

## LM8364 Micropower Undervoltage Sensing Circuits

Check for Samples: [LM8364](#)

### FEATURES

- **Extremely Low Quiescent Current:** 0.65 $\mu$ A, at  $V_{IN} = 2.87V$
- **High Accuracy Threshold Voltage ( $\pm 2.5\%$ )**
- **Open Drain Output**
- **Input Voltage Range:** 1V to 6V
- **Surface Mount Package (5-Pin SOT-23)**
- **Pin for Pin Compatible with MC33464**

### APPLICATIONS

- **Low Battery Detection**
- **Microprocessor Reset Controller**
- **Power Fail Indicator**
- **Battery Backup Detection**

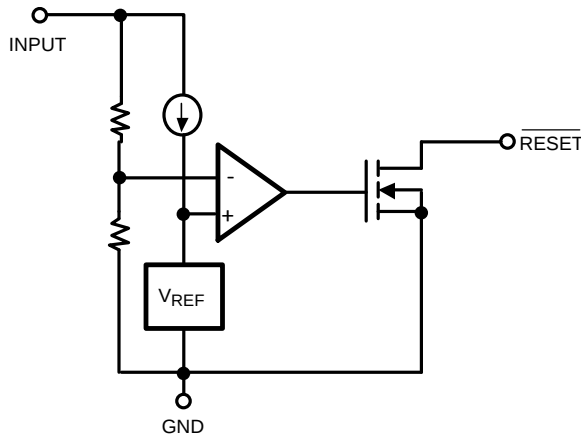
### DESCRIPTION

The LM8364 series are micropower undervoltage sensing circuits that are ideal for use in battery powered microprocessor based systems, where extended battery life is a key requirement.

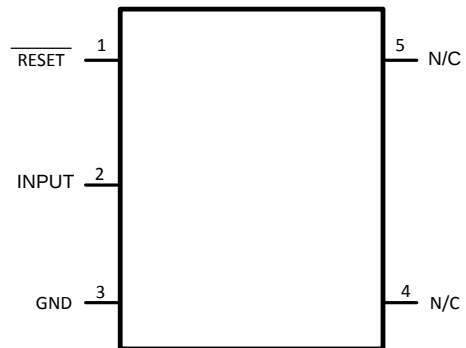
A range of threshold voltages from 2.0V to 4.5V are available with an active low open drain output. These devices feature a very low quiescent current of 0.65 $\mu$ A typical. The LM8364 series features a highly accurate voltage reference, a comparator with precise thresholds and built-in hysteresis to prevent erratic reset operation, and ensured Reset operation down to 1.0V with extremely low standby current.

These devices are available in the space saving SOT-23 5-pin surface mount package. For other undervoltage thresholds and output options, please contact Texas Instruments.

### Functional Block Diagram



### Connection Diagram



**Figure 1. 5-Pin SOT-23  
Top View**



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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)(2)</sup>

|                           |                               |                |
|---------------------------|-------------------------------|----------------|
| Supply Voltage            |                               | –0.3V to 6.5V  |
| RESET Output Voltage      |                               | –0.3V to 6.5V  |
| RESET Output Current      |                               | 70mA           |
| Storage Temperature Range |                               | –65°C to 150°C |
| Mounting Temp.            | Lead Temp (Soldering, 10 sec) | 260°C          |
| Junction Temperature      |                               | 125°           |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For ensured specifications and the test conditions, see the Electrical Characteristics.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.

## Operating Ratings<sup>(1)</sup>

|                                                 |  |               |
|-------------------------------------------------|--|---------------|
| Temperature Range                               |  | –40°C to 85°C |
| Thermal Resistance to ambient ( $\theta_{JA}$ ) |  | 265°C/W       |
| ESD Tolerance                                   |  |               |
| Human Body Model                                |  | 2000V         |
| Machine Model                                   |  | 200V          |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For ensured specifications and the test conditions, see the Electrical Characteristics.

