Protection of Lithium-Ion Batteries
Monolithic IC MM1412

Outline

This IC is used to protect lithium-ion batteries consisting of two cells. It adopts a compact package and has the functions of previous models, with functions for overcharge detection, overdischarge detection and overcurrent detection. A dead time can be set externally.

Features

1. Overcharge detection voltage accuracy (0°C to 50°C)	±25mV/cell
2. Consumption current (Vcell=4.5V)	150μA typ.
3. Consumption current (Vcell=3.5V)	15.0μA typ.
4. Consumption current (Vcell=1.9V)	0.5μA typ.
5. Overcharge sensing dead time	can be set externally.

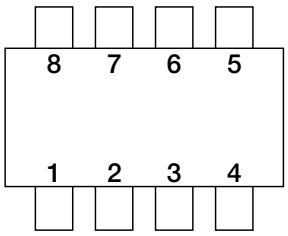
Package

VSOP-8A

Applications

IC for protection of lithium-ion batteries consisting of two cells.

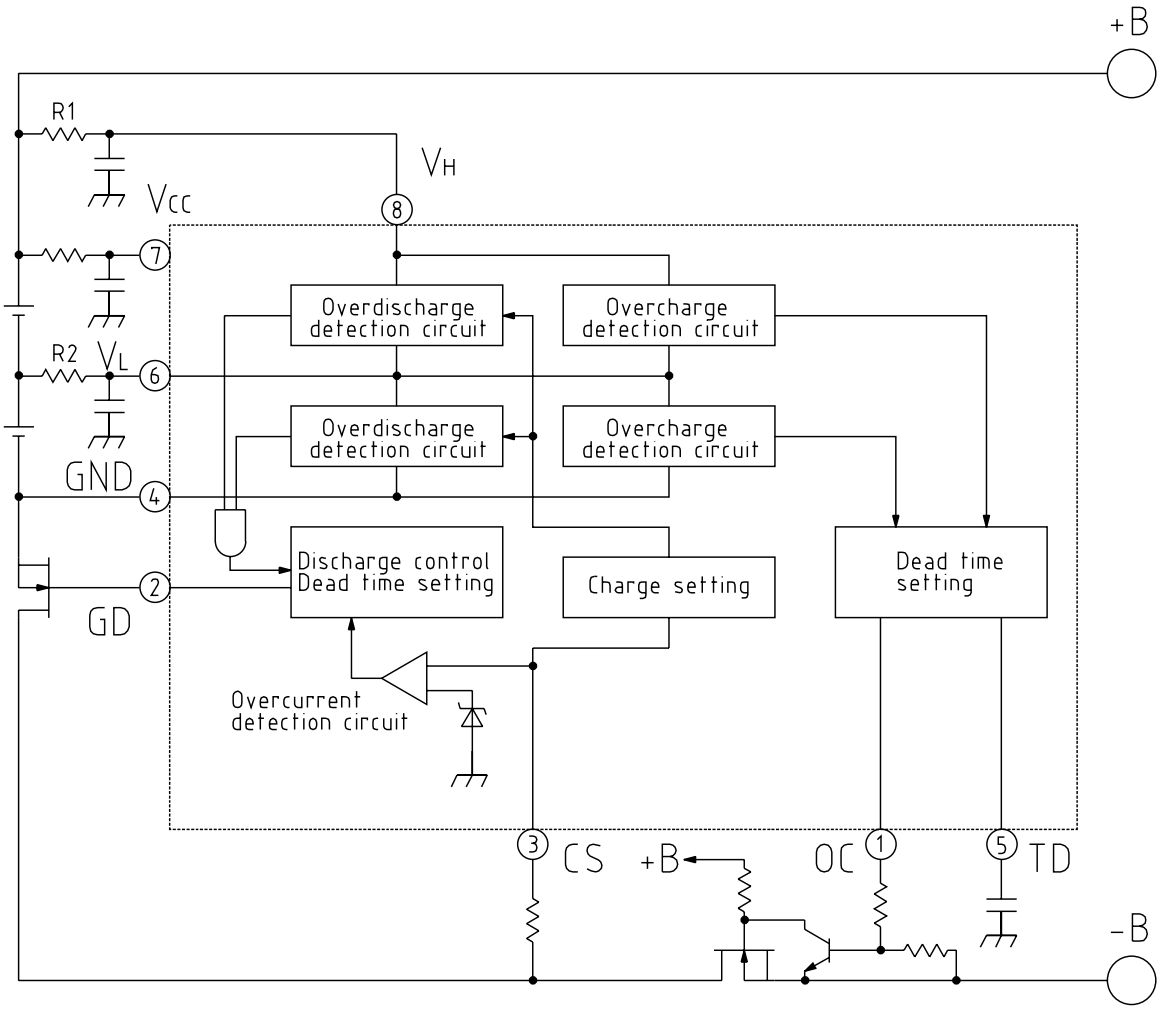
Pin Assignment



VSOP-8A

1	OC
2	GD
3	CS
4	GND
5	TD
6	VL
7	Vcc
8	VH

Block Diagram



Pin Description

Pin No.	Pin name	Functions
1	OC	Overcharge detection output pin PNPTR open collector output Overcharge mode: ON Normal mode, overdischarge mode, overcurrent mode: OFF
2	GD	Discharge control FET (N-ch) control output pin Normal mod, overcharge mode: H Overdischarge mode, overcurrent mode: L
3	CS	Overcurrent detection input pin Monitors discharge current equivalently by the voltage drop between discharge control FET source and drain. Stops discharge when voltage between CS pin and GND pin goes above overcurrent detection threshold value, and holds until load is released.
4	GND	Ground pin, or lower cell load negative pole input pin.
5	TD	Overcharge detection dead time setting pin Dead time can be set by adding a capacitor between TD and GND pins.
