

# Protection of Lithium Ion Batteries (one cell) Monolithic IC MM1301

## Outline

This IC provides protection for the MM1291 series of compact, high-precision type lithium ion batteries which have been in use for some time. Precision of  $\pm 30\text{mV}$  is guaranteed between  $0^\circ\text{C}$  and  $+50^\circ\text{C}$ , and this IC can be used in applications where precision is crucial.

## 1-Cell Protection ICs

Package		Overcharge detection voltage	Hysteresis	Dead time	Overdischarge detection	Release voltage	Delay	Overcurrent detection		
SOP-8	VSOP-8							Overcurrent	Detec time	shot-mode
MM1301	AW	4.27V	200mV	at	2.3V	2.9V	min. 5mS	100mV	min. 5mS	0.9V
	BW	4.17V	100mV	Ctd=	2.3V	2.9V		100mV		0.9V
	CW	4.18V	100mV	0.082 $\mu\text{F}$	2.3V	2.9V		125mV		0.45V
	DW	4.28V	220mV	min. 0.5S	2.3V	2.9V	typ. 10mS	50mV	typ. 10mS	0.45V
	EW	4.20V	100mV		2.3V	2.9V		125mV		0.45V
	FW	4.28V	100mV	typ. 1S	2.3V	2.9V	max. 15mS	50mV	max. 15mS	0.45V
	GW	4.18V	220mV		2.3V	2.9V		125mV		0.45V
	HW	4.35V	220mV		2.3V	2.9V		50mV		0.45V
	JW	4.20V	220mV	max. 1.5S	2.3V	2.9V	125mV	0.45V		

Note : Under open-load conditions, returns to normal mode from overcurrent mode.

(For MM1291A to G, J, M,  $5\text{M}\Omega$  or higher; for MM1291H, K,  $50\text{M}\Omega$  or higher)

## Features

- 1 Overcharge detection voltage  $T_a=0\sim+50^\circ\text{C}$   $V_{\text{CEL}}\pm 30\text{mV}$
- 2 Overcharge detection delay time  $C_{\text{TD}}=0.082\mu\text{F}$  1.0S typ.
- 3 Current consumption (normal operation  $V_{\text{CEL}}=3.5\text{V}$ )  $10\mu\text{A}$  typ.
- 4 Current consumption (overdischarge operation  $V_{\text{CEL}}=1.9\text{V}$ )  $0.7\mu\text{A}$  typ.
- 5 Overcurrent cancel conditions Load removed : Load of  $5\text{M}\Omega$  or greater across battery pack terminals

