

# LM3622

## Lithium-Ion Battery Charger Controller

### General Description

The LM3622 is a charge controller for Lithium-Ion batteries. This monolithic integrated circuit accurately controls an external pass transistor for precision Lithium-Ion battery charging. The LM3622 provides a constant voltage or constant current (CVCC) configuration that changes, as necessary, to optimally charge lithium-ion battery cells. Voltage charging versions (4.1V, 4.2V, 8.2V, and 8.4V) are available for one or two cell battery packs and for coke or graphite anode battery chemistry.

The LM3622 accepts input voltages from 4.5V to 24V. Controller accuracy over temperature is  $\pm 30\text{mV}/\text{cell}$  for A grade and  $\pm 50\text{mV}/\text{cell}$  for the standard grade. No precision external resistors are required. Furthermore, the LM3622's proprietary output voltage sensing circuit drains less than 200nA from the battery when the input source is disconnected.

The LM3622 circuitry includes functions for regulating the charge voltage with a temperature compensated bandgap reference and regulating the current with an external sense resistor. The internal bandgap insures excellent controller performance over the operating temperature and input supply range.

The LM3622 can sink 15mA minimum at the EXT pin to drive the base of an external PNP pass transistor. It also has

low-voltage battery threshold circuitry that removes this drive when the cell voltage drops below a preset limit. The  $\text{LV}_{\text{SEL}}$  pin programs this threshold voltage to either 2.7V/cell or 2.15V/cell. The low-voltage detection, which is a user enabled feature, provides an output signal that can be used to enable a "wake up charge" source automatically to precondition a deeply discharged pack.

The LM3622 is available in a standard 8-lead SOIC surface mount package.

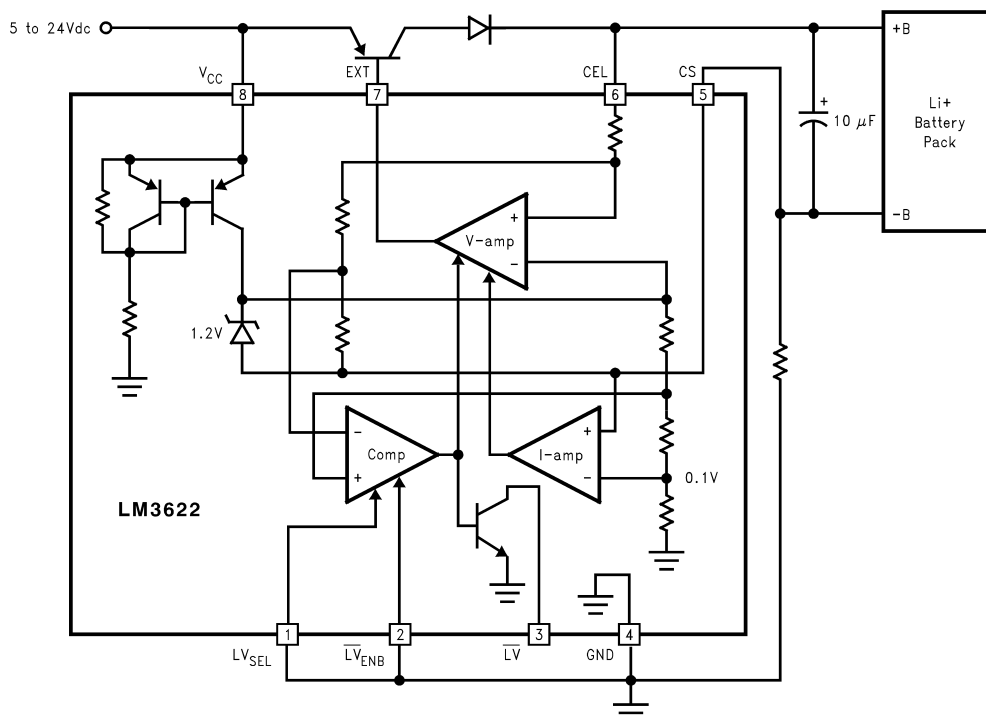
### Features

- Versions for charging of 1 cell (4.1V or 4.2V) or 2 cells (8.2V or 8.4V)
- Versions for coke or graphite anode
- Precision ( $\pm 30\text{mV}/\text{cell}$ ) end-of-charge control
- Wide input range: 4.5V-24V
- Low battery drain leakage: 200nA
- 15 mA available to drive low cost PNP

