National Semiconductor

March 2005

# LM8365
# Micropower Undervoltage Sensing Circuits with Programmable Output Delay

## General Description

The LM8365 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 or CMOS, output. These devices feature a very low quiescent current of 0.65µA typical. The LM8365 series features a highly accurate voltage reference, a comparator with precise thresholds and built-in hysterisis to prevent erratic reset operation, a time delayed output which can be programmed by the system designer, and guaranteed Reset operation down to 1.0V with extremely low standby current.

These devices are available in the space saving 5-Pin SOT23 surface mount package. For additional undervoltage thresholds and output options, please contact National Semiconductor.

## Features

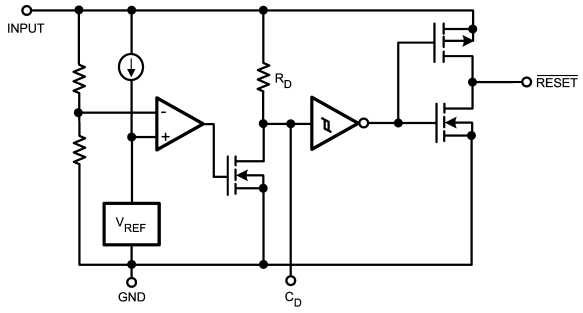
- Extremely Low Quiescent Current: 0.65µA, at $V_{IN}$ = 2.87V
- High Accuracy Threshold Voltage (±2.5%)
- Complementary or Open Drain Output
- Programmable output delay by external Capacitor (100ms typ with 0.1µF)
- Input Voltage Range: 1V to 6V
- Surface Mount Package (5-Pin SOT23)
- Pin for pin compatible with MC33465

## Applications

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

## Functional Diagrams

**CMOS Output**

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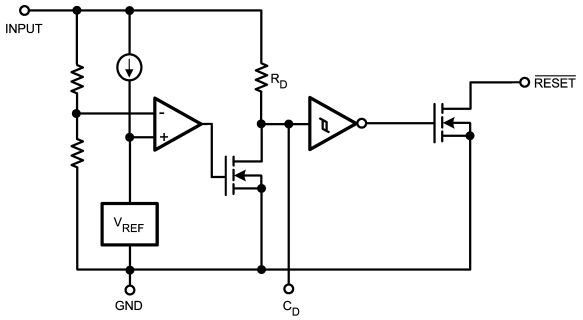
**Open Drain Output**

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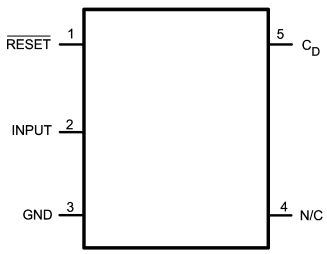
## Connection Diagram

**5-Pin SOT23**

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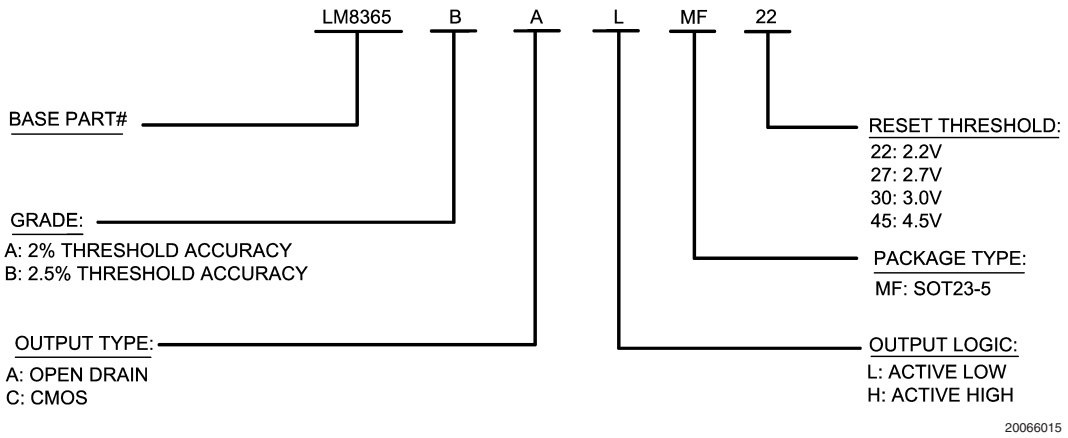
**Top View**