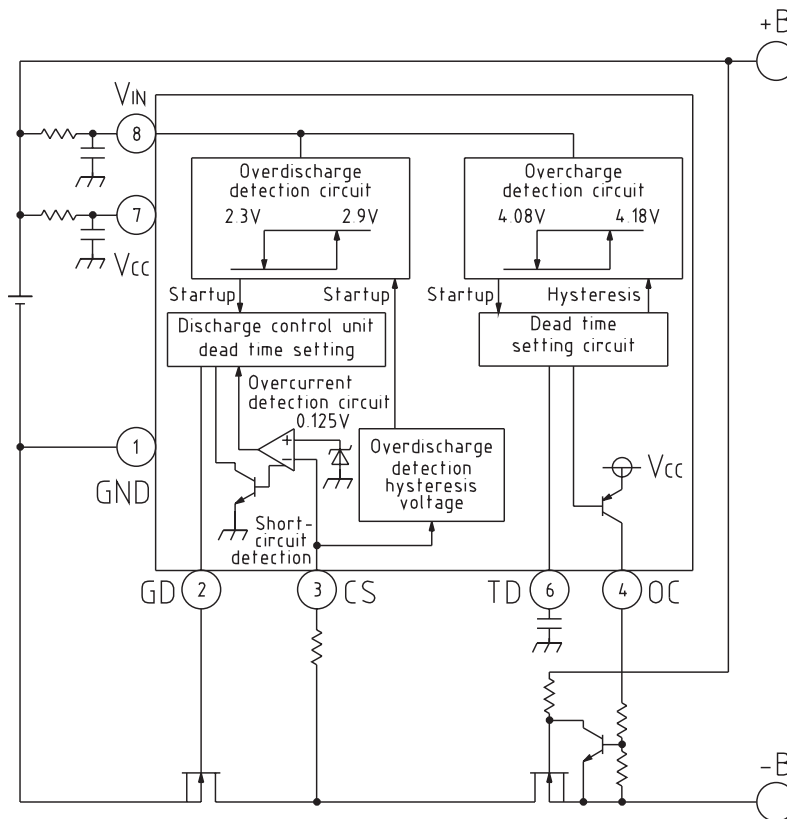
## Package

VSOP-8A

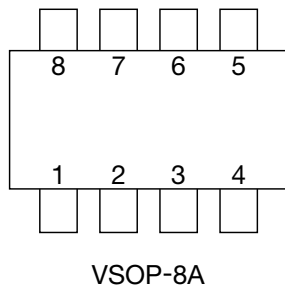
## Applications

Lithium ion battery pack (for battery protection)

Block Diagram



Pin Assignment



1	GND
2	GD
3	CS
4	OC
5	N.C
6	TD
7	VCC
8	VIN

Pin Description

Pin No.	Pin name	Function
1	GND	Negative power supply pin Also serves as voltage detection pin for battery connected between V <sub>IN</sub> and GND
2	GD	Gate connection pin for discharge-control FET (N-ch) Turns the gate off in overdischarge mode and overcurrent mode. Gate is turned on in overcharge and normal modes.
3	CS	Overcurrent detection input pin Discharge current detected by connection to drain pin of discharge-control FET. Discharge current = (CS-GND voltage) / (FET turn-on resistance)

4	OC	Overcharge detection output pin On overcharge, an external transistor is driven to turn off the charge-control FET (N-ch)
5	N.C	
6	TD	Overcharge detection dead time setting pin
7	V <sub>CC</sub>	Positive power supply voltage pin
8	V <sub>IN</sub>	Voltage detection pin for battery connected between V <sub>IN</sub> and GND

Notes : Overcharge mode : Battery voltage > overcharge detection voltage

Normal mode : Overdischarge detection voltage < battery voltage < overcharge detection voltage,  
discharge current < overcurrent detection level

Overdischarge mode : Overdischarge detection voltage > battery voltage

Overcurrent mode : Discharge current > overdischarge detection level=CS-GND voltage > discharge current  
turn-on resistance (discharge-control FET)

### Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Units
Storage temperature	T <sub>STG</sub>	-40~+125	°C
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Power supply voltage	V <sub>CC</sub> max.	-0.3~+18	V
OC pin voltage	V <sub>OC</sub> max.	-0.6~V <sub>CC</sub>	V
CS pin voltage	V <sub>CS</sub> max.		
Allowable loss	P <sub>d</sub>	300	mW

### Recommended Operating Conditions

Item	Symbol	Ratings	Units
Operating temperature	T <sub>OPR</sub>	-20~+70	°C
Operating voltage	V <sub>OP</sub>	+0.9~+18	V

### Electrical Characteristics (Except where noted otherwise, Ta=25°C)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Overcharge detection voltage	V <sub>OC</sub>	V <sub>CC</sub> =V <sub>IN</sub> =L → H, Ta=0~50°C	4.15	4.18	4.21	V
Overcharge release voltage	V <sub>OCR</sub>	V <sub>CC</sub> =V <sub>IN</sub> =H → L	4.04	4.09	4.14	V
Overcharge sensing hysteresis V <sub>OCH</sub> =V <sub>OC</sub> -V <sub>OCR</sub>	V <sub>OCH</sub>		60	90	120	mV
Overdischarge detection voltage	V <sub>ODC1</sub>	V <sub>CC</sub> =V <sub>IN</sub> =H → L	2.20	2.30	2.40	V
Overdischarge release voltage	V <sub>ODR</sub>	V <sub>CC</sub> =V <sub>IN</sub> =L → H	2.78	2.90	3.02	V
Overcurrent detection threshold	V <sub>CS</sub>	V <sub>CS</sub> =L → H	112	125	138	mV
Overcurrent short-circuit detection	V <sub>CSS</sub>		0.35	0.45	0.55	V
Overcurrent release conditions		Load open : Load of 5MΩ or greater across battery pack terminals				
Consumption current 1 (Normal mode) (I <sub>s1</sub> =I <sub>CC</sub> +I <sub>IN</sub> )	I <sub>s1</sub>	V <sub>CC</sub> =V <sub>IN</sub> =3.5V		10.0	14.0	μA
Consumption current 2 (Overdischarge mode)	I <sub>s2</sub>	V <sub>CC</sub> =V <sub>IN</sub> =1.9V		0.7	1.0	μA