### Applications

- Cellular phone cradle charger
- PDA/Notebook cradle charger
- Camcorder cradle charger

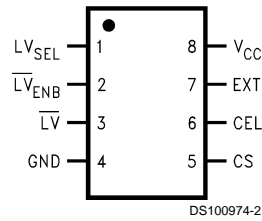
### Typical Application



DS100974-1

## Connection Diagram

8-Lead Surface Mount Package



Refer to the Ordering Information Table in this Datasheet for Specific Part Number  
See NS Package M08A

## Pin Description

Pin No.	Name	I/O	Description
1	LV <sub>SEL</sub>	Input	Low-voltage detection threshold Select. The threshold is 2.15V/cell when this pin is pulled low to GND and 2.70V/cell when it is pulled up to V <sub>CC</sub> . The battery voltage is sensed between CEL and CS pins.
2	LV <sub>ENB</sub>	Input	Low-voltage detection Enable. The low-voltage detection is enabled when this pin is pulled Low to GND. Pulling this pin HIGH to V <sub>CC</sub> disables the low-voltage detection.
3	LV	Output	Output of the low-voltage detection. This pin is a NPN open-collector output that goes to low impedance state when LV <sub>ENB</sub> is pulled LOW and the battery voltage is below the threshold set by LV <sub>SEL</sub> . LV stays in HIGH impedance state at any battery voltage when LV <sub>ENB</sub> is pulled HIGH to V <sub>CC</sub> . LV can be used for turning on a low current source to recondition a deeply depleted battery.
4	GND	Ground	IC common.
5	CS	Input	Input for battery charge current and battery negative-terminal voltage sensing. Battery charging current is sensed through an external resistor, R <sub>CS</sub> , connected between the battery's negative terminal and GND. The maximum charge current is regulated to a value of 100mV/R <sub>CS</sub> .
6	CEL	Input	Battery positive-terminal voltage sensing.
7	EXT	Output	Output of the controller for driving a PNP transistor or P-MOSFET. The controller modulates the current sinking into this pin to control the regulation of either the charge current or the battery voltage.
8	V <sub>CC</sub>	Power Supply	IC power supply

## Ordering Information

Voltage	Grade	Accuracy	Order Information	Supplied As
4.1V	A	$\pm 30\text{mV}$	LM3622AM-4.1	95 unit increments in rail
4.1V	A	$\pm 30\text{mV}$	LM3622AMX-4.1	2500 unit increments in tape and reel
4.1V	Standard	$\pm 50\text{mV}$	LM3622M-4.1	95 unit increments in rail
4.1V	Standard	$\pm 50\text{mV}$	LM3622MX-4.1	2500 unit increments in tape and reel
4.2V	A	$\pm 30\text{mV}$	LM3622AM-4.2	95 unit increments in rail
4.2V	A	$\pm 30\text{mV}$	LM3622AMX-4.2	2500 unit increments in tape and reel
4.2V	Standard	$\pm 50\text{mV}$	LM3622M-4.2	95 unit increments in rail
4.2V	Standard	$\pm 50\text{mV}$	LM3622MX-4.2	2500 unit increments in tape and reel
8.2V	A	$\pm 60\text{mV}$	LM3622AM-8.2	95 unit increments in rail
8.2V	A	$\pm 60\text{mV}$	LM3622AMX-8.2	2500 unit increments in tape and reel
8.2V	Standard	$\pm 100\text{mV}$	LM3622M-8.2	95 unit increments in rail
8.2V	Standard	$\pm 100\text{mV}$	LM3622MX-8.2	2500 unit increments in tape and reel
8.4V	A	$\pm 60\text{mV}$	LM3622AM-8.4	95 unit increments in rail
8.4V	A	$\pm 60\text{mV}$	LM3622AMX-8.4	2500 unit increments in tape and reel
8.4V	Standard	$\pm 100\text{mV}$	LM3622M-8.4	95 unit increments in rail
8.4V	Standard	$\pm 100\text{mV}$	LM3622MX-8.4	2500 unit increments in 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 ( $V_{CC}$ )	-0.3 to 24V
$\overline{LV}$	-0.3 to 24V
EXT (Note 2)	-0.3 to 24V
$LV_{SEL}$	-0.3 to 24V
$\overline{LV}_{ENB}$	-0.3 to 24V
ESD Susceptibility (Note 3)	2500V
Storage Temperature	-40°C to +125°C
Lead Temp. Soldering	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C