## Pin Description

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## Ordering Information

| Package | Part Number | Package Marking | Threshold | Output Type | Transport Media | NSC Drawing |
|---|---|---|---|---|---|---|
| 5-Pin SOT23 | LM8365BALMF22 | F08A | 2.2V | Open Drain, Active Low | 1k Units Tape and Reel | MF05A |
| | LM8365BALMFX22 | | | | 3k Units Tape and Reel | |
| | LM8365BALMF27 | F07A | 2.7V | Open Drain, Active Low | 1k Units Tape and Reel | |
| | LM8365BALMFX27 | | | | 3k Units Tape and Reel | |
| | LM8365BCLMF30 | F02A | 3.0V | CMOS, Active Low | 1k Units Tape and Reel | |
| | LM8365BCLMFX30 | | | | 3k Units Tape and Reel | |
| | LM8365BALMF45 | F06A | 4.5V | Open Drain, Active Low | 1k Units Tape and Reel | |
| | LM8365BALMFX45 | | | | 3k Units Tape and Reel | |

## Absolute Maximum Ratings (Note 1)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.**

| | |
|---|---|
| Supply Voltage | −0.3V to 6.5V |
| $\overline{\text{RESET}}$ Output Voltage | −0.3V to 6.5V |
| $\overline{\text{RESET}}$ Output Current | 70mA |
| Storage Temperature Range | −65˚C to 150˚C |
| Mounting Temperature | |
| Lead Temp. (Soldering 10 sec) | 260˚C |
| Junction Temperature | 125˚C |

## Operating Ratings (Note 1)

| | |
|---|---|
| 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 |

## Electrical Characteristics

Unless otherwise specified, all limits guaranteed for $T_A$ = 25˚C.

| Symbol | Parameter | Conditions | Min (Note 3) | Typ (Note 2) | Max (Note 3) | Units |
|---|---|---|---|---|---|---|
| $V_{DET-}$ | Detector Threshold Voltage | High to Low State Output ($V_{IN}$ Decreasing) | | | | V |
| | | 22 Suffix | 2.145 | 2.2 | 2.255 | |
| | | 27 Suffix | 2.633 | 2.7 | 2.767 | |
| | | 30 Suffix | 2.925 | 3.0 | 3.075 | |
| | | 45 Suffix | 4.388 | 4.5 | 4.613 | |
| $V_{HYS}$ | Detector Threshold Hysteresis | $V_{IN}$ Increasing | | | | V |
| | | 22 Suffix | 0.066 | 0.110 | 0.154 | |
| | | 27 Suffix | 0.081 | 0.135 | 0.189 | |
| | | 30 Suffix | 0.090 | 0.150 | 0.210 | |
| | | 45 Suffix | 0.135 | 0.225 | 0.315 | |
| $\Delta$Vdet/$\Delta$T | Detector Threshold Voltage Temperature Coefficient | | | ±100 | | PPM/˚C |
| $V_{OH}$<br>$V_{OL}$ | $\overline{\text{RESET}}$ Output Voltage | (CMOS Output: $I_{SOURCE}$ = 1mA)<br>(Open Drain or CMOS Output: $I_{SINK}$ = 1mA) | $V_{IN}$-2.1 | $V_{IN}$-1.0<br>0.25 | $V_{IN}$<br>0.5 | V |
| $I_{OL}$ | $\overline{\text{RESET}}$ Output Sink Current | $V_{IN}$ = 1.5V, $V_{OL}$ = 0.5V | 1.0 | 2.5 | | mA |
| $I_{OH}$ | $\overline{\text{RESET}}$ Output Source Current | $V_{IN}$ = 4.5V, $V_{OL}$ = 2.4V | 1.0 | 7.0 | | mA |
| $I_{CD}$ | Delay Pin Output Sink Current | $V_{IN}$ = 1.5V, $V_{CD}$ = 0.5V | 0.2 | 1.8 | | mA |
| $R_D$ | Delay Resistance | | 0.5 | 1.0 | 2.0 | MΩ |
| $V_{IN}$ | Operating Input Voltage Range | | 1.0 | | 6.0 | V |
| $I_{IN}$ | Quiescent Input Current | 22 Suffix | | | | µA |
| | | $V_{IN}$ = 2.10V | | 0.57 | 0.8 | |
| | | $V_{IN}$ = 4.20V | | 0.71 | 1.3 | |
| | | 27 Suffix | | | | |
| | | $V_{IN}$ = 2.60V | | 0.62 | 0.9 | |
| | | $V_{IN}$ = 4.70V | | 0.75 | 1.3 | |
| | | 30 Suffix | | | | |
| | | $V_{IN}$ = 2.87V | | 0.65 | 0.9 | |
| | | $V_{IN}$ = 5.00V | | 0.77 | 1.3 | |
| | | 45 Suffix | | | | |
| | | $V_{IN}$ = 4.34V | | 0.70 | 1.0 | |
| | | $V_{IN}$ = 6.00V | | 0.85 | 1.4 | |

