R5499Z SERIES

No. EA-388-161004

Outline

The R5499Z is high voltage tolerance CMOS-based protection IC for over-charge/discharge and over-current of rechargeable one-cell Lithium-ion (Li+)/Lithium polymer battery. The R5499Z 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 and the excess charge-current. The R5499Z consists of four voltage detectors, a reference unit, a delay circuit, a short circuit detector, an oscillator, a counter, and a logic circuit.
When the R5499Z detects over-charge or over-charge current, the output of COUT pin switches to “L” level, that is, the charger’s negative pin level after the internal fixed delay time. When the R5499Z detects over-discharge or excess discharge current, the output of DOUT pin switches to “L” level after the internal fixed delay time.
After detecting over-charge or excess charge current, the R5499Z can be reset and the output of COUT becomes “H” when a charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold.

However, depending on the characteristics of external components such as MOSFETs, release conditions may be not enough just removing a charger from the battery pack. In that case, a kind of load must be set to release the over-charge detect.

If a charger is continuously connected to the battery pack, even if the cell voltage becomes lower than over-charge detector threshold, over-charge state is not released.

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, the R5499Z is released and the voltage of DOUT pin becomes “H”. If the battery discharges into 0V level, recharge current is accepted. Once after detecting excess discharge-current or short circuit, the R5499Z is released and DOUT level becomes “H” with detaching a battery pack from a load system. After detecting over-discharge, supply current is kept extremely low by halting internal circuits' operation.

When the output of COUT is "H", by setting the V- pin at equal or lower than the delay shortening mode voltage (Typ. -2.0V), the output delay can be shortened. Especially, the delay time of over charge detector can be reduced into approximately 1/110. Thus, testing time of protector circuit board can be reduced. Output type of COUT and DOUT is CMOS.

FEATURES

- Absolute Maximum Rating... 30V
- Supply current (At normal mode)................................ TYP 4.0μA
- Supply current (At standby mode) .... MAX 0.1μA

Detector thresholds accuracy

- Over-charge detector threshold.................................. ±12mV(0°C~50°C)
- Over-discharge detector threshold .... ±2.5%
- Excess discharge current threshold .... ±5mV
- Excess charge current threshold .... ±15mV
- Short detector threshold .... ±50mV

Detector thresholds range

- Over-charge detector threshold.................................. 4.3V~4.6V step of 0.005V
- Over-discharge detector threshold .... 2.0V ~ 3.0V step of 0.005V
- Excess discharge current threshold .... Code_AC: 0.055V~0.080V step of 0.005V
  Code_AD: 0.030V~0.050V step of 0.005V
- Excess charge current threshold .... -0.050V~-0.100V step of 0.005V
- Short current threshold .... 0.150V or 0.230V (selectable)

Output delay time

- Over-charge detector Output Delay............................ 1.0s
- Over-discharge detector Output Delay........................ 32ms
- Excess discharge current detector Output Delay........ 128ms
- Excess charge current detector Output Delay............. 8ms
- Short detector Output Delay 250μs

Functions

- Output Delay Time Shorting Function......................... At C_{OUT} is “H”, if V- level is set at –2.0V, the Output Delay time of detect the over-charge and over-discharge can be reduced. (Delay Time for over-charge becomes about 1/110 of normal state.)
- Conditions for release over-charge detector .... Latch type
- Conditions for release over-discharge detector........... Latch type
- Package WLCSP-6-P4

APPLICATIONS

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

Absolute Maximum Ratings

Ta=25°C, Vss=0V

Item	Symbol	Ratings	Unit
Supply Voltage	V_{DD}	-0.3 to 12	V
Input Voltage V- pin Voltage	V-	V_{DD}-30 to V_{DD}+0.3	V
Output Voltage C_{OUT} pin Voltage D_{OUT} pin Voltage	 V_{COUT} V_{DOUT}	 V_{DD}-30 to V_{DD}+0.3 Vss-0.3 to V_{DD}+0.3	 V V
Power Dissipation	P_D	150	mW
Operating Temperature	Ta	-40 to 85	°C
Storage Temperature	Tstg	-55 to 125	°C

*Note: Exposure to the condition exceeded Absolute Maximum Ratings may cause the permanent damages and affects the reliability and safety of both device and systems using the device. The functional operations cannot be guaranteed beyond specified values in the recommended conditions.

