Li-Ion Battery Protector

General Description

The RT9545 Series are protection ICs for over-charge/discharge of rechargeable one-cell Lithium-ion (Li+) batteries by CMOS process.

The RT9545 Series can detect over-charge/discharge of Li+ one-cell and excess load current and charge current, further include a short circuit protector for preventing large external short circuit current.

Each of these ICs is composed of four voltage detectors, a reference unit, a hysteresis circuit, and a bidirectional short circuit protector. Package of SOT-23-6 is available.

Ordering Information

RT9545□□□□

- Package Type
  - E : SOT-23-6
  - ER : SOT-23-6 (R-Type)
- Operating Temperature Range
  - C : Commercial Standard
  - P : Pb Free with Commercial Standard
- Over-charge / Over-discharge
  - O : 4.35V / 2.5V
  - T : 4.25V / 2.9V
  - S : 4.35V / 2.9V

Note :

RichTek Pb-free products are :

–RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.

–Suitable for use in SnPb or Pb-free soldering processes.

–100%matte tin (Sn) plating.

Marking Information

For marking information, contact our sales representative directly or through a RichTek distributor located in your area, otherwise visit our website for detail.

Features

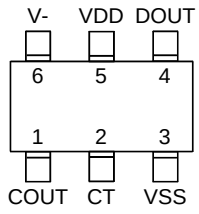
- **Low Supply Current**
  - **–Supply Current: Typical 2.0μA**
  - **–Standby Current (after Detecting Over-discharge) : Less than 0.2μA**
- **High Accuracy Detector Threshold**
  - **–Over-Charge Detector : –90mV to +40mV**
  - **–Over-Discharge Detector : ± 2.5%**
- **Built-in Protection Circuit :**
  Excess Current Trip/Short Circuit Protector in both Charging and Discharging Direction
- **Output Delay of Over-charge Adjustable with an External Capacitor: 75ms at 0.01μF**
- **Ultra Small Package: SOT-23-6**
- **RoHS Compliant and 100% Lead (Pb)-Free**

Applications

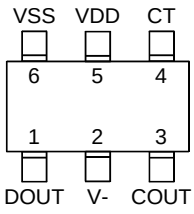
- Over-charge/Over-discharge Protection for Li+ One-cell Pack
- High Precision Protectors for Cellular Phones or Instruments Using Li+ One-cell Battery

Pin Configurations

(TOP VIEW)



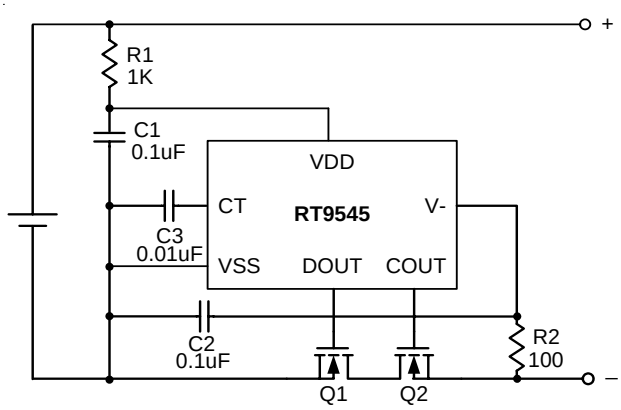
SOT-23-6



SOT-23-6 (R-Type)

Note : There is no pin1 indicator on top mark for SOT-23-6 type, and pin1 will be lower left pin when reading top mark from left to right.

