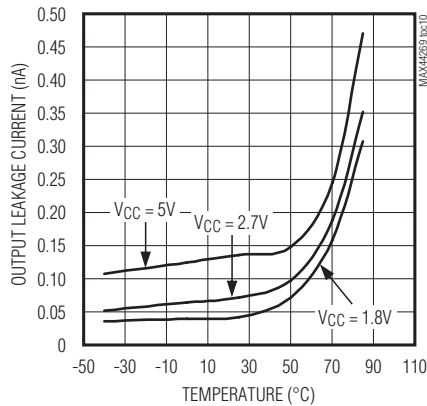
MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

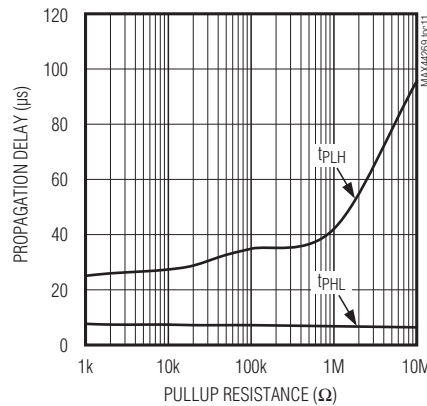
Typical Operating Characteristics (continued)

($V_{CC} = 5V$, $V_{GND} = 0V$, $V_{IN-} = V_{IN+} = 1.2V$, $R_{PULLUP} = 100k\Omega$ to V_{CC} ; $T_A = -40^\circ C$ to $+85^\circ C$. Typical values are at $T_A = +25^\circ C$, unless otherwise noted. All devices are 100% production tested at $T_A = +25^\circ C$. Temperature limits are guaranteed by design.)

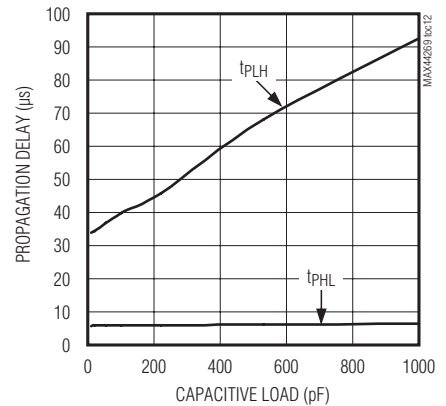
LEAKAGE CURRENT vs. TEMPERATURE



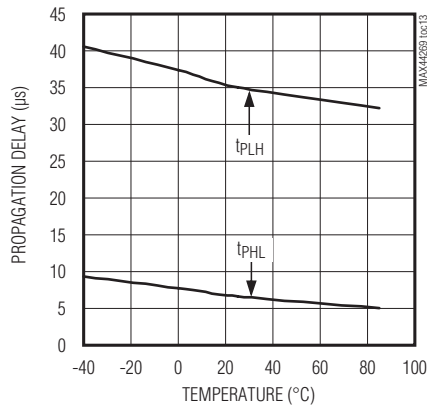
PROPAGATION DELAY vs. PULLUP RESISTANCE



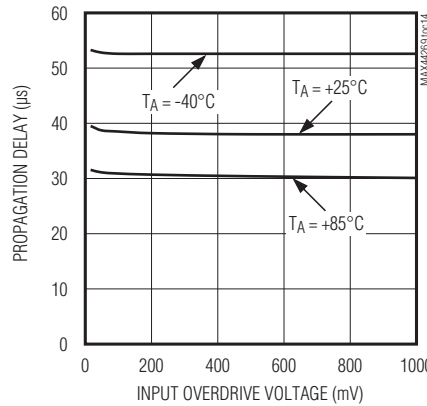
PROPAGATION DELAY vs. CAPACITIVE LOAD



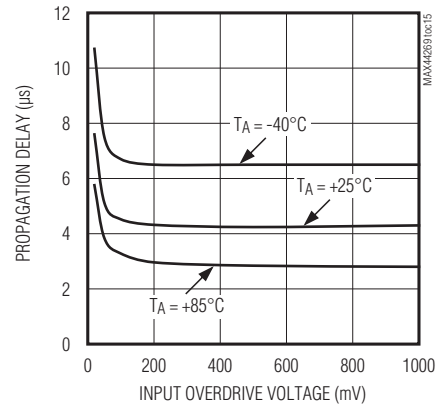
PROPAGATION DELAY vs. TEMPERATURE (V_{OVERDRIVE} = 100mV, V_{DD} = 5V)



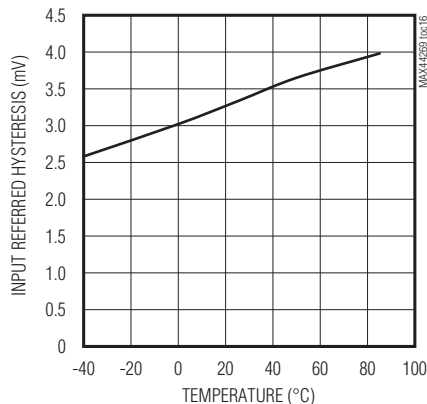
PROPAGATION DELAY vs. INPUT OVERDRIVE (t_{PLH})