Electrical Characteristics

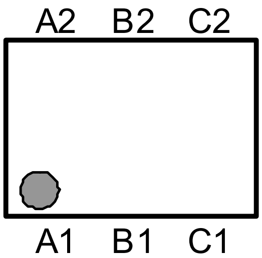
Unless otherwise provided, Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	$V_{DD}1$	V_{DD}- Vss	1.5		5.0	V
Minimum Operating Voltage for 0V Charging	Vst	Voltage Defined as V_{DD}-V-, V_{DD}-Vss=0V			1.8	V
Over-charge Threshold Voltage	$V_{DET}1$	R1=330Ω, Ta=0°C~50°C *Note1	VDET1 -0.012	VDET1	VDET1 +0.012	V
Output Delay of Over-charge	$tV_{DET}1$	V_{DD} = 3.6V → $V_{DET}1$ + 0.05V	$tV_{DET}1$ ×0.7	$tV_{DET}1$	$tV_{DET}1$ ×1.3	s
Release Delay for VD1	$tV_{REL}1$	V_{DD} = 4V, V- = 0V → 1V	11	16	21	ms
Over-discharge Threshold	$V_{DET}2$	Detect falling edge of supply voltage	VDET2 ×0.975	VDET2	VDET2 ×1.025	V
Output Delay of Over-discharge	$tV_{DET}2$	V_{DD}=3.6V to 2.0V	$tV_{DET}2$ ×0.7	$tV_{DET}2$	$tV_{DET}2$ ×1.3	ms
Release Delay for VD2	$tV_{REL}2$	V_{DD}=3V, V-=3V to 0V	0.7	1.2	1.7	ms
Excess discharge-current threshold	$V_{DET}3$	Detect rising edge of 'V-' pin voltage	VDET3 -0.005	VDET3	VDET3 +0.005	V
Output delay of excess discharge-current	$tV_{DET}3$	V_{DD}=3.0V, V-=0V to VDET3+0.01V	$tV_{DET}3$ ×0.7	$tV_{DET}3$	$tV_{DET}3$ ×1.3	ms
Output delay of release from excess discharge-current	$tV_{REL}3$	V_{DD}=3.0V, V-=3V to 0V	0.7	1.2	1.7	ms
Short Protection Voltage	Vshort	V_{DD}=3.0V	Vshort -0.05	Vshort	Vshort +0.05	V
Delay Time for Short Protection	tshort	V_{DD}=3.0V, V-=0V to 0.5V	150	250	350	μs
Reset Resistance for Excess Current Protection	Rshort	V_{DD}=3.6V,V- =1.0V	20	45	70	kΩ
Excess charge-current threshold	$V_{DET}4$	Detect falling edge of 'V-' pin voltage	VDET4 -0.015	VDET4	VDET4 +0.015	V
Output delay of excess charge-current	$tV_{DET}4$	V_{DD}=3.0V, V-=0V to -1V	$tV_{DET}4$ ×0.7	$tV_{DET}4$	$tV_{DET}4$ ×1.3	ms
Output delay of release from excess charge-current	$tV_{REL}4$	V_{DD}=3.0V, V-=-1V to 0V	0.7	1.2	1.7	ms
Delay Time Shortening Mode Voltage	V_{DS}	V_{DD}=3.6V	-2.6	-2.0	-1.4	V
Nch ON-Voltage of C_{OUT}	$V_{OL}1$	Iol=50μA, V_{DD}= 4.55V		0.4	0.5	V
Pch ON-Voltage of C_{OUT}	$V_{OH}1$	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
Nch ON-Voltage of D_{OUT}	$V_{OL}2$	Iol=50μA, V_{DD}= 1.9V		0.2	0.5	V
Pch ON-Voltage of D_{OUT}	$V_{OH}2$	Ioh=-50μA, V_{DD}=3.9V	3.4	3.7		V
Supply Current	I_{DD}	V_{DD}=3.9V, V- =0V		4.0	8.0	μA
Standby Current	Istandby	V_{DD}=2.0V			0.1	μA

●: 'Note1' 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 mass production tested.