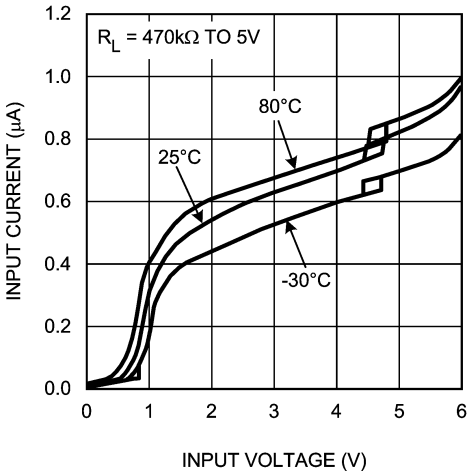
**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical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

**Note 2:** Typical values represent the most likely parametric norm.

**Note 3:** All limits are guaranteed by testing or statistical analysis.

## Typical Performance Characteristics

**Input Current vs. Input Voltage**
**LM8365BALMF45**

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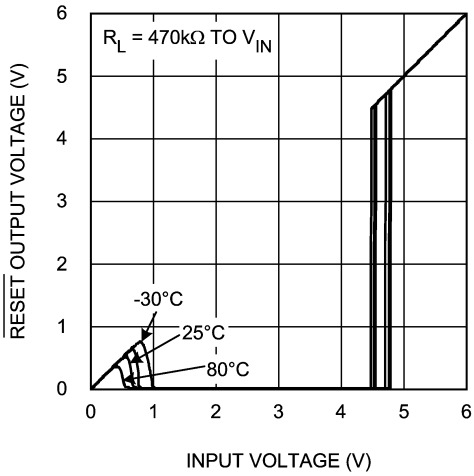
**$\overline{\text{Reset}}$ Output Voltage vs. Input Voltage**
**LM8365BALMF45**

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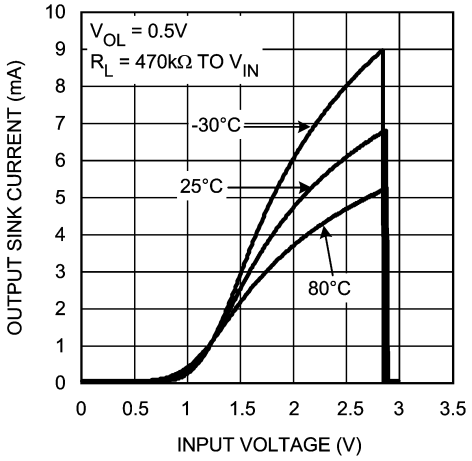
**$\overline{\text{Reset}}$ Output Sink Current vs. Input Voltage**
**LM8365BALMF27**