## Electrical Characteristics

Unless otherwise specified, all limits ensured for  $T_A = 25^\circ\text{C}$ .

| Symbol                    | Parameter                                          | Conditions                                      | Min<br>(1) | Typ<br>(2) | Max<br>(1) | Units  |
|---------------------------|----------------------------------------------------|-------------------------------------------------|------------|------------|------------|--------|
| $V_{DET-}$                | Detector Threshold Voltage                         | High to Low State Output ( $V_{IN}$ Decreasing) |            |            |            | V      |
|                           |                                                    | 20 Suffix                                       | 1.950      | 2.0        | 2.050      |        |
|                           |                                                    | 27 Suffix                                       | 2.633      | 2.7        | 2.767      |        |
|                           |                                                    | 30 Suffix                                       | 2.925      | 3.0        | 3.075      |        |
|                           |                                                    | 32 Suffix                                       | 3.120      | 3.2        | 3.280      |        |
|                           |                                                    | 45 Suffix                                       | 4.388      | 4.5        | 4.613      |        |
| $V_{HYS}$                 | Detector Threshold Hysteresis                      | $V_{IN}$ Increasing                             |            |            |            | V      |
|                           |                                                    | 20 Suffix                                       | 0.060      | 0.100      | 0.140      |        |
|                           |                                                    | 27 Suffix                                       | 0.081      | 0.135      | 0.189      |        |
|                           |                                                    | 30 Suffix                                       | 0.090      | 0.150      | 0.210      |        |
|                           |                                                    | 32 Suffix                                       | 0.096      | 0.160      | 0.224      |        |
|                           |                                                    | 45 Suffix                                       | 0.135      | 0.225      | 0.315      |        |
| $\Delta V_{det}/\Delta T$ | Detector Threshold Voltage Temperature Coefficient |                                                 |            | ±100       |            | PPM/°C |
| $V_{OL}$                  | RESET Output Voltage Low State                     | (Open Drain Output: $I_{SINK} = 1\text{mA}$ )   |            | 0.25       | 0.5        | V      |
| $I_{OL}$                  | RESET Output Sink Current                          | $V_{IN} = 1.5\text{V}$ , $V_{OL} = 0.5\text{V}$ | 1.0        | 2.5        |            | mA     |
| $V_{IN}$                  | Operating Input Voltage Range                      |                                                 | 1.0        |            | 6.0        | V      |

- (1) All limits are ensured by testing or statistical analysis.
- (2) Typical values represent the most likely parametric norm

## Electrical Characteristics (continued)

Unless otherwise specified, all limits ensured for  $T_A = 25^\circ\text{C}$ .

| Symbol   | Parameter                                       | Conditions              | Min<br>(1) | Typ<br>(2) | Max<br>(1) | Units         |
|----------|-------------------------------------------------|-------------------------|------------|------------|------------|---------------|
| $I_{IN}$ | Quiescent Input Current                         | 20 Suffix               |            |            |            | $\mu\text{A}$ |
|          |                                                 | $V_{IN} = 1.9\text{V}$  |            | 0.55       | 0.8        |               |
|          |                                                 | $V_{IN} = 4.0\text{V}$  |            | 0.70       | 1.3        |               |
|          |                                                 | 27 Suffix               |            |            |            |               |
|          |                                                 | $V_{IN} = 2.6\text{V}$  |            | 0.62       | 0.9        |               |
|          |                                                 | $V_{IN} = 4.7\text{V}$  |            | 0.75       | 1.3        |               |
|          |                                                 | 30 Suffix               |            |            |            |               |
|          |                                                 | $V_{IN} = 2.87\text{V}$ |            | 0.65       | 0.9        |               |
|          |                                                 | $V_{IN} = 5.0\text{V}$  |            | 0.77       | 1.3        |               |
|          |                                                 | 32 Suffix               |            |            |            |               |
|          |                                                 | $V_{IN} = 3.08\text{V}$ |            | 0.66       | 0.9        |               |
|          |                                                 | $V_{IN} = 5.20\text{V}$ |            | 0.79       | 1.3        |               |
|          |                                                 | 45 Suffix               |            |            |            |               |
|          |                                                 | $V_{IN} = 4.34\text{V}$ |            | 0.70       | 1.0        |               |
|          |                                                 | $V_{IN} = 6.0$          |            | 0.85       | 1.4        |               |
| $t_p$    | Propagation Delay Time <a href="#">Figure 7</a> |                         |            | 60         | 300        | $\mu\text{s}$ |

## Typical Performance Characteristics

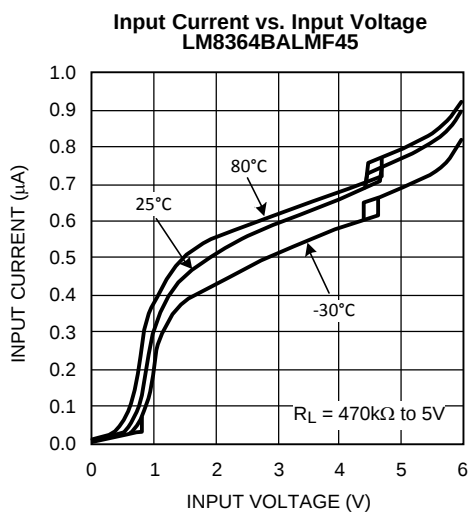


Figure 2.

