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Li-LON/POLYMER 1CELL PROTECTOR

R5402xxxxx SERIES (Preliminary)

OUTLINE

The R5402xxxxx Series are high voltage CMOS-based protection ICs for over-charge/discharge of rechargeable one-cell Lithium-ion (Li+) / Lithium polymer excess load current, further include a short circuit protector for preventing large external short circuit current and Excess charge/discharge-current.

Each of these ICs is composed of four voltage detectors, a reference unit, a delay circuit, a short circuit protector, an oscillator, a counter, and a logic circuit. When the over-charge voltage or the excess charge-current threshold crosses the each detector threshold from a low value to a high value, the output of C_{OUT} pin switches to low level after internal fixed delay time. The conditions to release over-charge detector are different by mask options. In terms of so called "Latch function" version, after detecting over-charge or excess charge current, these detectors can be reset and the output of C_{OUT} becomes "H" when a kind of load is connected to V_{DD} after a charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold. If a charger is continue to be connected to the battery pack, even the cell voltage becomes lower than over-charge detector threshold, over-charge state is not released. On the other hand, in terms of so called, " Released by voltage level" version, after detecting over-charge, when the cell voltage reaches the released voltage from over-charge, the output of C_{OUT} becomes "H"

The output of D_{OUT} pin, the output of Over-discharge detector and Excess discharge-current detector, switches to "L" level after internally fixed delay time, when discharged voltage crosses the detector threshold from a high value to a value lower than V_{DET2}.

The conditions to release over-discharge detector are also different by mask options. In terms of so called "Latch function" version, after detecting over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than over-discharge detector threshold, VD2 is released and the voltage of D_{OUT} pin becomes "H" level. On the other hand, in terms of so called "Released by voltage level" version, in case that the charger is not connected, when the cell voltage becomes equal released voltage from over-discharge, over-discharge detector is released. In case that a charger is connected, and when the cell voltage becomes the released voltage from over-discharge, the over-discharge detector is released.

An excess discharge-current and short circuit state can be sensed and cut off through the built in excess current detector, VD3, with D_{OUT} being enabled to low level. Once after detecting excess discharge-current or short circuit, the VD3 is released and D_{OUT} level switches to high by detaching a

battery pack from a load system.