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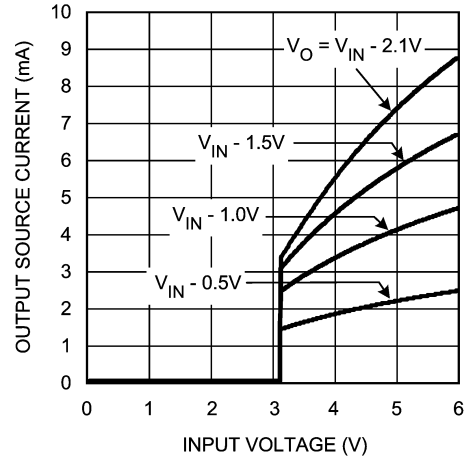
**$\overline{\text{Reset}}$ Output Source Current vs. Input Voltage**
**LM8365BCLMF30**

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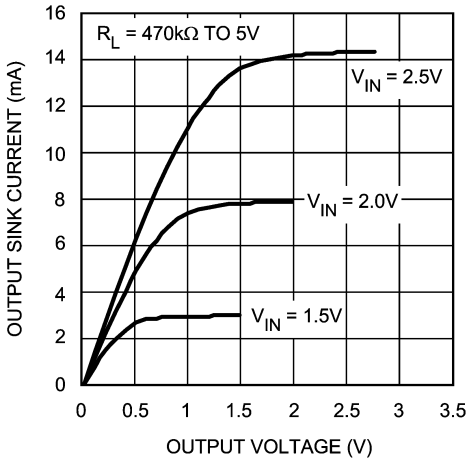
**$\overline{\text{Reset}}$ Output Sink Current vs. $\overline{\text{Reset}}$ Output Voltage**
**LM8365BALMF45**

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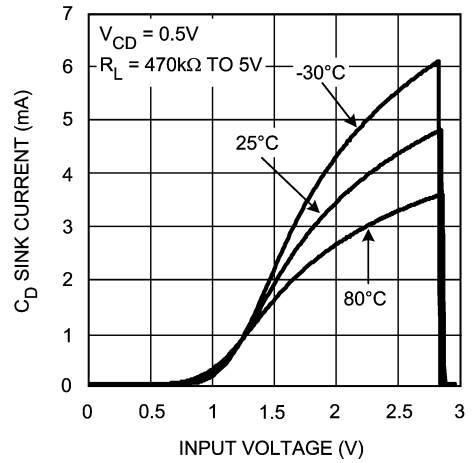
**$C_D$ Sink Current vs. Input Voltage**
**LM8365BALMF27**

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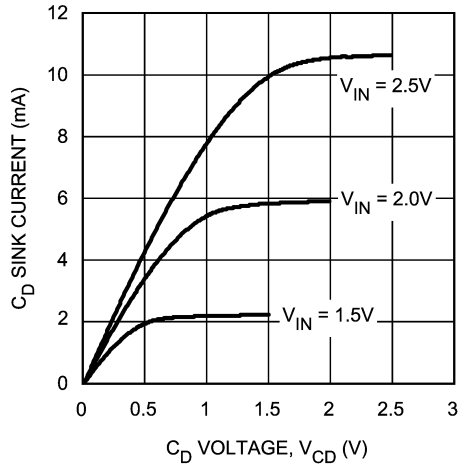
## Typical Performance Characteristics (Continued)

**$C_D$ Sink Current vs. $C_D$ Voltage**

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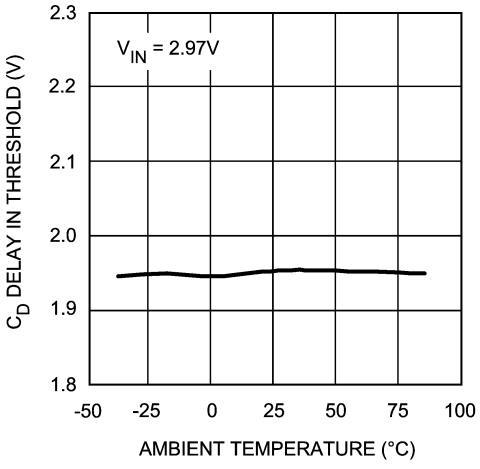
**$C_D$ Delay Pin Threshold Voltage vs. Temperature LM8365BALMF27**

