

MC33349

Product Preview

Lithium Battery Protection Circuit for One Cell Battery Packs

The MC33349 is a monolithic lithium battery protection circuit that is designed to enhance the useful operating life of a one cell rechargeable battery pack. Cell protection features consist of internally trimmed charge and discharge voltage limits, charge and discharge current limit detection, and a virtually zero current sleepmode state when the cell is discharged. This protection circuit requires a minimum number of external components and is targeted for inclusion within the battery pack. This MC33349 is available in the SOT-23 6 lead surface mount package.

- Internally Trimmed Charge and Discharge Voltage Limits
- Charge and Discharge Current Limit Detection
- Virtually Zero Current Sleepmode State when Cells are Discharged
- Dedicated for One Cell Applications
- Minimum Components for Inclusion within the Battery Pack
- Available in a Low Profile Surface Mount Package

Ordering Information shown on following page.

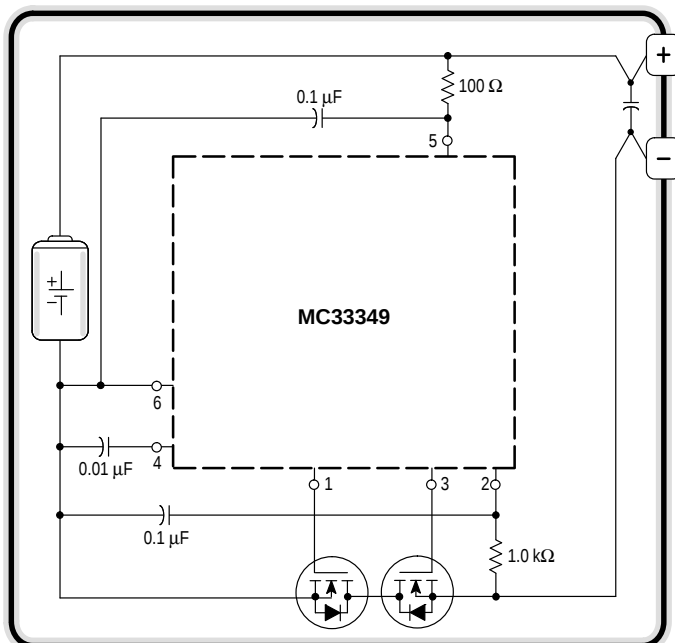
LITHIUM BATTERY PROTECTION CIRCUIT FOR ONE CELL SMART BATTERY PACKS

SEMICONDUCTOR TECHNICAL DATA



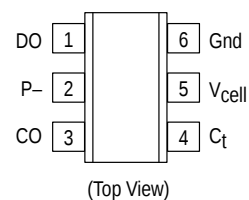
N SUFFIX
PLASTIC PACKAGE
CASE 1262
(SOT-23)

Typical One Cell Smart Battery Pack



This device contains 264 active transistors.

PIN CONNECTIONS



MC33349

ORDERING INFORMATION

Device	Charge Overvoltage Threshold (V)	Charge Overvoltage Hysteresis (mV)	Discharge Undervoltage Threshold (V)	Current Limit Threshold (mV)	Operating Temperature Range	Package
MC33349N-1	4.2	200	2.28	150	$T_A = -40$ to 85°C	SOT-23
MC33349N-2	4.2			75		
MC33349N-3	4.25		2.28	150		
MC33349N-4	4.25			75		
MC33349N-5	4.3		2.29	150		
MC33349N-6	4.3			75		
MC33349N-7	4.35		2.30	150		
MC33349N-8	4.35			75		
MC33349N-9	4.65		2.35	150		
MC33349N-10	4.65			75		

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Input Voltage Discharge Gate Drive Output (Pin 1) to Gnd (Pin 6) Charge Gate Drive Common/Current Limit (Pin 2) to V_{cell} (Pin 5) Charge Gate Drive Output (Pin 3) to V_{cell} (Pin 5) Overvoltage Delay Capacitor (Pin 4) to Gnd (Pin 6) Cell Voltage (Pin 5) to Gnd (Pin 6)	V_{IR}	5.0 to -1.0 1.0 to -18 1.0 to -18 5.0 to -1.0 5.0 to -1.0	V
Thermal Resistance, Junction-to-Air N Suffix, SOT-23 Plastic Package, Case 1262	$R_{\theta\text{JA}}$	TBD	$^\circ\text{C/W}$
Operating Junction Temperature (Note 1)	T_{J}	-40 to 85	$^\circ\text{C}$
Storage Temperature	T_{stg}	-55 to 125	$^\circ\text{C}$

