Lithium Ion Battery Protection (for 1-cell in series)
Monolithic IC MM1491

Outline

This IC is a smaller, higher precision type of lithium ion battery protection IC as compared to the MM1301 series, and precision of ±25mV is guaranteed at 0°C ~ 50°C.
MM1301 had both V_{CC} and V_{IN} pins, but MM1491 has only the V_{CC} pin.

1-Cell Protection ICs

Temperature conditions A:Ta=−25 ~ 75°C, B:Ta=-20 ~ 70°C, C:Ta=0 ~ 50°C, D:Ta=0 ~ 40°C, E:Ta=−20 ~ 25°C

Model	Package SOT-26A	Overcharge detection voltage (V)	Overcharge detection voltage temperature conditions	Overcharge detection hysteresis voltage (V)	Overdischarge detection voltage (V)	Overdischarge resumption voltage (V)	Overcurrent detection voltage (mV)
MM1491	AN	4.200±0.025	C	200±100	2.3±0.1	3.00±0.12	200±26
	BN	4.350±0.025	C	200±100	2.4±0.1	3.00±0.12	200±26
	GN	4.280±0.025	C	200±100	2.3±0.1	2.90±0.12	120±16
	HN	4.200±0.025	C	200±100	2.3±0.1	3.90±0.12	200±26
	JN	4.250±0.025	C	200±100	2.3±0.1	3.00±0.12	200±26
	MN	4.250±0.025	C	150±100	2.4±0.1	3.00±0.12	150±20
	SN	4.295±0.025	C	150±100	2.4±0.1	3.00±0.12	150±20
	WN	4.325±0.025	C	200±100	2.5±0.1	3.00±0.12	200±26
	YN	4.300±0.025	C	150±100	2.4±0.1	3.00±0.12	150±20
	ZN	4.325±0.025	C	200±100	2.5±0.1	3.00±0.12	200±26

* The series will continue to be expanded.
* Overcharge and overdischarge voltages and overcurrent detection voltage can be changed at the customer's request.

Features

1. Overcharge detection voltage Ta = 0 ~ +50°C V_{CEL} ± 25mV
2. Overcharge detection dead time C_{TD} = 0.01µF 100 ms
3. Consumption current (normal mode V_{CEL} = 3.6V) 10µA typ.
4. Consumption current (overdischarge mode V_{CEL} = 1.9V) 0.05µA typ.
5. Overcurrent detection reset conditions Load open: between both ends of battery pack 50MΩ typ. load

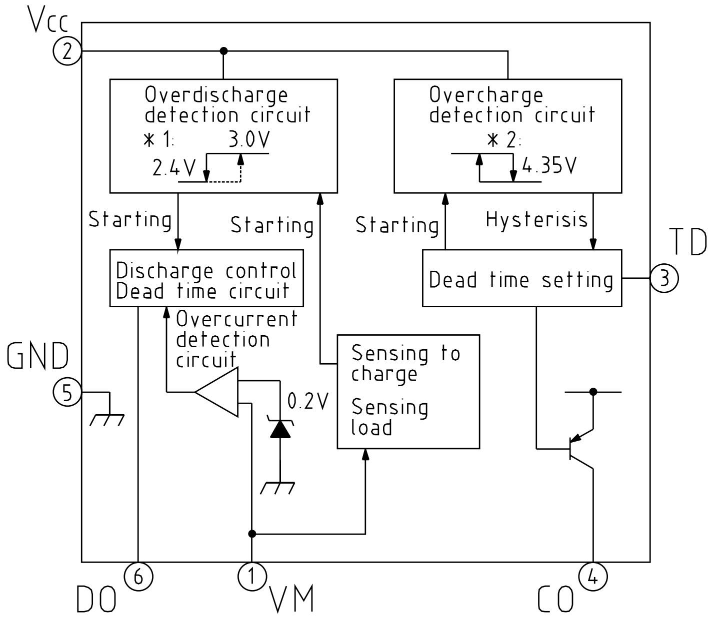
Package

SOT-26A

Applications

Lithium ion battery packs (for battery protection)

