LM8365 Micropower Undervoltage Sensing Circuits with Programmable Output Delay

Check for Samples: LM8365

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 SOT-23)**
- **Pin for pin compatible with MC33465**

APPLICATIONS

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

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 hystersis to prevent erratic reset operation, a time delayed output which can be programmed by the system designer, and specified Reset operation down to 1.0V with extremely low standby current.

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

Functional Diagrams

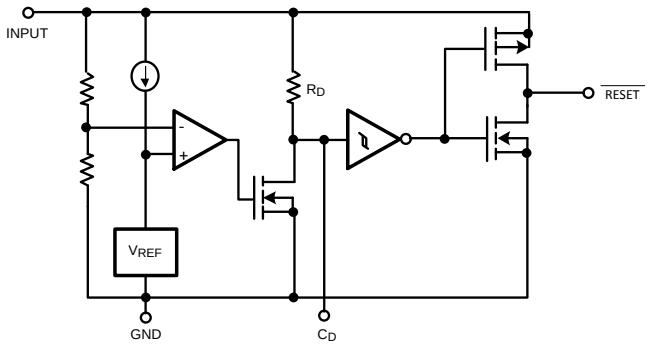

Figure 1. CMOS Output

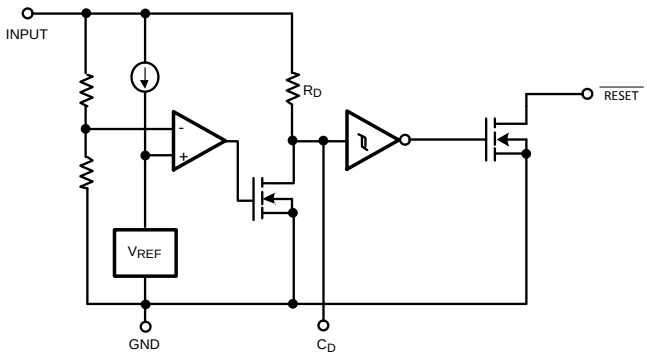

Figure 2. Open Drain Output

Connection Diagram

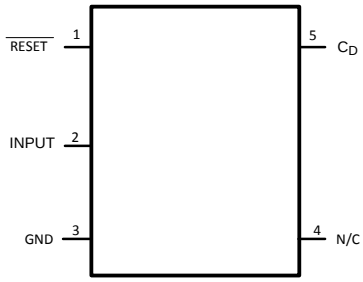

Figure 3. 5-Pin SOT-23 (Top View)

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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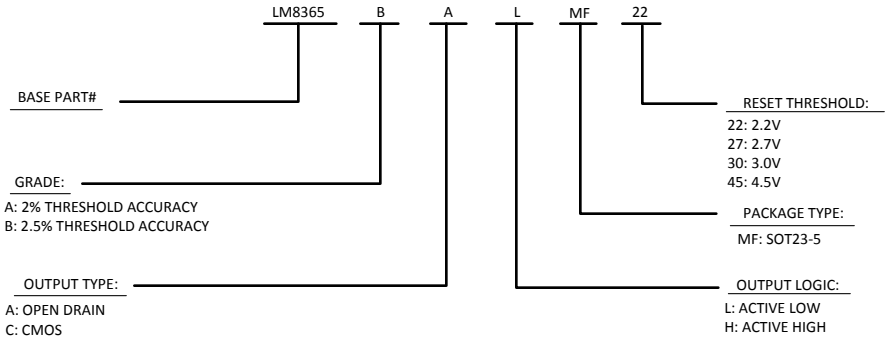
PIN DESCRIPTION



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(1)(2)

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

(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(1)

Temperature Range	−40°C to 85°C
Thermal Resistance to Ambient (θ_{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 specified for T_A = 25°C.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	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	

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

ELECTRICAL CHARACTERISTICS (continued)

Unless otherwise specified, all limits specified for T_A = 25°C.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
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	
ΔVdet/ΔT	Detector Threshold Voltage Temperature Coefficient			±100		PPM/°C
V_{OH} V_{OL}	$\overline{RESET}$ Output Voltage	(CMOS Output: I_{SOURCE} = 1mA) (Open Drain or CMOS Output: I_{SINK} = 1mA)	V_{IN}-2.1	V_{IN}-1.0 0.25	V_{IN} 0.5	V
I_{OL}	$\overline{RESET}$ Output Sink Current	V_{IN} = 1.5V, V_{OL} = 0.5V	1.0	2.5		mA
I_{OH}	$\overline{RESET}$ 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	

