3 to 5 cells Lithium-ion/Lithium-polymer battery protection IC
MM3684 Series

Outline

The MM3684 series are protection IC using high voltage CMOS process for overcharge, secondary overcharge, overdischarge, overcurrent and temperature protection of the rechargeable Lithium-ion or Lithium-polymer battery. The overcharge, overdischarge, discharging overcurrent, charging overcurrent, temperature of the rechargeable 3 to 5 cells Lithium-ion or Lithium-polymer battery can be detected. The internal circuit of IC is composed by the voltage detector, the reference voltage source, delay time control circuit, and the logical circuit, etc.

Features   (Unless otherwise specified, Topr=+25℃)

(1) Range and accuracy of detection/release voltage

• Overcharge detection voltage 1 (0V output)	3.6V to 4.5V, 5mV steps	Accuracy ±25mV (Topr=±0 to +50℃)
• Overcharge release voltage 1 (0V output) *1	3.4V to 4.5V, 50mV steps	Accuracy ±50mV
• Overcharge detection voltage 2 (PF output)	3.6V to 4.5V, 5mV steps	Accuracy ±25mV (Topr=±0 to +50℃)
• Overdischarge detection voltage 1	2.0V to 3.0V, 50mV steps	Accuracy ±80mV
• Overdischarge detection voltage 2	2.0V to 3.0V, 50mV steps	Accuracy ±100mV
• Overdischarge release voltage *2	2.0V to 3.5V, 50mV steps	Accuracy ±100mV
• Discharging overcurrent detection voltage 1	30mV to 300mV, 5mV steps	Accuracy ±15%
• Discharging overcurrent detection voltage 2	Twice or 4 times of discharging overcurrent 1 *3	Accuracy ±20%
• Short detection voltage	4 or 8 times of discharging overcurrent 1 *3	Accuracy ±100mV
• Charging overcurrent detect voltage	−300mV to −20mV, 5mV steps	Accuracy ±10mV

(2) Range of detection delay time

• Overcharge detection delay time 1	Setting by a capacitor of COV pin.	Accuracy ±50%
• Overcharge release delay time 1	Setting by a capacitor of COV pin.	Accuracy ±50%
• Overcharge detection delay time 2	Setting by a capacitor of CPF pin.	Accuracy ±50%
• Overdischarge detection delay time	Setting by a capacitor of CUV pin.	Accuracy ±50%
• Overdischarge release delay time	Setting by a capacitor of CUV pin.	Accuracy ±50%
• Discharging overcurrent detection delay time 1	Setting by a capacitor of DCOC pin.	Accuracy ±50%
• Discharging overcurrent detection delay time 2	Setting by a capacitor of DCOC pin.	Accuracy ±50%
• Short detection delay time	Selection from 100μs, 200μs, 300μs	Accuracy −50%, +100%
• Discharging overcurrent release delay time	Setting by a capacitor of DCOC pin.	Accuracy ±50%
• Charging overcurrent detection delay time	Setting by a capacitor of CCOC pin.	Accuracy ±50%
• Charging overcurrent release delay time	Setting by a capacitor of CCOC pin.	Accuracy ±50%
• Temperature protection detection ON time	Setting by a capacitor of CIOT pin.	Accuracy ±50%
• Temperature protection detection OFF time	Setting by a capacitor of CIOT pin.	Accuracy ±50%

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

*2 : Overdischarge release function is selectable from 3 options.
(voltage increase , charger remove, load connect)

*3 : option

(3) The setting for three cell , for four cell , and for five cell protection can be set with the SEL1,2 pin.

(4) Threshold of over-discharge detection can be switched to over-discharge detection voltage 1, 2 at the DVSEL terminal.

(5) 0V battery charge function Selection from "Prohibition" or "Permission"

(6) Power save mode built-in
   • When all cells is detected overdischarge and charger disconnecting, IC becomes low consumption mode.