    After detecting over-discharge, supply current will be kept extremely low by halting internal circuits' operation.
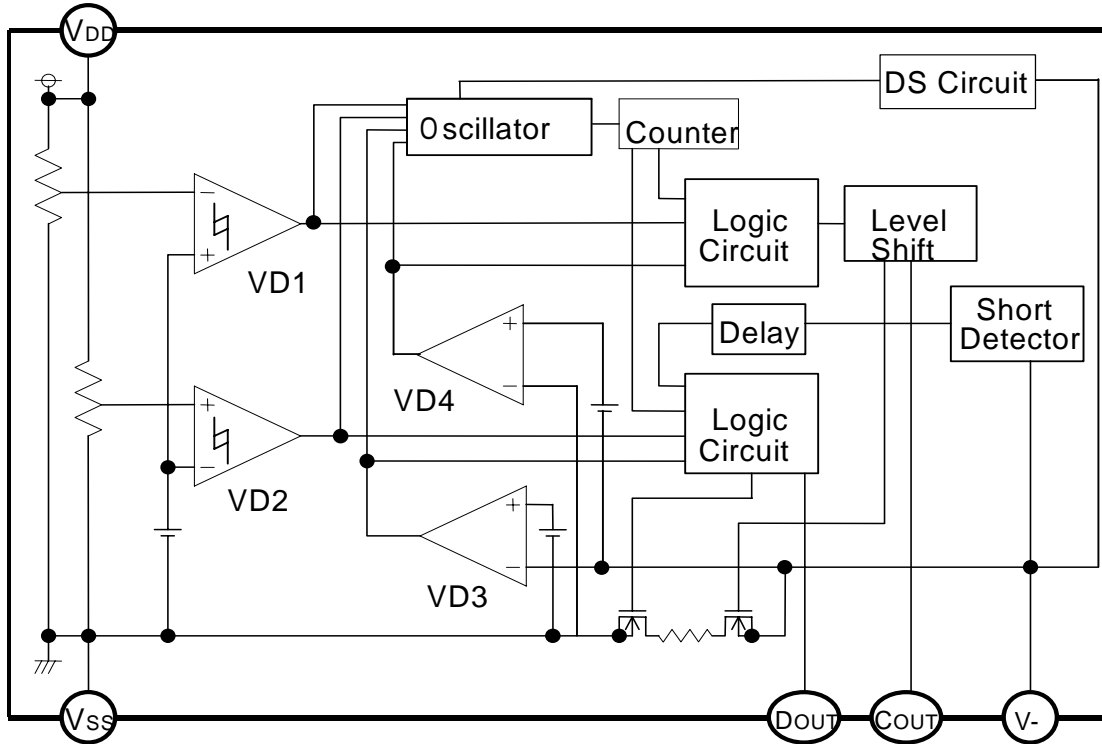
    When the output of C$_{OUT}$ is "H", if V- pin level is set at Vss-2V, the delay time of detector can be shortened. Especially, the delay time of over-charge detector can be reduced into approximately 1/57. Therefore, testing time of protector circuit board can be reduced. Output type of C$_{OUT}$ and D$_{OUT}$ are CMOS. 6-pin, SOT-23-6 is available.
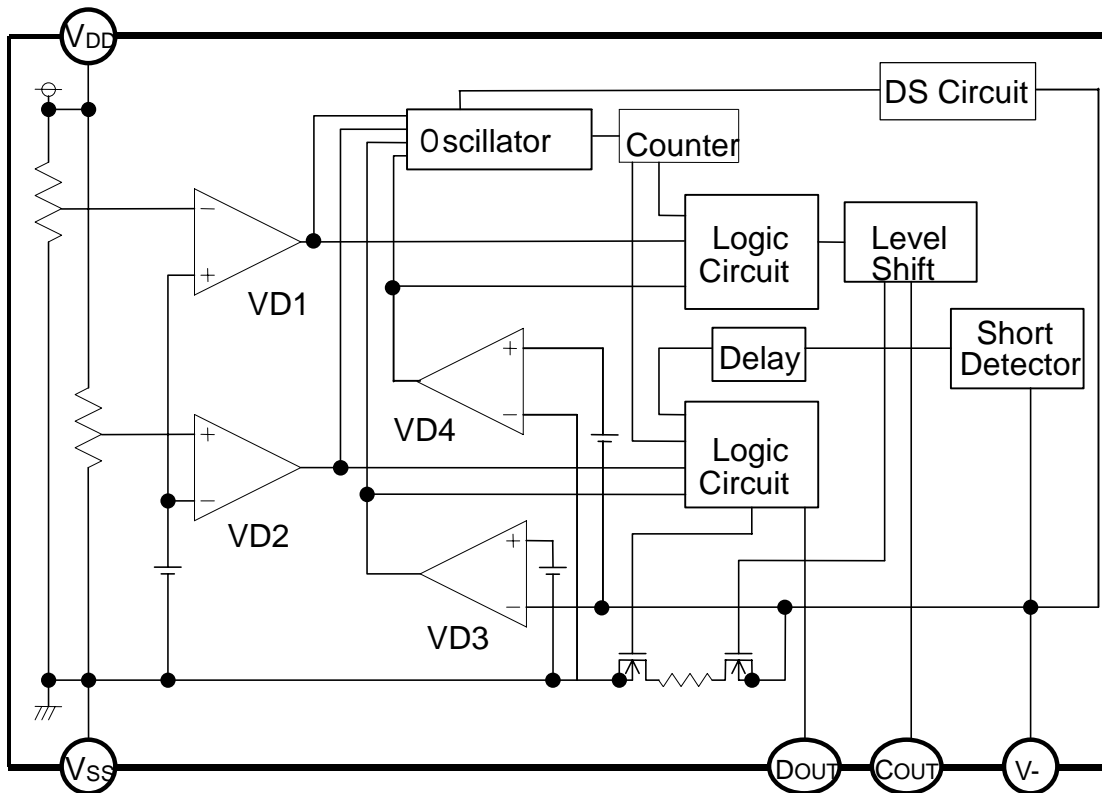
FEATURES