TYPICAL PERFORMANCE CHARACTERISTICS

Input Current vs. Input Voltage
LM8365BALMF45

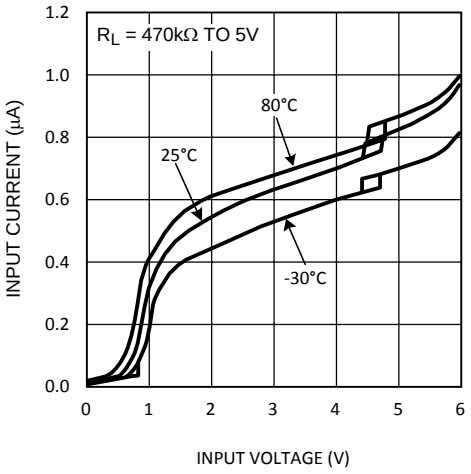


Figure 4.

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

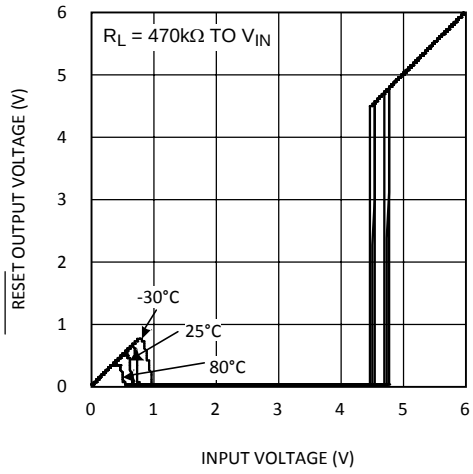


Figure 5.

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

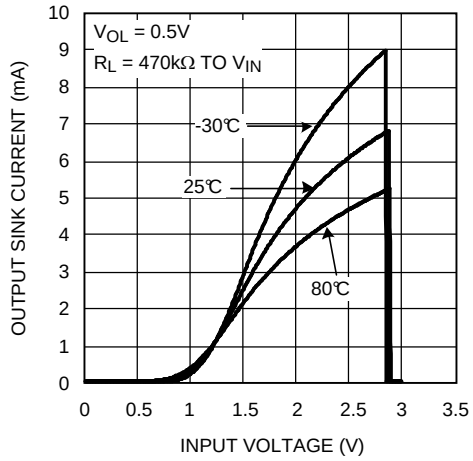


Figure 6.

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

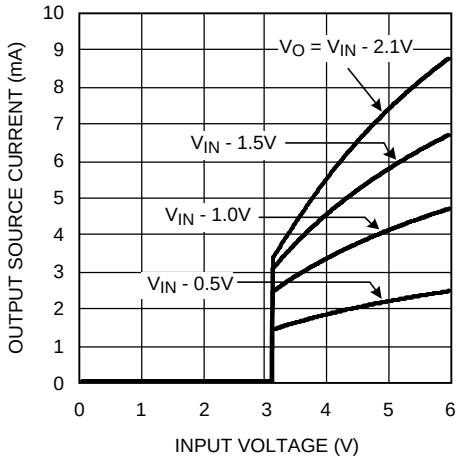


Figure 7.

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

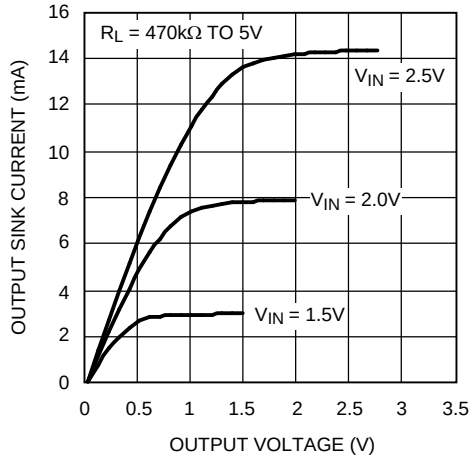


Figure 8.