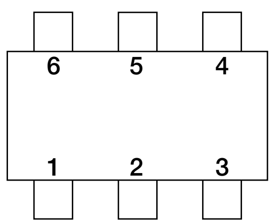
Block Diagram



*1: Over-discharge detection voltage

*2: Over-charge detection voltage

Pin Assignment



SOT-26A

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

Pin Description

PIN No.	PIN Name	TERMINAL EXPLANATIONS
1	VM	Overcurrent detection input pin. Detects discharge current by connection to charging control FET source pin. Discharge current = (voltage between V_M and GND) / (FET × 2 ON resistance)
2	V_{CC}	The positive source pin of this IC and connecting the positive terminal of the cell.
3	TD	Setting the dead time of over-charge detection with the outer capacitor.
4	CO	This pin drives the gate of the charge control N-ch FET, needs to connect resistor between source and gate of FET. Over-charge mode (when charging) : FET OFF Over-charge mode (when discharging) : FET ON Over-discharge mode (when discharging) : FET OFF Over-discharge mode (when charging) : FET ON Normal mode : FET ON
5	GND	The ground pin of this IC and connecting the negative terminal of the cell.
6	DO	This pin drives the gate of the discharge control N-ch FET. Over-discharge mode : FET OFF Over-discharge current mode : FET OFF Over-charge mode : FET ON Normal mode : FET ON

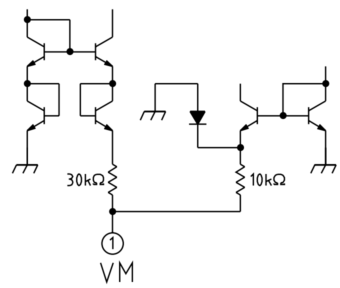
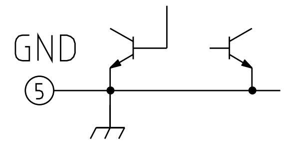
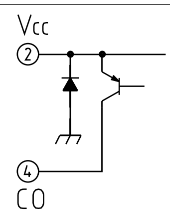
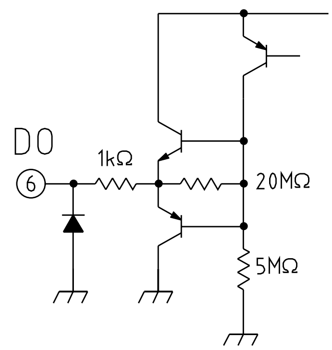
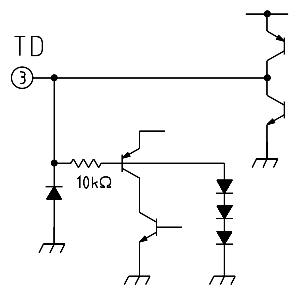
* •Overcharge mode: Battery voltage > overcharge detection voltage

•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 > overcurrent detection level, voltage between V_M and GND = discharge current × FET ON resistance
(discharge/charge control FET)

Pin Description

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
Storange temparature	T_{STG}	–40~+125	°C
Operating temparature	T_{OPR}	–20~+70	°C
Supply voltage	V_{CC} max.	–0.3~+18	V
Pin voltage	V_{CO} max. V_{VM} max.	V_{CC}–28~V_{CC}	V
Allowable loss	P_D	200	mV

Recommended Operating Conditions

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

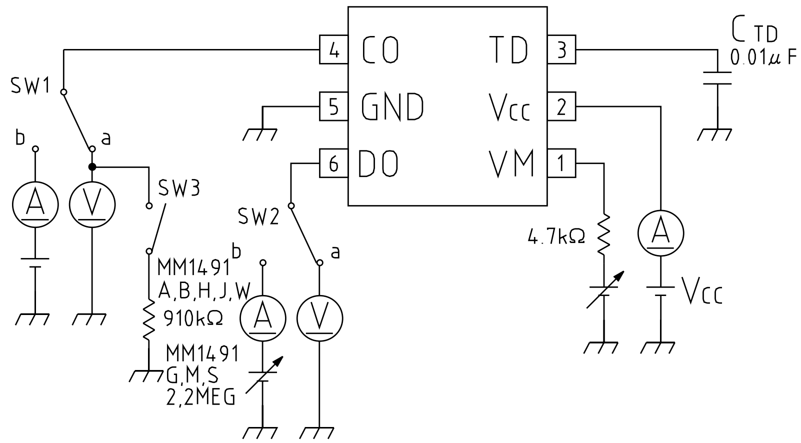
Electrical Characteristics (Unless otherwise specified Ta=25°C, V_{CC}=3.6V, model name MM1491B)