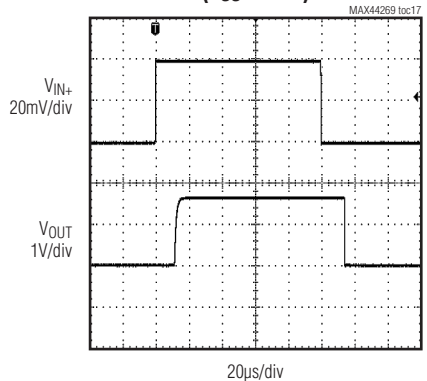
PROPAGATION DELAY vs. INPUT OVERDRIVE (t_{PHL})



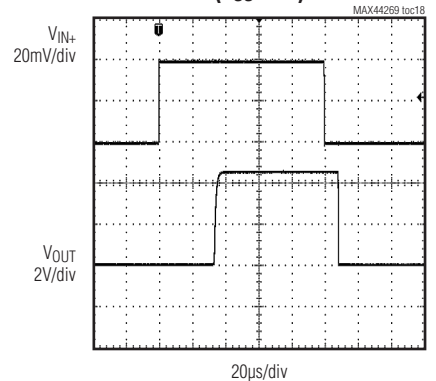
INPUT REFERRED HYSTERESIS vs. TEMPERATURE



SMALL-SIGNAL TRANSIENT RESPONSE (V_{CC} = 1.8V)



SMALL-SIGNAL TRANSIENT RESPONSE (V_{CC} = 5V)



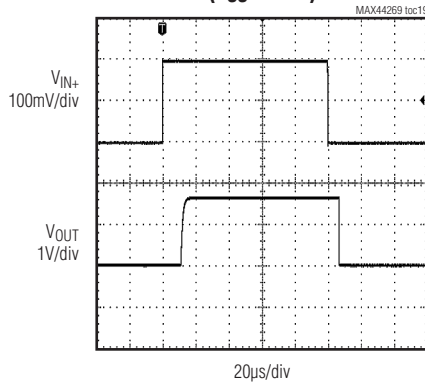
MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

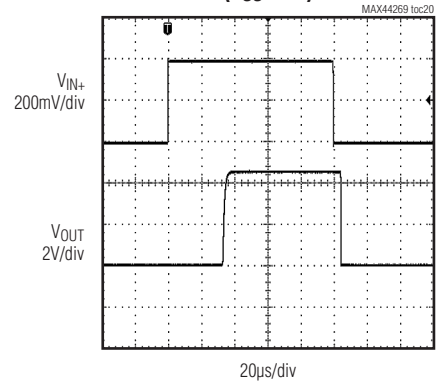
Typical Operating Characteristics (continued)

($V_{CC} = 5V$, $V_{GND} = 0V$, $V_{IN-} = V_{IN+} = 1.2V$, $R_{PULLUP} = 100k\Omega$ to V_{CC} , $T_A = -40^{\circ}C$ to $+85^{\circ}C$. Typical values are at $T_A = +25^{\circ}C$, unless otherwise noted. All devices are 100% production tested at $T_A = +25^{\circ}C$. Temperature limits are guaranteed by design.)

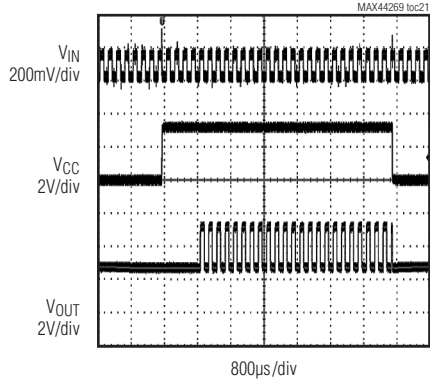
LARGE-SIGNAL TRANSIENT RESPONSE
($V_{CC} = 1.8V$)



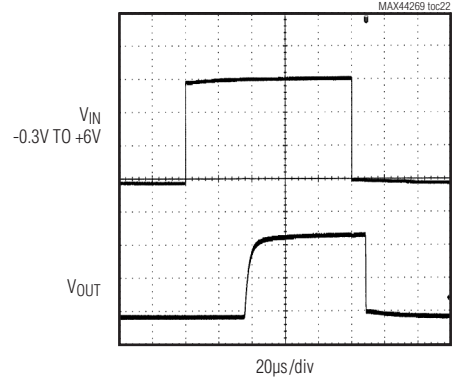
LARGE-SIGNAL TRANSIENT RESPONSE
($V_{CC} = 5V$)



