RIGOH

PRELIMINARY

Li-Ion BATTERY PROTECTOR R5422NxxxC/xxxE series

The R5422NxxxC/E Series are protection ICs for over-charge/discharge of rechargeable one-cell Lithium-ion (Li+) 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 delay circuit, a short circuit protector, and a logic circuit. When charging voltage crosses the detector threshold from a low value to a value higher than V_{DET1}, the output of C_{OUT} pin, the output of over-charge detector/VD1, switches to low level, charger's negative pin level after the delay time by setting an external capacitor. After detecting over-charge the VD1 can be reset and the output of C_{OUT} becomes high when the V_{DD} voltage is coming down to a level lower than "V_{REL1}", or when a kind of loading is connected to V_{DD} after a charger is disconnected from the battery pack while the V_{DD} level is in between "V_{DET1}" and "V_{REL1}" in the R5422NxxxC/E version.

The output of Dour pin, the output of over-discharge detector/VD2, switches to low level after internally fixed delay time passed, when discharging voltage crosses the detector threshold from a high value to a value lower than VDET2.

After R5422NxxxC/E Series detect the over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than the over-discharge detector threshold, VD2 is released and the voltage of DOUT becomes "H" level.

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 Dour being enabled to low level. Once after detecting excess current, the VD3 is released and Dour level switches to high by detaching a battery pack from a load system.

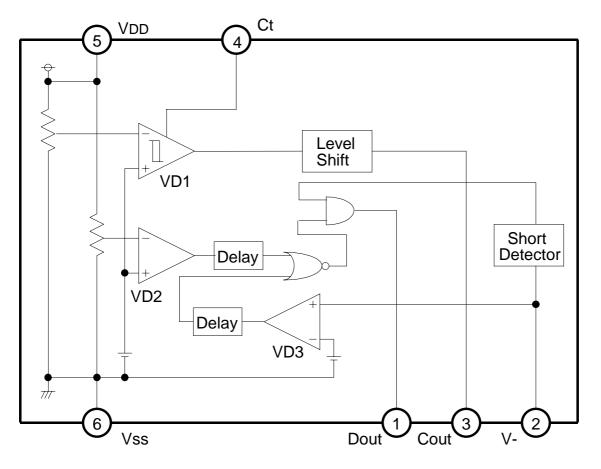
Further, short circuit protector makes Dour level to low immediately with external short circuit current and removing external short circuit leads Dour level to high. After detecting over-discharge, supply current will be kept extremely low by halt some internal circuits operation. Output type of Cour and Dour is CMOS. 6-pin, SOT23-6 is available.

FEATURES

•	High Voltage Process Technology Low supply current	Absolute Maximum Rating of Voltage Supply current Standby current (detecting over-disch	Т	en VDD-V- 28ν γp. 6.0μΑ γp. 0.1μΑ
•	High accuracy detector threshold	Over-charge detector (Topt=25°C) (Topt=0 to 50°C		25mV 30 mV
		Over-discharge detector	<u>+</u>	2.5%
		Excess current detector	±	20mV
٠	Variety of detector threshold	Over-charge detector threshold	4.0V - 4.5V	step of 0.01V
		Over-discharge detector threshold	2.0V - 3.0V	step of 0.01V
٠	Built-in protection circuit	Excess current protection	0.05V - 0.4	V step of 0.01V
•	Output delay of over-charge	Time delay at C=0.01µF tVDET1=75m	ns, tVREL1=2	20ms
•	Output delay of over-discharge	Internally fixed TYP. 17ms		
•	Output delay of excess-current	Internally fixed TYP. 10ms		
•	2 Over-current modes	Excess Current Mode / Short Mode		
•	Charging Available / non-available at 0V Cell	Acceptable of 0V Cell C version	1	
		Non-acceptable of 0V Cell E version	1	
•	Small package	SOT-23-6 / 6-pin		

• Li+ one-cell protector for battery pack

BLOCK DIAGRAM



SELECTION GUIDE

In the R5422Nxxxx Series, three of the input threshold for over-charge, over-discharge and excess current detectors can be designated.