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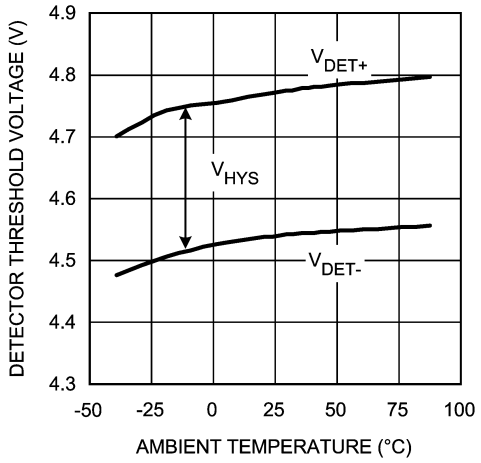
**Detector Threshold Voltage vs. Temperature LM8365BALMF45**

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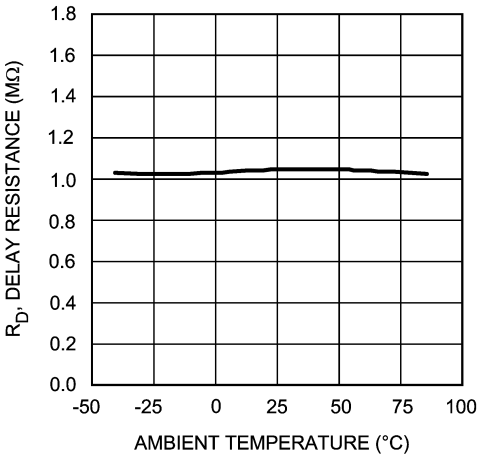
**Delay Resistance vs. Temperature**

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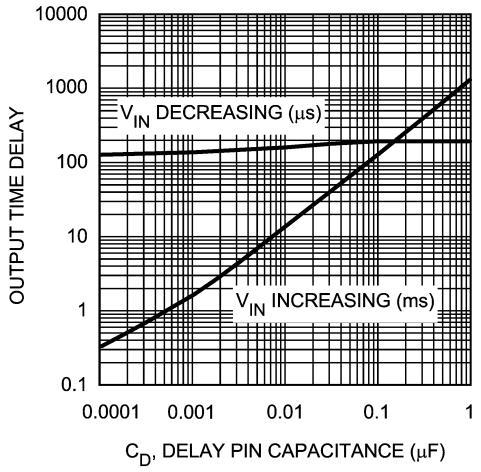
**Output Time Delay vs. Capacitance**

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## Application Notes

The propagation delay time for the LM8365 is measured using a 470kΩ pull-up resistor connected to from the $\overline{\text{RESET}}$ output pin to 5V in addition to a 10pF capacitive load connected from the same pin to GND. *Figure 1* 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, $V_{HYS}$. $t_{D1}$ is the propagation time from High-to-Low and $t_{D2}$ is the propagation from Low-to-High.