POWER-UP RESPONSE



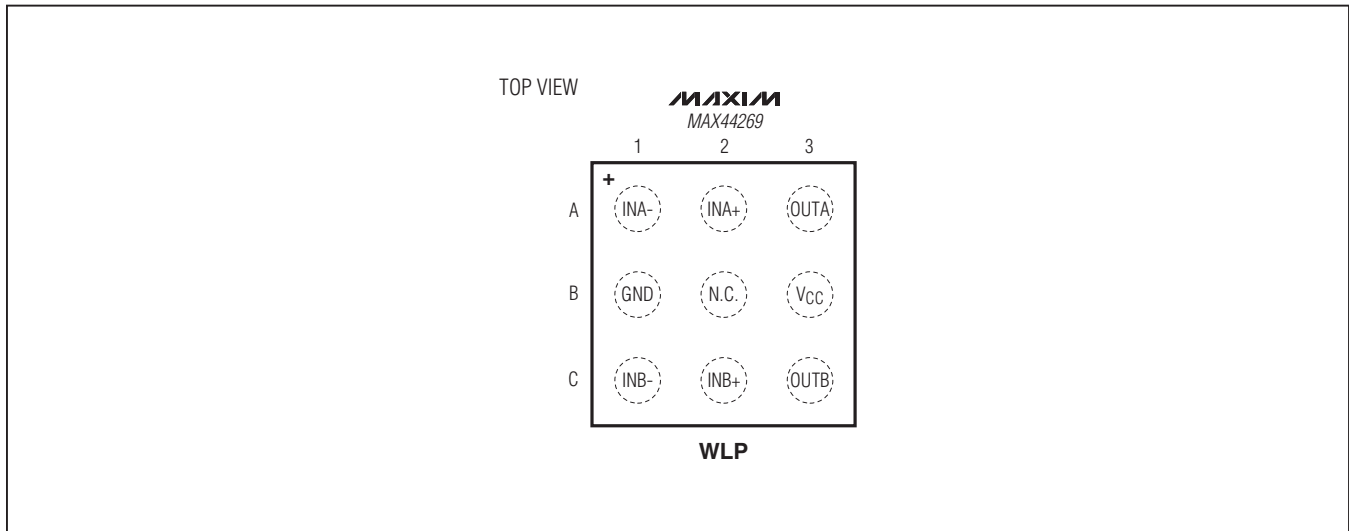
NO OUTPUT PHASE REVERSAL



MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

Bump Configuration



Bump Description

| PIN | NAME | FUNCTION |
|-----|-----------------|--|
| A1 | INA- | Comparator A Inverting Input |
| A2 | INA+ | Comparator A Noninverting Input |
| A3 | OUTA | Comparator A Output |
| B1 | GND | Negative Supply Voltage. Bypass to GND with a 1.0μF capacitor. |
| B2 | N.C. | Not Connected |
| B3 | V _{CC} | Positive Supply Voltage. Bypass to GND with a 1.0μF capacitor. |
| C1 | INB- | Comparator B Inverting Input |
| C2 | INB+ | Comparator B Noninverting Input |
| C3 | OUTB | Comparator B Output |

MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

Detailed Description

The MAX44269 is a general-purpose dual comparator for battery-powered devices where area, power, and cost constraints are crucial. The IC can operate with a low 1.8V supply rail typically consuming 0.5 μ A quiescent current per comparator. This makes it ideal for mobile and very low-power applications. The IC's common-mode input voltage range extends 200mV beyond-the-rails. An internal 4mV hysteresis ensures clean output switching, even with slow-moving input signals.

Input Stage Structure

The input common-mode voltage range extends from ($V_{GND} - 0.2V$) to ($V_{CC} + 0.2V$). The comparator operates at any different input voltage within these limits with low input bias current. Input bias current is typically 0.15nA if the input voltage is between the supply rails.

The IC features a unique input ESD structure that can handle voltages from -0.3V to 6V independent of supply voltage. This allows for the device to be powered down with a signal still present on the input without damaging the part. This feature is useful in applications where one of the inputs has transient spikes that exceed the supply rails.

No Output Phase Reversal for Overdriven Inputs

The IC's design is optimized to prevent output phase reversal if both the inputs are within the input common mode voltage range. If one of the inputs is outside the input common-mode voltage range, then output phase reversal does not occur as long as the other input is kept within the valid input common-mode voltage range. This behavior is shown in the No Output Phase Reversal graph in the [Typical Operating Characteristics](#) section.

Open-Drain Output

The IC features an open-drain output, enabling greater control of speed and power consumption in the circuit design. The output logic level is also independent from the input, allowing for simple level translation.

RF Immunity

The IC has very high RF immunity due to on-chip filtering of RF sensitive nodes. This allows the IC to hold its output state even in the presence of high amounts of RF noise. This improved RF immunity makes the IC ideal for mobile wireless devices.

Applications Information

Hysteresis

Many comparators oscillate in the linear region of operation because of noise or undesired parasitic feedback. This tends to occur when the voltage on one input is equal or very close to the voltage on the other input.