- Manufactured with High Voltage Tolerant Process ...Absolute Maximum Rating   35V
- Low supply current ....Supply current (At normal mode)   Typ. 4.0μA
  C version: (detecting over-discharge)   Max. 0.1μA
  B/D version: (detecting over-discharge) Typ. 1.2μA/Max. 2.0μA
- High accuracy detector threshold ....Over-charge detector (Topt=25°C)   ±25mV
  (Topt=-5 to 55°C)   ±30mV
  Over-discharge detector   ±2.5%
  Excess discharge-current detector   ±15mV
  Excess charge-current detector   ±30mV
- Variety of detector threshold ....Over-charge detector threshold   4.0V-4.5V step of 0.005V
  Over-discharge detector threshold   2.0V-3.0V step of 0.005V
  Excess discharge-current threshold   0.05V-0.20V step of 0.005V
  Excess charge-current threshold   Fixed at -0.1V
  Short Detector Threshold   Fixed at 0.8V
- Internal fixed Output delay time...............Over-charge detector Output Delay 250ms(F type) /1s (C, K type)
  (Select among the options)   Over-discharge detector Output Delay   20ms
  Excess discharge-current detector Output Delay   12ms
  Short Circuit detector Output Delay   300μs
  Excess charge-current detector Output Delay 8ms(K Type) /16ms(C,F Type)
- Output Delay Time Shortening Function..At COUT is "H", if V- level is set at –2V, the Output Delay time of all items except short-circuit can be reduced. (Delay Time for over-charge becomes about 1/57 of normal state.)
- 0V-battery charge option...........................acceptable/unacceptable
  Conditions   for   release   over-charge   detector   With   Latch   function   (B/C   version)
  With Released voltage, (D version)
  Conditions for Release over-discharge detector   Latch Type: (C version)

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.... Released Voltage (B/D version)

- Ultra Small package SOT-23-6

APPLICATIONS

- Li+ / Li Polymer protector of over-charge, over-discharge, excess-current for battery pack
- High precision protectors for cell-phones and any other gadgets using on board Li+ / Li Polymer battery

BLOCK DIAGRAMS

B version

D version

C version

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SELECTION GUIDE

In the R5402xxxxx Series, four of the input threshold for over-charge, over-discharge, excess discharge current, and excess charge current detectors can be designated.

Part Number is designated as follows:

R5402x xxxxx-xx   ←Part Number

   ↑ ↑ ↑↑ ↑

   a   b cd   e

Code	Contents
a	Package Type N: SOT-23-6
b	Serial Number for the R5402 Series designating input four threshold for over-charge, over-discharge, excess discharge-current, and excess charge-current detectors.
c	Designation of Output delay option of over-charge, excess charge-current, and excess discharge-current.
d	Designation of version symbols B version: With Latch function after over-charge, Released by voltage level from Over-discharge C version: With Latch function after Over-charge and Over-discharge D version: Released by voltage level from Over-charge and Over-discharge
e	Taping Type: TR (refer to Taping Specification)

PIN CONFIGURATIONS

SOT-23-6
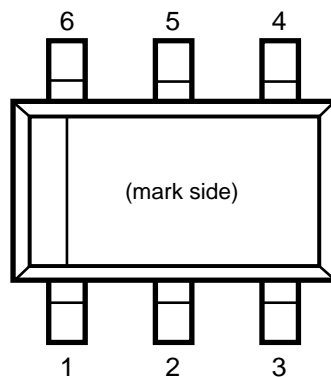
PIN DESCRIPTION

Pin No.	Symbol	Description
1	D_{OUT}	Output of over-discharge detection, CMOS output
2	V-	Pin for charger negative input
3	C_{OUT}	Output of over-charge detection, CMOS output
4	NC	No Connection
5	V_{DD}	Power supply pin, the substrate voltage level of the IC.
6	V_{SS}	Vss pin. Ground pin for the IC