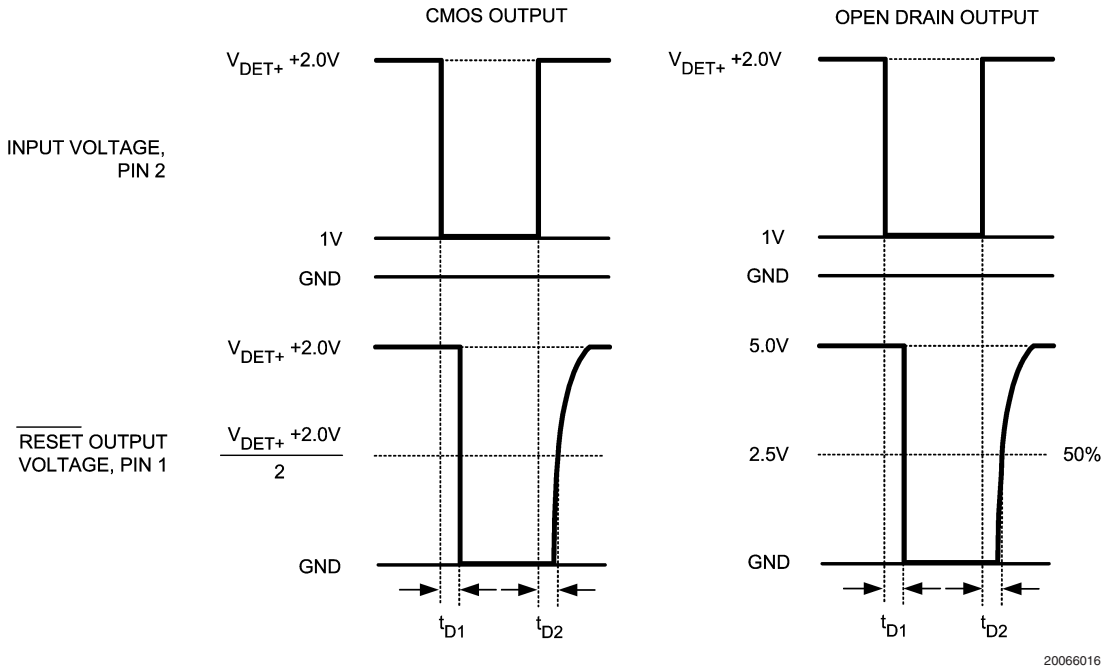



**FIGURE 1. Propagation Delay Timing Diagrams**

The LM8365 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. The voltage detector of the LM8365 drives a time delay generator that may be programmed for fixed lengths of time depending on the application needs. This characteristic is displayed in the typical operating timing diagram in *Figure 2*. $V_{IN}$ is the voltage that is being monitored and as it decreases passed the precisely trimmed threshold $V_{DET-}$ the Active Low $\overline{\text{RESET}}$ output drops to a Logic Low state and the $C_D$ pin drops to 0V. During this state the external capacitor connected to the $C_D$ pin is immediately discharged by an internal N-Channel MOSFET. When $V_{IN}$ increases above the threshold $V_{DET+}$ ($V_{DET-}$ + $V_{HYS}$) the capacitor connected to the $C_D$ pin starts to charge up to $V_{IN}$ through an internal pull-up resistor $R_D$. Once the capacitor has charged up past the internal Delay Pin Threshold, which is typically 0.675 $V_{IN}$, the $\overline{\text{RESET}}$ output will revert back to it's original state. The LM8365 has built-in hysteresis to help prevent erratic reset operation when the input voltage crosses the threshold.

The LM8365 has a wide variety of applications that can take advantage of it's 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 guaranteed supply voltage and time delay for proper operation.