Item	Symbol	Measurement Conditions	Min.	Typ.	Max.	Unit
Current consumption 1 (Condition : SET)	I_{CC1}	V_{CC}=3.6V : Set between CO–GND : 910kΩ connected		10.0	14.0	µA
Current consumption 2 (Condition : IC only)	I_{CC2}	V_{CC}=3.6V : IC only between CO–GND : 910kΩ connected		6.0	10.0	µA
Current consumption 3 (FET : OFF on SET)	I_{CC3}	V_{CC}=3.6V : Discharge FET OFF between CO–GND : 910kΩ no connected				µA
Current consumption 4 (FET : OFF on SET)	I_{CC4}	V_{CC}=1.9V : Discharge FET OFF between CO–GND : 910kΩ no connected		0.05	0.3	µA
Current consumption 5 (Condition : SET)	I_{CC5}	V_{CC}=4.5V between CO–BG : 910kΩ connected		35	60	µA
Over-charge voltage	V_{ALM1}	Ta=0°C ~ 50°C V_{CC} : L→H	4.325	4.350	4.375	V
Over-charge hysterisis	V_{ALM1}	V_{CC} : H→L	100	200	300	mV
Over-discharge voltage	V_{ALM2}	V_{CC} : H→ L	2.30	2.40	2.50	V
Release over-discharge mode			2.88	3.00	3.12	V
Over-current detect level	V_{VMD}	V_{VM} : L→H	174	200	226	mV
Release over-current level	V_{VMDF}	V_{VM} : H→L		130		mV
Condition of release over-current mode		Load condition		50		MΩ
Short detect level	V_{VMSHT}			1.3		V
Over-discharge dead time	t_{ALM2}		7.0	10.0	15.0	ms
Over-current dead time	t_{VMD}	VM : 0V→0.5V	7.0	10.0	15.0	ms
Short detect delay time	t_{VMSHT}	VM : 0V→2V		0.02	0.20	ms
Over-charge dead time	t_{ALM1}	C_{TD}=0.01µF	50	100	150	ms
DO pin low level	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	µA
DO pin source current 2	I_{DOH2}	V_{DO}=V_{CC}–0.3V		–0.40	–0.07	µA
DO pin sink current 1	I_{DOL1}	V_{VM}>1.0V V_{DO}=1.0V	50	300		µA
DO pin sink current 2	I_{DOL2}	V_{VM}>1.0V V_{DO}=0.3V	30	100		µA
CO pin source current 1	I_{CO1}	V_{CO}=V_{CC}–1.0V		–20	–10	µA
CO pin source current 2	I_{CO2}	V_{CO}=V_{CC}–0.3V		–15	–5	µA
Start trigger voltage	V_{ST}	V_{VM} : 0V→ –0.5V	–0.2	–0.1	0	V
Over-voltage charger protection	V_{PRO}	V_{CC}=3.6V, between GND–VM voltage	–1.5	–2.5	–3.0	V
OV charge minimum voltage	V_{0V}	V_{CC}=0V, Charger voltage		2.0	3.0	V

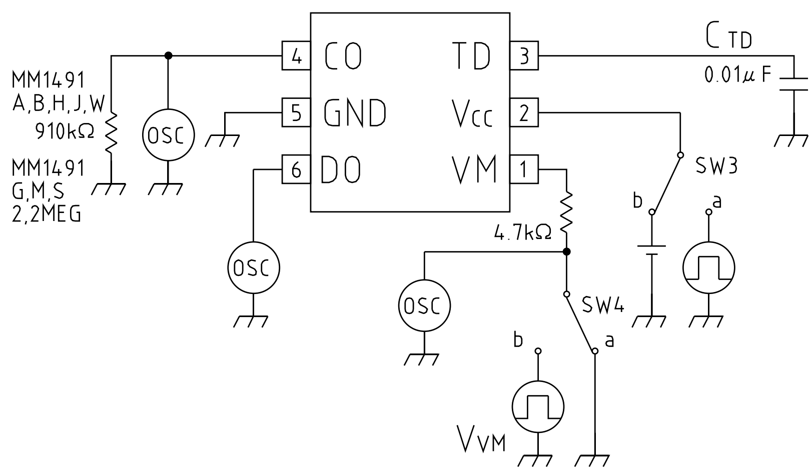
*The overcurrent detection current value is Vvm/ (FET's on resistance × 2).

