MITSUMI

3 cell Lithium-ion/Lithium-polymer battery protection IC
MM3783 Series

Outline

MM3783 series are an overcharge, overdischarge, overcurrent and temperature protection IC for a Lithium-ion/Lithiumpolymer rechargeable battery. Lithium-ion/Lithium-polymer battery overcharge each cell, over discharge, and discharge and charging overcurrent, short circuits can be detected.

The detection of the temperature is enabled by connecting resistance between thermistor, TH terminal -VSS terminals between REG terminal -TH terminals.

Each of these IC composed of six voltage detectors, short detection circuit, reference voltage sources, delay time generation circuit , logical circuits and regulator circuit etc.

Features   (Unless otherwise specified, Topr=+25°C)

(1) Range and accuracy of detection/release voltage

● Overcharge detection voltage	3.6V to 4.5V, 5mV steps	Accuracy±25mV (Topr=±0 to +50°C)
● Overcharge release voltage (Note1)	3.4V to 4.5V, 50mV steps	Accuracy±50mV
● Overdischarge detection voltage	2.0V to 3.0V, 50mV steps	Accuracy±80mV
● Overdischarge release voltage (Note2)	2.0V to 3.5V, 50mV steps	Accuracy±100mV
● Discharge overcurrent detection voltage 1	30mV to 300mV, 5mV steps	Accuracy±15mV (Typ. 50mV~)
● Discharge overcurrent detection voltage 2	Twice or 4 times of discharging overcurrent 1	Accuracy±15%
● Short detection voltage	4 or 8 times of discharging overcurrent 1	Accuracy±100mV
● Charging overcurrent detect voltage	–300mV to –20mV, 5mV steps	Accuracy±10mV
● Temperature protection detection voltage (Note3)	–25°C to 75°C, 5°C step 3	Accuracy±3°C

(2) Each detection delay time set by the external capacitor

● Overcharge detection delay time	Setting by capacitor of COV	Accuracy±50%
● Overcharge release delay time	1/10 to 10times of tVDET1	Accuracy±50%
● Overdischarge detection delay time	Setting by capacitor of CUV	Accuracy±50%
● Overdischarge release delay time	1/10 to 10times of tVDET2	Accuracy±50%
● Discharging overcurrent detection delay time1	Setting by capacitor of CDOC	Accuracy±50%
● Discharging overcurrent detection delay time2	1/10 to 10times of tVDET3-1	Accuracy±50%
● Short detection delay time	Typ. 200µs fixed	Accuracy Min.100µs / Max.400µs
● Discharging overcurrent release delay time	1/10 to 10times of tVDET3-1	Accuracy±50%
● Charging overcurrent detection delay time	Setting by capacitor of CCOC	Accuracy±50%
● Charging overcurrent release delay time	1/10 to 10times of tVDET4	Accuracy±50%
● Temperature protection detection delay time	Setting by capacitor of CTH	Accuracy±50%
● Temperature protection release delay time	1/10 to 10times of tVDET5	Accuracy±50%

Note1 : Overcharge release function is selectable from 3 options (voltage decrease, charger remove, load connect).

Note2 : Overdischarge release function is selectable from 3 options(voltage increase , charger remove, load connect).
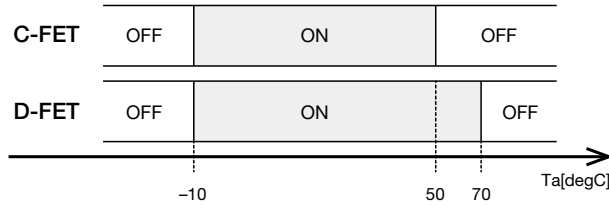
Note3 : Temperature protection detection temperature accuracy is guaranteed by design.

Detection accuracy may change with the specification of the used NTC thermistor.

(3) Temperature protection function
- ●Temperature protection thresholds can be setting 3 value (two thresholds of high temperature, one threshold of low temperature) by using a NTC thermistor.

Example of temperature protection setting

| C-FET | OFF | ON | OFF |
| D-FET | OFF | ON | OFF |

−10   50   70   Ta[degC]

High temp protection :	Charge control	Detect : +50°C ±3°C, Release : +40°C ±3°C
	Discharge control	Detect : +70°C ±3°C, Release : +60°C ±3°C
Lot temp protection :	Charge/Discharge control	Detect : −10°C ±3°C, Release : 0°C ±3°C

Note4 : Detection and release temperature change according to the spec (R, B constant) of NTC.