(7) Achieve low consumption by making the temperature detection for regulator and temperature detection circuit to intermittent operation

(8) Low current consumption
   • VDD pin current consumption (Vcell=4.3V)　　Typ. 15.0μA,　Max. 25.0μA
   • VDD pin current consumption (Vcell=3.5V)　　Typ. 10.0μA,　Max. 20.0μA
   • VDD pin current consumption at power save　Typ. 3.0μA,　Max. 6.0μA
     (Vcell=1.8V)
   • V5 pin current consumption (Vcell=4.3V)　　Typ. 1.0μA,　Max. 2.0μA
   • V5 pin current consumption (Vcell=3.5V)　　Typ. 0.8μA,　Max. 1.5μA
   • V5 pin current consumption (Vcell=1.8V)　　Max. 0.5μA

(9) Input cerrent
   • V4 pin input current (Vcell=3.5V)　　Max. 0.3μA
   • V3 pin input current (Vcell=3.5V)　　Max. 0.3μA
   • V2 pin input current (Vcell=3.5V)　　Max. 0.3μA
   • V1 pin input current (Vcell=3.5V)　　Max. 0.3μA

(10) Absolute maximum ratings
   • VDD pin　　　　　　　　　　　　　　VSS−0.3V to VSS+30V
   • V5 pin　　　　　　　　　　　　　　V4−0.3V to VDD+0.3V
   • Voltage between the input terminals　　−0.3V to +10V
   • V−, 0V pin　　　　　　　　　　　　VDD−30V to VDD+0.3V
   • PF, DCHG, CS pin　　　　　　　　　VSS−0.3V to VDD+0.3V
   • SEL1, SEL2, DVSEL pin　　　　　　　VSS−0.3V to VDD+0.3V
   • CPF, COV, CUV pin　　　　　　　　VSS−0.3V to VDD+0.3V
   • CDOC, CCOC, CIOT pin　　　　　　VSS−0.3V to VDD+0.3V
   • REG, TH pin　　　　　　　　　　　VSS−0.3V to VDD+0.3V
   • Storage temperature　　　　　　　　−55 to +125℃

(11) Recommended operating conditions
   • Operating Temperature　　　　　　　−40 to +85℃
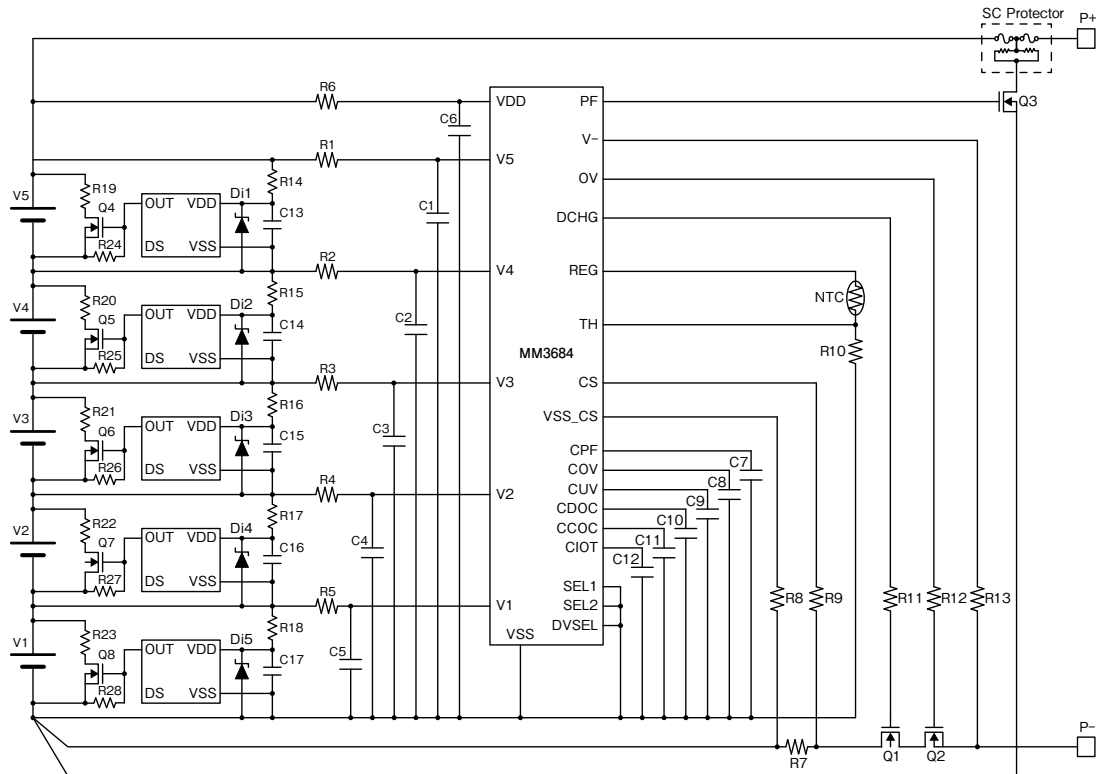   • Supply Voltage　　　　　　　　　　VSS+3.5V to +22.5V