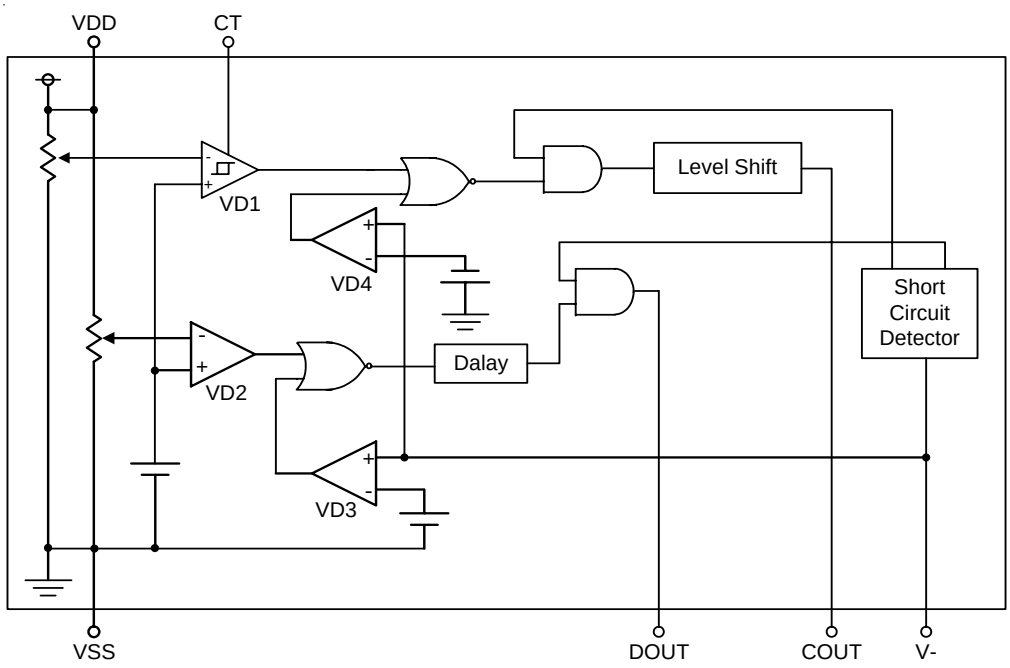
Typical Application Circuit



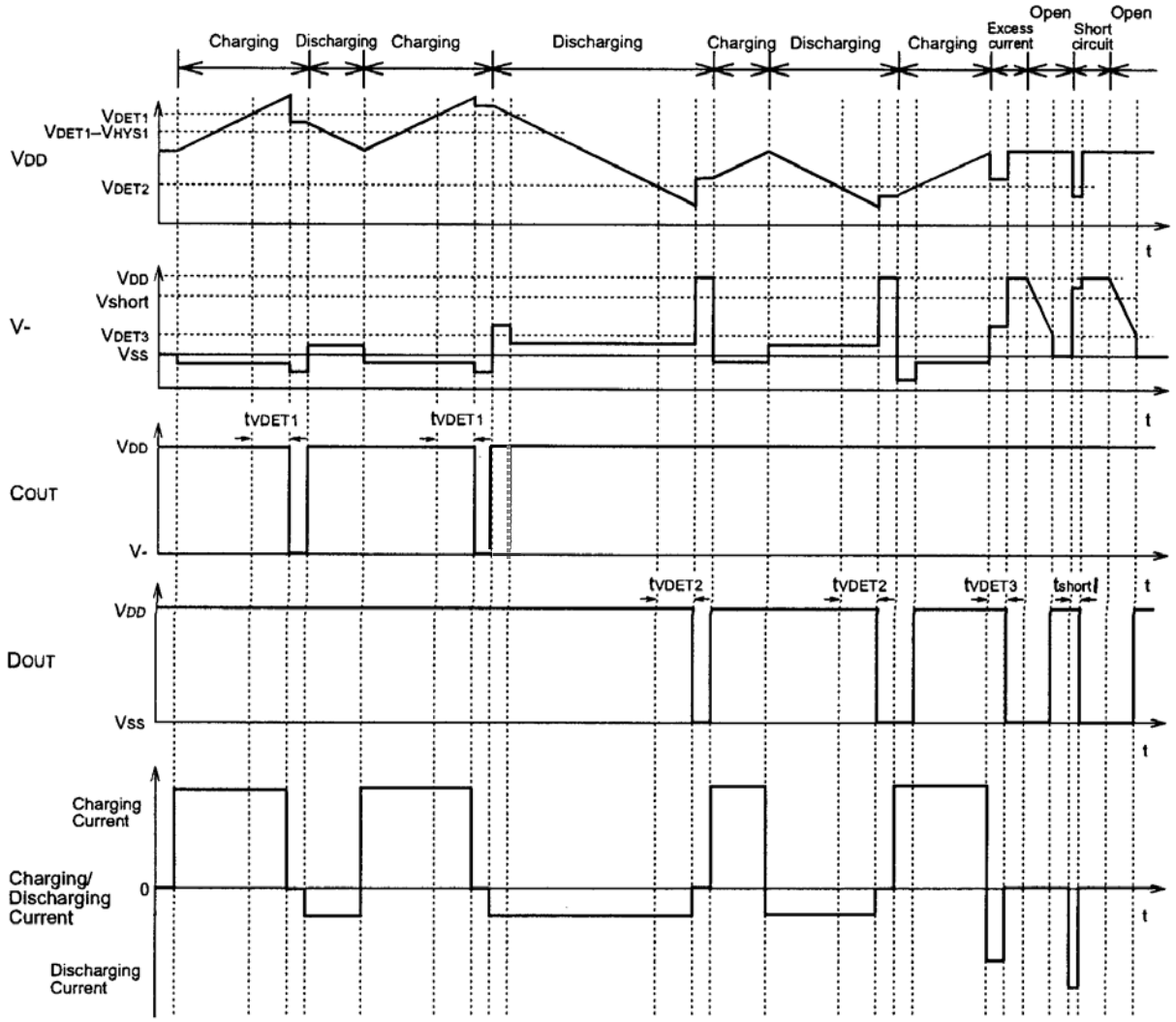
Functional Pin Description

Pin No.		Pin Name	Pin Function
RT9545-□□E	RT9545-□□ER		
1	3	COUT	Output of Over-charge Detection, CMOS output
2	4	CT	Pin for external capacitor setting output delay of VD1
3	6	VSS	Ground
4	1	DOUT	Output of Over-discharge Detection, CMOS output
5	5	VDD	Power Supply, through a resistor (R1)
6	2	V–	Pin for Charge Negative Input, through a resistor (R2)

Function Block Diagram



Timing Diagram



Absolute Maximum Ratings (Note 1)

- Allowable Battery Voltage ---------- –0.3V to 7V
- Input Voltage [(V–) Pin] ---------- VDD – 25V to VDD+ 0.3V
- Input Voltage (CT Pin) ---------- VSS – 0.3V to VDD+ 0.3V
- Output Voltage (COUT Pin) ---------- VDD – 14V to VDD+ 0.3V
- Output Voltage (DOUT Pin) ---------- VSS – 0.3V to VDD+ 0.3V
- Power Dissipation, P_D @ T_A = 25°C
  SOT-23-6 ---------- 0.25W
- Package Thermal Resistance
  SOT-23-6, θ_{JA} ---------- 250°C/W
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Junction Temperature ---------- 150°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 2)
  HBM (Human Body Mode) ---------- 2kV
  MM (Machine Mode) ---------- 200V

Recommended Operating Conditions (Note 3)