ABSOLUTE MAXIMUM RATINGS

V_{SS}=0V

Symbol	Item	Ratings	Unit
V_{DD}	Supply voltage	-0.3 to 12	V
V-	Input Voltage V- pin	V_{DD} -35 to V_{DD} +0.3	V
VC_{OUT} VD_{OUT}	Output voltage C_{OUT} pin D_{OUT} pin	V_{DD} -35 to V_{DD} +0.3 V_{SS} -0.3 to V_{DD} +0.3	V V
P_D	Power dissipation	150	mW
Topt	Operating temperature range	-40 to 85	°C
Tstg	Storage temperature range	-55 to 125	°C

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ELECTRICAL CHARACTERISTICS

Unless otherwise specified, Topt=25°C

*R5402x1xxCB

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DD1}	Operating input voltage	Voltage defined as V_{DD}-V_{SS}	1.5		5.0	V
V_{st}	Minimum operating Voltage for 0V charging *Note 1	Voltage defined as V_{DD}-V-, V_{DD}-V_{SS}=0V			1.8	V
V_{DET1}	Over-charge threshold	Detect rising edge of supply voltage R1=330Ω R1=330Ω (Topt=-5 to 55°C) *Note3	V_{DET1}-0.025 V_{DET1}-0.030	V_{DET1} V_{DET1}	V_{DET1}+0.025 V_{DET1}+0.030	V V
tV_{DET1}	Output delay of over-charge	V_{DD}=3.6V to 4.4V	0.7	1.0	1.3	s
tV_{REL1}	Output delay of release from over-charge	V_{DD}=4.5V to 3.6V	11	16	21	ms
V_{DET2}	Over-discharge threshold	Detect falling edge of supply voltage	V_{DET2}×0.975	V_{DET2}	V_{DET2}×1.025	V
V_{REL2}	Released Voltage from Over-discharge	Detect rising edge of supply voltage	V_{REL2}×0.975	V_{REL2}	V_{REL2}×1.025	V
tV_{DET2}	Output delay of over-discharge	V_{DD}=3.6V to 2.2V	14	20	26	ms
tV_{REL2}	Output delay of release from over-discharge	V_{DD}=3V V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET3}	Excess discharge-current threshold	Detect rising edge of 'V-' pin voltage	V_{DET3}-0.015	V_{DET3}	V_{DET3}+0.015	V
tV_{DET3}	Output delay of excess discharge-current	V_{DD}=3.0V, V-=0V to 1V	8	12	16	ms
tV_{REL3}	Output delay of release from excess discharge-current	V_{DD}=3.0V, V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET4}	Excess charge-current threshold	Detect falling edge of 'V-' pin voltage	-0.13	-0.10	-0.07	V
tV_{DET4}	Output delay of excess charge-current	V_{DD}=3.0V V-=0V to -1V	11	16	21	ms
tV_{REL4}	Output delay of release from excess charge-current	V_{DD}=3.0V, V-=-1V to 0V	0.7	1.2	1.7	ms
Vshort	Short protection voltage	V_{DD}=3.0V	0.55	0.8	1.0	V
Tshort	Output Delay of Short protection	V_{DD}=3.0V, V-=0V to 3V	230	300	500	μs
Rshort	Reset resistance for Excess discharge-current protection	V_{DD}=3.6V, V-=1V	25	50	75	kΩ
V_{DS}	Delay Shortening Mode input voltage	V_{DD}=4.4V	-2.6	-2.0	-1.4	V
V_{OL1}	Nch ON voltage of C_{OUT}	Iol=50μA, V_{DD}=4.5V		0.4	0.5	V
V_{OH1}	Pch ON voltage of C_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
V_{OL2}	Nch ON voltage of D_{OUT}	Iol=50μA, V_{DD}=2.0V		0.2	0.5	V
V_{OH2}	Pch ON voltage of D_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
I_{DD}	Supply current	V_{DD}=3.9V, V- =0V		4.0	8.0	μA
Is	Standby current	V_{DD}=2.0V		1.2	2.0	μA

*Note: We compensate for this characteristic related to temperature by laser-trim, however, this specification is guaranteed by design, not production tested.