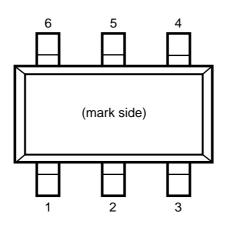
Part Number is designated as follows:

R5422N \underline{XXX} X- $\underline{XX} \leftarrow$ Part Number

 $\uparrow \uparrow \uparrow \\ a b c$

Code	Description
а	Serial Number for the R5422N Series designating input threshold for over-charge, over-discharge and excess current detectors as well as hysteresis range for over-charge detector.
b	Designation of version symbols
с	Taping Type: TR (refer to Taping Specification)

■ PIN CONFIGURATION



■ PIN DESCRIPTION

Pin No.	Symbol	Pin description		
1	Dout	Output of over-discharge detection, CMOS output		
2	V-	Pin for charger negative input		
3	Cout	Output of over-charge detection, CMOS output		
4	Ct	Pin for external capacitor setting output delay of VD1		
5	V _{DD}	Power supply(Substrate voltage level of the IC)		
6	Vss	Ground(Ground pin of the IC)		

ABSOLUTE MAXIMUM RATINGS

			Vss=0V
Symbol	Item	Ratings	Unit
VDD	Supply voltage	-0.3 to 12	V
	Input Voltage		
V-	V - pin	V_{DD} -28 to V_{DD} +0.3	V
VCt	Ct pin	Vss -0.3 to VDD +0.3	V
	Output voltage		
VCout	Cout pin	VDD -28 to VDD +0.3	V
VDout	Dout pin	Vss -0.3 to VDD +0.3	V
Pd	Power dissipation	150	mW
Topt	Operating temperature	-40 to 85	°C
Topt	range	-+0 10 05	C
Tstg	Storage temperature range	-55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded ever 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.

ELECTRICAL CHARACTERISTIC

R5422N111C				Unless otherwise provided, Topt=25°			
Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit	
V _{DD1}	Operating input voltage	Voltage defined as VDD - Vss	1.5		10	V	
Vst	Minimum operating Voltage for 0V charging	Voltage defined as V _{DD} - V- , V _{DD} - V _{SS} =0V			1.2	V	
V det1	Over-charge threshold	R1=330Ω(Topt=25°C) R1=330Ω (Topt=0 to 50°C) ^{*Note}	4.225 4.220	4.250 4.250	4.275 4.280	V V	
V _{REL1}	Release voltage for over- charge detection		4.000	4.050	4.100	V	
tV _{DET1}	Output delay of over- Charge	C=0.01µF, V _{DD} =3.6V to 4.3V	60	75	90	ms	
tV_{REL1}	Output delay of Release from Over-charge	C=0.01µF, V _{DD} =4.3V to 4.1V	15	20	25	ms	
VDET2	Over-discharge threshold	Detect falling edge of supply voltage	2.437	2.500	2.563	V	
tVdet2	Output delay of over- Discharge	V _{DD} =3.6V to 2.4V	12	17	22	ms	
VDET3	Excess current threshold	Detect rising edge of 'V-' pin voltage	0.18	0.20	0.22	V	
tVdet3	Output delay of excess Current		7	10	13	ms	
Vshort	Short protection voltage	VDD=3.0V	VDD-1.2	VDD-0.9	Vdd-0.6	V	
tshort	Output Delay of Short protection	V _{DD} =3.0V		5	50	μs	
Rshort	Reset resistance for Excess current protection	V _{DD} =3.6V, V-=1.0V	37	75	113	kΩ	
Vol1	Nch ON voltage of Cout	Iol=40µA, Vdd=4.4V		0.3	0.5	V	
Voh1	Pch ON voltage of Cour	Ioh=-40 μ A, VDD=3.9V	3.4	3.75		V	
Vol2	Nch ON voltage of DOUT	Iol= $40\mu A$, VDD= $2.2V$		0.2	0.5	V	
Voh2	Pch ON voltage of DOUT	Ioh=-40 μ A, Vdd=3.9V	3.4	3.7		V	
Idd	Supply current	V _{DD} =3.9V, V-=0V		6.0	10.0	μA	
Istandby	Standby current	$V_{DD}=2.0V$			0.1	μA	

*Note: Considering of variation in process parameters, we compensate for this characteristic related to temperature by laser-trim, however, this specification is guaranteed by design, not production tested.