The hysteresis in a comparator creates two trip points: one for the rising input voltage and one for the falling input voltage ([Figure 1](#)). The difference between the trip points is the hysteresis. When the comparator's input voltages are equal and the output trips, the hysteresis effectively causes one comparator input to move quickly past the other. This takes the input out of the region where oscillation occurs. This provides clean output transitions for noisy, slow-moving input signals. The IC has an internal hysteresis of 4mV. Additional hysteresis can be generated with three resistors using positive feedback ([Figure 2](#)).

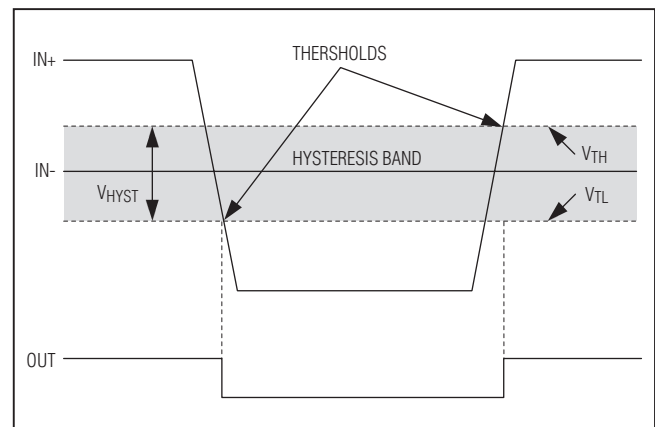


Figure 1. Threshold Hysteresis Band (Not to Scale)

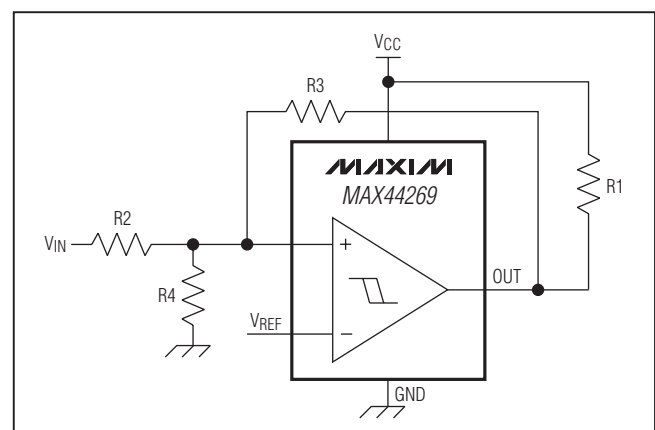


Figure 2. Adding Hysteresis with External Resistors

1.3mm x 1.3mm, Low-Power Dual Comparator

Use the following procedure to calculate resistor values.

- 1) Select R3. Input bias current at IN₊ is less than 15nA. To minimize errors caused by the input bias current, the current through R3 should be at least 1.5μA. Current through R3 at the trip point is (V_{REF} - V_{OUT})/R3. Considering the two possible output states in solving for R3 yields two formulas:

$$R3 = V_{REF}/I_{R3} \text{ and } R3 = [(V_{CC} - V_{REF})/I_{R3}] - R1$$

Use the smaller of the two resulting resistor values. For example, for V_{CC} = 5V, I_{R3} = -1.5μA, R1 = 200kΩ, and a V_{REF} = 1.24V, the two resistor values are 827kΩ and 1.5MΩ. Therefore, for R3 choose the standard value of 825kΩ.

- 2) Choose the hysteresis band required (V_{HB}). In this example, the V_{HB} = 50mV.
- 3) Calculate R2 according to the following equation:

$$R2 = (R1 + R3) \left(\frac{V_{HB}}{V_{CC} + (V_{REF} \times R1) / R3} \right)$$

For this example, insert the value:

$$R2 = (200k\Omega + 0.825M\Omega) \left(\frac{50mV}{5.3} \right) = 9.67k\Omega$$

For this example, choose standard value R2 = 9.76kΩ.

- 4) Choose the trip point for V_{IN} rising (V_{THR}) in such a way that:

$$V_{THR} > V_{REF} \left(1 + \frac{V_{HB}}{V_{CC}} \right)$$

V_{THR} is the threshold voltage at which the comparator switches its output from low to high, as V_{IN} rises above the trip point. For this example, choose V_{THR} = 3V.

- 5) Calculate R4 as follows:

$$R4 = \frac{1}{\left(\frac{V_{THR}}{V_{REF} \times R2} \right) - \left(\frac{1}{R2} \right) - \left(\frac{1}{R3} \right)}$$

$$R4 = \frac{1}{\left(\frac{3}{1.24 \times 9.76} \right) - \left(\frac{1}{9.76} \right) - \left(\frac{1}{825} \right)} = 6.93k\Omega$$

For this example, choose a standard value of 6.98kΩ.