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*R5402x1xxKD **Unless otherwise specified, Topt=25°C**

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DD1}	Operating input voltage	Voltage defined as V_{DD}-V_{SS}	1.5		5.0	V
Vst	Minimum operating Voltage for 0V charging *Note 1	Voltage defined as V_{DD}-V-, V_{DD}-V_{SS}=0V			1.8	V
V_{DET1}	Over-charge threshold	Detect rising edge of supply voltage R1=330Ω R1=330Ω (Topt=-5 to 55°C)*Note3	V_{DET1}-0.025 V_{DET1}-0.030	V_{DET1} V_{DET1}	V_{DET1}+0.025 V_{DET1}+0.030	V V
V_{REL1}	Released Voltage from Over-charge	Detect falling edge of supply voltage	V_{REL1}-0.05	V_{REL1}	V_{REL1}+0.05	V
tV_{DET1}	Output delay of over-charge	V_{DD}=3.6V to 4.4V	0.7	1.0	1.3	s
tV_{REL1}	Output delay of release from over-charge	V_{DD}=4.5V to 3.6V	11	16	21	ms
V_{DET2}	Over-discharge threshold	Detect falling edge of supply voltage	V_{DET2}×0.975	V_{DET2}	V_{DET2}×1.025	V
V_{REL2}	Released Voltage from Over-discharge	Detect rising edge of supply voltage	V_{REL2}×0.975	V_{REL2}	V_{REL2}×1.025	V
tV_{DET2}	Output delay of over-discharge	V_{DD}=3.6V to 2.2V	14	20	26	ms
tV_{REL2}	Output delay of release from over-discharge	V_{DD}=3V V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET3}	Excess discharge-current threshold	Detect rising edge of 'V-' pin voltage	V_{DET3}-0.015	V_{DET3}	V_{DET3}+0.015	V
tV_{DET3}	Output delay of excess discharge-current	V_{DD}=3.0V, V-=0V to 1V	8	12	16	ms
tV_{REL3}	Output delay of release from excess discharge-current	V_{DD}=3.0V, V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET4}	Excess charge-current threshold	Detect falling edge of 'V-' pin voltage	-0.13	-0.10	-0.07	V
tV_{DET4}	Output delay of excess charge-current	V_{DD}=3.0V V-=0V to -1V	5	8	11	ms
tV_{REL4}	Output delay of release from excess charge-current	V_{DD}=3.0V, V-=-1V to 0V	0.7	1.2	1.7	ms
Vshort	Short protection voltage	V_{DD}=3.0V	0.55	0.8	1.0	V
Tshort	Output Delay of Short protection	V_{DD}=3.0V, V-=0V to 3V	230	300	500	μs
Rshort	Reset resistance for Excess discharge-current protection	V_{DD}=3.6V, V-=1V	25	50	75	kΩ
V_{DS}	Delay Shortening Mode input voltage	V_{DD}=4.4V	-2.6	-2.0	-1.4	V
V_{OL1}	Nch ON voltage of C_{OUT}	Iol=50μA, V_{DD}=4.5V		0.4	0.5	V
V_{OH1}	Pch ON voltage of C_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
V_{OL2}	Nch ON voltage of D_{OUT}	Iol=50μA, V_{DD}=2.0V		0.2	0.5	V
V_{OH2}	Pch ON voltage of D_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
I_{DD}	Supply current	V_{DD}=3.9V, V- =0V		4.0	8.0	μA
Is	Standby current	V_{DD}=2.0V		1.2	2.0	μA

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*R5402x1xxFC   **Unless otherwise specified, Topt=25°C**