Power Dissipation ( $T_A = 25^\circ\text{C}$ )  
(Note 4)

Max. Package Dissipation 350mW

**Operating Ratings** (Note 1)

Supply Voltage ( $V_{CC}$ )	4.5V to 24V
Ambient Temperature Range	-20°C to 70°C
Junction Temperature Range	-20°C to 85°C
Thermal Resistance, $\theta_{JA}$	
SOIC-8	170°C/W

**Electrical Characteristics****LM3622-XX**

Unless otherwise specified  $V_{CC} = 5\text{V/Cell}$   $T_A = T_J = 25^\circ\text{C}$ . Limits with standard typeface apply for  $T_J = 25^\circ\text{C}$ , and limits in **bold-face type** apply over the indicated temperature range.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$V_{CC}$	Operating power supply range		4.5		24.0	V
$I_{CC}$	Quiescent Current			210		$\mu\text{A}$
$V_{CEL}$	Regulation Voltage	$T_J = 0^\circ\text{C}$ to $+70^\circ\text{C}$ $V_{CC} = 4.5\text{V/cell}$ (Note 5)	<b>4.070</b>	4.100	<b>4.130</b>	V
	LM3622A-4.1		<b>8.140</b>	8.200	<b>8.260</b>	V
	LM3622A-8.2		<b>4.170</b>	4.200	<b>4.230</b>	V
	LM3622A-4.2		<b>8.340</b>	8.400	<b>8.460</b>	V
	LM3622-4.1		<b>4.050</b>	4.100	<b>4.150</b>	V
	LM3622-8.2		<b>8.100</b>	8.200	<b>8.300</b>	V
	LM3622-4.2		<b>4.150</b>	4.200	<b>4.250</b>	V
	LM3622-8.4		<b>8.300</b>	8.400	<b>8.500</b>	V
	Long Term Stability	(Note 6)		0.02		%
$V_{CS}$	Current limit threshold at CS pin	$V_{CEL} = 4\text{V}$ for LM3622-4.X $V_{CEL} = 8\text{V}$ for LM3622-8.X	90	100	110	mV
$I_{CEL}$	Current in CEL pin	$V_{CC}$ Supply connected		25		$\mu\text{A}$
		$V_{CC}$ Supply Open		200		nA
$LV_{th}$	Low voltage detect threshold (between pins CS and GND)	$\overline{LV}_{ENB} = 0\text{V}$ and $LV_{SEL} = 0\text{V}$	2.00	2.15	2.30	V/Cell
		$\overline{LV}_{ENB} = 0\text{V}$ and $LV_{SEL} = V_{CC}$	2.55	2.70	2.85	V/Cell
$I_{EXT}$	EXT pin output sink current	$V_{EXT} = 4\text{V}$ for LM3622-4.X $V_{EXT} = 8\text{V}$ for LM3622-8.X	15	25		mA
$I_{IN1}$	$LV_{SEL}$ input current	$LV_{SEL} = 5\text{V}$ , LM3622-4.X		20		$\mu\text{A}$
		$LV_{SEL} = 10\text{V}$ , LM3622-8.X		50		
$I_{IN2}$	$\overline{LV}_{ENB}$ input current	$\overline{LV}_{ENB} = 5\text{V}$ , LM3622-4.X		20		$\mu\text{A}$
		$\overline{LV}_{ENB} = 10\text{V}$ , LM3622-8.X		50		
$I_{\overline{LV}}$	$\overline{LV}$ pin leakage current	$\overline{LV} = 5\text{V/Cell}$			250	nA
$V_{\overline{LV}}$	$\overline{LV}$ pin saturation voltage	$I_{SINK} = 1\text{mA}$ $T_J = -20^\circ\text{C}$ to $85^\circ\text{C}$		0.25	<b>0.40</b>	V