6	VL	Battery intermediate potential input pin Connection pin for lower cell positive electrode side and upper cell negative electrode side.
7	VCC	Power supply input pin
8	VH	Upper cell positive electrode input pin

Note: Mode Descriptions

(1) Overcharge mode
Either H cell or L cell battery voltage exceeds overcharge detection voltage. Overcharge detection operation delay can be set by the dead time setting pin.

(2) Normal mode
Both H and L cell battery voltages exceed overdischarge detection voltage and are less than overcharge detection voltage.

(3) Overdischarge mode
Either H or L cell battery voltage is less than overdischarge detection voltage.
Overdischarge detection dead time is set internally. Overdischarge mode is released when charging causes voltage to rise above overdischarge detection voltage. Also, when battery voltage goes above overdischarge release voltage, it resets without charging, but the value is set high. (This function is included in case charging can not be detected. Also, this release voltage has a temperature coefficient of −6mV/°C.)

(4) Overcurrent mode
Voltage between CS and GND exceeds overcurrent detection voltage during discharge.

Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Unit
Storage temperature	T_{STG}	−40~+125	°C
Operating temperature	T_{OPR}	−20~+70	°C
Power supply voltage	V_{CC} max.	−0.3~+18	V
OC pin impressed voltage	V_{OC} max.	−0.6~V_{CC}	V
CS pin impressed voltage	V_{CS} max.	−0.6~V_{CC}	V
Allowable loss	Pd	300	mW

Recommended Operating Conditions

Item	Symbol	Ratings	Unit
Operating temperature	T_{OPR}	−20~+70	°C
Operating power supply voltage	V_{OP}	+0.9~+18	V

