TP3102

1Cell Li-ion Battery Protector IC

DataSheet

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Contents：

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General Specification

The TP3102 series are protection IC for over-charge/discharge of rechargeable one-cell Lithium-ion (Li+) batteries by CMOS process.

The TP3102 series can detect over-charge/discharge of Li+ one-cell and excess load current, further include a short circuit protector for preventing large external short circuit current.

Each of these ICs is composed of three voltage detectors, a reference unit, a hysteresis circuit, and a short circuit protector. 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, switches to low level, charger's negative pin level. After detecting overcharge 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 while the VDD level is in between 'VDET1" and ' VDET1 – VHYS1 " in the TP3102 version.

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 passed 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.

Further, short circuit protector makes Dout level to "L" immediately with external short circuit current and removing external short circuit leads DOUT level to "H". After detecting over-discharge, supply current will be kept extremely "L" by halting some internal circuits operation. The output delay of over - charge detectors can be set by connecting external capacitors. Output type of COUT and DOUT are CMOS. SOT26-w is available.

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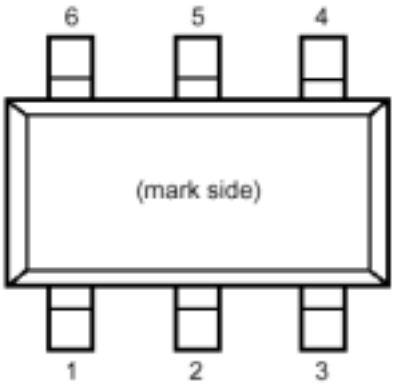
Pin Configurations and Package Type:



PIN DESCRIPTION:

Pin No	Symbol	Pin description
3	C_{OUT}	Output of over-charge detection, CMOS output
4	ID	Battery ID
6	V_{SS}	Ground
1	D_{OUT}	Output of over-discharge detection, CMOS output
5	V_{DD}	Power supply
2	V-	Pin for charger negative input

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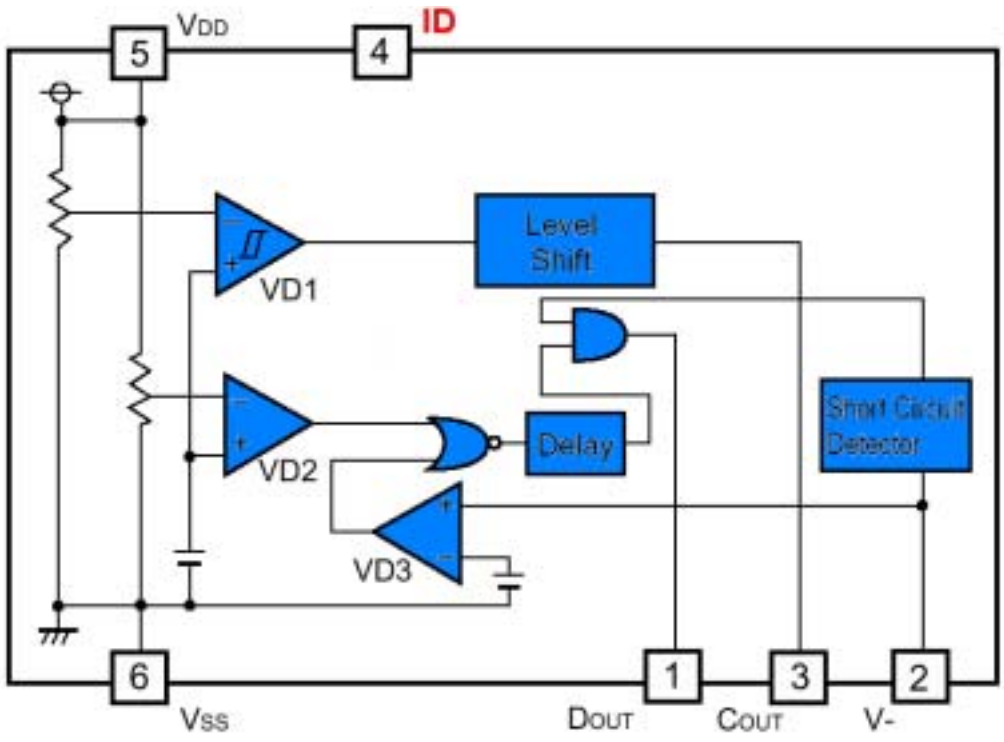
Function Block Diagram



Function Descriptions:

● VD1/Over-Charge Detector

- The VD1 monitors VDD pin voltage. When the VDD voltage crosses over-charge detector threshold VDET1 from a low value to a value higher than the VDET1 the VD1 can sense over-charging and an external charge control Nch-MOS-FET turns to "OFF' with COUT pin being at "L".

- A level shifter incorporated in a buffer driver for the COUT pin makes the "L" of COUT pin to the V- pin voltage and the "H" of COUT pin is set to VDD voltage with CMOS buffer.