Measuring Circuit

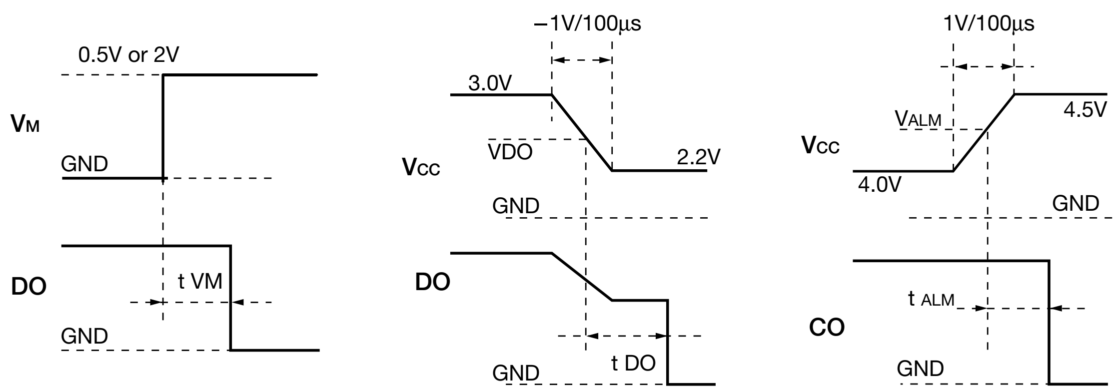
Measuring Circuit 1



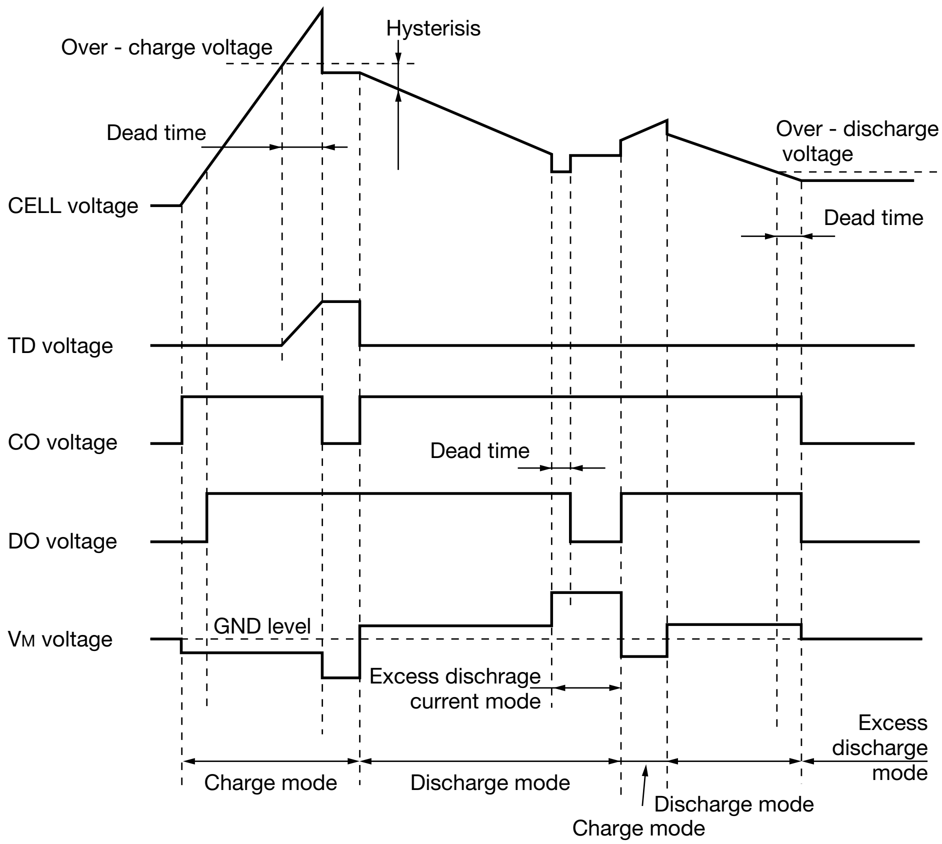
Measuring Circuit 2



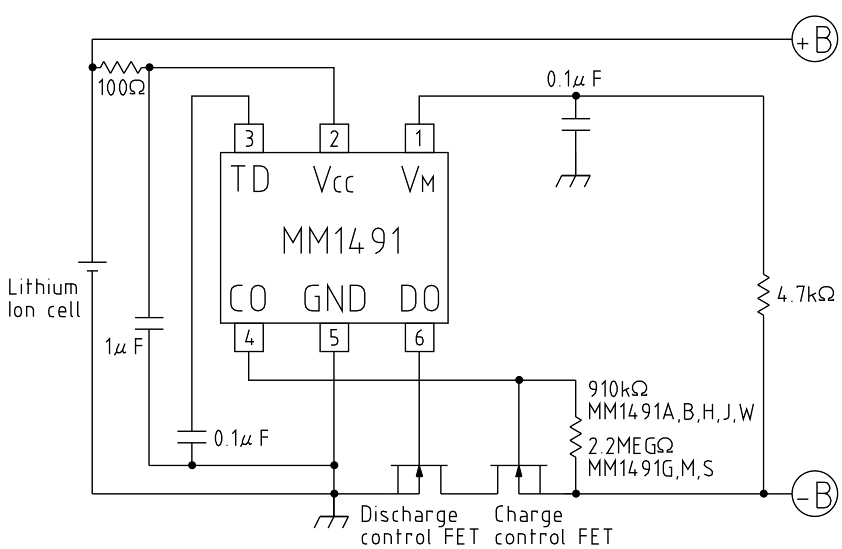
Note :



Timing Chart



Application Circuits

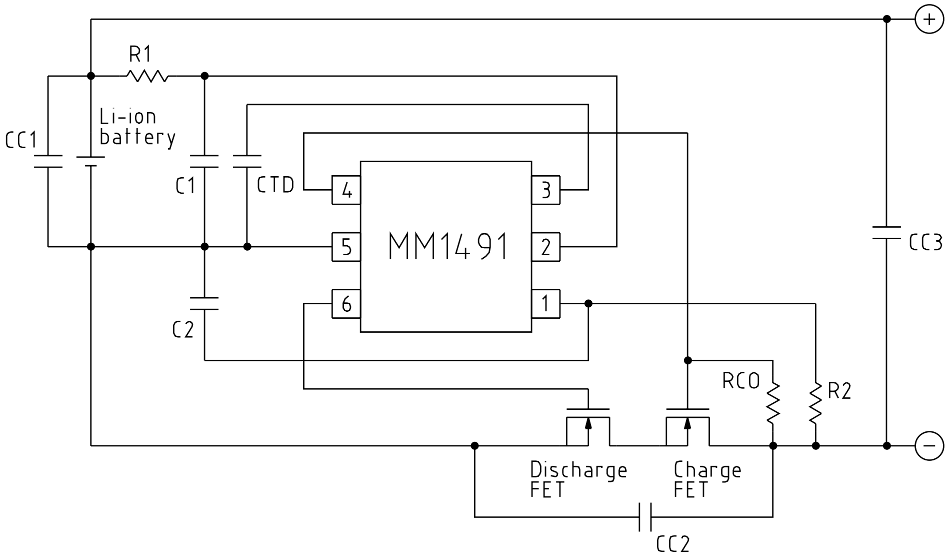


Note: Applicable circuits shown are typical examples provided for reference purposes. Mitsumi cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

Application Description

Outline

The MM1491 Series are protection IC for over-charge, over-discharge and over-current of rechargeable one-cell Lithium-ion, further include a short circuit protector for preventing large external short circuit current.



Parts List

· R1 : 100Ω	· RCO : 2.2MΩ
· C1 : 1μF	· CTD : 0.1μF/Temp. chr. code B
· R2 : 4.7kΩ	(· CC1 : 0.1μF/25V)
· C2 : 0.047μF	(· CC2 : 0.1μF/25V)
	(· CC3 : 0.1μF/25V)

1. Overcharge detection

· The overcharge detector monitors V_{CC} pin voltage. When the V_{CC} voltage crosses overcharge detector threshold VALMI (4.2V typ.) from a low value higher than the VALMI, the overcharge detector can sense a overcharging and an external charge control Nch-MOS-FET tums to "OFF" with the resister (910kΩ typ.) between the gate (CO pin) and source of FET, then CO pin "OFF".
(This resistor makes the CO pin "L". Current flows the resister on normal condition, therefore it makes the resistance value larger because to reduce the consumption current. However it makes resistance value smaller than 2.2MΩ because of relation between leak current of FET and cut-off time of FET by gate-source capacitance. : It changes the resistance value from 910KΩ to 2.2MΩ, the consumption current can be reduced about 2μA.)