C_D Sink Current vs. Input Voltage
LM8365BALMF27

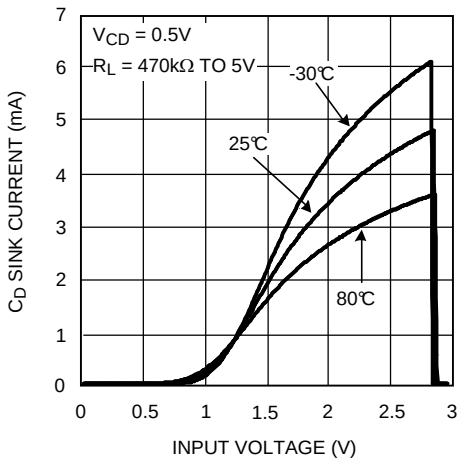


Figure 9.

TYPICAL PERFORMANCE CHARACTERISTICS (continued)

C_D Sink Current vs. C_D Voltage

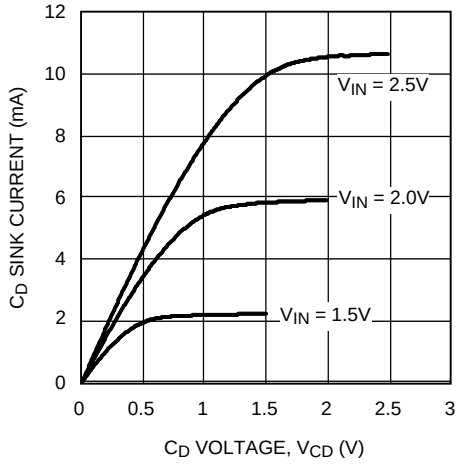


Figure 10.

C_D Delay Pin Threshold Voltage vs. Temperature LM8365BALMF27

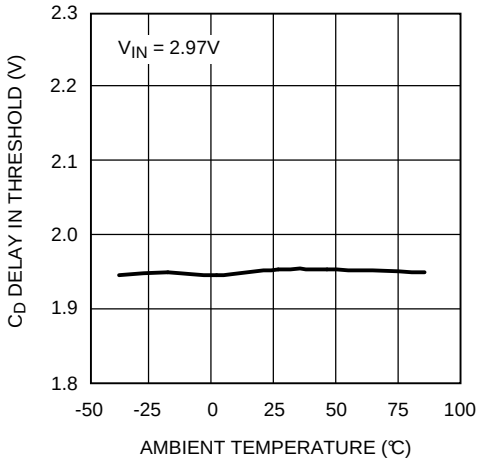


Figure 11.

Detector Threshold Voltage vs. Temperature LM8365BALMF45

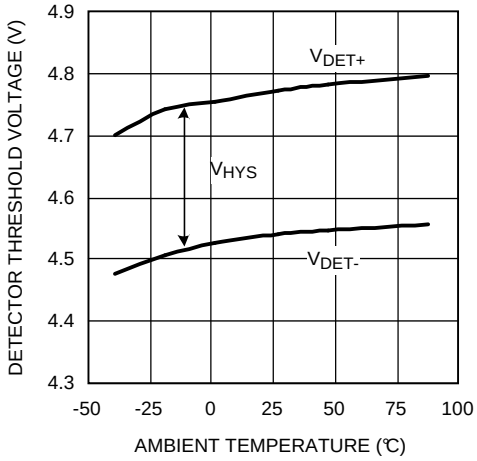


Figure 12.

Delay Resistance vs. Temperature

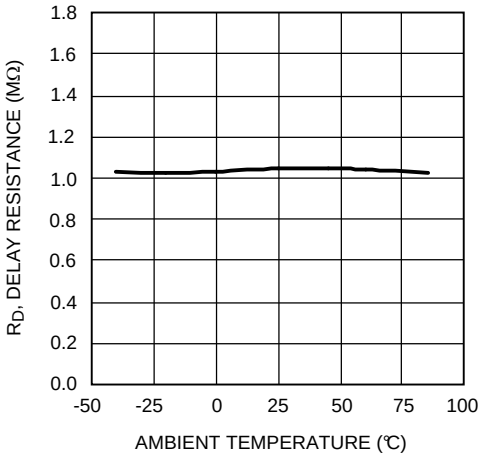


Figure 13.

Output Time Delay vs. Capacitance

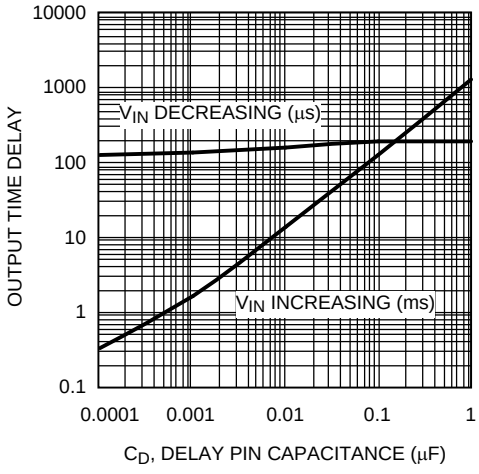


Figure 14.