(4) 0V battery charge function   Selection from "Permission" or " Inhibition"

(5) Low current consumption

●Consumption current1 (VDD), Vcell=4.4V	Typ. 22.0μA Max. 34.0μA
●Consumption current2 (VDD), Vcell=3.5V	Typ. 20.0μA Max. 26.0μA
●Consumption current3 (VDD), Vcell=1.8V	Typ. 1.5μA, Max. 3.0μA

(6) Input current

| ●V2 pin input current, Vcell=3.5V | Max. ±0.3μA |
| ●V1 pin input current, Vcell=3.5V | Max. ±0.3μA |

(7) Absolute maximum ratings
●VDD pin	VSS−0.3V to VSS+21V
●Voltage between the input terminal	−0.3V to +10V
●0V pin, V− pin	VDD−30V to VDD+0.3V
●DCHG, CS, VSS_CS pin	VSS−0.3V to VDD+0.3V
●REG, TH pin	VSS−0.3V to VDD+0.3V
●COV, CUV pin	VSS−0.3V to VDD+0.3V
●CDOC, CCOC, CTH pin	VSS−0.3V to VDD+0.3V
●Storage temperature	−55°C to +125°C

(6) Charge and discharge FET control to temperature
| ●Operation temperature | −30°C to +80°C |
| ●Supply voltage | VSS+3.5V to +18.0V |

Pin Assignment

Top view TSOP-16B	Pin No.	Input / Output	Function
	1	OUTPUT	Charge control output pin. Output type is CMOS. · Normal mode : "High" · Charge prohibited mode : "Low"
	2	INPUT	Negative voltage of charger and load input pin. Detected charger connection and load connection.
	3	OUTPUT	Discharge control output pin. Output type is CMOS. · Normal mode : "High" · Discharge prohibited mode : "Low"
	4	INPUT	This pin is delay time setting of overcharge detection and overcharge release. If a capacitor is connected between COV pin and VSS pin, overcharge detection delay time setting becomes possible.
	5	INPUT	This pin is delay time setting of overdischarge detection and overdischarge release. If a capacitor is connected between CUV pin and VSS pin, overdischarge detection delay time setting becomes possible.
	6	INPUT	This pin is delay time setting of discharging overcurrent detection and discharging overcurrent release. If a capacitor is connected between CDOC pin and VSS pin, discharging overcurrent delay time setting becomes possible.
	7	INPUT	This pin is delay time setting of charging overcurrent detection and charging overcurrent release. If a capacitor is connected between CCOC pin and VSS pin, charging overcurrent delay time setting becomes possible.
	8	INPUT	This pin is delay time setting of temperature detection and temperature release. If a capacitor is connected between CTH pin and VSS pin, temperature delay time setting becomes possible.
	9	INPUT	Input of overcurrent detection. Detected overcurrent by sense resistor between CS pin and VSS_CS pin. Detection of an discharging overcurrent will output a Low level from a DCHG pin. Detection of a charging overcurrent will output a Low level from OV pin. It protects from high current by these control.
	10	INPUT	Temperature detection pin.
	11	OUTPUT	The regulator output pin for a thermo sense resistor drive.
	12	INPUT	Common pin of overcurrent detection circuit.
	13	INPUT	The input pin of the negative voltage of V1 cell. The input pin of the ground of IC.
	14	INPUT	The input pin of the positive voltage of V1 cell, and the negative voltage of V2 cell.
	15	INPUT	The input pin of the positive voltage of V2 cell, and the negative voltage of V3 cell.
	16	INPUT	The input pin of the power supply of IC, and the positive voltage of V3 cell.

Pin layout (Top view):
- OV 1 — 16 VDD
- V– 2 — 15 V2
- DCHG 3 — 14 V1
- COV 4 — 13 VSS
- CUV 5 — 12 VSS_CS
- CDOC 6 — 11 REG
- CCOC 7 — 10 TH
- CTH 8 — 9 CS