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

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Overcharge detection voltage	V_{OC}	Ta=0°C~50°C	4.325	4.350	4.375	V
Overcharge detection hysteresis voltage	$\triangle V_{OC}$		170	220	270	mV
Overdischarge detection voltage	V_{OD}		2.20	2.30	2.40	V
Consumption current 1	I_{VH1}	V_H=V_L=1.0V V_{CS}=1.4V			0.1	µA
Consumption current 2	I_{VH2}	V_H=V_L=1.9V V_{CS}=3.2V		0.5	0.8	µA
Consumption current 3	I_{VH3}	V_H=V_L=3.5V		15.0	20.0	µA
Consumption current 4	I_{VH4}	V_H=V_L=4.5V, R_{OC}=270kΩ		150		µA
VL pin input current	I_{VL}	V_H=V_L=3.5V	−0.3	0	0.3	µA
Overdischarge release voltage	V_{DF}	Discharge resume by voltage rise	3.30	3.50	3.70	V
GD pin H output voltage	V_{GDH}	V_H=V_L=3.5V, IL=−10µA	V_H−0.3	V_H−0.2		V
GD pin L output voltage	V_{GDL}	V_H=V_L=3.5V, IL=10µA		0.2	0.3	V
OC pin output current	I_{OCH}	V_H=V_L=4.5V	30	150		µA
Overcurrent detection threshold value	V_{CS1}		135	150	165	mV
Overcurrent short threshold value	V_{CS2}	When both battery pack pins are shorted	0.35	0.45	0.55	V
Overcurrent release		Load release: Load of 5MEGΩ or more between both battery pack pins				
Overcurrent detection delay time 1	toc1		7	12	18	mS
Overcurrent detection delay time 2	toc2	*1		30	100	uS
Overdischarge detection delay time	t_{OD}		8	13	20	mS
Overcharge detection dead time	t_{OCH}	C_{TC}=0.18µF	0.5	1.0	1.5	S
Start-up voltage	V_{ST}	V_H=V_L=2.5V	−0.24	−0.12	−0.04	V

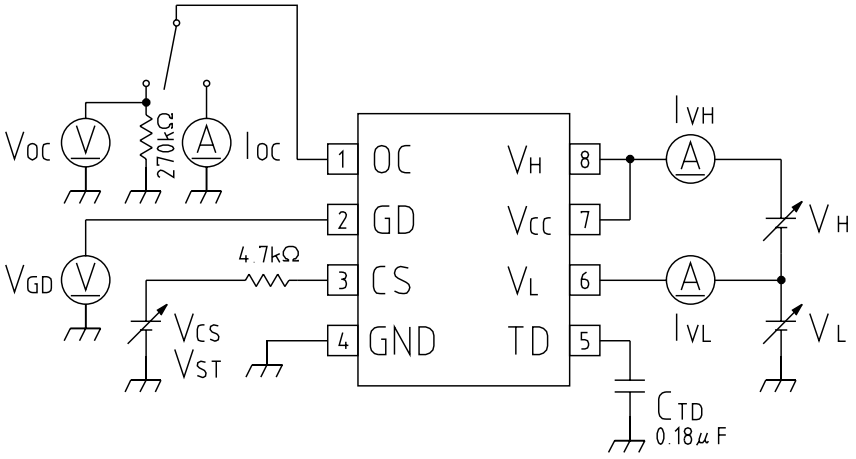
Note 1: Overcurrent short mode delay time (overcurrent delay time 2) is IC response speed.
In actual use, the time for discharging the discharge control FET gate capacity is added.
Also, when voltage change is large due to excess current, the IC internal bias current may turn off temporarily, causing response time to lengthen. Select the time constant for the capacitor connected to the power supply pin so that power supply fluctuation is more than 100µS/1V.

Note 2: Calculate overcharge dead time according to the following formula:
Overcharge detection dead time: $t_{ALM} - 5.55 \times C_{TD}$[S]
[C_{TD}: external capacitor, Unit:µF]

Measuring Circuit

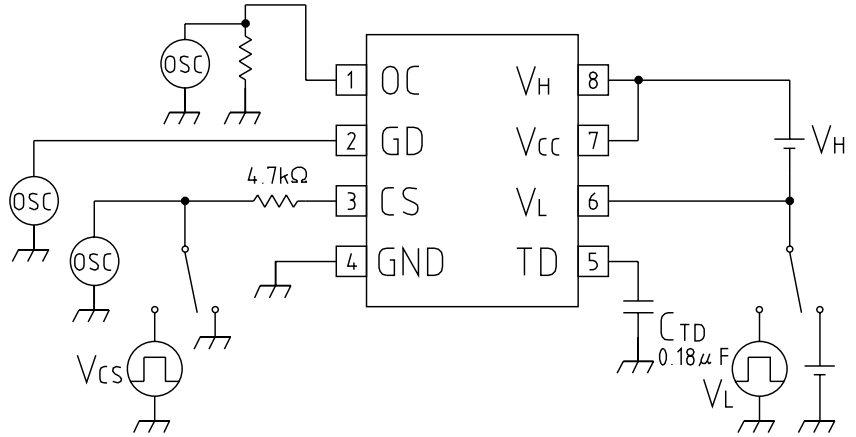
Measuring Circuit 1

(VOC, ⊿VOC, VOD, VDF, VST, VCS, IDCH, VGDH, VGDL)