- Junction Temperature Range ---------- –20°C to 85°C

Electrical Characteristics

Parameter		Symbol	Test Conditions	Min	Typ	Max	Units
Operating Input Voltage		V_{DD}	Voltage defined as V_{DD}-V_{SS}	1	--	6	V
Charger Voltage		V_{CHG}	Voltage defined as V_{DD}-(V-)	--	--	25	V
Minimum Operating Voltage for 0V Charging			Voltage defined as V_{DD}-(V-) V_{DD}-V_{SS} = 0V	--	--	1	V
Accuracy of Over-charge Threshold Voltage	RT9545O	V_{OCHG}	Detect rising edge of supply voltage	4.26	4.35	4.39	V
	RT9545T			4.16	4.25	4.29	
	RT9545S			4.26	4.35	4.39	
Over-charge Threshold Hysteresis				0.1	0.15	0.2	V
Output Delay Time of Over-charge		T_{OCHG}	C3 = 0.01µF, V_{DD} = 3.6V to 4.3V	30	60	80	ms
Accuracy of Over-discharge Threshold Voltage	RT9545O	$V_{ODISCHG}$	Detect falling edge of supply voltage	2.4375	2.5	2.5625	V
	RT9545T			2.8275	2.9	2.9725	
	RT9545S			2.8275	2.9	2.9725	
Output Delay Time of Over-discharge		$T_{ODISCHG}$	V_{DD} = 3.6V ~ 2.4V	10	15	20	ms
Excess Current Threshold Voltage During Discharge			Detect rising edge of “V-“ pin voltage	0.10	0.12	0.14	V
Output Delay of Charge Excess Current			V_{DD} = 3.0V	15	20	25	ms
Excess Current Threshold Voltage During Charge			Detect falling edge of “V-“ pin voltage	-0.14	-0.12	-0.10	V