- 6) Verify the trip voltages and hysteresis as follows:

$$V_{THR} = V_{REF} \times R2 \left(\left(\frac{1}{R2} \right) + \left(\frac{1}{R3} \right) + \left(\frac{1}{R4} \right) \right)$$

$$V_{THF} = V_{REF} \times R2 \left(\left(\frac{1}{R2} \right) + \left(\frac{1}{R1 + R3} \right) + \left(\frac{1}{R4} \right) \right) - \frac{R2}{R1 + R3} \times V_{CC}$$

The hysteresis network in [Figure 2](#) can be simplified if the reference voltage is chosen to be at midrail and the trip points of the comparator are chosen to be symmetrical about the reference voltage. Use the circuit in [Figure 3](#) if the reference voltage can be designed to be at the center of the hysteresis band. For the symmetrical case, follow the same steps outlined in the paragraph above to calculate the resistor values except that in this case, resistor R4 approaches infinity (open). So in the previous example with V_{REF} = 2.5V, if V_{THR} = 2.525V and V_{THF} = 2.475V then using the above formulas, we get R1 = 200kΩ, R2 = 9.09kΩ and R3 = 825kΩ, R4 = not installed.

Jack Detect

The IC can be used to detect peripheral devices connected to a circuit. This includes a simple jack-detect scheme for cell phone applications. The [Typical Application Circuit](#) shows how the device can be used in conjunction with an external reference to detect a remote key connection and an accessory ID input. The open-drain output of the devices allows the output logic level to be controlled independent of the peripheral device's load, making interfacing and controlling external devices as simple as monitoring a few digital inputs on a micro-controller or codec.

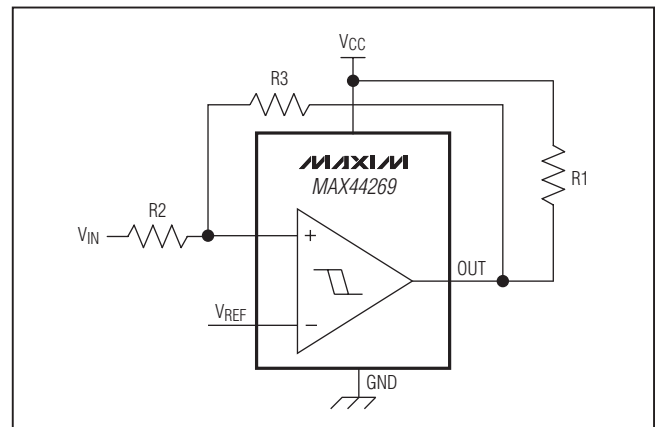


Figure 3. Simplified External Hysteresis Network if V_{REF} is at the Center of the Hysteresis Band

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1.3mm x 1.3mm, Low-Power Dual Comparator

Logic-Level Translator

Due to the open-drain output of the IC, the device can translate between two different logic levels (Figure 4). If the internal 4 mV hysteresis is not sufficient, then external resistors can be added to increase the hysteresis as shown in Figure 2 and Figure 3.

Power-On Reset Circuit

The IC can be used to make a power-on reset circuit as displayed in Figure 5. The positive input provides the ratiometric reference with respect to the power supply and is created by a simple resistive divider. Choose reasonably large values to minimize the power consumption in the resistive divider. The negative input provides the power-on delay time set by the time constant of the RC circuit formed by R2 and C1. This simple circuit can be used to power up the system in a known state after ensuring that the power supply is stable. Diode D1 provides a rapid reset in the event of unexpected power loss.

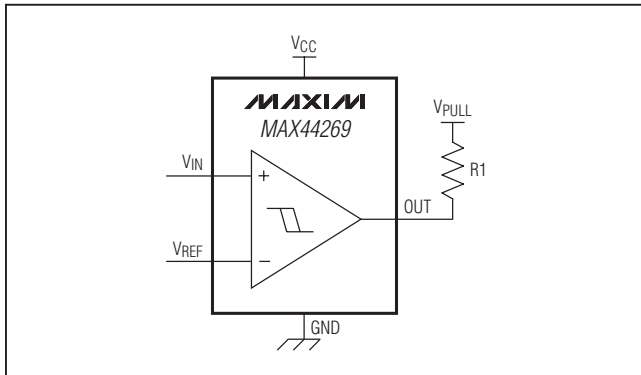


Figure 4. Logic-Level Translator

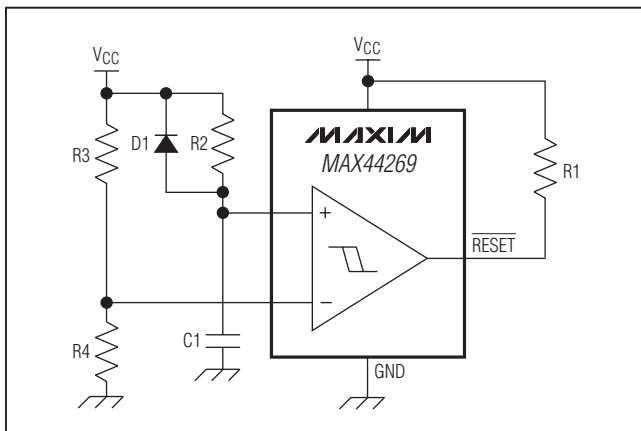


Figure 5. Power-On Reset Circuit

Relaxation Oscillator

The IC can also be used to make a simple relaxation oscillator (Figure 6). By adding the RC circuit R5 and C1, a standard Schmidt Trigger circuit is converted into an astable multivibrator. As shown in Figure 7, IN- is a sawtooth waveform with capacitor C1 alternately charging and discharging through resistor R5. The external hysteresis network formed by R1 to R4 defines the trip voltages as:

$$V_{T_RISE} = V_{CC} \left(\frac{R3 \times R4}{R2R3 + R2R4 + R3R4} \right)$$

$$V_{T_FALL} = V_{CC} \left(\frac{R4R5(R1 + R2 + R3) + R1R3R4}{R4R5(R1 + R2 + R3) + R1R3R4 + R2(R1R3 + R3R5 + R1R5)} \right)$$

Using the basic time domain equations for the charging and discharging of an RC circuit, the logic-high time, logic-low time, and frequency can be calculated as:

$$t_{LOW} = R5C1 \ln \left(\frac{V_{T_FALL}}{V_{T_RISE}} \right)$$

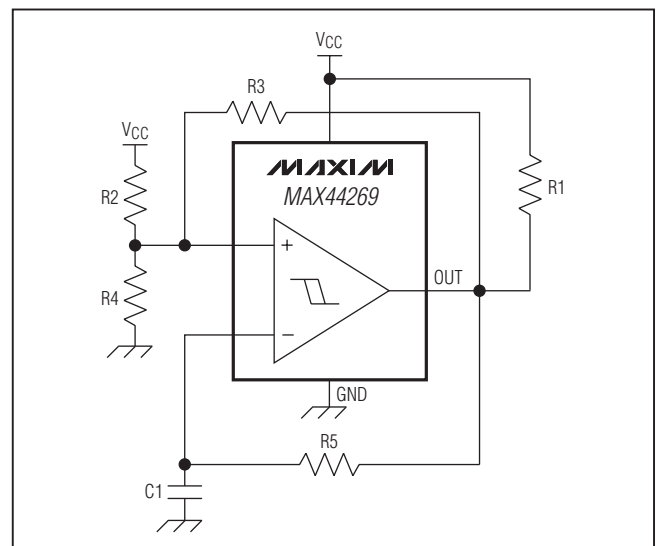


Figure 6. Relaxation Oscillator

1.3mm x 1.3mm, Low-Power Dual Comparator

Since the comparator's output is open drain, it goes to high impedance corresponding to logic-high. So, when the output is at logic-high, the C1 capacitor charges through the resistor network formed by R1 to R5 as shown in Figure 8. An accurate calculation of t_{HIGH} would have involved applying thevenin's theorem to compute the equivalent thevenin voltage (V_{THEVENIN}) and thevenin resistance (R_{THEVENIN}) in series with the capacitor C1. t_{HIGH} can then be computed using the basic time domain equations for the charging RC circuit as:

$$t_{HIGH} = R_{THEVENIN} C1 \ln \left(\frac{V_{THEVENIN} - V_{T_RISE}}{V_{THEVENIN} - V_{T_FALL}} \right)$$

$$R_{THEVENIN} = [(R2 \parallel R4) + R3] \parallel R1 + R5$$

$$V_{THEVENIN} = \frac{V_{CC} [(R2 \parallel R4) + R3]}{(R2 \parallel R4) + R3 + R1} + \frac{V_{CC} \times R4}{R2 + R4} \times \frac{R1}{(R2 \parallel R4) + R3 + R1}$$

The t_{HIGH} calculation can be simplified by selecting the component values in such a way that R3 >> R1 and R5 >> R1. This ensures that the output of the comparator goes close to V_{CC} when at logic-high (that is, V_{THEVENIN} ~ V_{CC} and R_{THEVENIN} ~ R5). With this selection, t_{HIGH} can be approximated as:

$$t_{HIGH} = R5C1 \ln \left(\frac{V_{CC} - V_{T_RISE}}{V_{CC} - V_{T_FALL}} \right)$$

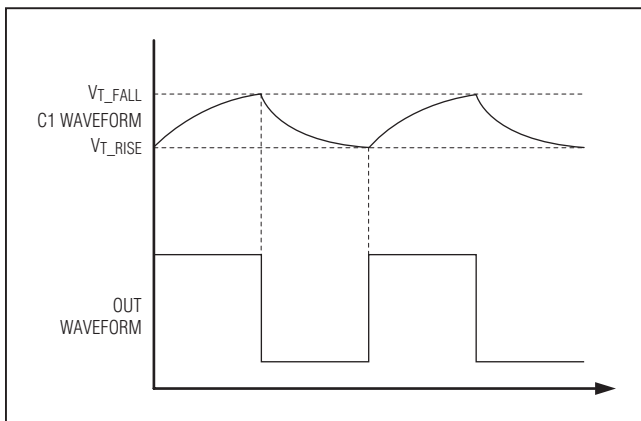


Figure 7. Relaxation Oscillator Waveforms

The frequency of the relaxation oscillator is:

$$f = \frac{1}{t_{HIGH} + t_{LOW}} = \frac{1}{R5C1 \ln \left(\frac{V_{T_FALL} (V_{CC} - V_{T_RISE})}{V_{T_RISE} (V_{CC} - V_{T_FALL})} \right)}$$