Selection Guide

Product name (MM3783***VBH)	Detection voltage / Release voltage											
	Overcharge detection voltage	Overcharge release voltage	Overdischarge detection voltage	Overdischarge release voltage	Discharging overcurrent detection voltage 1	Discharging overcurrent detection voltage 2	Short detection voltage	Charging overcurrent detection voltage	V- pin threshold voltage for discharging overcurrent release	V- pin threshold voltage for detecting Vf of charge FET	V- pin threshold voltage for detecting Vf of discharge FET	V- pin threshold voltage for overdischarge release
	V_{DET1}	V_{REL1}	V_{DET2}	V_{REL2}	V_{DET3-1}	V_{DET3-2}	V_{SHORT}	V_{DET4}	V_{VM1}	V_{VM2}	V_{VM3}	V_{VM4}
	V											
A01	4.250	4.100	2.750	3.000	0.040	0.080	0.160	−0.020	VDD×0.05	0.020	−0.020	
A02	4.200	4.050	2.750	3.000	0.040	0.080	0.160	−0.020	VDD×0.05	0.200	−0.200	
C01	4.180	4.100	2.750	3.000	0.090	0.180	0.360	−0.020	VDD×0.15	0.200	−0.300	VDD×0.30
C02	4.200	4.100	2.750	3.000	0.090	0.180	0.360	−0.020	VDD×0.15	0.200	−0.300	VDD×0.30
C06	4.250	4.100	2.750	3.000	0.040	0.080	0.160	−0.020	VDD×0.15	0.200	−0.300	VDD×0.30
C07	4.250	4.150	2.500	3.000	0.090	0.180	0.360	−0.020	VDD×0.15	0.200	−0.300	VDD×0.30

Product name (MM3783***VBH)	Temperature protection detection / release temperature/voltage													
	Temperature protection detection temperature 1	Temperature protection release temperature 1	Temperature protection detection temperature 2	Temperature protection release temperature 2	Temperature protection detection temperature 3	Temperature protection release temperature 3	Temperature protection detection voltage 1	Temperature protection release voltage 1	Temperature protection detection voltage 2	Temperature protection release voltage 2	Temperature protection detection voltage 3	Temperature protection release voltage 3	Regulator output voltage
	T_{THD1}	T_{THR1}	T_{THD2}	T_{THR2}	T_{THD3}	T_{THR3}	V_{THD1}	V_{THR1}	V_{THD2}	V_{THR2}	V_{THD3}	V_{THR3}	V_{REG}
	°C						VREG × xxx V						V
A01	−10	0	50	40	70	60	0.151	0.233	0.736	0.653	0.852	0.802	2.000
A02	−10	0	50	40	70	60	0.151	0.233	0.736	0.653	0.852	0.802	2.000
C01	0	5	55	45	65	55	0.233	0.281	0.771	0.697	0.828	0.771	2.000
C02	−10	0	55	45	75	65	0.151	0.233	0.771	0.697	0.872	0.828	2.000
C06	NA	NA	60	50	75	60	NA	NA	0.802	0.736	0.872	0.802	2.000
C07	−20	−10	60	50	75	60	0.092	0.151	0.802	0.736	0.872	0.802	2.000

Product name (MM3783***VBH)	detection delay time / release delay time											
	Overcharge detection delay time	Overcharge release delay time	Overdischarge detection delay time	Overdischarge release delay time	Discharging overcurrent detection delay time 1	Discharging overcurrent detection delay time 2	Discharging overcurrent release delay time	Short detection delay time	Charging overcurrent detection delay time	Charging overcurrent release delay time	Temperature protection detection delay time	Temperature protection release delay time
	(at COV=0.1µF)		(at CUV=0.1µF)		(at CDOC=0.01µF)				(at CCOC=0.047µF)		(at CTH=0.1µF)	
	t_{VDET1}	t_{VREL1}	t_{VDET2}	t_{VREL2}	$t_{VDET3-1}$	$t_{VDET3-2}$	t_{VREL3}	t_{SHORT}	t_{VDET4}	t_{VREL4}	t_{VDET5}	t_{VREL5}
	sec	msec	sec	msec	msec	msec	msec	µsec	msec	msec	sec	sec
A01	1.0	100	1.0	100	100	25.0	100	200	470	47.0	1.0	0.1
A02	1.0	100	1.0	100	100	25.0	100	200	470	47.0	1.0	0.1
C01	1.0	100	1.0	100	100	10.0	100	200	470	47.0	1.0	0.1
C02	1.0	100	1.0	100	100	10.0	100	200	470	47.0	1.0	0.1
C06	1.0	100	1.0	100	100	10.0	10	200	470	94.0	1.0	0.1
C07	1.0	100	1.0	100	100	10.0	10	200	470	94.0	1.0	0.1

Product name (MM3783***VBH)	Option function										
	Overcharge hysteresis cancel function	Overcharge release function	Overdischarge hysteresis cancel function	Overdischarge release function	Discharging overcurrent release function	Charging overcurrent release function	Temperature protection release function	0V battery charge function	Separated current pathway of the charge and the discharge	High side charge control
A01	enable	voltage	enable	voltage	load remove	charger remove	temp	Prohibition	Not supported	Supported
A02	enable	voltage	enable	voltage	load remove	charger remove	temp	Prohibition	Not supported	Supported
C01	enable	voltage	enable	load remove	load remove	charger remove	temp	Prohibition	Supported	Not supported
C02	enable	voltage	enable	load remove	load remove	charger remove	temp	Prohibition	Supported	Not supported
C06	enable	voltage	enable	load remove	load remove	charger remove	temp	Prohibition	Supported	Not supported
C07	enable	voltage	enable	load remove	load remove	charger remove	temp	Prohibition	Supported	Not supported