## Application Notes (Continued)

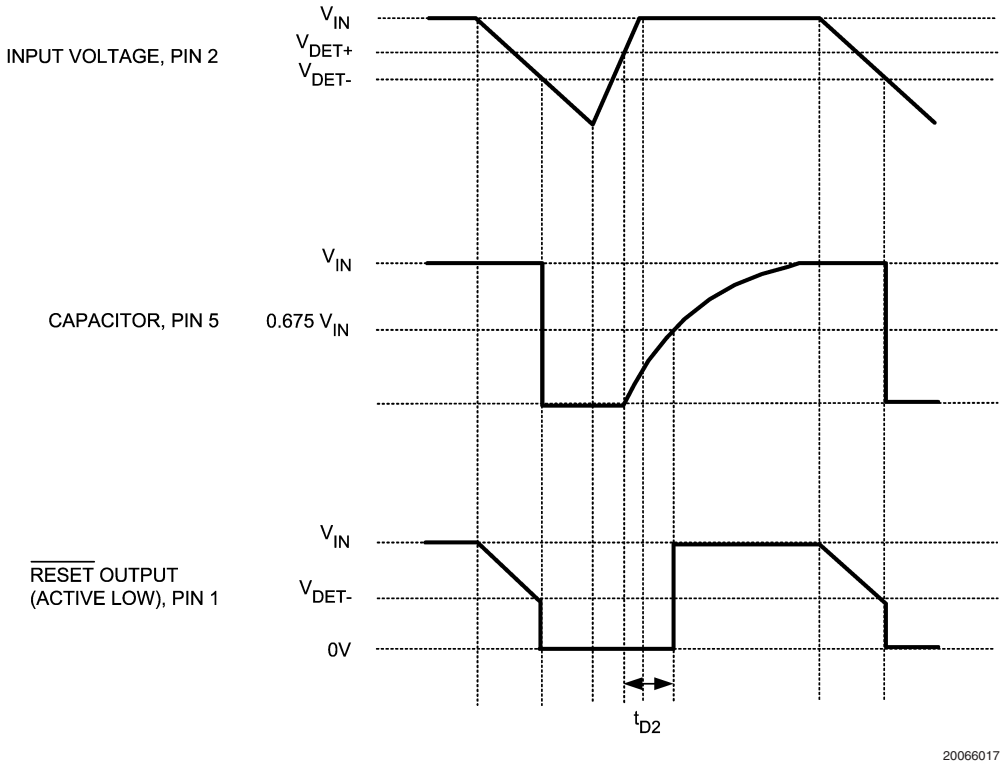
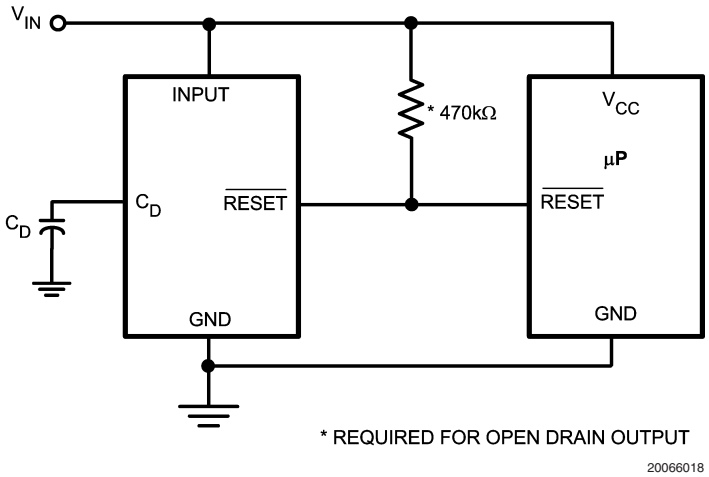
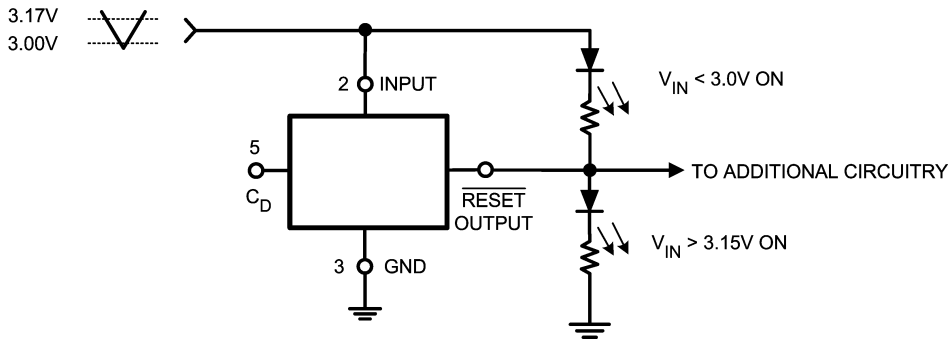