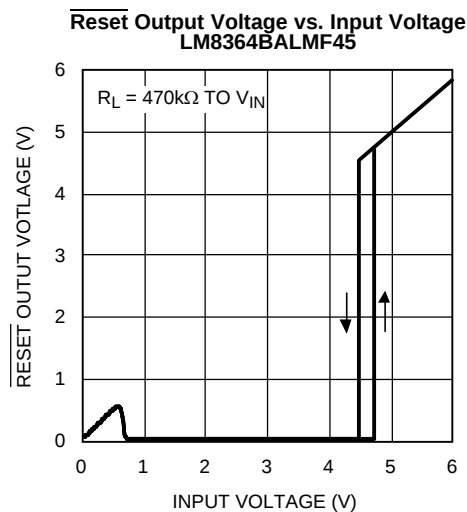


Figure 3.

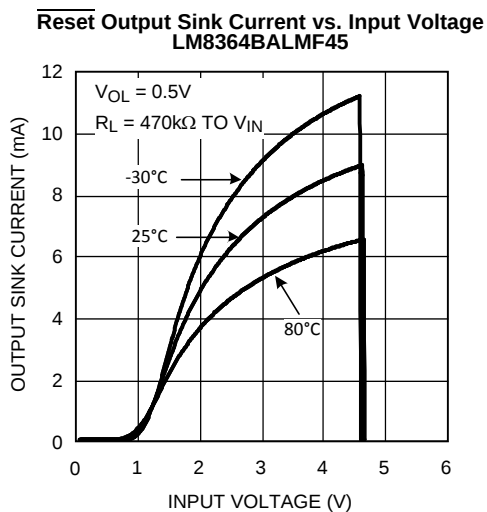


Figure 4.

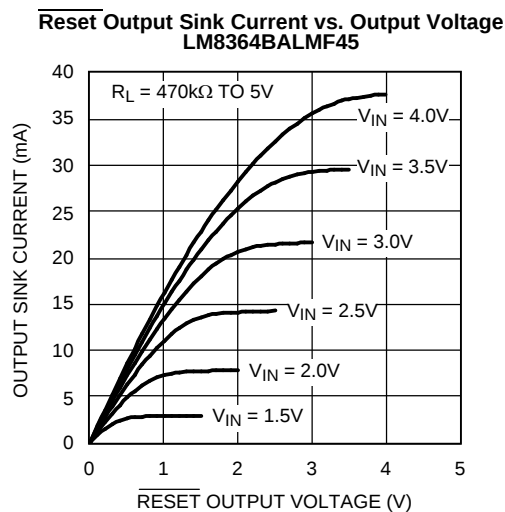


Figure 5.

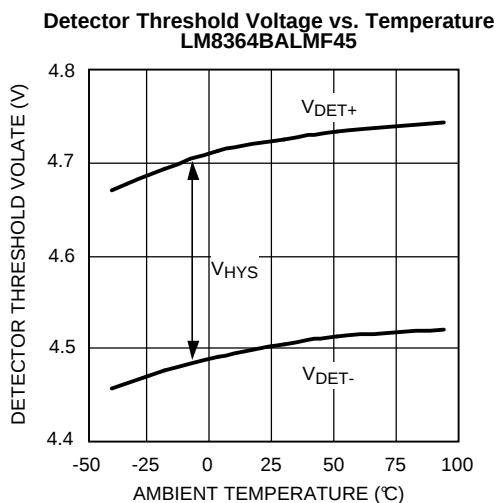


Figure 6.

## APPLICATION NOTES

The propagation delay time for the LM8364 is measured using a 470kΩ pull-up resistor connected to from the RESET output pin to 5V in addition to a 10pF capacitive load connected from the same pin to GND. Figure 7 shows the timing diagram for the measurement for the propagation delay.  $V_{DET+}$  is equal to the sum of the detector threshold,  $V_{DET-}$ , and the built in hysteresis,  $V_{HYS}$ .