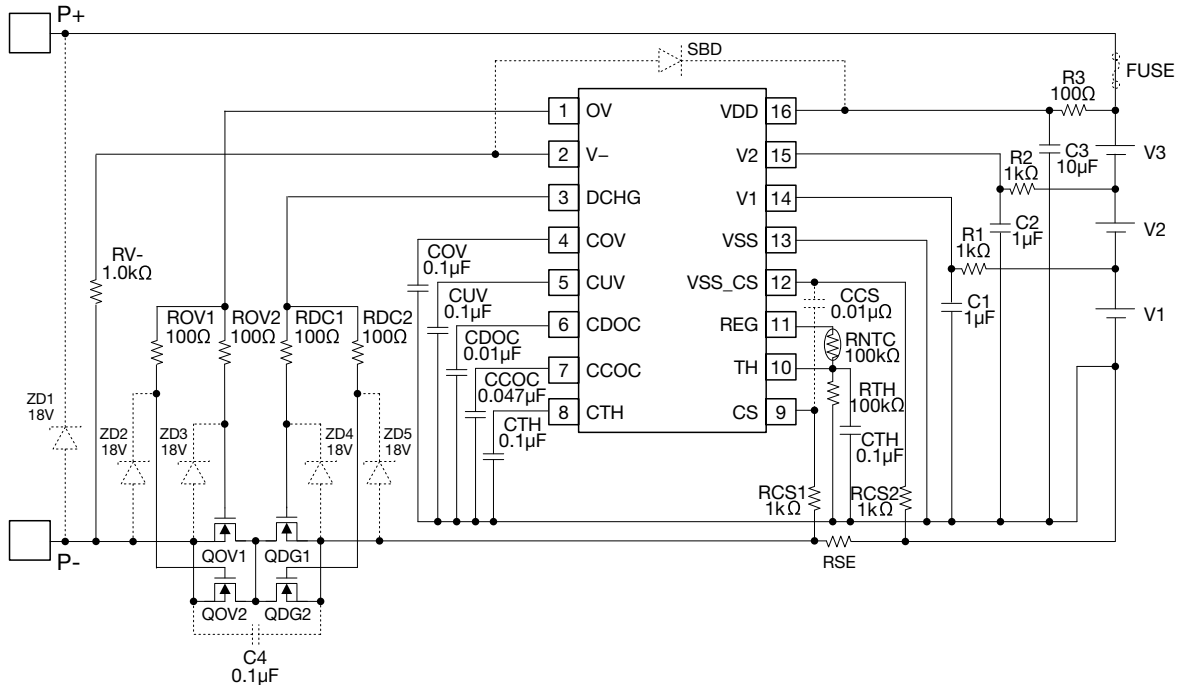Please inquire to us, if you request a rank other than the above.

Application Circuit

(1) 3 cells protection circuit (Current pathway : Separate)
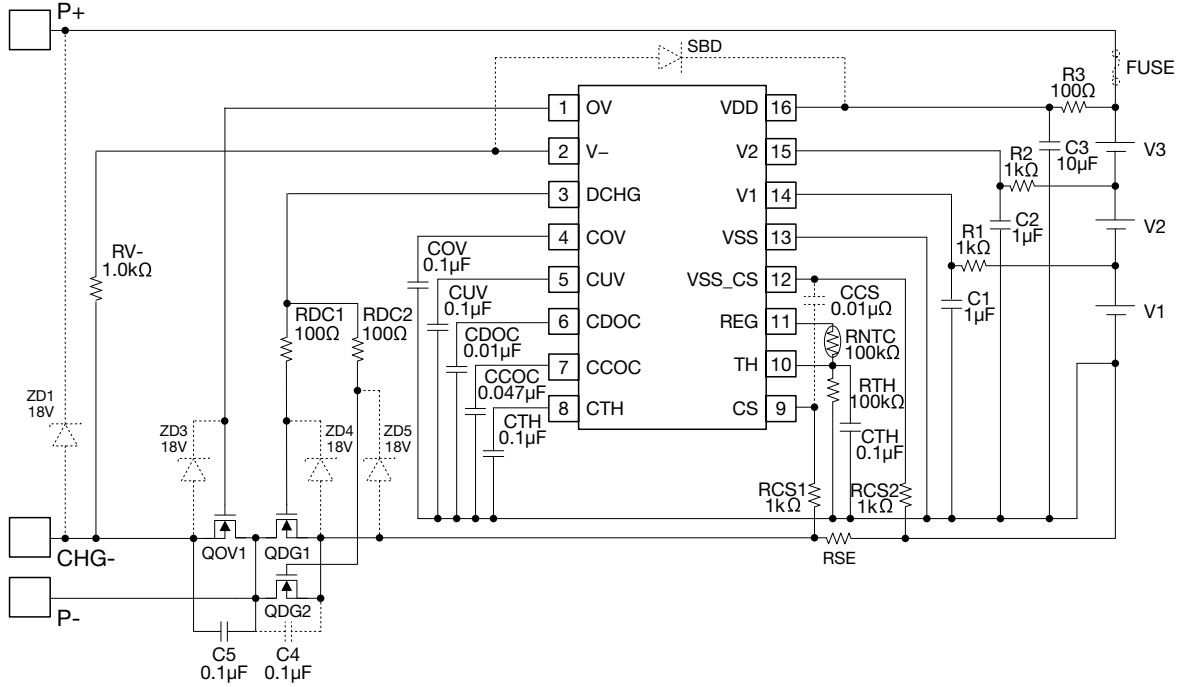
(2) 3 cells protection circuit (Current pathway : Common)