Pin Assignment

Top view	Pin No.	Function
VSOP-24A		
	1	Input terminal connected to charger negative voltage. Detected charger connection and load connection
	2	Charge control output pin. Output type is N-Ch FET open drain. Normal mode → "High" Charge prohibited mode → "Low"
	3	Discharge control output pin. Output type is CMOS. Normal mode → "High" Discharge prohibited mode → "Low"
	4	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
	5	This pin is delay time setting of overcharge detection 2. If a capacitor is connected between CPF pin and VSS pin, overcharge detection 2 delay time setting becomes possible
	6	This pin is delay time setting of overcharge detection 1 and overcharge release 1. If a capacitor is connected between COV pin and VSS pin, overcharge detection 1 delay time setting becomes possible
	7	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
	8	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
	9	This pin is delay time setting of intermittent operation of temperature detection. If a capacitor is connected between CIOT pin and VSS pin, temperature delay time setting becomes possible
	10	This pin is for changing function for overdischarge detection voltage 1,2 "High" → Overdischarge detection voltage 1 "Low" → Overdischarge detection voltage 2

Pin diagram (VSOP-24A):

Left	Pin		Pin	Right
V–	1	○	24	PF
OV	2		23	VDD
DCHG	3		22	V5
CUV	4		21	V4
CPF	5		20	V3
COV	6		19	V2
CDOC	7		18	V1
CCOC	8		17	VSS
CIOT	9		16	VSS_CS
DVSEL	10		15	REG
SEL1	11		14	TH
SEL2	12		13	CS

Pin No.	Function		
11	This pin is for changing function for 3cell in series or 4cell in series, 5cell in series.	SEL1="L", SEL2="L" → 5Cell in series	
		SEL1="H", SEL2="L" → 4Cell in series	
12		SEL1="L", SEL2="H" → 3Cell in series	
		SEL1="H", SEL2="H" → test mode	
13	Input of overcurrent detection. Detected overcurrent by sense resistor between CS pin and VSS pin. Detection of an discharging overcurrent will output a High level from a DCHG pin. It protects from high current by these control		
14	Temperature detection pin		
15	The regulator output pin for a thermo sense resistor drive		
16	Common pin of overcurrent detection circuit		
17	The input pin of the negative voltage of V1 cell. The input pin of the ground of IC		
18	The input pin of the positive voltage of V1 cell, and the negative voltage of V2 cell		
19	The input pin of the positive voltage of V2 cell, and the negative voltage of V3 cell		
20	The input pin of the positive voltage of V3 cell, and the negative voltage of V4 cell		
21	The input pin of the positive voltage of V4 cell, and the negative voltage of V5 cell		
22	The input pin of the positive voltage of V5 cell		
23	The input terminal of the power supply of IC		
24	Charge control output pin. Output type is CMOS. Normal mode → "Low" Charge prohibited mode → "High"		

Application Circuit

· 5 cells protection circuit.

Explanation of external parts

Parts name	Roles of parts
R1・R2・R3・R4・R5・R6 C1・C2・C3・C4・C5・C6	CR low-pass filter to stabilize a supply ripple of VDD pin, V5 pin, V4 pin, V3 pin, V2 pin and V1 pin
R8・R9・R13	Resistor to protect terminal
R11・R12	Resistor for preventing the gate destruction due to parasitic oscillation
R7	Sense resistance to observe charging/discharging current
NTC	NTC thermistor to observe to temperature
R10	The REG voltage is divided by NTC and RTH, and it's input to TH pin
C7	Capacitor to sets overcharge detection delay time 2
C8	Capacitor to sets overcharge detection/release delay time 1
C9	Capacitor to sets overdischarge detection/release delay time
C10	Capacitor to sets discharging overcurrent detection/release delay time
C11	Capacitor to sets charging overcurrent detection/release delay time
C12	Capacitor to set the ON / OFF time of the intermittent operation of the temperature protection
Q1	Nch MOS FET to control discharging current
Q2	Nch MOS FET to control charging current
Q3	Nch MOS FET to fuse cut at secondary protection detection