Protection of Lithium-Ion Batteries
Monolithic IC MM1421

Outline

This IC is used to protect single-cell lithium-ion batteries. It adopts an ultra-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=3.6V) 10.0µA typ.
3. Consumption current (Vcell=1.9V) 0.1µA typ.
4. Overcharge sensing dead time can be set externally
5. Overdischarge reset reset by charging

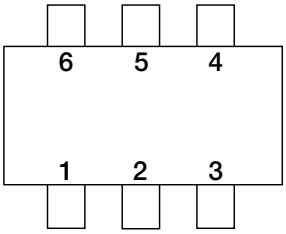
Package

SOT-26A

Applications

IC for protection of single-cell lithium-ion batteries.

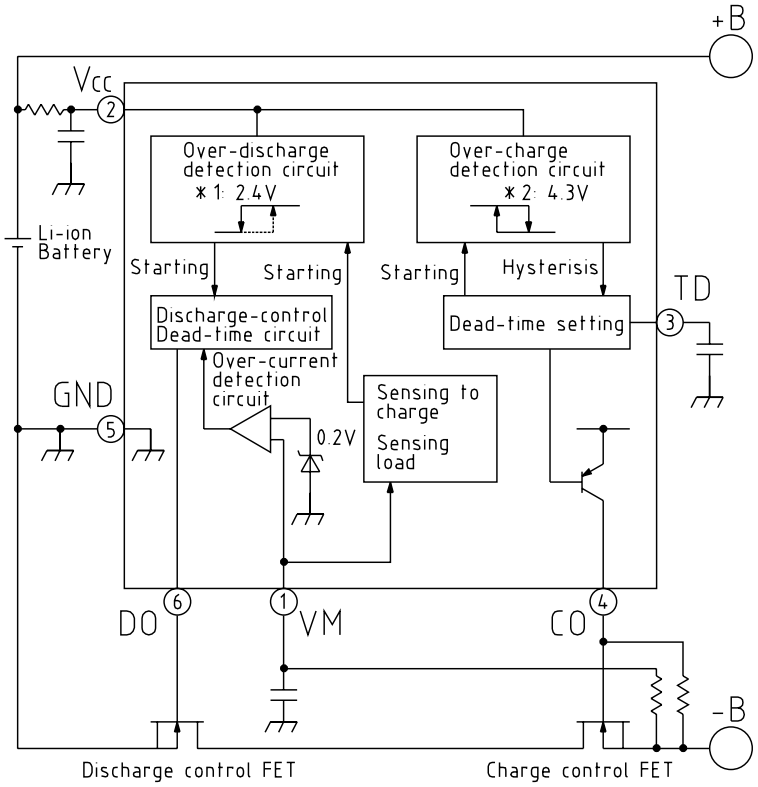
Pin Assignment



SOT-26A

1	VM
2	Vcc
3	TD
4	CO
5	GND
6	DO

Block Diagram



Note 1 : Overdischarge voltage

Note 2 : Overcharge voltage

Pin Description

Pin No.	Pin Name	Function
1	VM	Overcurrent detection input pin. Detects discharge current by connection to charging control FET source pin. Discharge current = (voltage between VM and GND) / (FET × 2 ON resistance)
2	Vcc	Positive power supply pin.
3	TD	Overcharge detection dead time setting pin.
4	CO	Charging control FET (N-ch) gate connection pin. An external resistor (910kΩ) is required between gate and source. Turns off charging control FET (N-ch) for overcharge mode (during charging) and overdischarge mode. Also, overcharge mode (during discharge) turns charging control FET (N-ch) ON, and suppresses FET power consumption.
5	GND	Negative power supply pin. Also, negative input pin for battery connected between Vcc and GND.
6	DO	Discharge control FET (N-ch) gate connection pin. Turns gate OFF for overdischarge mode and overcurrent mode. Turns gate ON for overcharge mode and normal mode.