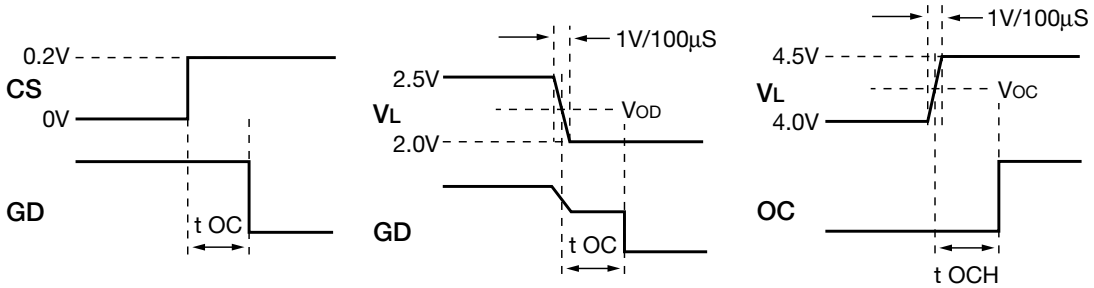


Measuring Circuit 2

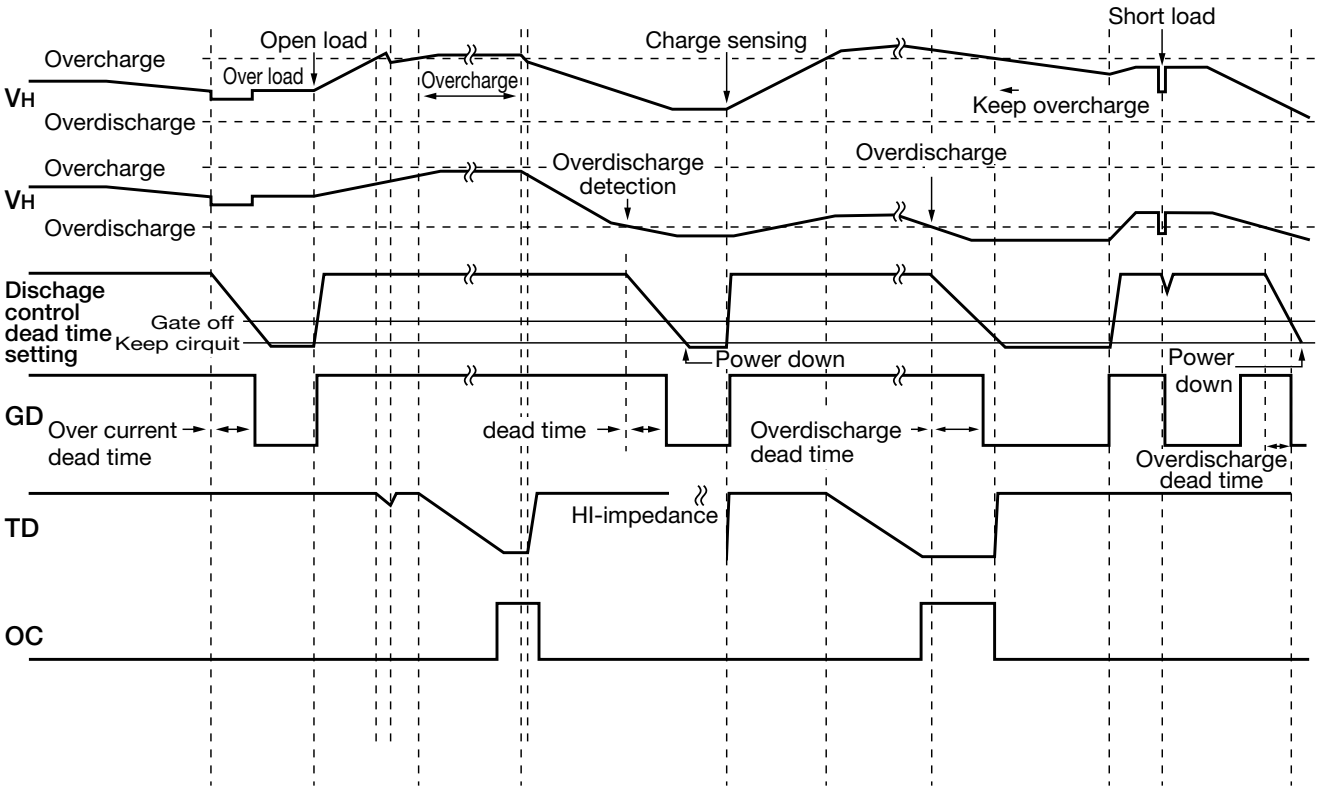
(tOC, tOD, tOCH)