2. Overdischarge detector

· The voltage of V_{CC} (2 pin) is observed when the battery is discharged, and V_{CC} enters the mode of the overdischarge detector under overdischarge detect voltage (2.3V typ.). The electrical discharge is stopped by DO pin (6 pin) outputting "L", and turning off FET for the discharge.

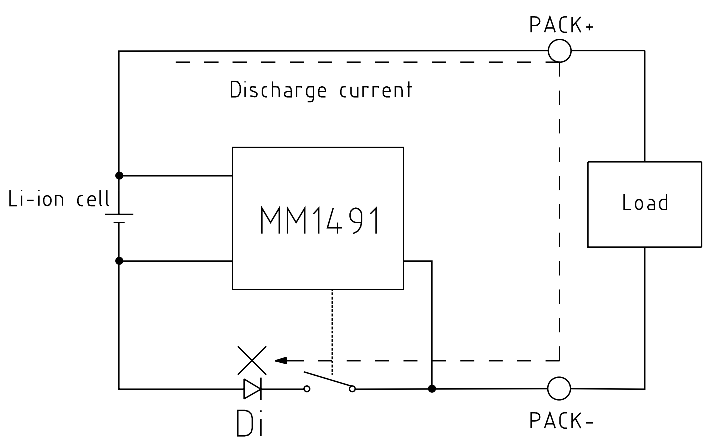
· About the release from the mode of overdischarge
Battery below the overdischarge detecting voltage through the parasitic diode of discharge FET.
The case that V_{CC} becomes more than the release overdischarge detect voltage by charging, from the mode of overdischarge, is turned on the discharge FET.

· It is assumed that CO can be assumed to be "H" and charge if the voltage of the charger which connects the charger is over 0V charging minimum operating voltage (2V typ.) at 0V in the voltage of the battery.

· The delay time when overdischarge is detected is set internally (10ms typ.).
It does not enter the mode of the overdischarge detection when rising more than the overdischarge detecting voltagein delay time even if V_{CC} becomes below the overdischarge detecting voltage.

· After overdischarge is detected, all circuit are stopped, and the current which IC consumes is decreased as much as possible. (at V_{CC}=1.9V : 0.05μA typ.)

Image figure when over-discharge mode



Note on use

· The power supply change is suppressed by R1 and C1. However, the detecting voltage rises about (current consumptions * resistance) when R1 is enlarged. Uses R1 below 330Ω.

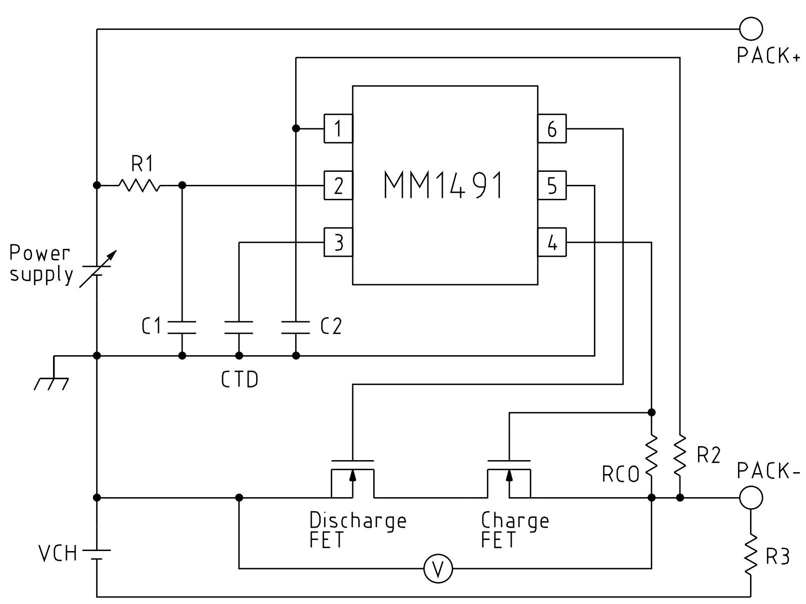
· The voltage change of (–) terminal is suppressed by R2 and C2.
Because the case with which the capacity load is connected includes the case that short detection works, the time constant is given to the terminal V_M for preventing. Use R2 4.7kΩ fixed, and change C2 and adjust the time constant. R1 and R2 can operate also as a part of current limit circuit against for applying excess charging voltage or for setting cell reverce.