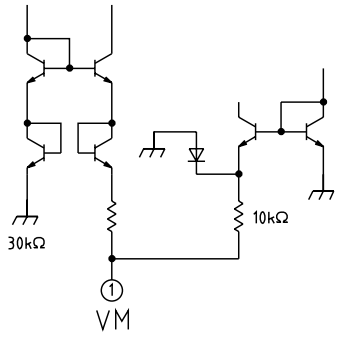
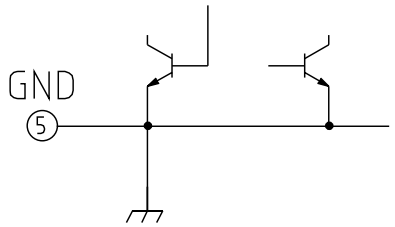
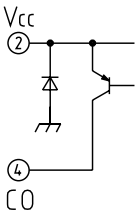
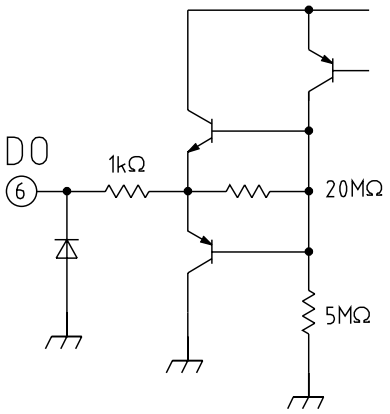
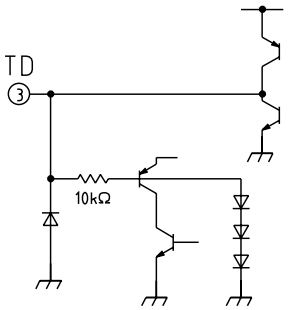
(1) Overcharge mode: Battery voltage > overcharge detection voltage

(2) Normal mode: Overdischarge detection voltage < battery voltage <overcharge detection voltage
Discharge current < overcurrent detection level

(3) Overdischarge mode: Overdischarge detection voltage > battery voltage

(4) Overcurrent mode: Discharge current > overcurrent detection level, voltage between VM and GND = discharge current × FET ON resistance
(discharge/charge control FET)

Pin Assignment

Pin No.	Pin name	Equivalent circuit diagram	Pin No.	Pin name	Equivalent circuit diagram
1	V_M		5	GND	
2 4	V_{CC} CO		6	DO	
3	TD				

Absolute Maximum Ratings (Ta=25°C)

Item	Symbol	Ratings	Unit
Storage temparature	T_{STG}	–40~+125	°C
Operating temparature	T_{OPR}	–20~+70	°C
Supply voltage	V_{CC} max.	–0.3~+18	V
CO pin voltage V_M pin voltage	V_{CO} max. V_{VM} max.	V_{CC}–28~V_{CC}	V
Allowable loss	Pd	200	mW

Recommended Operating Conditions

Item	Symbol	Ratings	Unit
Operating temparature	T_{OPR}	–20~+70	°C
Power supply voltage	V_{OP}	+1.8~+10	V