APPLICATION NOTES

The propagation delay time for the LM8365 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 15 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.

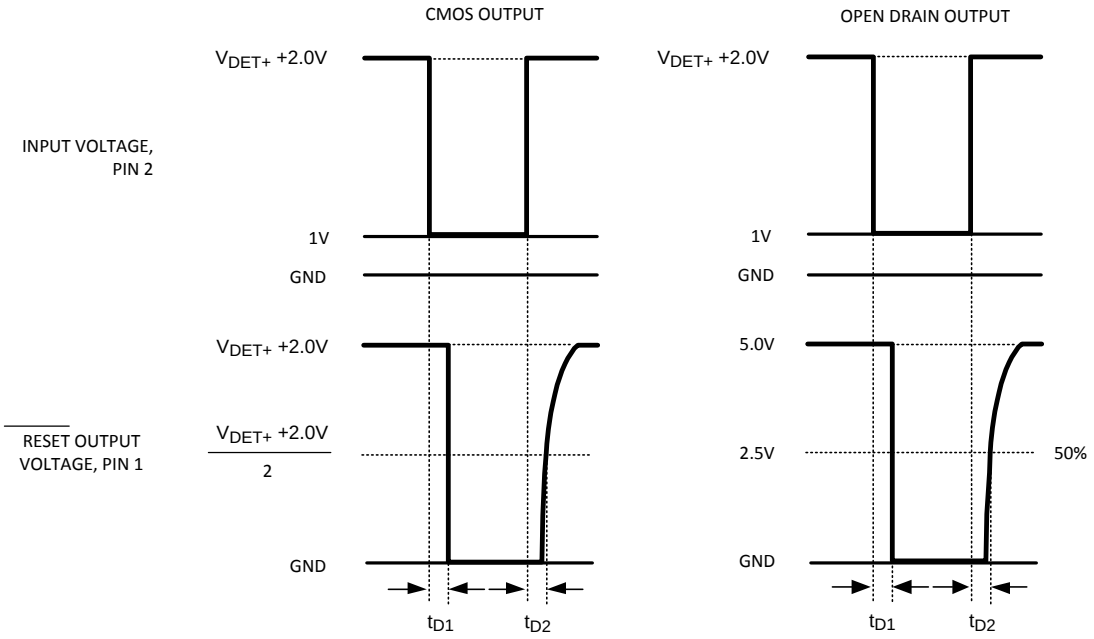


Figure 15. Propagation Delay Timing Diagrams

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 16. V_{IN} is the voltage that is being monitored and as it decreases passed the precisely trimmed threshold V_{DET-} the Active Low 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 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 specified supply voltage and time delay for proper operation.