• R5422N112C

Unless otherwise provided, Topt=25°C

R5422N11	20		Unless	otherwise	providea,	$10pt=25^{\circ}$
Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V _{DD1}	Operating input voltage	Voltage defined as VDD - Vss	1.5		10	V
Vst	Minimum operating Voltage for 0V charging	Voltage defined as VDD - V-, VDD - Vss=0V			1.2	V
Vdeti	Over-charge threshold	R1=330Ω(Topt=25°C) R1=330Ω (Topt=0 to 50° C) ^{*Note}	4.325 4.320	4.350 4.350	4.375 4.380	V V
V REL1	Release voltage for over- charge detection		4.100	4.150	4.200	V
tV _{DET1}	Output delay of over- Charge	C=0.01 μ F, V _{DD} =3.6V to 4.4V	61	77	93	ms
tV_{REL1}	Output delay of Release from Over-charge	C=0.01 μ F, V _{DD} =4.4V to 4.1V	15	20	25	ms
VDET2	Over-discharge threshold	Detect falling edge of supply Voltage	2.437	2.500	2.563	V
tVdet2	Output delay of over- Discharge	V _{DD} =3.6V to 2.4V	12	17	22	ms
Vdet3	Excess current threshold	Detect rising edge of 'V-' pin Voltage	0.18	0.20	0.22	V
tVdet3	Output delay of excess Current		7	10	13	ms
Vshort	Short protection voltage	$V_{DD}=3.0V$	Vdd-1.2	VDD-0.9	VDD-0.6	V
tshort	Output Delay of Short protection	VDD=3.0V		5	50	μs
Rshort	Reset resistance for excess current protection	V _{DD} =3.6V, V-=1.0V	37	75	113	kΩ
Vol1	Nch ON voltage of Cout	Iol= $40\mu A$, V _{DD} = $4.4V$		0.3	0.5	V
Voh1	Pch ON voltage of Cout	Ioh=-40 μ A, V _{DD} =3.9V	3.40	3.75		V
Vol2	Nch ON voltage of Dout	Iol=40 μ A, V _{DD} =2.2V		0.2	0.5	V
Voh2	Pch ON voltage of DOUT	Ioh=-40 μ A, V _{DD} =3.9V	3.4	3.7		V
Idd	Supply current	V _{DD} =3.9V,V-=0V		6.0	10.0	μA
Istandby	Standby current	$V_{DD}=2.0V$			0.1	μA