Simple PWM Generation Circuit

A pulse-width modulated (PWM) signal generator can be made utilizing both comparators in the IC (Figure 9). The capacitor/feedback resistor combination on INA- determines the switching frequency and the analog control voltage determines the pulse width.

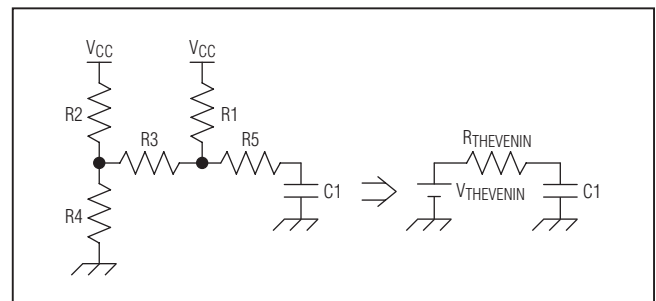


Figure 8. Charging Network Corresponding to Logic-High Output

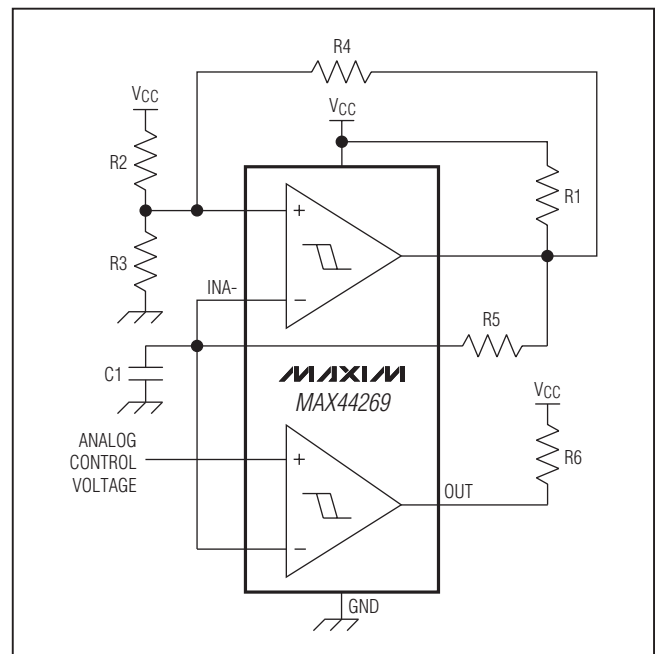


Figure 9. PWM Generator

MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

Window Detector Circuit

The IC is ideal for window detectors (undervoltage/over-voltage detectors). Figure 10 shows a window detector circuit for a single-cell Li+ battery with a 2.9V end-of-life charge, a peak charge of 4.2V, and a nominal value of 3.6V. Choose different thresholds by changing the values of R1, R2, and R3. OUTA provides an active-low undervoltage indication, and OUTB provides an active-low overvoltage indication. The open-drain outputs of both the comparators are wired OR to give an active-high power-good signal.

The design procedure is as follows:

- 1) Select R1. The input bias current into INB- is less than 15nA, so the current through R1 should exceed 1.5μA for the thresholds to be accurate. In this example, choose R1 = 825kΩ (1.24V/1.5μA).
- 2) Calculate R2 + R3. The overvoltage threshold should be 4.2V when VIN is rising. The design equation is as follows:

$$\begin{aligned} R2 + R3 &= R1 \times \left[\left(\frac{V_{OTH}}{V_{REF}} \right) - 1 \right] \\ &= 825 \times \left[\left(\frac{4.2}{1.24} \right) - 1 \right] \\ &= 1969k\Omega \end{aligned}$$

- 3) Calculate R2. The undervoltage threshold should be 2.9V when VIN is falling. The design equation is as follows:

$$\begin{aligned} R2 &= (R1 + R2 + R3) \times \left(\frac{V_{REF}}{V_{UTH}} \right) - R1 \\ &= ((825 + 1969) \times (1.24 / 2.9)) - 825 \\ &= 370k\Omega \end{aligned}$$

For this example, choose a 374kΩ standard value 1% resistor.

- 4) Calculate R3:

$$\begin{aligned} R3 &= (R2 + R3) - R2 \\ &= 1969k\Omega - 374k\Omega \\ &= 1.595M\Omega \end{aligned}$$

For this example, choose a 1.58MΩ standard value 1% resistor.

