

# MAX31091

## Automotive Temperature Range Spread-Spectrum EconOscillator™

### General Description

The MAX31091 is a low-cost clock generator that is factory trimmed to output frequencies from 200kHz to 66.6MHz with a nominal accuracy of  $\pm 0.25\%$ . The device can also produce a center-spread-spectrum output with pin-selectable dither magnitude and rate. Assembled in an 8-pin  $\mu\text{MAX}^{\text{®}}$  package, the MAX31091 is designed to operate with a 3.0V to 3.6V power supply over the automotive temperature range ( $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ).

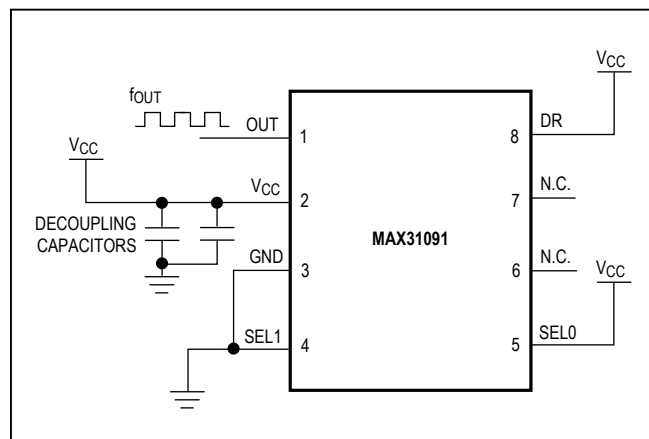
### Applications

- Automotive Infotainment
- Navigation
- Advanced Driver Assistance System (ADAS)
- Engine Control Unit (ECU) Instrumentation

### Features

- Spread-Spectrum Clock Output from 200kHz to 66.6MHz
- $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  Operating Temperature Range
- $\pm 1.75\%$  Accuracy Across Temperature
- Factory Trimmed
- Center-Dithered Spread-Spectrum Output
- Pin-Selectable Center-Dither Magnitude of 0%,  $\pm 1\%$ ,  $\pm 2\%$ , or  $\pm 4\%$
- Pin-Selectable Dither Rate
- 3.0V to 3.6V Supply Operation
- Lead(Pb)-Free, 8-Pin  $\mu\text{MAX}$  Package

### Typical Operating Circuit



### Custom Frequency Options

Custom frequency options are available. See the [Ordering Information](#) or contact the factory by email at [custom.oscillators@maximintegrated.com](mailto:custom.oscillators@maximintegrated.com) for more information.

[Ordering Information](#) appears at end of data sheet.

For related parts and recommended products to use with this part, refer to: [www.maximintegrated.com/MAX31091.related](http://www.maximintegrated.com/MAX31091.related)

EconOscillator is a trademark and  $\mu\text{MAX}$  is a registered trademark of Maxim Integrated Products, Inc.

## Absolute Maximum Ratings

Voltage Range on  $V_{CC}$  Relative to Ground ..... -0.5V to +4.0V  
 Voltage Range on DR, SEL0, SEL1  
     Relative to Ground..... -0.5V to ( $V_{CC} + 0.5V$ )\*  
 Continuous Power Dissipation ( $T_A = +70^\circ\text{C}$ )  
      $\mu\text{MAX}$  (derate 4.5mW/ $^\circ\text{C}$  above  $+70^\circ\text{C}$ ) ..... 362mW

Operating Temperature Range .....  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$   
 Storage Temperature Range .....  $-55^\circ\text{C}$  to  $+125^\circ\text{C}$   
 Lead Temperature (soldering, 10s) .....  $+300^\circ\text{C}$   
 Soldering Temperature (reflow) .....  $+260^\circ\text{C}$

\*This voltage must not exceed 4.0V.

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.

## Package Thermal Characteristics (Note 1)

$\mu\text{MAX}$

Junction-to-Ambient Thermal Resistance ( $\theta_{JA}$ ) .....  $206^\circ\text{C/W}$

**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.maximintegrated.com/thermal-tutorial](http://www.maximintegrated.com/thermal-tutorial).