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• R5422N111E

Unless otherwise provided, Topt=25°C

R04ZZINI I			Olliess (JUIEIWISE	provided,	10pt-23
Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V _{DD1}	Operating input voltage	Voltage defined as VDD - Vss	1.5		10	V
Vnochg	Maximum Voltage for disable of 0V charging	Voltage defined as $V_{\rm DD}$ - VSS , $V_{\rm DD}-V\text{-=}4V$	0.5	0.8		V
V DET1	Over-charge threshold	R1=330Ω(Topt=25°C) R1=330Ω (Topt=0 to 50°C) ^{*Note}	4.225 4.220	4.250 4.250	4.275 4.280	V V
V _{REL1}	Release voltage for over- charge detection		4.000	4.050	4.100	V
tV_{DET1}	Output delay of over- Charge	C=0.01 μ F, V _{DD} =3.6V to 4.3V	60	75	90	ms
tV_{REL1}	Output delay of Release from Over-charge	C=0.01 μ F, V _{DD} =4.3V to 4.1V	15	20	25	ms
Vdet2	Over-discharge threshold	Detect falling edge of supply Voltage	2.437	2.500	2.563	V
tVdet2	Output delay of over- Discharge	V _{DD} =3.6V to 2.4V	12	17	22	ms
Vdet3	Excess current threshold	Detect rising edge of 'V-' pin Voltage	0.18	0.20	0.22	V
tVdet3	Output delay of excess Current		7	10	13	ms
Vshort	Short protection voltage	VDD=3.0V	Vdd-1.2	VDD-0.9	Vdd-0.6	V
tshort	Output Delay of Short protection	V _{DD} =3.0V		5	50	μs
Rshort	Reset resistance for excess current protection	V _{DD} =3.6V, V-=1.0V	37	75	113	kΩ
Vol1	Nch ON voltage of Cout	Iol= $40\mu A$, V _{DD} = $4.4V$		0.3	0.5	V
Voh1	Pch ON voltage of COUT	Ioh=-40µA, V _{DD} =3.9V	3.4	3.75		V
Vol2	Nch ON voltage of Dour	Iol= $40\mu A$, V _{DD} = $2.2V$		0.2	0.5	V
Voh2	Pch ON voltage of DOUT	Ioh=-40µA, Vdd=3.9V	3.4	3.7		V
Idd	Supply current	VDD=3.9V,V-=0V		6.0	10.0	μA
Istandby	Standby current	$V_{DD}=2.0V$			0.1	μA

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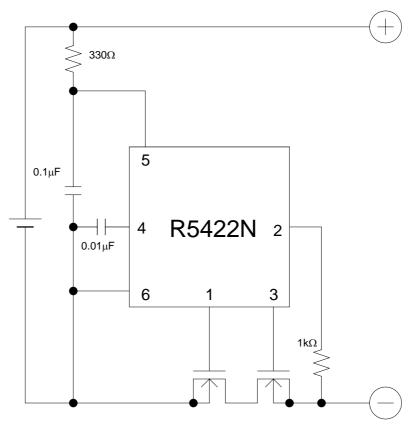
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Unless otherwise provided, Topt=25°C

R54ZZN11			Unless	Juliei wise	provided,	10pt=23
Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
VDD1	Operating input voltage	Voltage defined as VDD - Vss	1.5		10	V
Vnochg	Maximum Voltage for disable of 0V charging	Voltage defined as $V_{\rm DD}$ - VSS , $V_{\rm DD}-V\text{-=}4V$	0.5	0.8		V
V DET1	Over-charge threshold	R1=330Ω(Topt=25°C) R1=330Ω (Topt=0 to 50°C) ^{*Note}	4.325 4.320	4.350 4.350	4.375 4.380	V V
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tshort	Output Delay of Short protection	V _{DD} =3.0V		5	50	μs
Rshort	Reset resistance for excess current protection	V _{DD} =3.6V, V-=1.0V	37	75	113	kΩ
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Vol2	Nch ON voltage of DOUT	Iol= $40\mu A$, V _{DD} = $2.2V$		0.2	0.5	V
Voh2	Pch ON voltage of DOUT	Ioh=-40µA, Vdd=3.9V	3.4	3.7		V
Idd	Supply current	VDD=3.9V,V-=0V		6.0	10.0	μA
Istandby	Standby current	V _{DD} =2.0V			0.1	μA

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TYPICAL APPLICATION



APPLICATION HINTS

R1 and C1 will stabilize a supply voltage to the R5422Nxxxx. A recommended R1 value is less than $1k\Omega$. A larger value of R1 leads higher detection voltage, makes some errors, because of shoot through current flowed in the R5422Nxxxx.

R2 will stabilize a V- pin voltage. The resetting from over-discharge with connecting a charger possibly be disabled by larger value of R2. Recommended value is less than 1 k Ω .

R1 and R2 can operate also as a part of current limit circuit against for setting cell reverse direction or for applying excess charging voltage to the R5422Nxxxx, battery pack, while smaller R1 and R2 may cause a power consumption over rating of power dissipation of the R5422Nxxxx and a total of 'R1+R2' should be more than $1k\Omega$.