Overcurrent detection delay time 1	tcs1		5.0	10.0	15.0	mS
Overcurrent detection delay time 2	tcs2	*1		30	100	μS
Overdischarge detection delay time	tOD		5.0	10.0	15.0	mS
Overcharge detection delay time	toC	$C_{TD}=0.082\mu\text{F}$ *2	0.5	1.0	1.5	S
OC pin output current	I <sub>OC</sub>	$V_{CC}=V_{IN}=4.5\text{V}$			-30	μA
GD pin "H" Output voltage (Normal mode)	V <sub>G<sub>DH</sub></sub>	$V_{CC}=V_{IN}=3.5\text{V}$	V <sub>CC</sub> -0.3	V <sub>CC</sub> -0.1		V
GD pin "L" Output voltage (Overcurrent mode)	V <sub>G<sub>D</sub>L1</sub>	$V_{CC}=V_{IN}=3.5\text{V}$ $V_{CS}=0.5\text{V}$		0.1	0.3	V
GD pin "L" Output voltage (Overdischarge mode)	V <sub>G<sub>D</sub>L2</sub>	$V_{CC}=V_{IN}=1.5\text{V}$		0.2	0.4	V

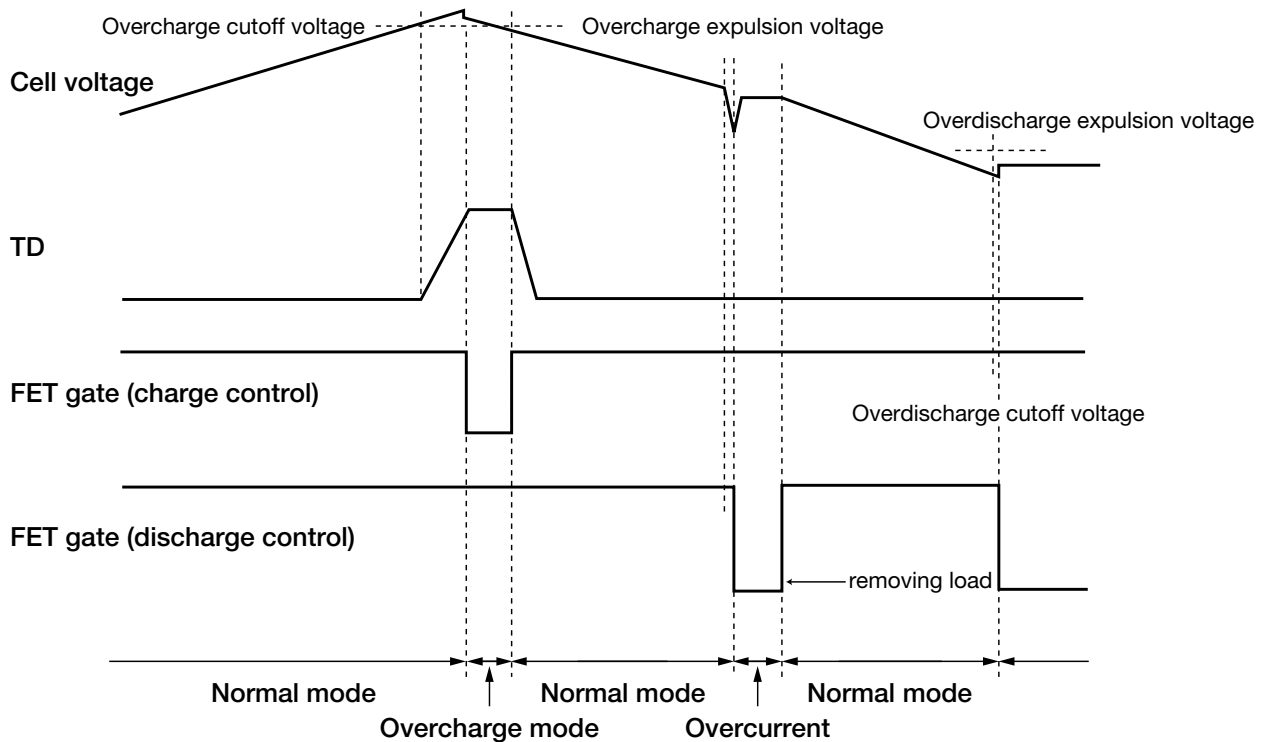
\*1: The overcurrent short mode delay time (overcurrent delay time 2) is the response time of the IC itself. In actual use, the time required for discharge of the gate capacitance of the discharge-controlling FET is added to this. When excessive currents cause considerable voltage fluctuation, the bias current within the IC may be temporarily turned off, so that the response time is lengthened. The time constant of the capacitance and resistance connected to the power supply pin should be set to at least 100μS/V, to limit power supply fluctuations.