## Recommended Operating Conditions

( $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.)

| PARAMETER                                    | SYMBOL   | CONDITIONS | MIN               | TYP | MAX               | UNITS |
|----------------------------------------------|----------|------------|-------------------|-----|-------------------|-------|
| Supply Voltage                               | $V_{CC}$ | (Note 1)   | 3.0               | 3.3 | 3.6               | V     |
| High-Level Input Voltage<br>(SEL0, SEL1, DR) | $V_{IH}$ |            | 0.7 x<br>$V_{CC}$ |     | $V_{CC} +$<br>0.3 | V     |
| Low-Level Input Voltage<br>(SEL0, SEL1, DR)  | $V_{IL}$ |            | -0.3              |     | 0.3 x<br>$V_{CC}$ | V     |

## DC Electrical Characteristics

( $V_{CC} = +3.0V$  to  $+3.6V$ ,  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted.)

| PARAMETER                                    | SYMBOL   | CONDITIONS                               | MIN | TYP | MAX | UNITS         |
|----------------------------------------------|----------|------------------------------------------|-----|-----|-----|---------------|
| High-Level Output Voltage (OUT)              | $V_{OH}$ | $I_{OH} = -4\text{mA}$ , $V_{CC} = 3.0V$ | 2.4 |     |     | V             |
| Low-Level Output Voltage (OUT)               | $V_{OL}$ | $I_{OL} = 4\text{mA}$                    |     |     | 0.4 | V             |
| High-Level Input Current<br>(SEL0, SEL1, DR) | $I_{IH}$ | $V_{CC} = 3.6V$                          |     |     | 1   | $\mu\text{A}$ |
| Low-Level Input Current<br>(SEL0, SEL1, DR)  | $I_{IL}$ | $V_{IL} = 0V$                            | -1  |     |     | $\mu\text{A}$ |
| Supply Current (Active)                      | $I_{CC}$ | (Note 2)                                 |     |     | 16  | mA            |

## AC Electrical Characteristics

( $V_{CC} = +3.0V$  to  $+3.6V$ ,  $T_A = -40^{\circ}C$  to  $+125^{\circ}C$ , unless otherwise noted.)

| PARAMETER                         | SYMBOL           | CONDITIONS                                         | MIN   | TYP | MAX   | UNITS |
|-----------------------------------|------------------|----------------------------------------------------|-------|-----|-------|-------|
| Output Frequency Range            | $f_{OUT}$        | (Note 3)                                           | 0.200 |     | 66.6  | MHz   |
| Output Center Frequency Tolerance | $\Delta f_{OUT}$ | $V_{CC} = 3.3V$ , $T_A = +25^{\circ}C$             | -0.25 | 0   | +0.25 | %     |
|                                   |                  | Across $T_A$ and $V_{CC} = 3.3V$                   | -1.75 |     | +1.75 |       |
|                                   |                  | $0^{\circ}C$ to $+70^{\circ}C$ and $V_{CC} = 3.3V$ | -1.2  |     | +1.2  |       |
| Power-Up Time                     | $t_{PU}$         | (Note 4)                                           |       |     | 0.1   | ms    |
| Load Capacitance                  | $C_L$            |                                                    |       | 15  | 50    | pF    |
| Duty Cycle                        |                  | $< 33.3MHz$ (Note 3)                               |       | 50  |       | %     |
|                                   |                  | $\geq 33.3MHz$ (Note 3)                            | 40    |     | 60    |       |
| Jitter (RMS), 50MHz               |                  |                                                    |       | 0.3 |       | %     |

**Note 1:** All voltages are referenced to ground. Currents entering the IC are specified positive and currents exiting the IC are negative.

**Note 2:** Supply current measured with  $C_L = 15pF$ ,  $V_{CC} = 3.6V$ ,  $T_A = +25^{\circ}C$ ,  $f_{OUT} = 66.6MHz$ , no dither.