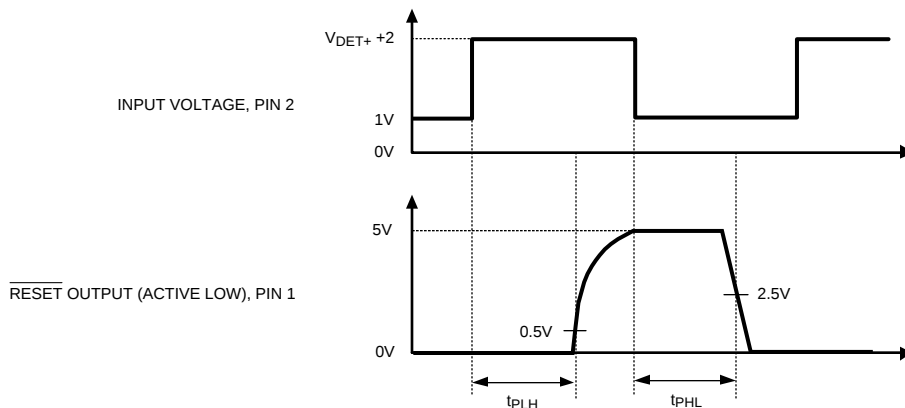


Figure 7. Propagation Delay Timing Diagrams

The LM8364 ultra-low current voltage detector was designed to monitor voltages and to provide an indication when the monitored voltage,  $V_{IN}$ , dropped below a precisely trimmed threshold voltage. This characteristic is displayed in the typical operating timing diagram below.  $V_{IN}$  is the voltage that is being monitored and a pull up resistor is connected from the RESET output pin to  $V_{IN}$ .  $V_{IN}$  is at some value above  $V_{DET+}$  and then begins to decrease. Since this is an Active Low device the RESET output is pulled High through the pull-up resistor and tracks  $V_{IN}$  until  $V_{IN}$  crosses the trimmed threshold  $V_{DET-}$ . At this point the LM8364 recognizes that  $V_{IN}$  is now in a fault condition and the output immediately changes to the Logic Low State. The RESET output will remain in this low state until  $V_{IN}$  increases above the threshold  $V_{DET-} + V_{HYS}$ . This point is also known as  $V_{DET+}$  as indicated earlier. This built-in hysteresis has been added to the design to help prevent erratic reset operation when the input voltage crosses the threshold.

The LM8364 has a wide variety of applications that can take advantage of its precision and low current consumption to monitor Input voltages even though it was designed as a reset controller in portable microprocessor based systems. It is a very cost effective and space saving device that will protect your more expensive investments of microprocessors and other devices that need a specified supply voltage for proper operation.