**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 do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

**Note 2:**  $V_{EXT}$  is not allowed to exceed ( $V_{CC} + 0.3\text{V}$ ) or damage to the device may occur.

**Note 3:** Rating is for the human body model, a 100 pF capacitor discharged through a 1.5k $\Omega$  resistor into each pin.

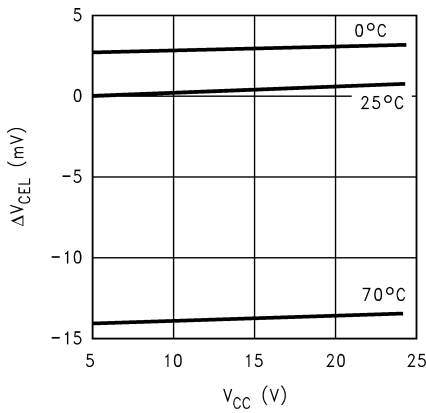
**Note 4:** The maximum power dissipation must be de-rated at elevated temperatures and is limited by  $T_{JMAX}$  (maximum junction temperature),  $\theta_{JA}$  (junction-to-ambient thermal resistance) and  $T_A$  (ambient temperature). The maximum power dissipation at any temperature is:  $PD_{MAX} = (T_{JMAX} - T_A) / \theta_{JA}$  up to the value listed in the Absolute Maximum Ratings.

**Note 5:** Limits reflect initial accuracy.

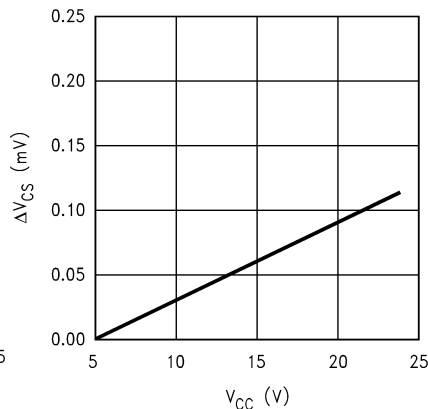
**Note 6:**  $T_J = 85^\circ\text{C}$ , 1000 hours. Activation energy of 0.78eV used.

# Typical Performance Characteristics Unless otherwise specified, $T_A = 25^\circ\text{C}$ .

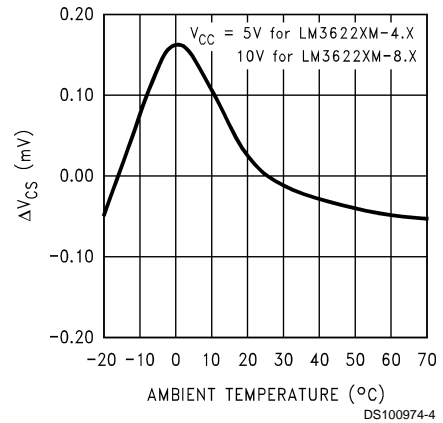
**Output Voltage Regulation Vs  $V_{CC}$**



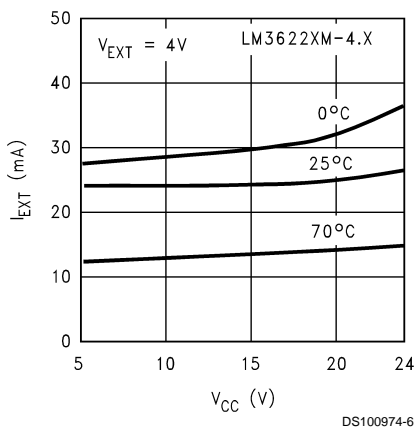
**Current Sense Voltage Regulation Vs  $V_{CC}$**