MC33349

ELECTRICAL CHARACTERISTICS ($C_T = 0.01 \mu\text{F}$, $T_A = 25^\circ\text{C}$, for min/max values T_A is the operating junction temperature range that applies, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
VOLTAGE SENSING					
Cell Charging Cutoff (Pin 5 to Pin 6) Overvoltage Threshold, V_{Cell} Increasing –3, –4 Suffix –7, –8 Suffix Overvoltage Hysteresis V_{Cell} Decreasing	$V_{\text{th(OV)}}$ V_H	 – – –	 4.25 4.35 200	 – – –	 V mV
Cell Discharging Cutoff (Pin 5 to Pin 6) Undervoltage Threshold, V_{Cell} Decreasing –3, –4 Suffix –7, –8 Suffix	$V_{\text{th(UV)}}$	 – –	 2.28 2.30	 – –	 V
Input Bias Current During Cell Voltage Sample (Pin 5)	I_{IIB}	–	20	–	μA
Overvoltage Delay Time ($V_{\text{Cell}} = 4.5 \text{ V}$)	$t_{\text{(ovd)}}$	–	75	–	ms
Undervoltage Delay Time ($V_{\text{Cell}} = 2.1 \text{ V}$)	$t_{\text{(uvd)}}$	–	13	–	ms
Cell Voltage Sampling Period	$t_{\text{(smp)}}$	–	2.0	–	ms
Cell Voltage Sampling Repetition Period	$t_{\text{(rep)}}$	–	26	–	ms
CURRENT SENSING					
Discharge/Charge Current Limit (Pin 2 to Pin 6) Discharge Threshold Voltage –3, –7 Suffix –4, –8 Suffix Discharge Current Hysteresis Charge Threshold Voltage –3, –7 Suffix –4, –8 Suffix Charge Current Hysteresis	$V_{\text{th(dschg)}}$ DCH $V_{\text{th(chg)}}$ CCH	 – – – – – – –	 150 75 50 –150 –75 25	 – – – – – –	 mV % mV %
Current Limit Delay Time (1.0 nF load @ CO & DO; to $V_{\text{DD}}/2$) Charge Gate Drive Output (Pin 3) Discharge Gate Drive Output (Pin 1)	$t_{\text{(ccld)}}$ $t_{\text{(dcld)}}$	 – –	 10 2.0	 – –	 μs μs
OUTPUTS					
Charge Gate Drive Output Low (Pin 3 to Pin 2 @ $I_O = 50 \mu\text{A}$)	V_{olc}	–	0.2	–	V
Charge Gate Drive Output High (Pin 5 to Pin 3 @ $I_O = -50 \mu\text{A}$)	V_{ohc}	–	0.1	–	V
Discharge Gate Drive Output Low (Pin 1 to Pin 6 @ $I_O = 50 \mu\text{A}$)	V_{old}	–	0.2	–	V
Discharge Gate Drive Output High (Pin 5 to Pin 1 @ $I_O = -50 \mu\text{A}$)	V_{ohd}	–	0.2	–	V
TOTAL DEVICE					
Average Cell Current Operating ($V_{\text{Cell}} = 3.9 \text{ V}$) Sleepmode ($V_{\text{Cell}} = 2.0 \text{ V}$)	I_{cell}	 – –	 8.5 4.0	 – –	 μA nA
Minimum Operating Cell Voltage	V_{cell}	–	1.5	–	V