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{DD1}	Operating input voltage	Voltage defined as V_{DD}-V_{SS}	1.5		5.0	V
Vst	Minimum operating Voltage for 0V charging *Note 1	Voltage defined as V_{DD}-V-, V_{DD}-V_{SS}=0V			1.8	V
V_{DET1}	Over-charge threshold	Detect rising edge of supply voltage $R1=330\Omega$ $R1=330\Omega$ (Topt=-5 to 55°C)*Note3	V_{DET1}-0.025 V_{DET1}-0.030	V_{DET1} V_{DET1}	V_{DET1}+0.025 V_{DET1}+0.030	V V
tV_{DET1}	Output delay of over-charge	V_{DD}=3.6V to 4.4V	175	250	325	ms
tV_{REL1}	Output delay of release from over-charge	V_{DD}=4.5V to 3.6V	11	16	21	ms
V_{DET2}	Over-discharge threshold	Detect falling edge of supply voltage	$V_{DET2}\times0.975$	V_{DET2}	$V_{DET2}\times1.025$	V
tV_{DET2}	Output delay of over-discharge	V_{DD}=3.6V to 2.2V	14	20	26	ms
tV_{REL2}	Output delay of release from over-discharge	V_{DD}=3V V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET3}	Excess discharge-current threshold	Detect rising edge of 'V-' pin voltage	V_{DET3}-0.015	V_{DET3}	V_{DET3}+0.015	V
tV_{DET3}	Output delay of excess discharge-current	V_{DD}=3.0V, V-=0V to 1V	8	12	16	ms
tV_{REL3}	Output delay of release from excess discharge-current	V_{DD}=3.0V, V-=3V to 0V	0.7	1.2	1.7	ms
V_{DET4}	Excess charge-current threshold	Detect falling edge of 'V-' pin voltage	-0.13	-0.10	-0.07	V
tV_{DET4}	Output delay of excess charge-current	V_{DD}=3.0V V-=0V to -1V	11	16	21	ms
tV_{REL4}	Output delay of release from excess charge-current	V_{DD}=3.0V, V-=-1V to 0V	0.7	1.2	1.7	ms
Vshort	Short protection voltage	V_{DD}=3.0V	0.55	0.8	1.0	V
Tshort	Output Delay of Short protection	V_{DD}=3.0V, V-=0V to 3V	230	300	500	μs
Rshort	Reset resistance for Excess discharge-current protection	V_{DD}=3.6V, V-=1V	25	50	75	kΩ
V_{DS}	Delay Shortening Mode input voltage	V_{DD}=4.4V	-2.6	-2.0	-1.4	V
V_{OL1}	Nch ON voltage of C_{OUT}	Iol=50μA, V_{DD}=4.5V		0.4	0.5	V
V_{OH1}	Pch ON voltage of C_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
V_{OL2}	Nch ON voltage of D_{OUT}	Iol=50μA, V_{DD}=2.0V		0.2	0.5	V
V_{OH2}	Pch ON voltage of D_{OUT}	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
I_{DD}	Supply current	V_{DD}=3.9V, V- =0V		4.0	8.0	μA
Is	Standby current	V_{DD}=2.0V		1.2	2.0	μA

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OPERATION

- **VD1 / Over-Charge Detector**

The VD1 monitors V_{DD} pin voltage while charge the battery pack. When the V_{DD} voltage crosses over-charge detector threshold V_{DET1} from a low value to a value higher than the V_{DET1}, the VD1 can detect over-charge and an external charge control Nch MOSFET turn off with C_{OUT} pin being at "L" level.

In terms of B /C version, to reset the VD1 making the C_{OUT} pin level to "H" again after detecting over-charge, in such conditions that a time when the V_{DD} voltage is down to a level lower than over-charge voltage, by connecting a kind of loading to V_{DD} after disconnecting a charger from the battery pack. Output voltage of C_{OUT} pin becomes "H", and it makes an external Nch MOSFET turn on, and charge cycle is available. In other words, once over-charge is detected, even if the supply voltage becomes low enough, if a charger is continuously connected to the battery pack, recharge is not possible. Therefore this over-charge detector has no hysteresis. To judge whether or not load is connected, the built-in excess-discharge current detector is used. In other words, by connecting some load, V- pin voltage becomes equal or more than excess-discharge current detector threshold, and reset the over-charge detecting state.