\*2: Use the following formula to calculate the overcharge detection time:

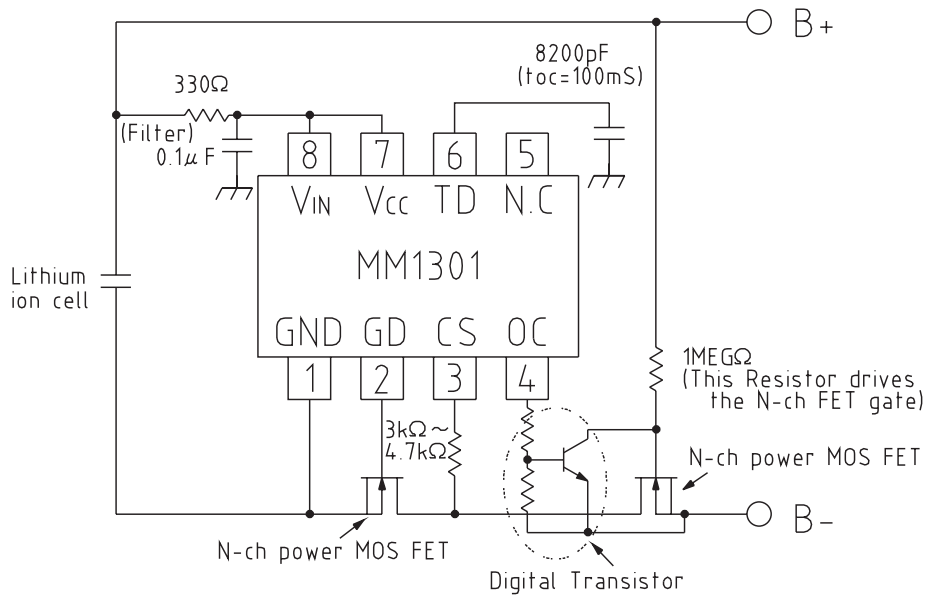
$$\text{overcharge detection dead time } t_{OC} = 12.2 \times C_{TD} \text{ [S]}$$

[where C<sub>TD</sub> is the external capacitance in μF]

### Timing Chart

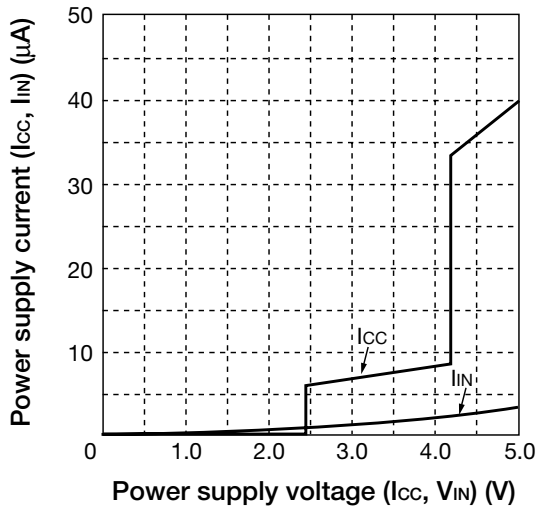


Application circuits



Characteristics

Power supply current vs power supply voltage



Overcharge detection time