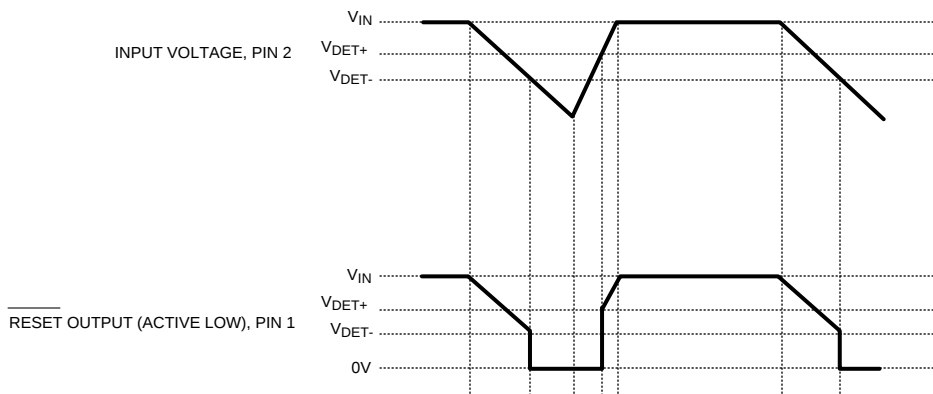


Figure 8. Timing Waveforms

## Typical Applications

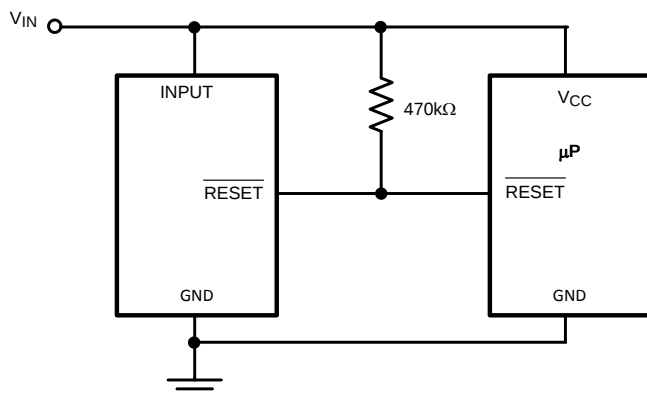


Figure 9. Microprocessor Reset Circuit

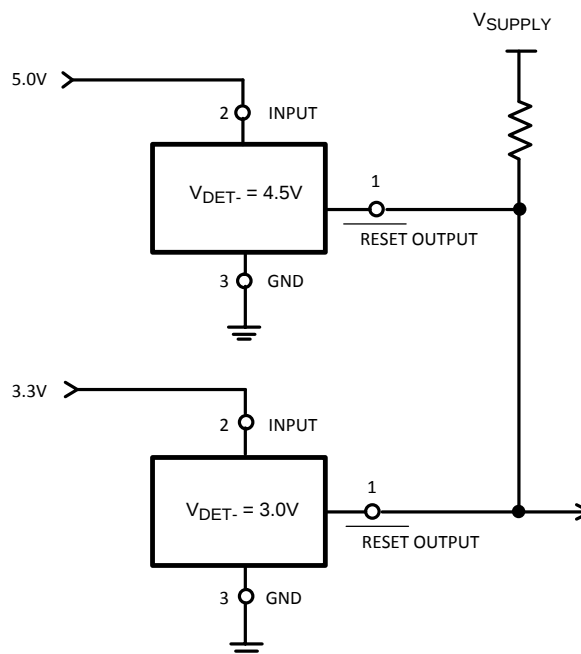
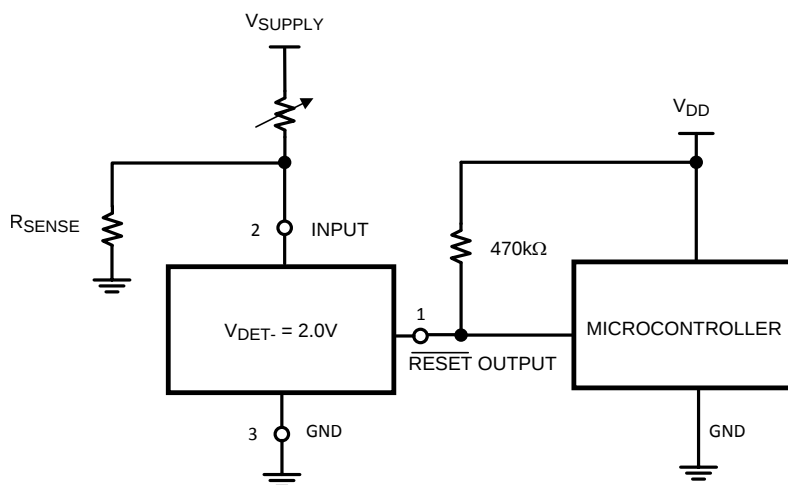