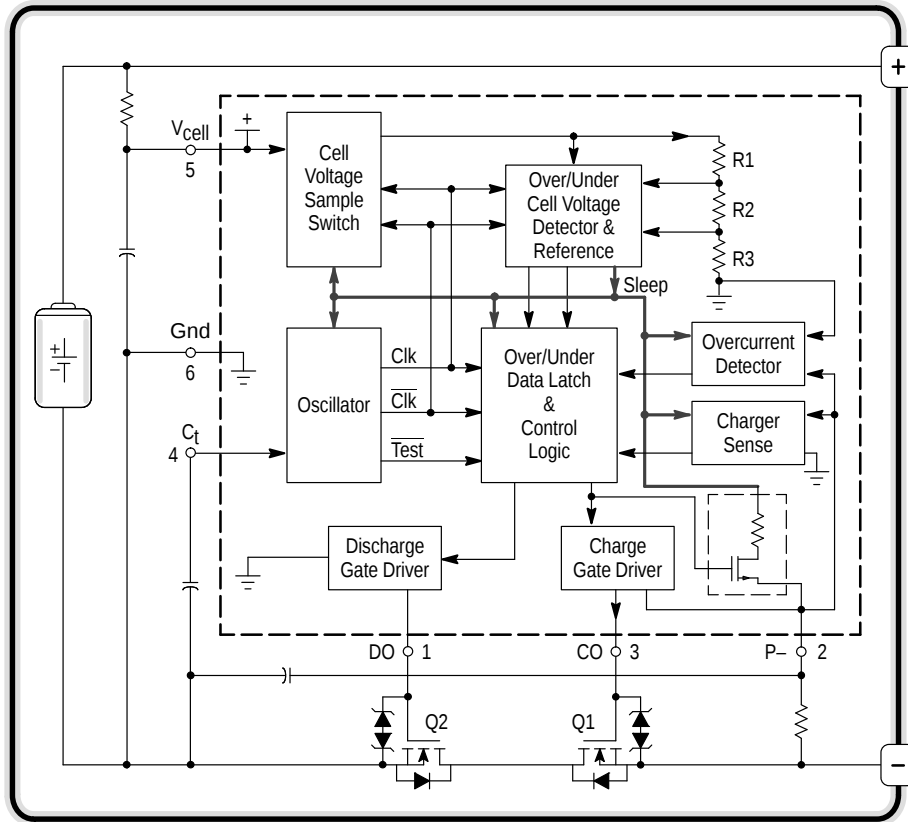


Figure 1. Detailed Block Diagram

PIN FUNCTION DESCRIPTION

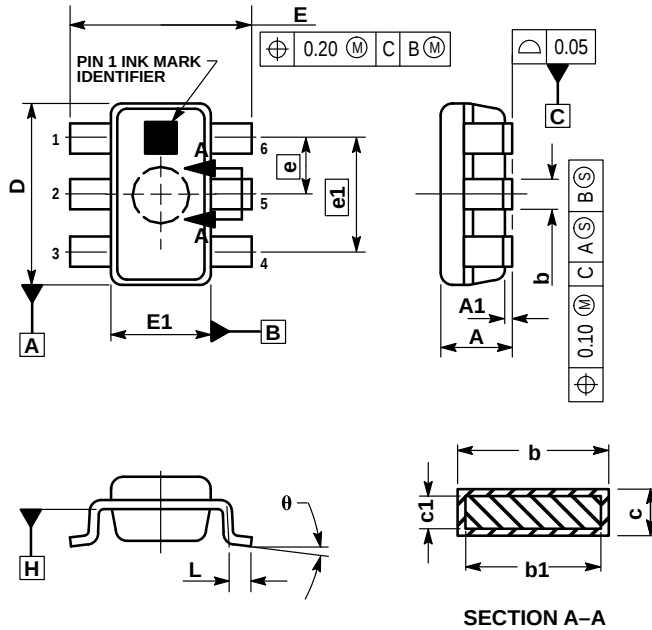
Pin	Symbol	Description
1	DO	This output connects to the gate of discharge MOSFET switch Q2 allowing it to enable or disable battery pack discharging.
2	P-	This is a multifunction pin that is used to monitor cell charge and discharge current and to provide a gate turn-off path for charge switch Q1. A current limit fault is set when the combined voltage drop of charge switch Q1 and discharge switch Q2 exceeds the discharge current limit threshold voltage, $V_{th}(dscg)$ above Pin 6 caused by a load; or charge current limit threshold voltage, $V_{th}(chg)$ below Pin 6 caused by a charger.
3	CO	This output connects to the gate of charge MOSFET switch Q1 allowing it to enable or disable battery pack charging.
4	C_t	An external capacitor connects between this pin and ground (Pin 6) to set the sample timer frequency and overvoltage delay time.
5	V_{cell}	This input connects to the positive terminal of the cell for voltage monitoring and provides operating bias for the integrated circuit. Internally, the Cell Voltage Sample Switch periodically applies this voltage to a resistor divider where it is compared by the Cell Voltage Detector to an internal reference.
6	Gnd	This is the ground pin of the IC.