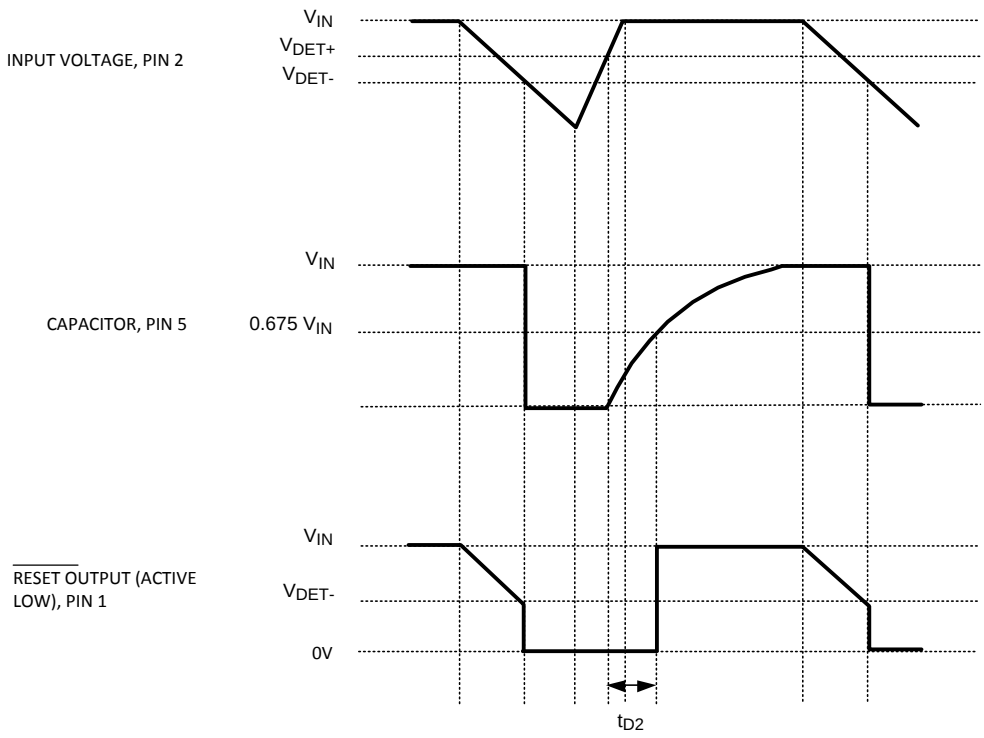


Figure 16. Timing Waveforms

Typical Applications

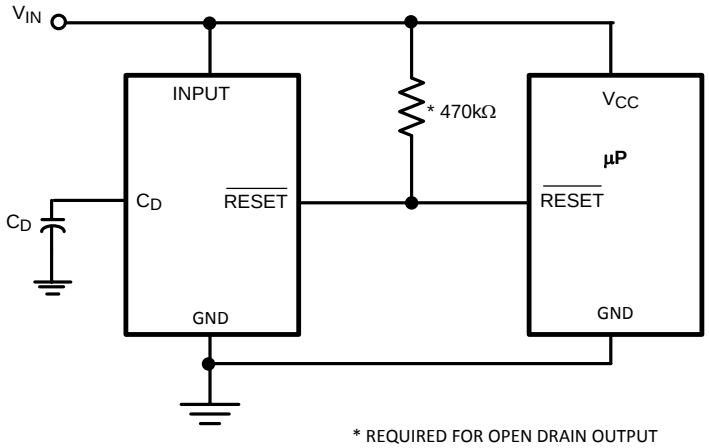


Figure 17. Microprocessor $\overline{\text{Reset}}$ Circuit

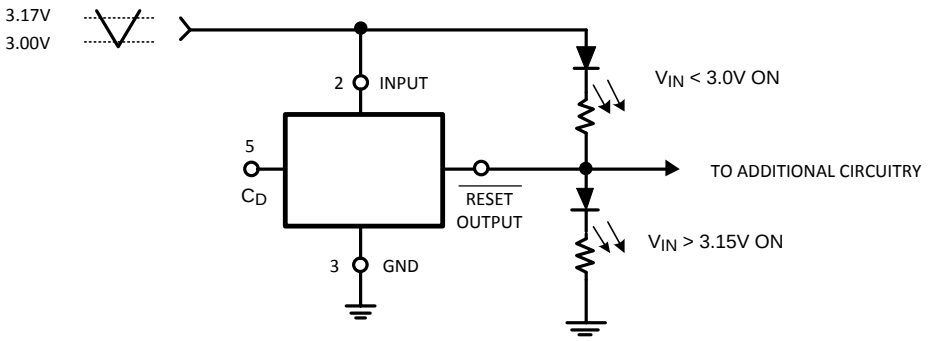


Figure 18. Battery Charge Indicator Using LM8365BCLMF30

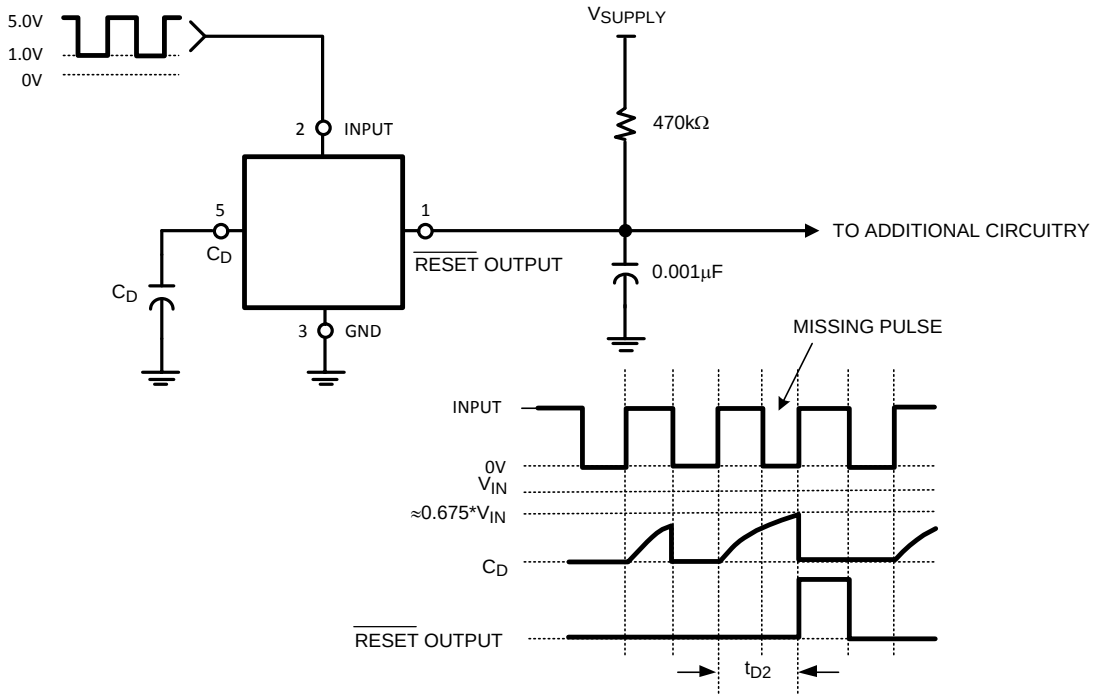


Figure 19. Missing Pulse Detector or Frequency Detector Using LM8365BALMF45

REVISION HISTORY

Changes from Revision A (April 2013) to Revision B	Page
• Changed layout of National Data Sheet to TI format	8

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LM8365BALMF27/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	F07A	Samples
LM8365BALMFX27	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	F07A	Samples
LM8365BALMFX27/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	F07A	Samples
LM8365BALMFX45	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	F06A	Samples
LM8365BALMFX45/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	F06A	Samples

(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)

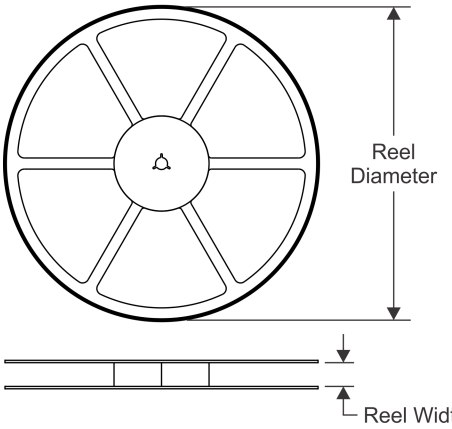
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

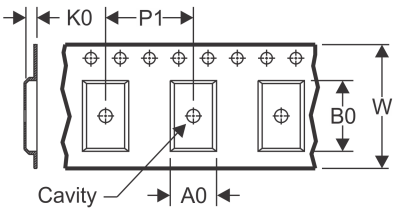
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