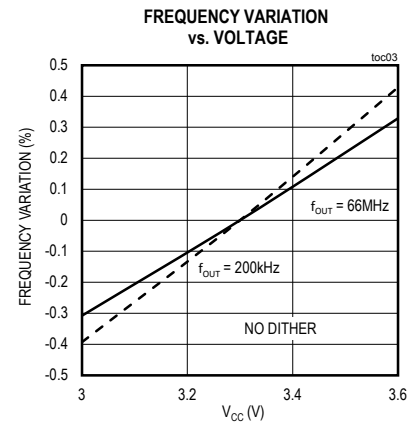
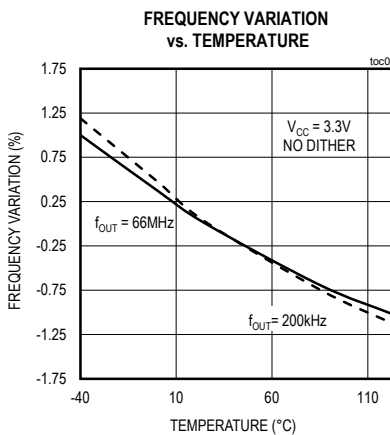
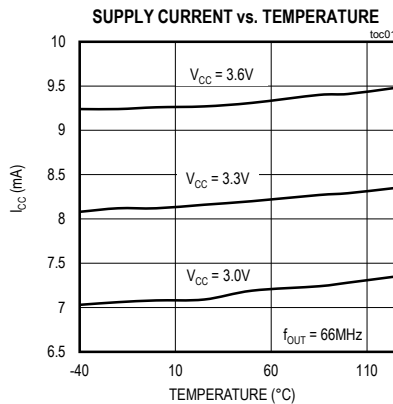
**Note 3:** No dither.

**Note 4:** Guaranteed by design.

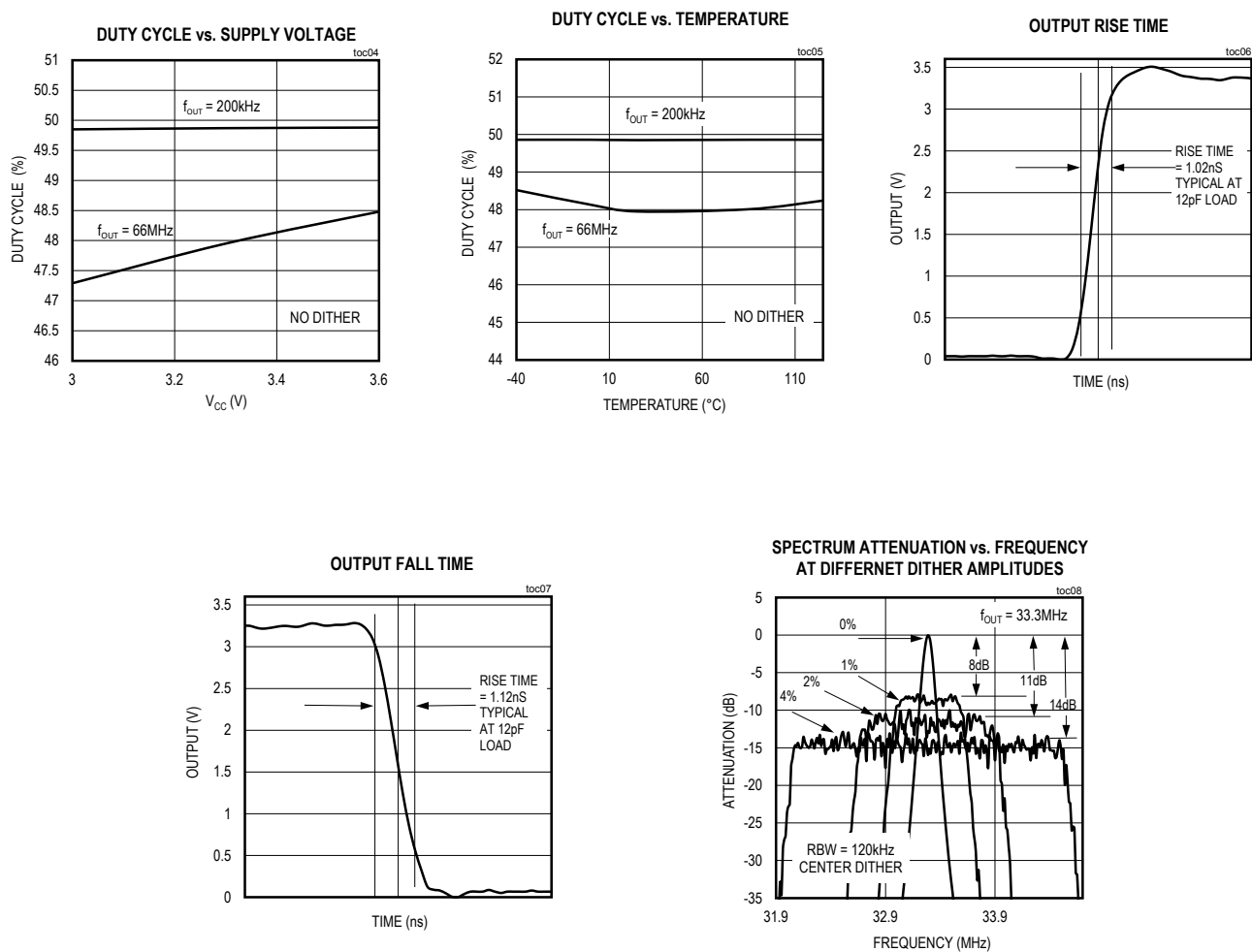
**Note 5:** For aging characteristics, contact factory.