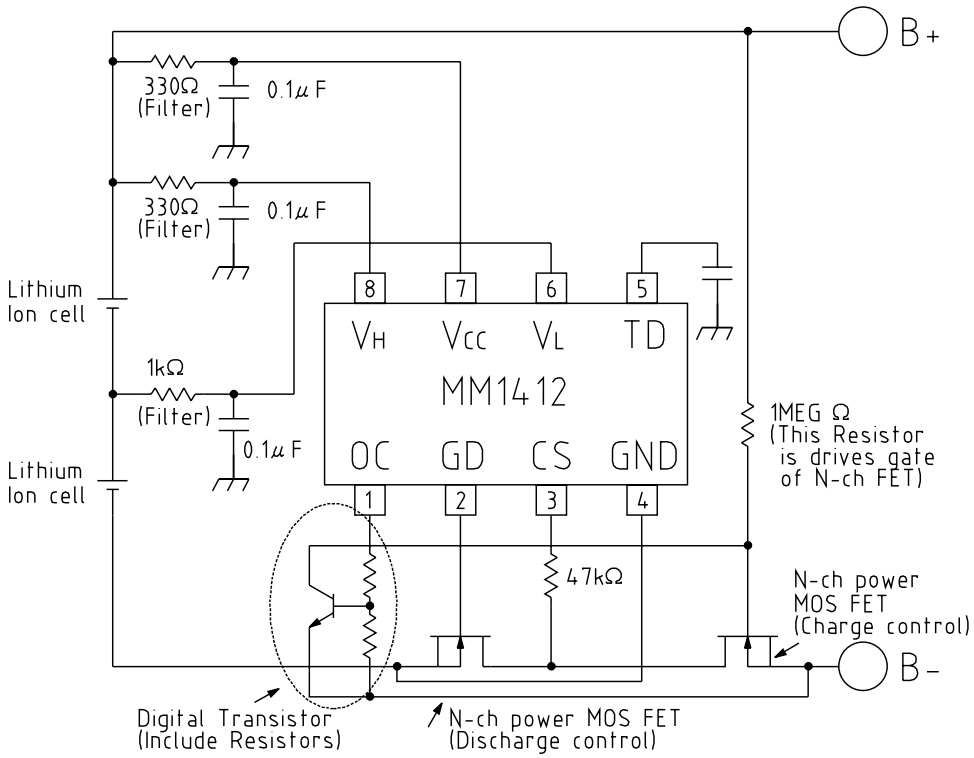
Note :



Timing Chart

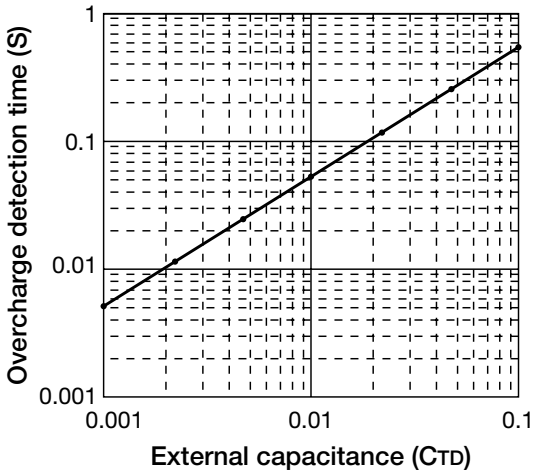


Application Circuit



Characteristics

Overcharge Detection Time (Dead Time)



Note: Dead time can be calculated according to the following formula:

$t_{OC}=5.55\times C_{TD}$ [S]

t_{OC}=Overcharge Detection Time

C_{TD}=External Capacitor···Unit : μF