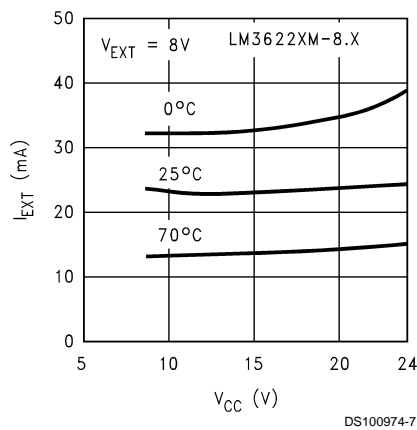
**Current Sense Voltage Regulation Vs Temperature**



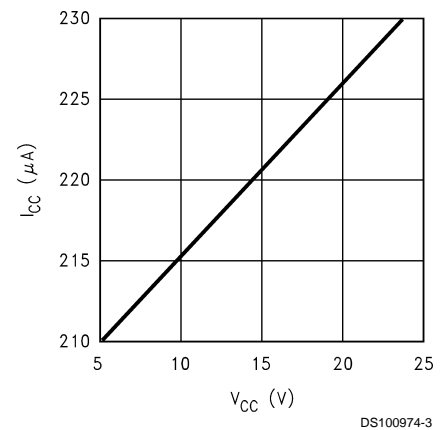
**Output Drive Current Vs  $V_{CC}$**



**Output Drive Current Vs  $V_{CC}$**



**Quiescent Current Vs  $V_{CC}$**



## Functional Description

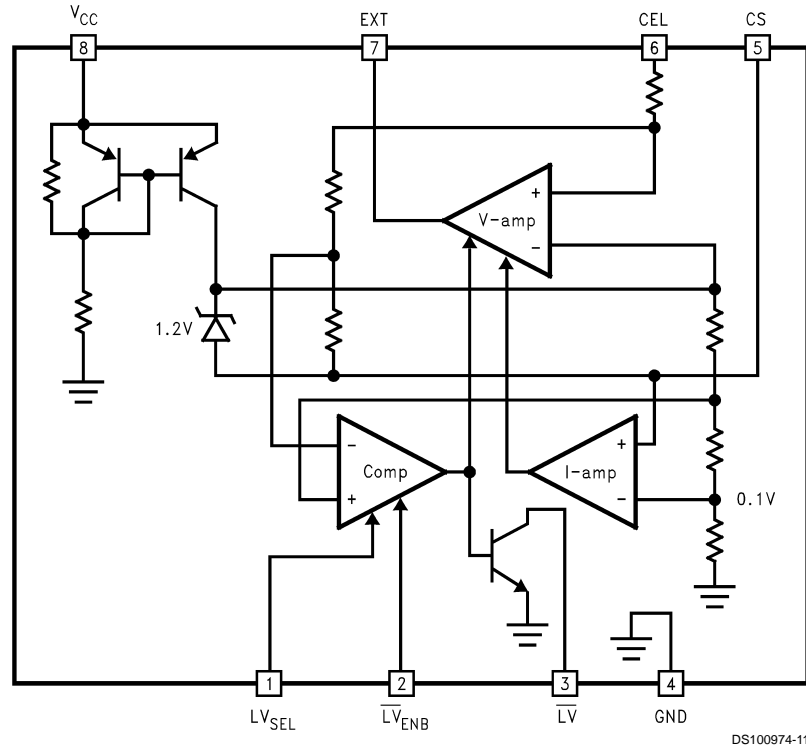


FIGURE 1. LM3622 Simplified Block Diagram

The simplified LM3622 block diagram in *Figure 1* gives a general idea of the circuit operation. The controller integrates the reference, feedback and drive functions on-chip to control a linear, lithium-ion battery charger in constant voltage and constant current (CVCC) charge operation. The regulated output voltage is sensed between CEL and CS, and the battery charge current is sensed across a current-sense resistor between CS and GND. The EXT pin is designed for driving a series pass element, which can be a PNP transistor or a P-MOSFET.