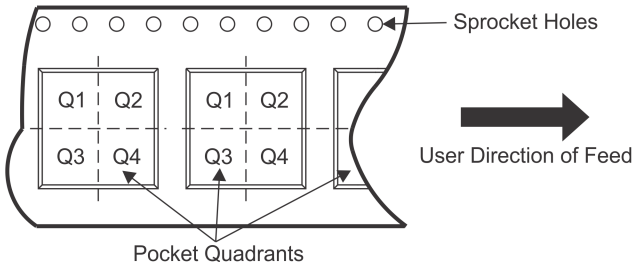


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

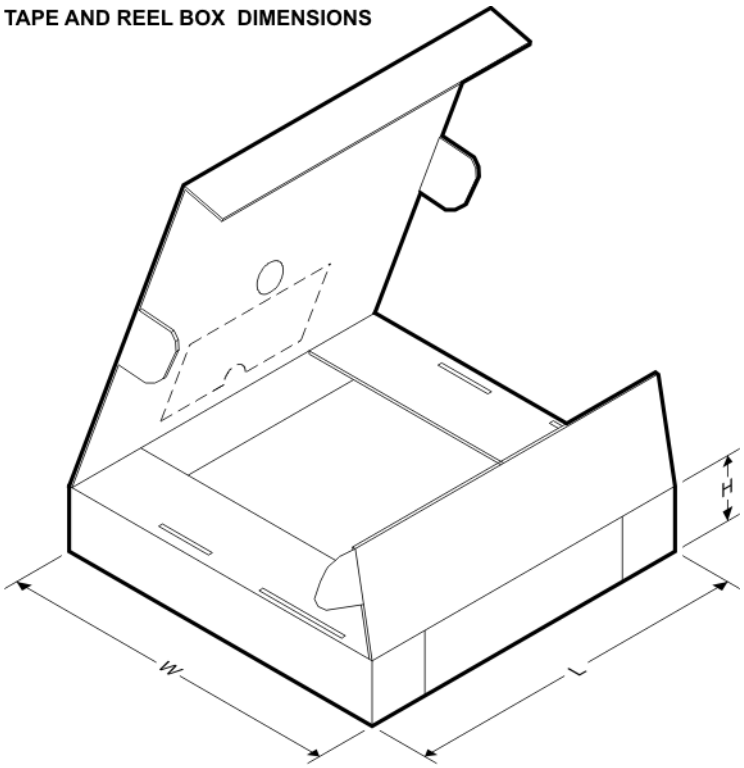
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LM8365BALMF27/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM8365BALMFX27	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM8365BALMFX27/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM8365BALMFX45	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LM8365BALMFX45/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3

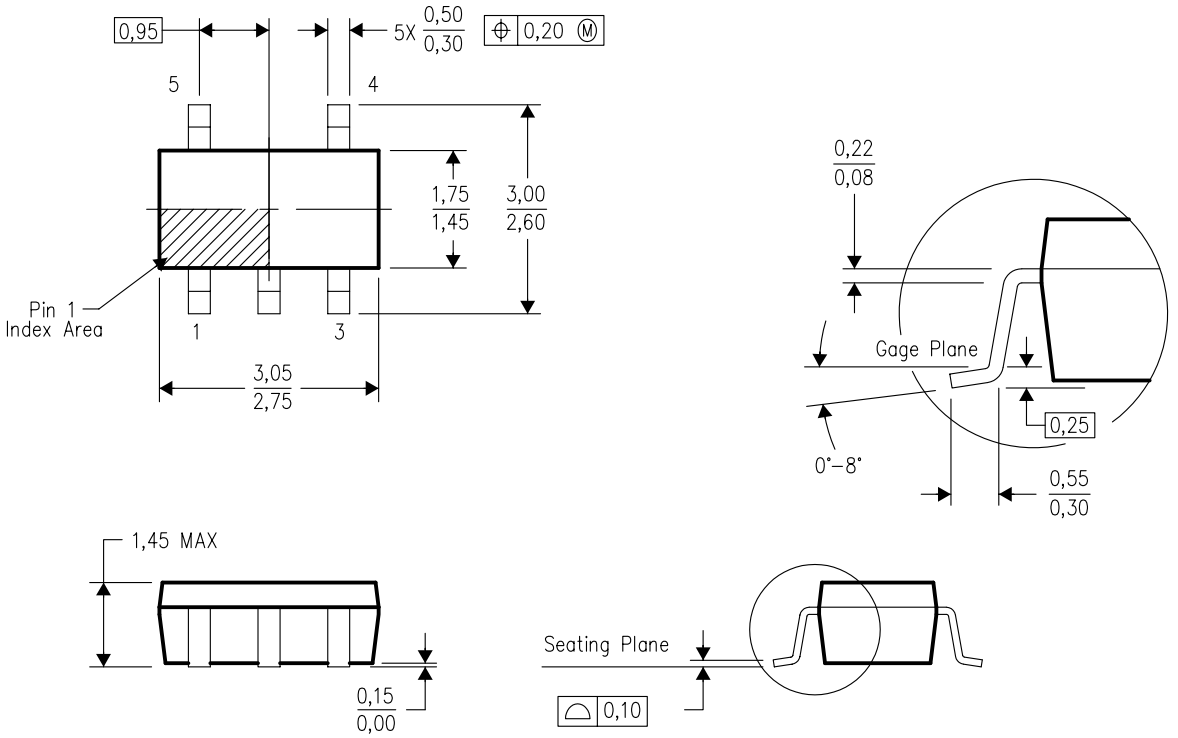
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LM8365BALMF27/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LM8365BALMFX27	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM8365BALMFX27/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM8365BALMFX45	SOT-23	DBV	5	3000	210.0	185.0	35.0
LM8365BALMFX45/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0

DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4073253–4/K 03/2006

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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