Board Layout and Bypassing

Use 1.0μF bypass capacitors from VCC to GND. To maximize performance, minimize stray inductance by putting this capacitor close to the VCC pin and reducing trace lengths.

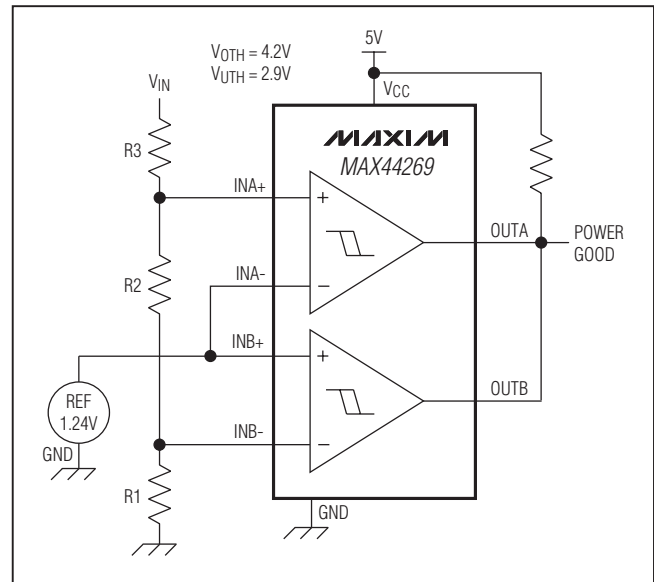


Figure 10. Window Detector Circuit

Chip Information

PROCESS: BiCMOS

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE | TOP MARK |
|---------------|----------------|-------------|----------|
| MAX44269EWL+T | -40°C to +85°C | 9 WLP | +AJL |

+Denotes a lead(Pb)-free/RoHS-compliant package.
T = Tape and reel.

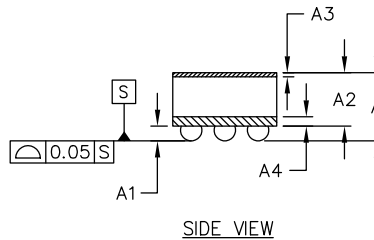
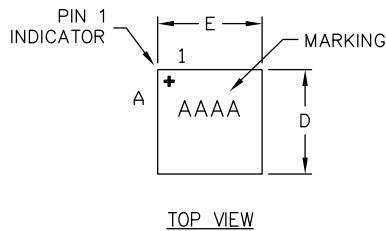
MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

Package Information

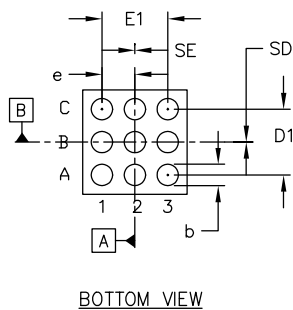
For the latest package outline information and land patterns (footprints), go to www.maxim-ic.com/packages. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | OUTLINE NO. | LAND PATTERN NO. |
|--------------|--------------|-------------------------|--|
| 9 WLP | W91B1-6 | 21-0430 | Refer to Application Note 1891 |



| COMMON DIMENSIONS | |
|-------------------|-------------|
| A | 0.64±0.05 |
| A1 | 0.21±0.03 |
| A2 | 0.43 REF |
| A3 | 0.025 BASIC |
| A4 | 0.07 BASIC |
| b | ∅0.26±0.03 |
| D1 | 0.80 BASIC |
| E1 | 0.80 BASIC |
| e | 0.40 BASIC |
| SD | 0.00 BASIC |
| SE | 0.00 BASIC |

| PKG. CODE | E | | D | | DEPOPULATED BUMPS |
|-----------|------|------|------|------|-------------------|
| | MIN | MAX | MIN | MAX | |
| W91B1+6 | 1.22 | 1.30 | 1.22 | 1.30 | NONE |



NOTES:

1. Terminal pitch is defined by terminal center to center value.
2. Outer dimension is defined by center lines between scribe lines.
3. All dimensions in millimeters.
4. Marking shown is for package orientation reference only.
5. Tolerance is ± 0.02mm unless specified otherwise.
6. All dimensions apply to PbFree (+) package codes only.



TITLE:
PACKAGE OUTLINE
9 BUMPS, WLP PKG. 0.4mm PITCH

| APPROVAL | DOCUMENT CONTROL NO. | REV. | 1/1 |
|----------|----------------------|------|-----|
| | 21-0430 | B | |

-DRAWING NOT TO SCALE-

MAX44269

1.3mm x 1.3mm, Low-Power Dual Comparator

Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|-----------------|---------------|--|----------------|
| 0 | 9/11 | Initial release | — |
| 1 | 12/11 | Revised <i>Electrical Characteristics</i> , <i>Typical Operating Characteristics</i> , and Figure 5. | 3, 5, 6, 9, 10 |

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