**FIGURE 2. Timing Waveforms**

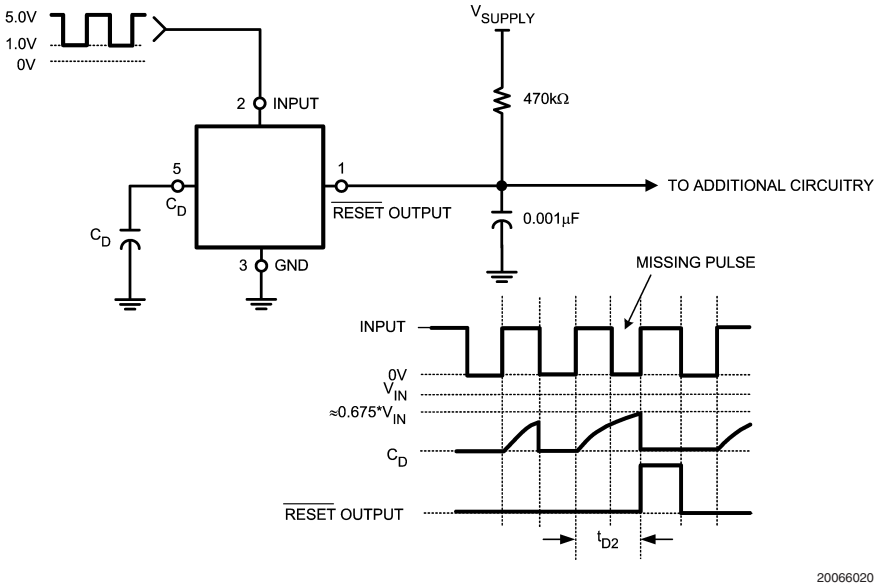
## Typical Applications




**Microprocessor $\overline{\text{Reset}}$ Circuit**



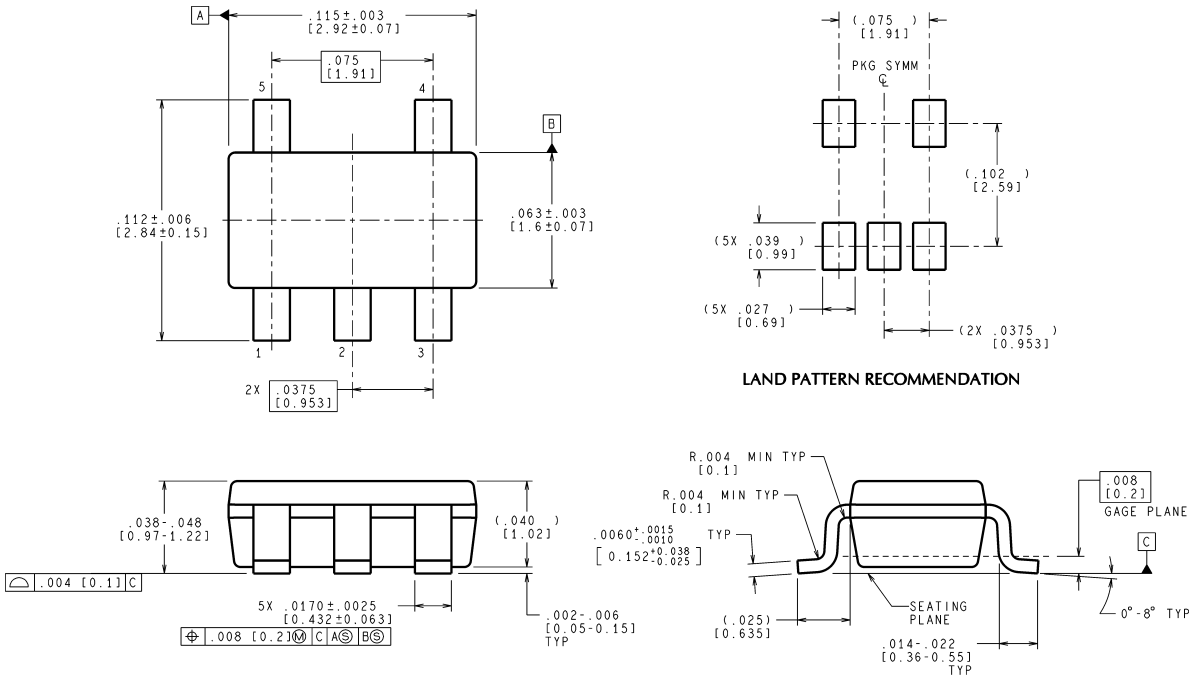

**Battery Charge Indicator Using LM8365BCLMF30**




**Missing Pulse Detector or Frequency Detector Using LM8365BALMF45**

## Physical Dimensions inches (millimeters)

unless otherwise noted




CONTROLLING DIMENSION IS INCH
VALUES IN [ ] ARE MILLIMETERS

MF05A (Rev B)

**5-Pin SOT23-5**
**NSC Package Number MF05A**



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