To be continued

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Short Detection Voltage During Discharge		VDD = 3.0V	VDD-1.1	VDD-0.8	VDD-0.5	V
Output Delay of Discharge Short Circuit	TSHORT	VDD = 3.0V	--	5	50	μs
Reset Resistance for Excess Current Protection	RSHORT	VDD = 3.6V, V- = 1.0V	25	50	75	kΩ
Supply Current	IDD	VDD = 3.9V, V- = 0V	--	2.0	5.0	μA
Standby Current	ISTANDBY	VDD = 2.0V	--	0.1	0.5	μA

Note 1. Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. Devices are ESD sensitive. Handling precaution recommended.

Note 3. The device is not guaranteed to function outside its operating conditions.

Application Information

(1) Operation Description

Refering to the "Function Block Diagram", when charging voltage crosses the detector threshold from a low value to a value higher than VDET1, the output of COUT pin, the output of over-charge detector/VD1, swiches to low level, charger's negative pin level. After detecting over-charge the VD1 can be reset and the output of COUT pin becomes "H" when the VDD voltage is coming down to a level lower than "VDET1 –VHYS1", or when a charger is disconnected from the battery pack.

The output of DOUT pin, the output of over-discharge detector/VD2, switches to "L" after internally fixed delay time passed, when discharging voltage crosses the detector threshold from a high value to a value lower than VDET2. An excess load current can be sensed and cut off after internally fixed delay time passsed through the built in excess current detector, VD3, with DOUT being enabled to low level. Once after detecting excess current, the VD3 is released and DOUT level switches to "H" by detaching a battery pack from a load system.

Futher, short circuit protector makes DOUT level to "L" immediately with external short circuit current and removing external short circuit leads DOUT level to "H".

The excess charging current is also monitored, and the charging path will be cut off (by turn low COUT) after excess charging current was detected lasting a internally fixed delay time. The charging path will be re-started (by turn high COUT) after another internally fixed delay. If the excess charging current is still there, the same process will be repeated and cause the charging path toggling on and off with a 12.5% on duty. Such a protection function reduces the average charging current to 12.5% of original value when excess charging current detected.

The short circuit protection function in charging direction was also provided. When COUT high and the "V-" pin voltage 5V lower than VSS pin, the RT9545 will turn low COUT with a fixed delay. The COUT will go high after the short circuit condition was removed.

After detecting over-discharge, supply current will be kept extremely low by halting some internal circuits operation. The output delay of over-charge detectors can be set by connecting an external capacitor. Output type of COUT and DOUT are CMOS.

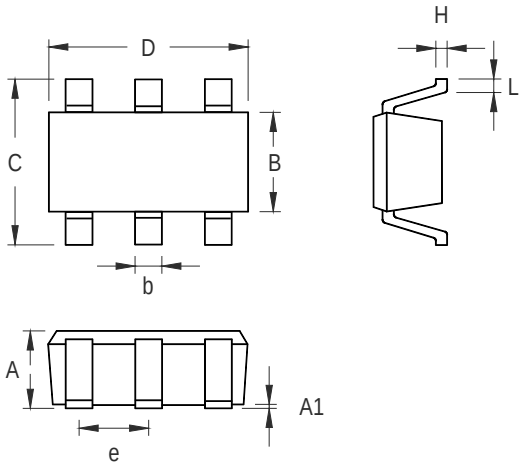
(2) Component Selection Guide:

For Charger Voltage ≤ 15V, the constrain is 1.5kΩ ≥ R1 ≥ 680W, 75Ω ≤ R2 ≤ 1.5kΩ, C1 ≥ 0.047μF.

For Charger Voltage ≥ 15V, the constrain is 1.5kΩ ≥ R1 ≥ 680Ω, 75Ω ≤ R2 ≤ 220Ω, C1 ≥ 0.047μF.

And R1=1kΩ, R2=100Ω, C1=0.1μF are recommended to cover all applications above.

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.889	1.295	0.031	0.051
A1	0.000	0.152	0.000	0.006
B	1.397	1.803	0.055	0.071
b	0.250	0.560	0.010	0.022
C	2.591	2.997	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.838	1.041	0.033	0.041
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

SOT-23-6 Surface Mount Package

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