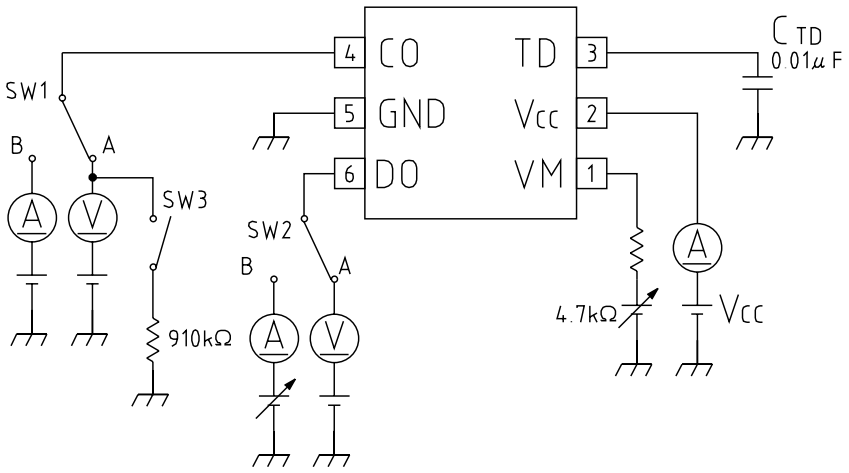
Electrical Characteristics (Except where noted otherwise, Ta=25°C, V_{CC}=3.6V)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Unit
Consumption current 1 (condition: SET)	I_{CC1}	V_{CC} = 3.6V: Set state between CO-GND: 910kΩ connected		10.0	14.0	uA
Consumption current 2 (condition: IC only)	I_{CC2}	V_{CC} = 3.6V: IC alone between CO-GND: 910kΩ not connected		6.0	10.0	uA
Consumption current 3 (FET: OFF on SET)	I_{CC3}	V_{CC}=3.6V: Discharge FET OFF state between CO-GND: 910kΩ not connected				uA
Consumption current 4 (FET: OFF on SET)	I_{CC4}	V_{CC}=1.9V: Discharge FET OFF state between CO-GND: 910kΩ not connected		0.2	1.0	uA
Consumption current 5 (condition: SET)	I_{CC5}	V_{CC}=4.5V between CO-GND: 910kΩ connected		35	60	uA
Overcharge detection voltage	V_{ALM1}	Ta=0~50°C V_{CC}: L→H	4.325	4.350	4.375	V
Overcharge hysterisis voltage	V_{ALM1}	V_{CC}: H→L	100	200	300	mV
Overdischarge detection voltage	V_{ALM2}	V_{CC}: H→L	2.30	2.40	2.50	V
Release overdischarge voltage			2.88	3.00	3.12	V
Overcurrent detection level	V_{VMD}	V_{VM}: L→H	174	200	226	mV
Release overcurrent level	V_{VMDF}	V_{VM}: H→L		130		mV
Condition of release overcurrent		Load condition		50		MΩ
Short detection voltage	V_{VMSHT}			1.3		V
Overdischarge detection dead time	t_{ALM2}		7.0	10.0	15.0	mS
Overcurrent detection dead time	t_{VMD}	V_M: 0V→0.5V	7.0	10.0	15.0	mS
Short detection delay time	t_{VMSHT}	V_M: 0V→2V		0.02	0.20	mS
Overcharge detection dead time	t_{ALM1}	C_{TD}=0.01µF	50	100	150	mS
DO pin output voltage	V_{GDH}	V_{CC}=3.6V	V_{CC}–0.3	V_{CC}–0.1	V_{CC}	V
DO pin source current 1	I_{DOH1}	V_{DO}=V_{CC}–1.0V		–100	–30	uA
DO pin source current 2	I_{DOH2}	V_{DO}=V_{CC}–0.3V		–0.40	–0.70	uA
DO pin sink current 1	I_{DOL1}	V_{VM}>1.0V, V_{DO}=1.0V	50	300		uA
DO pin sink current 2	I_{DOL2}	V_{VM}>1.0V, V_{DO}=0.3V	30	100		uA
DO pin sink current 3	I_{DOL3}	V_{CC}=3.6V, V_{DO}=1V (Stand-by mode)	1	5		uA
CO pin source current 1	I_{CO1}	V_{CO}=V_{CC}–1.0V		–20	–10	uA
CO pin source current 2	I_{CO2}	V_{CO}=V_{CC}–0.3V		–15	–5	uA
CO pin source current 3	I_{CO3}	V_{CO}=V_{CC}–0.3V (Stand-by mode)				uA
Starting trigger voltage	V_{ST}	V_{VM}: 0V→–0.5V	–0.2	–0.1	0	V

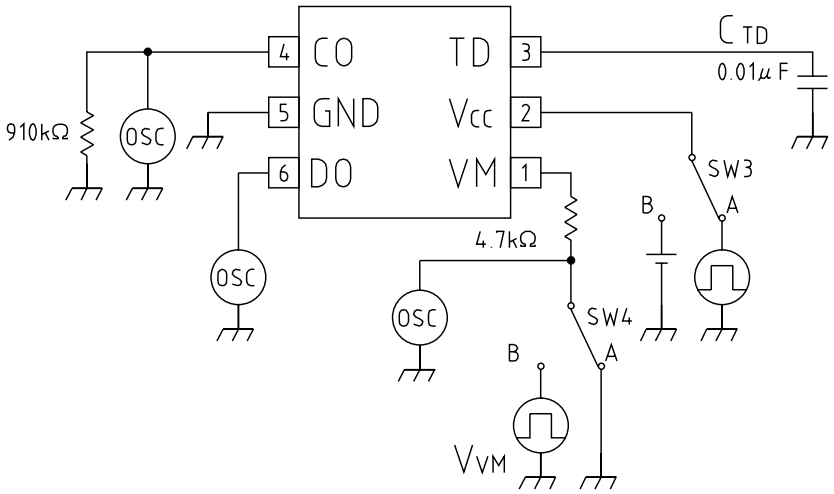
Note: Overcurrent detection current value is V_{VM}/(FET ON resistance×2).