In terms of D version, after detecting over-charge, if V_{DD} pin voltage is lower than released from over-charge, even if a charger is connected, over-charge detector is released. Further, in case that V_{DD} pin level is lower than detector threshold and higher than released voltage from over-charge, if a charger is removed and some load is connected, over-charge detector is also released.

After detecting over-charge with the V_{DD} voltage of higher than V_{DET1}, connecting system load to the battery pack makes load current allowable through parasitic diode of external charge control FET.

The C_{OUT} level would be "H" when the V_{DD} level is down to a level below the V_{DET1} by continuous drawing of load current.

Internal fixed output delay times for over-charge detection and release from over-charge exist. Even when the V_{DD} pin level becomes equal or higher level than V_{DET1} if the V_{DD} voltage would be back to a level lower than the V_{DET1} within a time period of the output delay time, VD1 would not output a signal for turning off the charge control FET. Besides, after detecting over-charge, while the V_{DD} is lower than over-charge detector, even if a charger is removed and a load is connected, if the voltage is recovered within output delay time of release from over-charge, over-charge state is not released.

A level shifter incorporated in a buffer driver for the C_{OUT} pin makes the "L" level of C_{OUT} pin to the V - pin voltage and the "H" level of C_{OUT} pin is set to V_{DD} voltage with CMOS buffer.

- **VD2 / Over-Discharge Detector**

The VD2 is monitoring a V_{DD} pin voltage. When the V_{DD} voltage crosses the over-discharge detector threshold V_{DET2} from a high value to a value lower than the V_{DET2}, the VD2 can detect an over-discharge and the external discharge control Nch MOSFET turns off with the D_{OUT} pin being at "L" level.

In terms of C version, to reset the VD2 with the D_{OUT} pin level being "H" again after detecting over

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discharge, it is necessary to connect a charger to the battery pack. When the V_{DD} voltage stays under over-discharge detector threshold V_{DET2}, charge-current can flow through parasitic diode of an external discharge control MOSFET, then after the V_{DD} voltage comes up to a value larger than V_{DET2}, then, D_{OUT} becomes "H" and discharging process would be able to advance through ON state MOSFET for discharge control.

Connecting a charger to the battery pack makes the D_{OUT} level being "H" instantaneously when the V_{DD} voltage is higher than V_{DET2}.

In terms of B/D version, released operation by connecting a charger is same as C version. However, without a charger, if V_{DD} pin voltage is equal or more than the released voltage from over-discharge, D_{OUT} pin becomes "H" immediately.

When a cell voltage equals to zero, if the voltage of a charger is equal or more than 0V-charge minimum voltage (Vst), C_{OUT} pin becomes "H" and a system is allowable to charge.

An output delay time for over-discharge detection is fixed internally. When the V_{DD} level is down to a equal or lower level than V_{DET2} if the V_{DD} voltage would be back to a level higher than the V_{DET2} within a time period of the output delay time, VD2 would not output a signal for turning off the discharge control FET. Output delay time for release from over-discharge is also set.

After detecting over-discharge by VD2, supply current would be reduced and be into standby by halting unnecessary circuits and consumption current of IC itself is made as small as possible.

The output type of D_{OUT} pin is CMOS having "H" level of V_{DD} and "L" level of V_{SS}.

- **VD3 /Excess discharge-current Detector, Short Circuit Protector**

Both of the excess current detector and short circuit protection can work when the both of control FETs are in "ON" state.

When the V- pin voltage is up to a value between the short protection voltage Vshort /V_{DD} and excess discharge-current threshold V_{DET3}, VD3 operates and further soaring of V- pin voltage higher than Vshort makes the short circuit protector enabled. This leads the external discharge control Nch MOSFET turns off with the D_{OUT} pin being at "L" level.

An output delay time for the excess discharge-current detector is internally fixed. A quick recovery of V- pin level from a value between Vshort and V_{DET3} within the delay time keeps the discharge control FET staying "H" state. Output delay time for Release from excess discharge-current detection is also set.