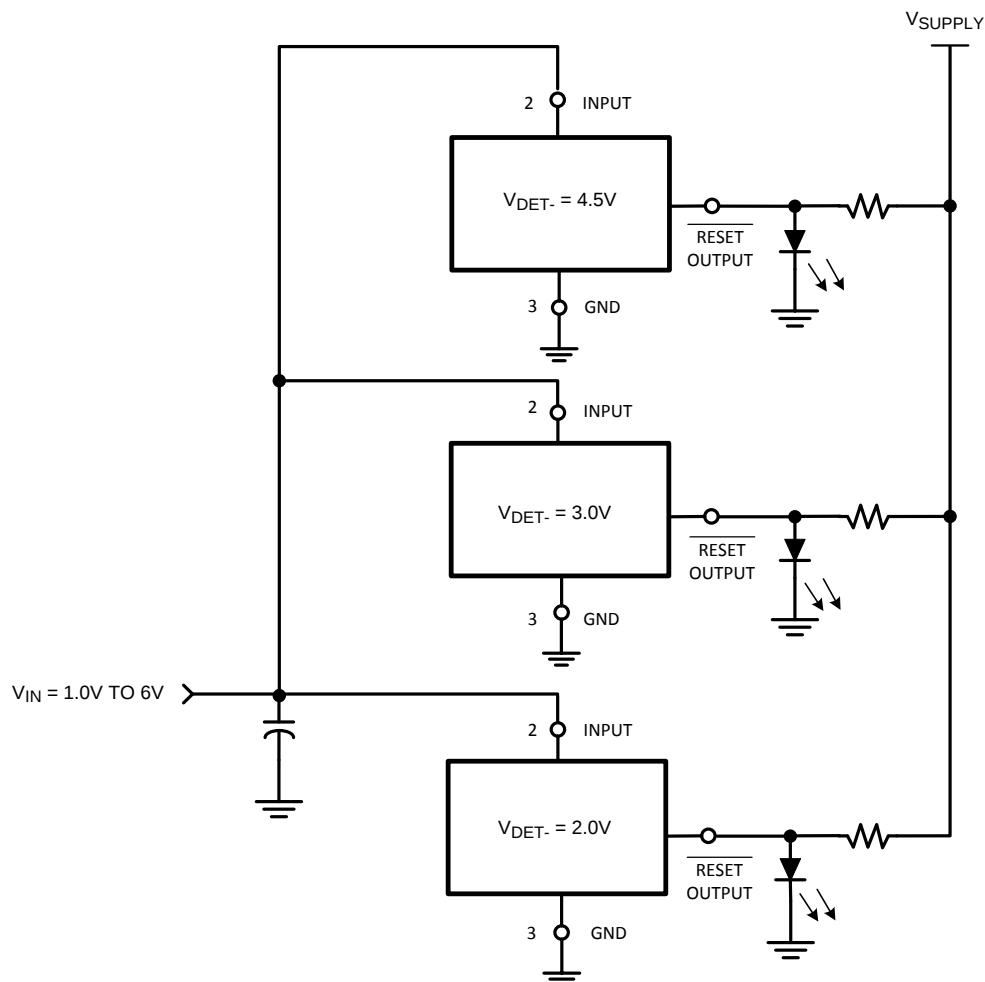
Figure 10. Dual Power Supply Undervoltage Supervision



THIS CIRCUIT MONITORS THE CURRENT AT THE LOAD. AS CURRENT FLOW THROUGH THE LOAD, A VOLTAGE DROP WITH RESPECT TO GROUND APPEARS ACROSS  $R_{SENSE}$  WHERE  $V_{SENSE} = I_{LOAD} * R_{SENSE}$ . THE FOLLOWING CONDITIONS APPLY:

|                                                  |                                            |
|--------------------------------------------------|--------------------------------------------|
| IF:                                              | THEN:                                      |
| $I_{LOAD} < V_{DET-} / R_{SENSE}$                | $\overline{RESET} \text{ OUTPUT} = 0V$     |
| $I_{LOAD} \geq (V_{DET-} + V_{HYS}) / R_{SENSE}$ | $\overline{RESET} \text{ OUTPUT} = V_{DD}$ |

Figure 11. Microcontroller System Load Sensing



EACH LED WILL SEQUENTIALLY TURN ON WHEN THE RESPECTIVE VOLTAGE DETECTOR THRESHOLD ( $V_{DET-} + V_{HYS}$ ) IS EXCEEDED.

**Figure 12. LED Bar Graph Voltage Monitor**

## REVISION HISTORY

### Changes from Revision A (April 2013) to Revision B

### Page

- Changed layout of National Data Sheet to TI format ..... [7](#)

## PACKAGING INFORMATION

| Orderable Device    | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|---------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| LM8364BALMF20       | NRND          | SOT-23       | DBV                | 5    | 1000           | TBD                        | Call TI                 | Call TI              | -40 to 85    | F01A                    |                         |
| LM8364BALMF20/NOPB  | ACTIVE        | SOT-23       | DBV                | 5    | 1000           | Green (RoHS<br>& no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | -40 to 85    | F01A                    | <a href="#">Samples</a> |
| LM8364BALMFX20/NOPB | ACTIVE        | SOT-23       | DBV                | 5    | 3000           | Green (RoHS<br>& no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | -40 to 85    | F01A                    | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