Measuring Circuit

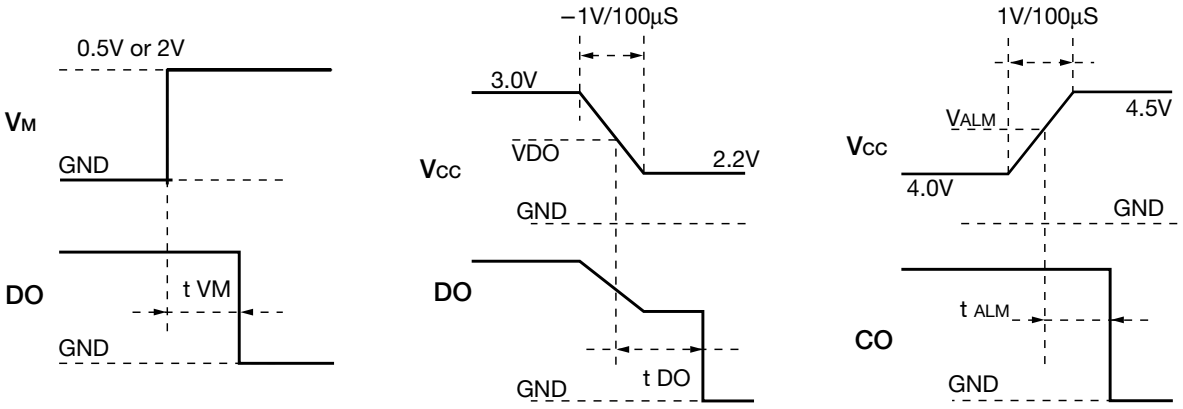
Measuring circuit 1



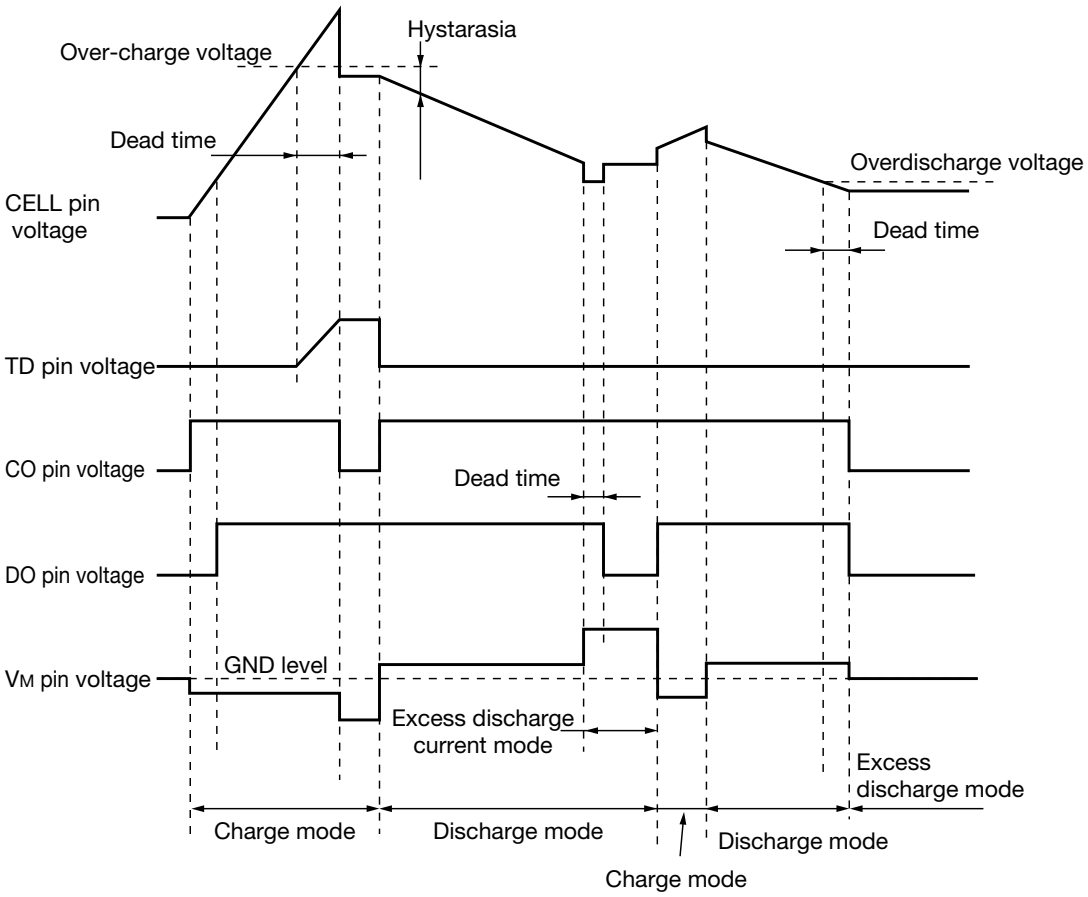
Measuring circuit 2



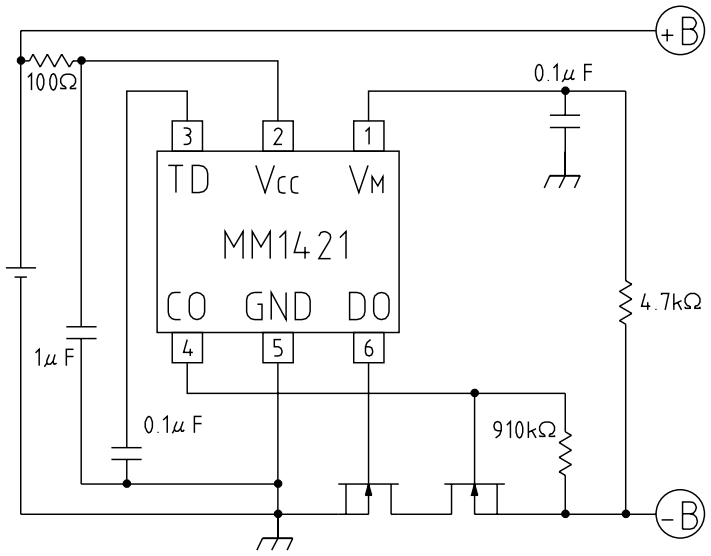
Note :



Timing Chart

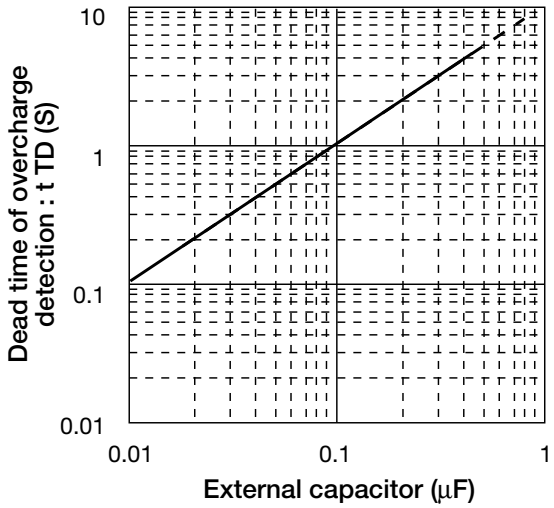


Application Circuit

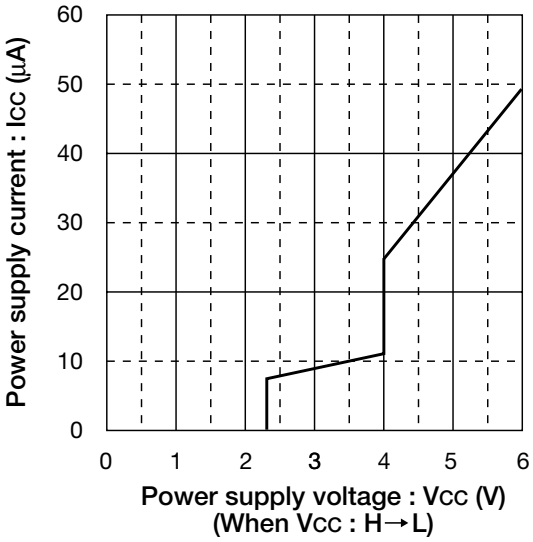


Characteristics

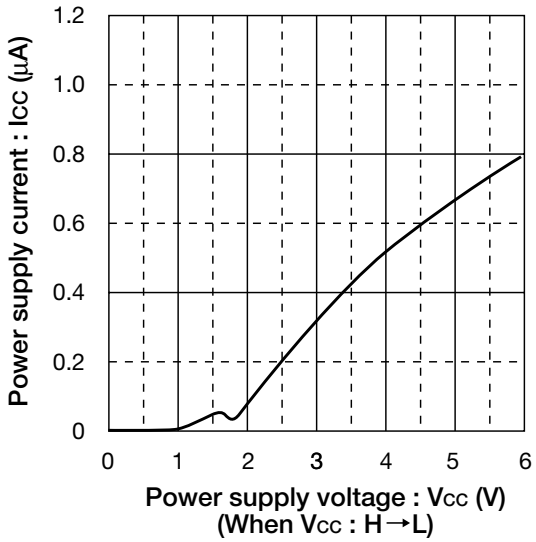
Dead time vs external capacitor
When overcharge detection



Power supply current vs power supply voltage



When stand-by mode
Power supply current vs power supply voltage



DO source current - DO pin voltage
Vcc=3.6V