When the short circuit protector is enabled, the D_{OUT} would be "L" and the delay time is also set.

The V - pin has a built-in pull-down resistor to the Vss pin, that is, the resistance to release from excess-discharge current.

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

The reset resistor of excess discharge-current is off at normal state. Only when detecting excess discharge-current or short circuit, the resistor is on.

Output delay time of excess discharge-current is set shorter than the delay time for over-discharge detector. Therefore, if V_{DD} voltage would be lower than V_{DET2} at the same time as the excess discharge-current is detected, the R5402xxxxxx is at excess discharge-current detection mode. By disconnecting a load, VD3 is automatically released from excess discharge-current.

- **VD4/ Excess charge-current detector**

When the battery pack is chargeable and discharge is also possible, VD4 senses V- pin voltage. For example, in case that a battery pack is charged by an inappropriate charger, an excess current flows, then the voltage of V- pin becomes equal or less than excess charge-current detector threshold. Then, the output of C_{OUT} becomes "L", and prevents from flowing excess current in the circuit by turning off the external Nch MOSFET.

Output delay of excess charge current is internally fixed. Even the voltage level of V- pin becomes equal or lower than the excess charge-current detector threshold, the voltage is higher than the VD4 threshold within the delay time, the excess charge current is not detected. Output delay for the release from excess charge current is also set.

VD4 can be released with disconnecting a charger and connecting a load.

- **DS (Delay Shorten) function**

Output delay time of over-charge, over-discharge, and release from those detecting modes can be shorter than those setting value by forcing equal or less than the delay shortening mode voltage to V-pin.

TYPICAL APPLICATION
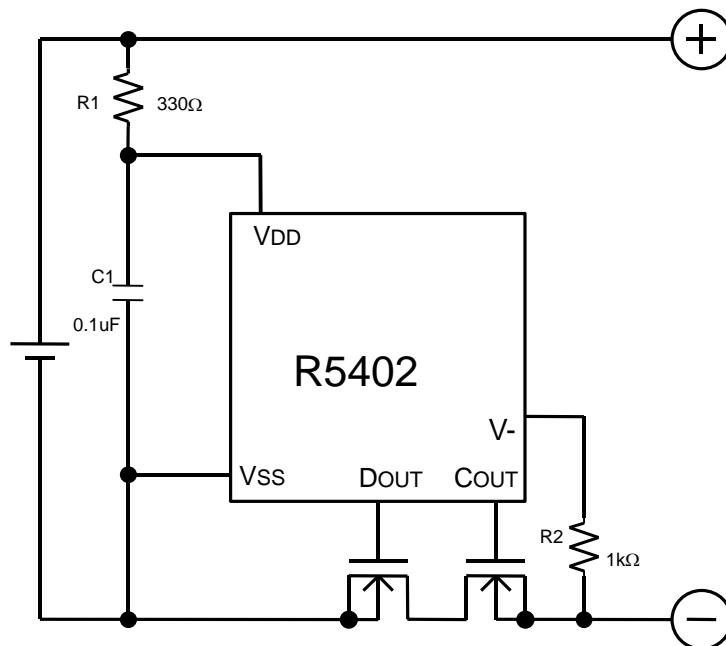
APPLICATION HINTS

R1 and C1 will stabilize a supply voltage to the R5402xxxxxx. A recommended R1 value is less than 1kΩ.

 A larger value of R1 leads higher detection voltage, makes some errors because of some conduction current may flow in the R5402xxxxxx. To stabilize the operation, the value of C1 should be equal or more than 0.01μF.

R1 and R2 can operate also as parts for current limit circuit against reverse charge or applying a charger with excess charging voltage to the R5402xxxxxx, battery pack. Small value of R1 and R2 may cause over-power consumption rating of power dissipation of the R5402xxxxx. Thus, the total value of 'R1+R2' should be equal or more than 1kΩ.

On the other hand, if large value of R2 is set, release from over-discharge by connecting a charger might not be possible. Recommended R2 value is equal or less than 10kΩ.