Tying the  $\overline{\text{LV}}_{\text{ENB}}$  pin to ground enables the controller's low-voltage detection circuit. When the low-voltage detection circuit is enabled and a battery voltage below a preset threshold is detected, the LM3622 will drive the  $\overline{\text{LV}}$  pin low and shut off the current flowing into the EXT pin to suspend the CVCC charge process. The low-voltage threshold is user selectable to be either 2.15V/cell or 2.7V/cell by pulling the  $\text{LV}_{\text{SEL}}$  pin to GND or  $V_{\text{CC}}$  respectively. The  $\overline{\text{LV}}$  pin is a NPN open collector output that can be used to turn on a low current source to wake up charge a deeply depleted battery. When the low-voltage detection is disabled ( $\overline{\text{LV}}_{\text{ENB}}$  pulled up to  $V_{\text{CC}}$ ), the LM3622 always starts the charge cycle in constant current mode at any battery voltage below the controller's regulation level, and maintains the  $\overline{\text{LV}}$  pin at a high-impedance state.

## Application Information

### CEL Pin Current Drain

The LM3622 has an internal power down switch in series with the on-chip resistor divider that is used for sensing the battery voltage. In the event that the  $V_{\text{CC}}$  supply is removed,

the power down switch will disconnect the resistor divider from the CS pin, preventing the battery from discharging through the CEL pin.

### EXT Pin

The EXT pin is internally pulled up to  $V_{\text{CC}}$  via a 20µA current source making it possible to eliminate the external base-emitter resistor when driving a PNP transistor, or the gate-source resistor when driving a P-MOSFET. However, the voltage applied to EXT is not allowed to be higher than ( $V_{\text{CC}} + 0.3\text{V}$ ), otherwise the reverse current from EXT pin to  $V_{\text{CC}}$  pin may cause damage to the device.

### $\overline{\text{LV}}$ Pin Current Rating

The  $\overline{\text{LV}}$  pin is a low power, NPN open collector output that is rated to sink 10mA maximum. Therefore, the value of the pull up resistor should be chosen high enough to limit the current to be less than 10mA.

### CS Pin

In normal operation, the current limit threshold voltage for the CS pin is 100mV typical. In case of a fault condition, the voltage to this pin should be limited to below 5V.