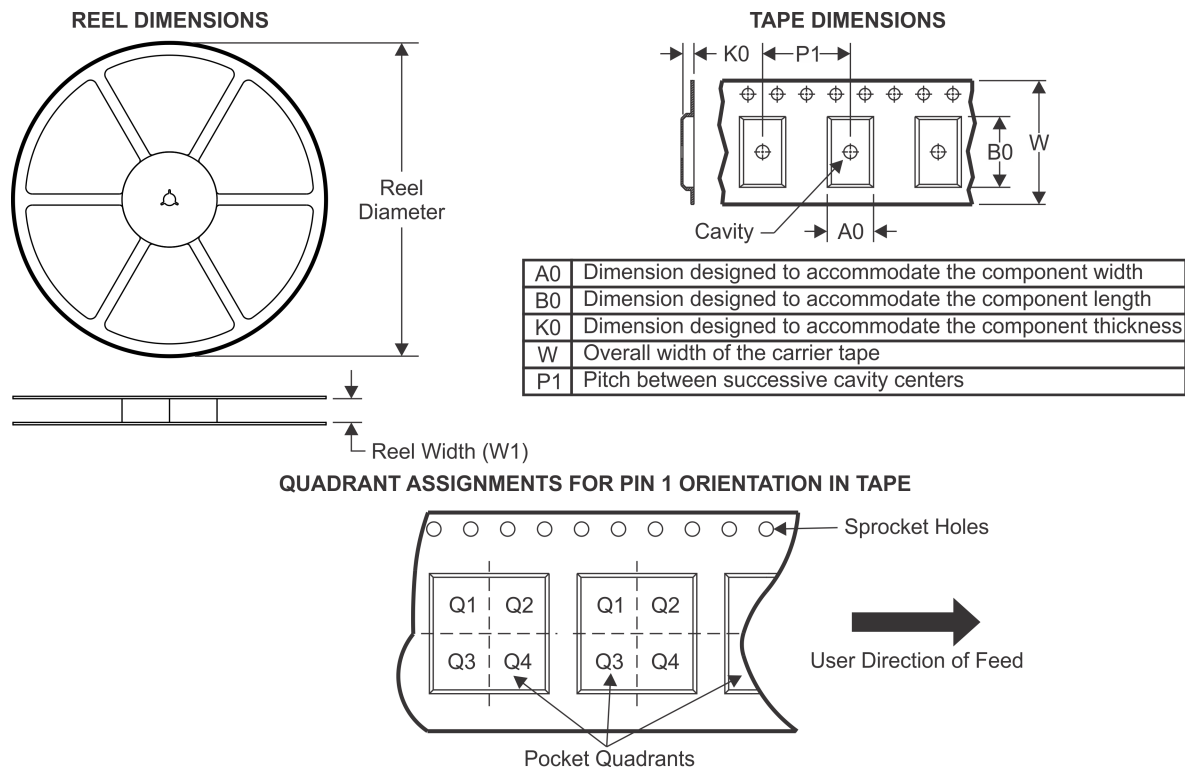
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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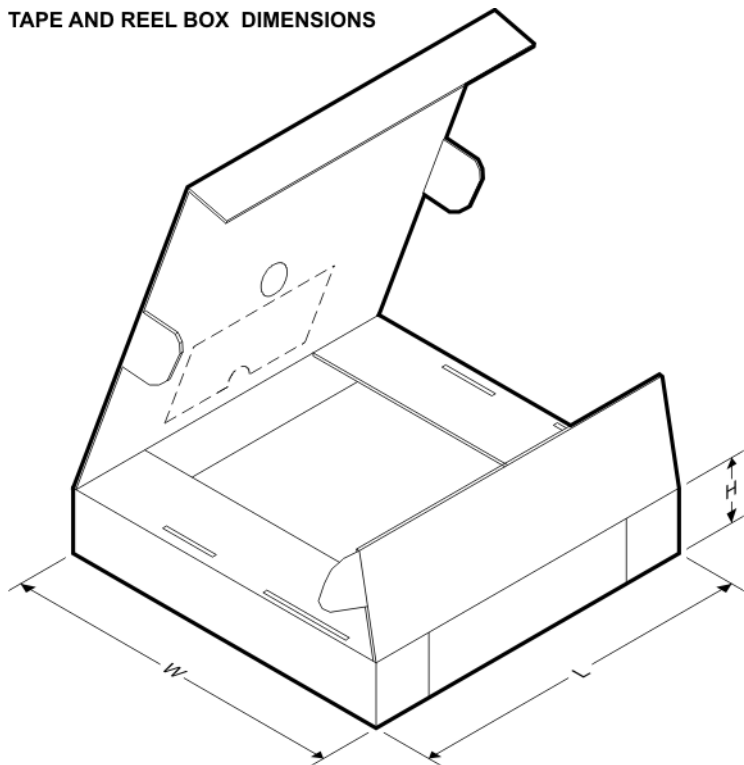
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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LM8364BALMF20       | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM8364BALMF20/NOPB  | SOT-23       | DBV             | 5    | 1000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| LM8364BALMFX20/NOPB | SOT-23       | DBV             | 5    | 3000 | 178.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS

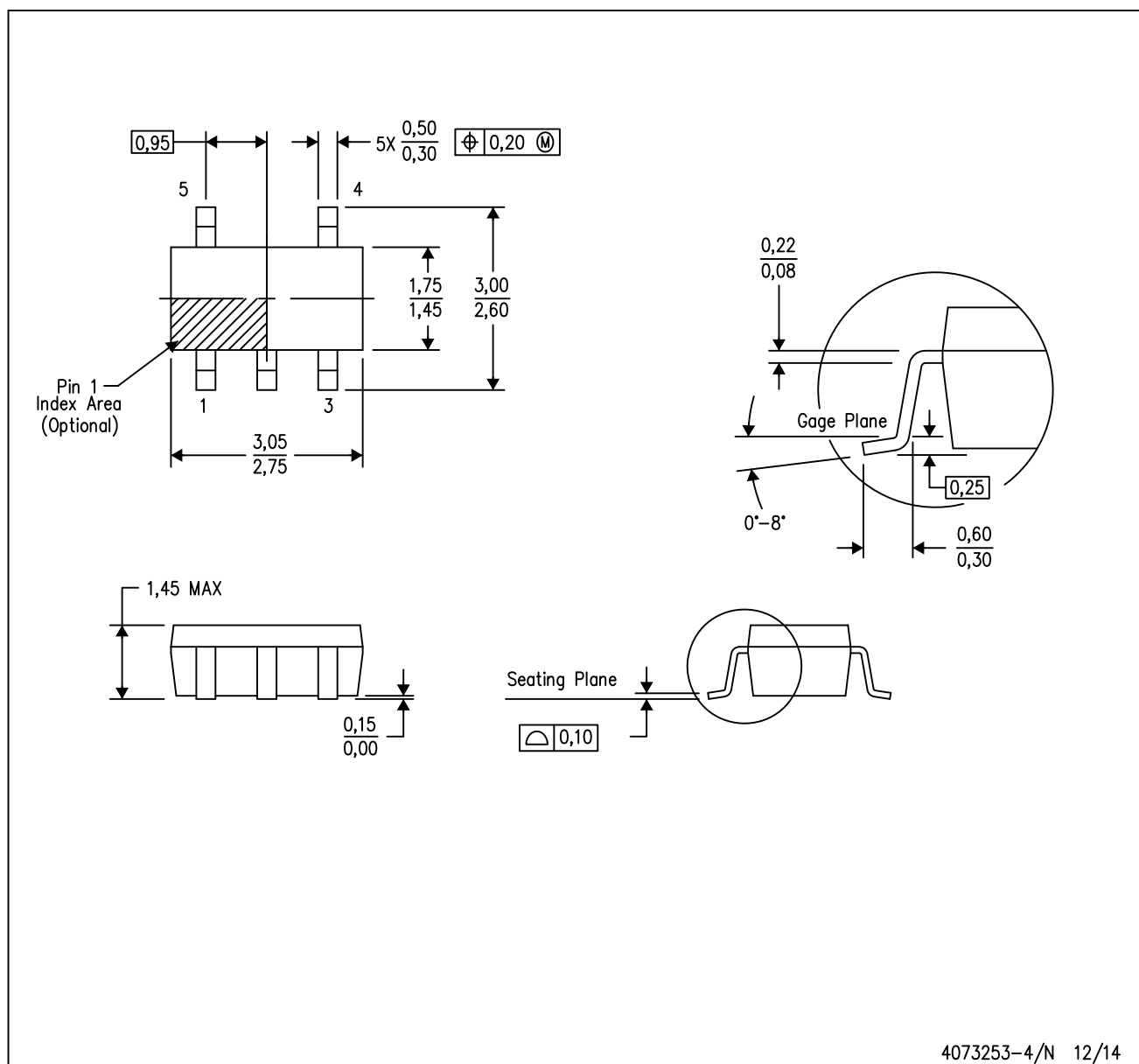


\*All dimensions are nominal

| Device              | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| LM8364BALMF20       | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| LM8364BALMF20/NOPB  | SOT-23       | DBV             | 5    | 1000 | 210.0       | 185.0      | 35.0        |
| LM8364BALMFX20/NOPB | SOT-23       | DBV             | 5    | 3000 | 210.0       | 185.0      | 35.0        |

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-178 Variation AA.

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| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
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### Applications

|                               |                                                                                          |
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| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
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