Reset conditions from overcharging of TP3102

- There can be two cases to reset the VD1 making the COUT pin level to "H" again after detecting overcharge. Resetting the VD1 makes the charging system ready for resumption of charging process. The first case is in such condition that a time when the VDD voltage is coming down to a level lower than “VDET1- VHYS1”.
  While in the second case, disconnecting a charger from the battery pack can make the VD1 resetting when the VDD level is within hysteresis width (VDET1 – VHYS1<VDD<VDETl)

- After detecting overcharge with the VDD voltage of higher than VDET1, connecting system load to the battery pack makes load current allowable through parasitic diode of external charge control Nch-MOS-FET. The COUT level would be "H" when the VDD level is coming down to a level below the VDET1 by continuous drawing of load current.

● VD2/Over-Discharge Detector

- The VD2 monitors a VDD pin voltage. When the VDD voltage crosses the over-discharge detector threshold VDET2 from a high value to a value lower than the VDET2, the VD2 can sense an over-discharging and the external discharge control Nch-MOS-FET turns to “OFF” with the DOUT pin being at "L".

- Resetting the VD2 with the DOUT pin level being "H" again after detecting over-discharge is only possible by connecting a charger to the battery pack. When the VDD voltage stays under over-discharge detector threshold VDET2 charge current can flow through parasitic diode of external discharge control Nch-MOS-FET, then after the VDD voltage comes up to a value larger than VDET2 discharging process would be advanced

through “ON” state discharge control Nch-MOS-FET. Connecting a charger to the battery pack makes the DOUT level being "H" instantaneously when the VDD voltage is higher than VDET2.

- When a cell voltage equals to zero, connecting charger to the battery pack makes the system allowable for charge with higher charge voltage than Vst, 1.2V Max.

- An output delay time for the over-discharge detection is fixed internally. Though the VDD voltage would be going down to a lower level than VDET2 if it is within a time period of the output delay time, VD2 would not output a signal for turning “OFF” of discharge control Nch-MOS-FET.

- After detection of an over-discharge by VD2, supply current would be reduced to 0.2 μATYP. at VDD=2.0V and into standby, only the charger detector is operating.

- The output type of DOUT pin is CMOS having “H” level of VDD and “L” level of Vss.

● VD3/Excess Current Detector, Short Circuit Protector

• Both of the excess current detector and short circuit protector can work when both control Nch-MOS-FETs are in “ON” state.

When the V- pin voltage is going up to a value between the short protection voltage Vshort and excess current threshold VDET3, the excess current detector operates and further soaring of V- pin voltage higher than Vshort makes the short circuit protector enabled. As a result the external discharge control Nch-MOS-FET turns to “OFF” with the DOUT pin being at “L”.

• An output delay time for the excess current detector is internally fixed, 13ms TYP. at VDD=3.0V. A quick recovery of V- pin level from a value between Vshort and VDET3 within the delay time keeps the discharge control FET staying “ON” state.

When the short circuit protector is enabled, the DOUT would be "L" and its delay time would be 5μs TYP.

• The V- pin has a built-in pull down resistor, TYP.100 kΩ, connected to the Vss pin.

After an excess current or short circuit protection is detected, removing a cause of excess current or external short circuit makes an external discharge control Nch-MOS-FET to an "ON" state automatically with the V- pin level being down to the Vss level through the built-in pull down resistor.

• When VDD voltage is higher than VDET2 at a time when the excess current is detected the TP3102 does not enter a standby mode, while VDD voltage is lower than VDET2 the TP3102 enters a standby mode.

After detecting short circuit the TP3102 will not enter a standby mode.

Absolute Maximum Rating:

Vss=0V

Symbol	Item		Rating	Unit
V_{DD}	Supply Voltage		-0.3 to 20V	V
V-	Input Voltage	V- pin	V_{DD}-20 to V_{DD}+0.3 V	V
V_{COUT}	Output Voltage	C_{OUT} pin	V_{DD}-20 to V_{DD}+0.3	V
V_{DOUT}		D_{OUT} pin	V_{DD}-0.3 to V_{DD}+0.3	V
P_D	Power Dissipation		150	mW
T_{OPT}	Operating Temperature Range		-10 to 85	℃
Tstg	Storage Temperature Range		-55 to 125	℃

ABSOLUTE MAXIMUM RATINGS
Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

DC Electrical Characteristic:

◆ **TP3102**

Topt=25℃

Symbol	Item	Conditions	MIN	TYP	MAX	Unit
V_{DD}	Operating input voltage	Voltage defined as V_{DD}-Vss	1.5		18	V
Vst	Minimum operating voltage for 0V charging	Voltage defined as V_{DD}-V-, V_{DD}-Vss=0V			1.2	V
V_{DET1}	Over-charge threshold voltage	Detect rising edge of supply voltage	4.275	4.30	4.325	V
V_{HYS1}	Over-charge threshold hysteresis range		0.15	0.2	0.25	V
t_{VDET1}	Output delay time of over-charge	V_{DD}=3.6V→ 4.3V	450	500	550	ms
V_{DET2}	Over-discharge threshold voltage	Detect falling edge of supply voltage	2.437	2.50	2.563	V
t_{VDET2}	Output delay time of over-discharge	V_{DD}=3.6V→2.4V	7	10	13	ms
V_{DET3}	Excess current threshold voltage	Detect rising edge of "V-" pin voltage	0.17	0.20	0.23	V
			0.10	0.13	0.15	
t_{VDET3}	Output delay time of excess current	V_{DD}=3.0V	9	13	17	ms
Vshort	Short detection voltage	V_{DD}=3.0V	V_{DD}-1.1	V_{DD}-0.8	V_{DD}-0.5	V
tshort	Output delay time of short detection	V_{DD}=3.0V		5	50	μs
Rshort	Reset resistance for excess current protection	V_{DD}=3.6V, V-=l.0V	50	100	150	kΩ
V_{OL1}	Nch ON voltage of C_{OUT}	I_{OL}= 50uA, V_{DD}=4.4V		0.2	0.5	V
V_{OH1}	Pch ON voltage of C_{OUT}	I_{OH}= -50uA, V_{DD}=3.9V	3.4	3.8		V
V_{OL2}	Nch ON voltage of D_{OUT}	I_{OL}= 50uA, V_{DD}=2.4V		0.2	0.5	V
V_{OH2}	Pch ON voltage of D_{OUT}	I_{OH}= -50uA, V_{DD}=3.9V	3.4	3.7		V
I_{DD}	Supply current	V_{DD}=3.9V, V- =0V		3.0	6.0	μA
Istandby	Standby current	V_{DD}=2.0V		0.2	0.3	μA

★ Please refer to Test Circuit unless otherwise specified.

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Features:

◆Low supply current……..	Supply current	TYP. 3.0uA
	Standby current (after detecting over-discharge)	TYP. 0.2uA
◆High withstand voltage…….	Absolute maximum ratings 18V (VDD -- V-)	
◆High accuracy detector threshold….	Over-charge detector	±25mV
	Over-discharge detector	±2.5%
◆Variety of detector threshold……	Over-charge detector threshold	4.0V to 4.4V/step of 0.01V
	Over-discharge detector threshold	2.0V to 3.0V/step of 0.05V
◆Built-in protection circuit……	Excess current trip/Short circuit protector	
◆Output delay of over-charge…….	Time delay at VDD=4.3V	500mS for TP3102
◆Ultra small package……..	SOT-26	

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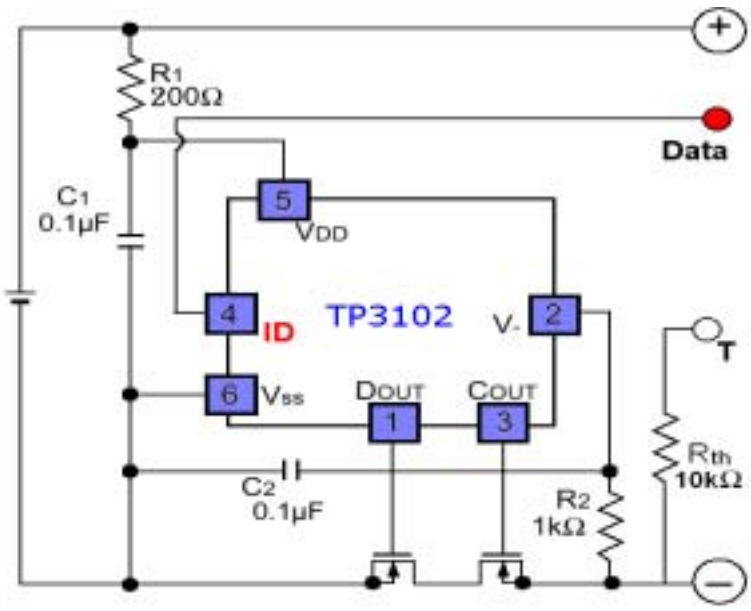
Application Diagram:



NOTE ON EXTERNAL COMPONENTS
• R_1 and C_1 will stabilize a supply voltage to the TP3102. A recommended R_1 value is less than 1kΩ. A larger value of R_1 leads higher detection voltage, makes some errors, because of shoot through current flowed in the TP3102.
• R_1 and R_2 can operate as a current limiter against setting cell reverse direction or for applying excess charging voltage to the TP3102. While smaller R_1 and C_2 may cause an over power dissipation rating of the TP3102 and a total of "R_1+R_2" should be more than 1kΩ. R_1 should be more than 200Ω.

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Application Notes:

◆Over-charge/overdischarge protection for Li+ one-cell pack

◆ High precision protectors for cell-phones and any other gadgets using on board Li+ onecell battery

◆ For Motorola serial battery ID