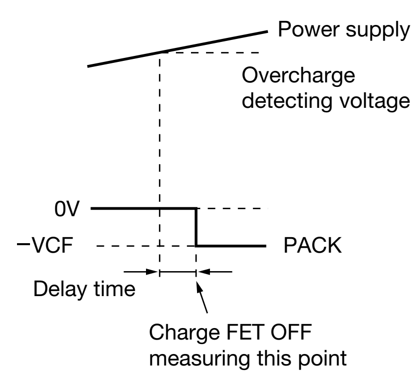
· Please note that the case whose time constant of the terminal V_M is larger than the time constant of the terminal V_{CC} includes the case which becomes a stand-by state when detecting short according to the impedance of the connected battery. Please set in (R1 * C1) ≧ (R2 * C2) as a standard.

· Please examine the necessity of CC1, CC2, and CC3 respectively to prevent the malfunction and destruction by ESD or the radio wave when you design the module. Please note that MM1421 of the charge release type has the case which enters the stand-by state by the ESD and radio wave etc. because of module patternning.

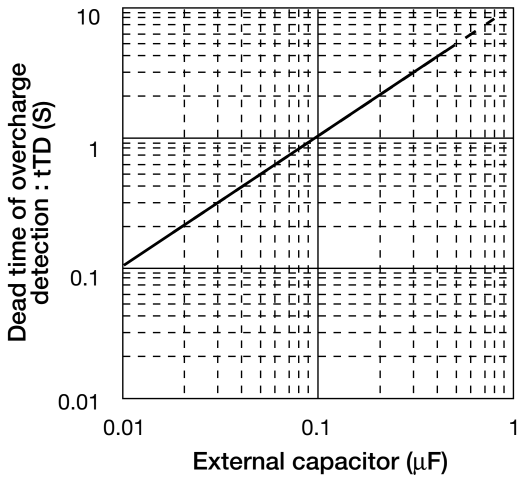
· When measuring over-charge voltage in module, evaluate with the measurement figure.
(When the battry has no loads, pack-ocillates if it enters the mode of overcharge detection. Because of the function of load detection.)

Test circuit to measure over-charge detect voltage

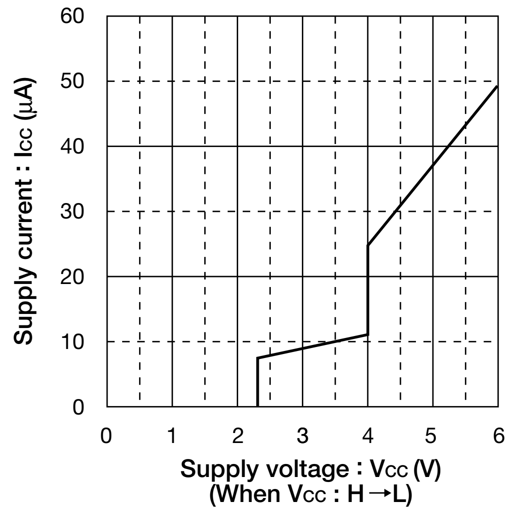




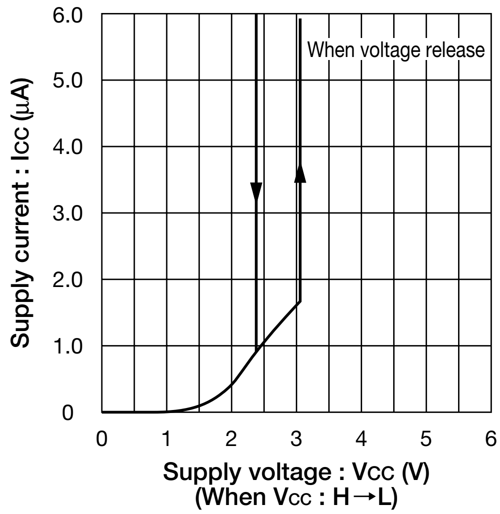
Dead time vs external capacitor (When overcharge detection)



Supply current vs supply voltage



When incleasing cell voltage supply current vs supply voltage



Note: The above specifications are representative, and are not guaranteed values.