## Typical Operating Characteristics

( $V_{CC} = 3.3V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.)



## Typical Operating Characteristics (continued)

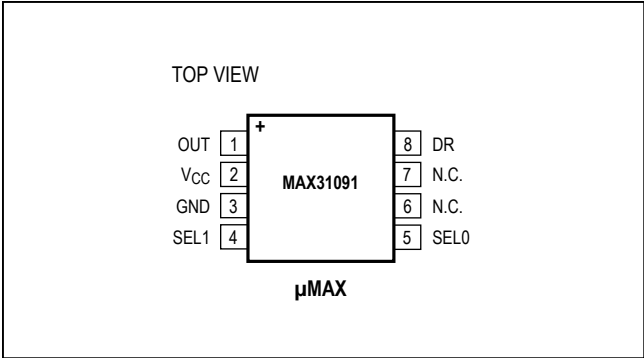
(V<sub>CC</sub> = 3.3V, T<sub>A</sub> = +25°C, unless otherwise noted.)

MAX31091

Automotive Temperature Range

Spread-Spectrum EconOscillator™

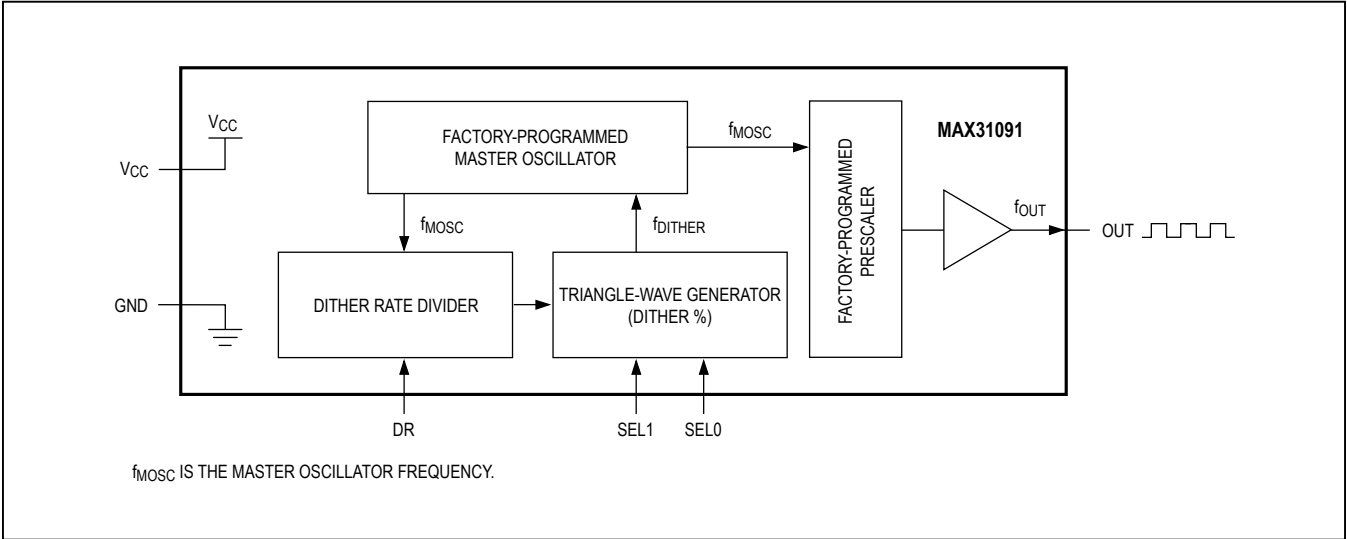
Pin Configuration



Pin Description

| PIN  | NAME            | FUNCTION                                                                                |
|------|-----------------|-----------------------------------------------------------------------------------------|
| 1    | OUT             | Spread-Spectrum Clock Output                                                            |
| 2    | V <sub>CC</sub> | Supply Voltage                                                                          |
| 3    | GND             | Ground                                                                                  |
| 4    | SEL1            | Spread-Spectrum Dither Magnitude Select Inputs. Selects dither magnitude (see Table 1). |
| 5    | SEL0            |                                                                                         |
| 6, 7 | N.C.            | No Connection                                                                           |
| 8    | DR              | Spread-Spectrum Dither Rate Selector. Selects dither rate (see Table 2).                |

Block Diagram



Detailed Description

The MAX31091 clock generator is capable of output frequencies from 200kHz to 66.6MHz over the full automotive temperature range (-40°C to +125°C). The device can also produce a spread-spectrum (dithered) square-wave output using four pin-selectable dither percentages. The device also features two selectable dither rates.

The MAX31091 is shipped from the factory-programmed to a customer-specified frequency.

Spread Spectrum

The MAX31091 can reduce radiated emission peaks. The dither percentage is controlled by the state of the SEL0 and SEL1 pins. The output frequency can be dithered at 0%, ±1%, ±2%, and ±4%, centered around the programmed frequency.

The two select pins SEL0 and SEL1 provide a means of selecting the dither magnitudes as follows:

A triangle-wave generator injects a control signal into the master oscillator to dither its output. The dither rate is a function of the output frequency,  $f_{OUT}$ , as well as the setting of the DR pin (see the equation below). [Figure 1](#) shows a plot of the output frequency vs. time.

$$\text{DITHER RATE} = \frac{f_{OUT}}{2^n}$$

where n is defined in [Table 2](#) as a function of output frequency. For example, for an output frequency of 27.0MHz, the dither rate would be 13.2kHz for DR = 1 and 6.6kHz for DR = 0.

Power-Up

Upon the application of power, the MAX31091 output is held in the low state until  $t_{PU}$  has elapsed. This removes any possibility of erroneous output transitions during initial power-up.

Table 1. Dither Magnitude

| SEL1<br>LOGIC LEVEL | SEL0<br>LOGIC LEVEL | DITHER MAGNITUDE (%) |
|---------------------|---------------------|----------------------|
|                     |                     | MAX31091AUA          |
| 0                   | 0                   | No dither            |
| 0                   | 1                   | Q1                   |
| 1                   | 0                   | Q2                   |
| 1                   | 1                   | Q4                   |

Table 2. Value of n w.r.t. Output Frequency

| OUTPUT FREQUENCY<br>$f_{OUT}$ (MHz) |                 | n                     |                       |
|-------------------------------------|-----------------|-----------------------|-----------------------|
| $f_{OUT}$ (min)                     | $f_{OUT}$ (max) | DR = LOGIC<br>LEVEL 1 | DR = LOGIC<br>LEVEL 0 |
| 0.200                               | 0.260           | 4                     | 5                     |
| 0.261                               | 0.521           | 5                     | 6                     |
| 0.522                               | 1.042           | 6                     | 7                     |
| 1.043                               | 2.083           | 7                     | 8                     |
| 2.084                               | 4.167           | 8                     | 9                     |
| 4.168                               | 8.333           | 9                     | 10                    |
| 8.334                               | 16.667          | 10                    | 11                    |
| 16.668                              | 33.333          | 11                    | 12                    |
| 33.334                              | 66.667          | 12                    | 13                    |