## Timing Diagram

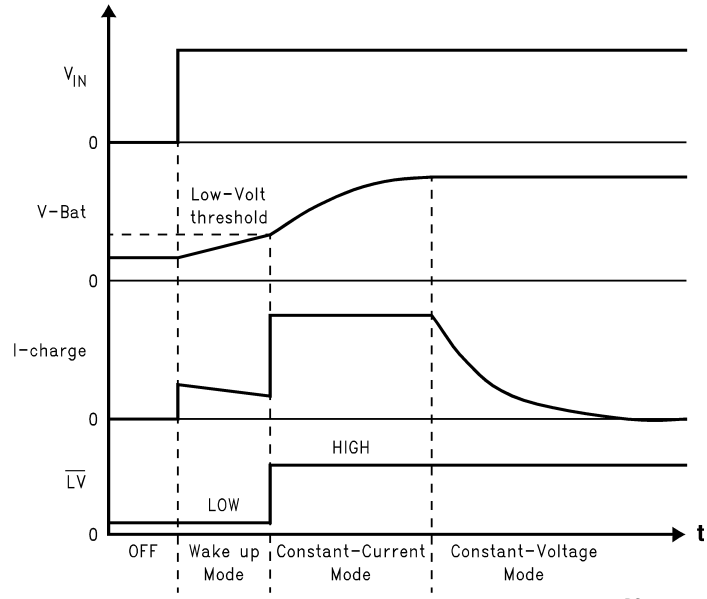
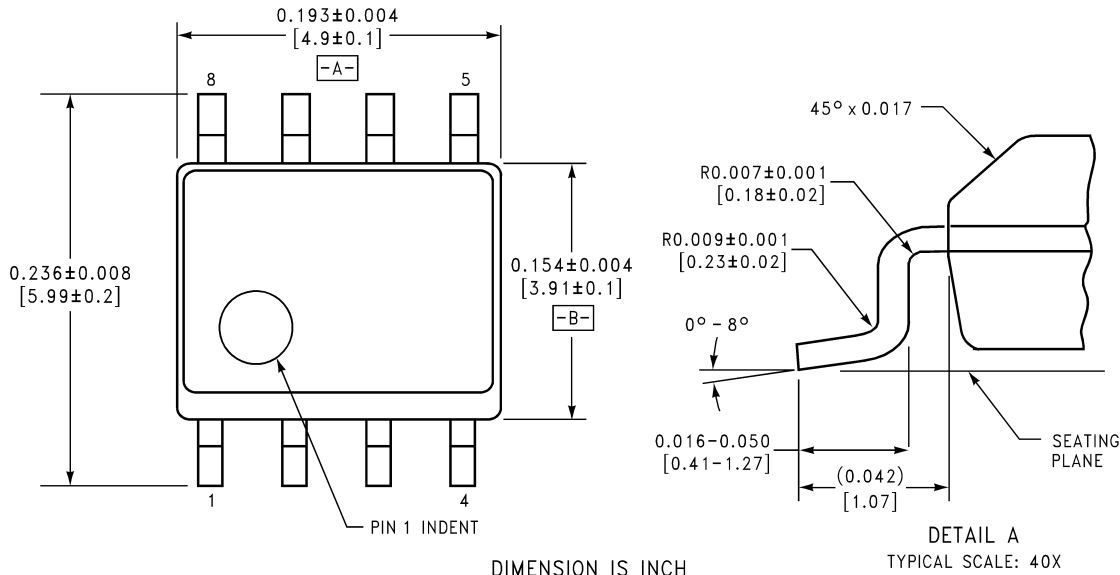


FIGURE 3. Typical Charge Cycle with Low-Voltage Detection Enabled.

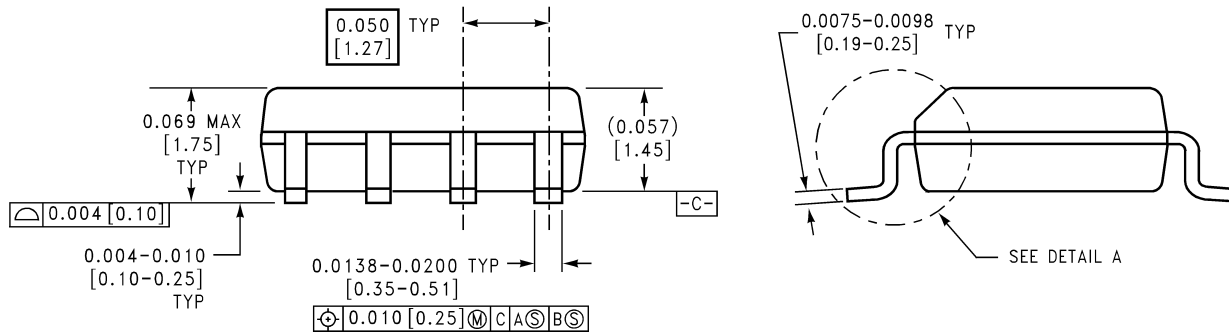


**Physical Dimensions** inches (millimeters) unless otherwise noted



DIMENSION IS INCH  
VALUES IN [ ] ARE MILLIMETERS

DETAIL A  
TYPICAL SCALE: 40X



**SOIC-8 Package**  
**8-Lead Small-Outline Package (M8)**  
For Ordering, Refer to Ordering Information Table  
NS Package Number M08A

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