PROTECTION CIRCUIT OPERATING MODE TABLE

Input Conditions Cell Status	Circuit Operation Battery Pack Status	Outputs	
		MOSFET Switches	
		Charge Q1	Discharge Q2
CELL CHARGING/DISCHARGING			
Storage or Nominal Operation: No current or voltage faults	Both Charge MOSFET Q1 and Discharge MOSFET Q2 are on. The battery pack is available for charging or discharging.	On	On
CELL CHARGING FAULT/RESET			
Charge Voltage Limit Fault: $V_{Pin\ 5} \geq V_{th(OV)}$ for two consecutive samples	Charge MOSFET Q1 is latched off and the cell is disconnected from the charging source. An internal current source pull-up is applied to divider resistors R1 and R2 creating a hysteresis voltage of V_H . The battery pack is available for discharging. Discharge current limit protection is disabled.	On to Off	On
Charge Voltage Limit Reset: $V_{Pin\ 5} < (V_{th(OV)} - V_H)$ for one sample, or $V_{Pin\ 2} > V_{th(dschg)}$	Charge MOSFET Q1 will turn on when the voltage across the cell falls sufficiently to overcome hysteresis voltage V_H , or when a load is applied to the battery pack.	Off to On	On
Charge Current Limit Fault: $V_{Pin\ 2} \leq (V_{Pin\ 6} + V_{th(chg)})$	Charge MOSFET Q1 is latched off and the cell is disconnected from the charger. Q1 will remain in the off state as long as $V_{Pin\ 6}$ exceeds $V_{Pin\ 2}$ by $\approx V_{th(chg)}$. The battery pack is available for discharging. Discharge current limit is disabled.	On to Off	On
Charge Current Limit Reset: $V_{Pin\ 6} - V_{Pin\ 2} < V_{th(chg)}$	The Sense Enable circuit will reset and turn on charge MOSFET Q1 when $V_{Pin\ 6}$ no longer exceeds $V_{Pin\ 2}$ by $\approx V_{th(chg)}$. This can be accomplished by either disconnecting the charger from the battery pack, or by connecting the battery pack to a load.	Off to On	On
CELL DISCHARGING FAULT/RESET			
Discharge Current Limit Fault: $V_{Pin\ 2} \geq (V_{Pin\ 6} + V_{th(dschg)})$	Discharge MOSFET Q2 is latched off and the cell is disconnected from the load. Q2 will remain in the off state as long as $V_{Pin\ 2}$ exceeds $V_{Pin\ 6}$ by $\approx V_{th(dschg)}$. The battery pack is available for charging. Charge current limit protection is disabled.	On	On to Off
Discharge Current Limit Reset: $V_{Pin\ 2} - V_{Pin\ 6} < V_{th(dschg)}$	The Sense Enable circuit will reset and turn on discharge MOSFET Q2 when $V_{Pin\ 2}$ no longer exceeds $V_{Pin\ 6}$ by $\approx V_{th(dschg)}$. This can be accomplished by either disconnecting the load from the battery pack, or by connecting the battery pack to the charger.	On	Off to On
Discharge Voltage Limit Fault: $V_{Pin\ 5} \leq V_{th(UV)}$ for one sample	Discharge MOSFET Q2 is latched off, the cell is disconnected from the load, and the protection circuit enters a low current sleepmode state. The battery pack is available for charging. Charge current limit protection is disabled.	On	On to Off
Discharge Voltage Limit Reset: $V_{Pin\ 6} > (V_{Pin\ 2} + 0.6\ V)$	The Sense Enable circuit will reset and turn on discharge MOSFET Q2 when $V_{Pin\ 6}$ exceeds $V_{Pin\ 2}$ by 0.6 V. This can be accomplished by connecting the battery pack to the charger.	On	Off to On
TEST MODE – PIN 4/PIN 5 SHORT			
Continuous Charge Voltage Limit Comparator $V_{Pin\ 4} = V_{Pin\ 5} = V_{cell} < V_{th(chg)}$ $V_{Pin\ 4} = V_{Pin\ 5} = V_{cell} > V_{th(chg)}$	This condition occurs if Pin 4 and Pin 5 are accidentally shorted together or purposely connected for rapid Charge Voltage Limit Testing. MOSFET Q1 On to Off is not delayed and no hysteresis is required for reset.	On Off	On On
FAULTY CELL			
Discharge Voltage Limit Fault: $V_{Pin\ 5} \leq 1.5\ V$	This condition can happen if the cell is defective ($<1.5\ V$) or if a momentary discharge current causes the cell voltage to fall below $V_{th(UV)}$ before a sample is taken.	Off	Off

OUTLINE DIMENSIONS

N SUFFIX
PLASTIC PACKAGE
CASE 1262-01
(SOT-23)
ISSUE O



NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSION D DOES NOT INCLUDE FLASH OR PROTRUSIONS, FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.23 PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. DIMENSIONS D AND E1 ARE TO BE DETERMINED AT DATUM PLANE H.

DIM	MILLIMETERS	
	MIN	MAX
A	0.90	1.45
A1	0.00	0.15
b	0.35	0.50
b1	0.35	0.45
c	0.09	0.20
c1	0.09	0.15
D	2.80	3.00
E	2.60	3.00
E1	1.50	1.75
e	0.95	
e1	1.90	
L	0.25	0.55
θ	0°	10°

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

Mfax is a trademark of Motorola, Inc.

How to reach us:

USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;
P.O. Box 5405, Denver, Colorado 80217. 1-303-675-2140 or 1-800-441-2447

JAPAN: Nippon Motorola Ltd.; SPD, Strategic Planning Office, 141,
4-32-1 Nishi-Gotanda, Shinagawa-ku, Tokyo, Japan. 81-3-5487-8488

Customer Focus Center: 1-800-521-6274

Mfax™: RMFAX0@email.sps.mot.com – TOUCHTONE 1-602-244-6609
Motorola Fax Back System – US & Canada ONLY 1-800-774-1848
– http://sps.motorola.com/mfax/

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

HOME PAGE: <http://motorola.com/sps/>