MAX31091 Frequency Spreading Profile as a Function of Dither %

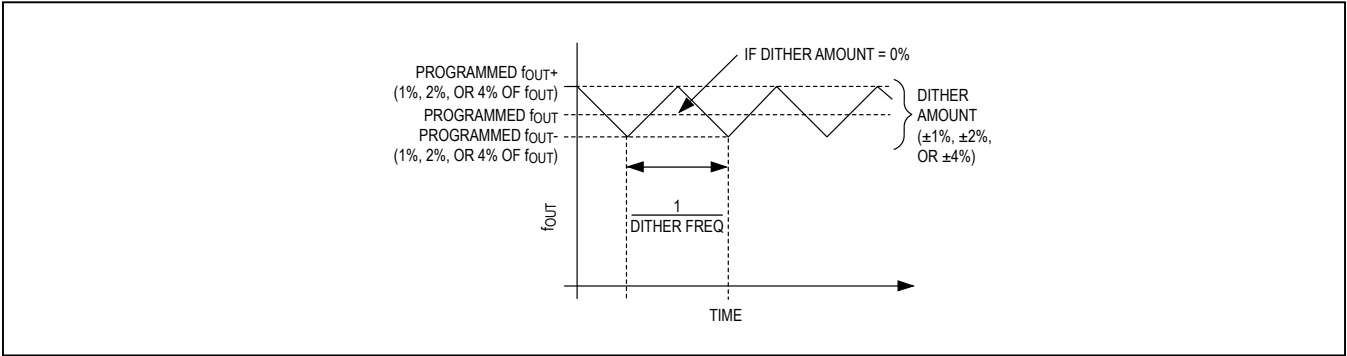


Figure 1. Center Dithered

## Applications Information

### Power-Supply Decoupling

To achieve best results, it is highly recommended that decoupling capacitors are used on the IC power-supply pins. Typical values of decoupling capacitors are 0.01µF and 0.1µF. Use a high-quality, ceramic, surface-mount capacitor, and mount it as close as possible to the V<sub>CC</sub> and GND pins of the IC to minimize lead inductance.

## Chip Information

SUBSTRATE CONNECTED TO GROUND

## Ordering Information

| PART               | TEMP RANGE      | SPREAD SPECTRUM | OUTPUT FREQUENCY (MHz) | PIN-PACKAGE |
|--------------------|-----------------|-----------------|------------------------|-------------|
| MAX31091AUA/V+033  | -40°C to +125°C | Center          | 33.3                   | 8 µMAX      |
| MAX31091AUA/V+T033 | -40°C to +125°C | Center          | 33.3                   | 8 µMAX      |
| MAX31091AUA/V+066  | -40°C to +125°C | Center          | 66.6                   | 8 µMAX      |
| MAX31091AUA/V+T066 | -40°C to +125°C | Center          | 66.6                   | 8 µMAX      |
| MAX31091AUA/V+172  | -40°C to +125°C | Center          | 1.7                    | 8 µMAX      |
| MAX31091AUA/V+T172 | -40°C to +125°C | Center          | 1.7                    | 8 µMAX      |
| MAX31091AUA/V+200  | -40°C to +125°C | Center          | 0.20                   | 8 µMAX      |
| MAX31091AUA/V+T200 | -40°C to +125°C | Center          | 0.20                   | 8 µMAX      |
| MAX31091AUA/V+330  | -40°C to +125°C | Center          | 33.0                   | 8 µMAX      |
| MAX31091AUA/V+T330 | -40°C to +125°C | Center          | 33.0                   | 8 µMAX      |

*V* denotes an automotive qualified part.

+Denotes a lead(Pb)-free/RoHS-compliant package.

T = Tape and reel.

## Package Information

For the latest package outline information and land patterns (foot-prints), go to [www.maximintegrated.com/packages](http://www.maximintegrated.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.        |
|--------------|--------------|-------------------------|-------------------------|
| 8 µMAX       | U8+4         | <a href="#">21-0036</a> | <a href="#">90-0092</a> |

## Revision History

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION     | PAGES<br>CHANGED |
|--------------------|------------------|-----------------|------------------|
| 0                  | 3/14             | Initial release | —                |

For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim Integrated's website at [www.maximintegrated.com](http://www.maximintegrated.com).

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: [ocean@oceanchips.ru](mailto:ocean@oceanchips.ru)

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А