(3) Explanation of external parts : 3 cells protection circuit

Parts name	Roles of parts
R1, E2, R3	CR low-pass filter to stabilize a supply ripple of VDD pin, V2 pin and V1 pin.
C1, C2, C3	
RCS1, RCS2, RV-	Resistor to protect terminal.
CCS	Capacitor to stabilize a supply ripple of CS pin.
C4	Capacitor to stabilize a supply ripple of drain of QDG1 and QDG2.
C5	Capacitor to stabilize a supply ripple of source of QOV1.
COV	Capacitor to sets overcharge detection/release delay time.
CUV	Capacitor to sets overdischarge detection/release delay time.
CDOC	Capacitor to sets discharging overcurrent detection/release delay time.
CCOC	Capacitor to sets charging overcurrent detection/release delay time.
CTH	Capacitor to sets temperature protection detection/release delay time.
R_{SENSE}	Sense resistance to observe charging/discharging current.
ROV1, ROV2, RDC1, RDC2	Resistor for preventing the gate destruction due to parasitic oscillation.
RNTC	NTC thermistor to observe to temperature.
RTH	The REG voltage is divided by NTC and RTH, and it's input to TH pin.
CTH	Capacitor to stabilize a supply ripple of TH pin.
ZD1	Zener diode to prevent destruction of IC by surge voltage and motor back electromotive voltage.
ZD2, ZD3, ZD4, ZD5	Zener diode to prevent destruction the gate and source of charge/discharge control FET.
QOV1, QOV2	Nch MOS FET to control charging current.
QDG1, QDG2	Nch MOS FET to control discharging current.
SBD	When V- pin becomes more than it in VDD pin voltage, it is schottky barrier diode to bypass the current so that an current does not flow through the IC inside.

(4) Instructions and directions for use

· When the current pathway of the charge and the discharge is separated, wiring is separated from the drain of charge and discharge control FET.

· When the current pathway of the charge and the discharge is separated, do not connect load and charger at the same time. It may incorrect-release from the discharging overcurrent detection state and the short detection state.

· When the current pathway of the charge and the discharge is separated, please be sure to connect capacitor (C5) of more than 0.1uF to between the drain and the source of charge control FET.

· If temperature protection function is repealed, please make TH pin and VDD pin connection and make a REG pin open.

· Temperature detection property is adjusted using the thermo sensitive register of the following part number, and resistance accuracy. In order to satisfy the characteristic of specification, it recommends using the following parts.

Symbol	Name	Function	Part name	Remarks
RTNC	NTC Thermistor	100kΩ ±1% B (25/50) =3950±1%	MF52D 104F 3950	Shenzhen DCH Electronic
RTH	Resistor	100kΩ ±1%		

Note5 : Calculation fomula of NTC resisance and voltage of TH terminal

· $Ra = R0 * \exp (B * (1 / Ta - 1 / T0))$

   Ra : NTC resistance when the surrounding temperature is Ta(K).
   R0 : NTC resistance when the surrounding temperature is T0(K).
   B   : Thermistor constant

· $Vdet = VREG * RTH / (RTH + Rdet)$

   Vdet : Temperature protection detection threshold of MM3783 TH terminal.
   VREG : Output voltage of MM3783 REG terminal.
   Rdet : NTC resistance when the surrounding temperature is detection temperature.
   RTH : The resistance between the TH terminal and the VSS terminal