PIN CONFIGURATIONS

R5499Z : WLCSP-6-P4



PIN DESCRIPTION

Pin No.	Symbol	Description
A1	V-	Charger negative Input Pin
B1	V_{DD}	Power supply pin, the substrate voltage level of the IC.
C1	V_{SS}	Ground Pin. The ground pin of the IC.
A2	C_{OUT}	Output Pin of Over-charge detection, CMOS output
B2	NC	No Connection (Open or connect with VSS)
C2	D_{OUT}	Output Pin of Over-discharge detection, CMOS output

SELECTION GUIDE

In the R5499 Series, input threshold of over-charge, over-discharge, excess discharge current, and excess charge current can be designated.

Part Number is designated as follows:

R5499 Z xxx AD

Package Type
R5499Z :
WLCSP-6-P4

Function Version
C : Over-Charge:Lactch Over-Discharge:Latch 0V Charge:OK VDET3:0.055˜0.080V VSHORT:0.150V/0.230V
D : Over-Charge:Lactch Over-Discharge:Latch 0V Charge:OK VDET3:0.030˜0.050V VSHORT:0.150V/0.230V

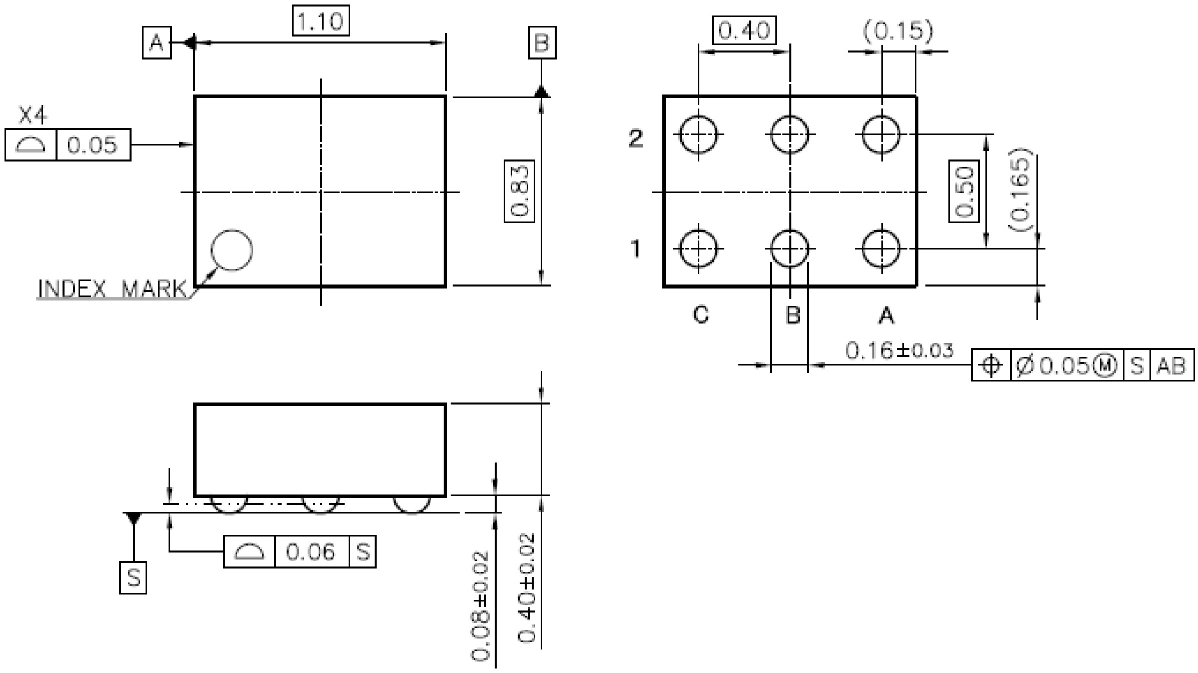
Delay Time Version

Voltage Version

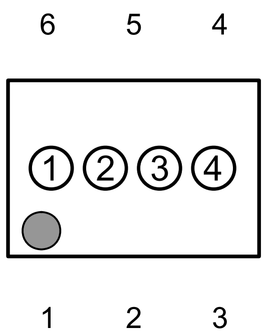
Code	Return from Over-Charge	Return from Over-Discharge	VDET3	VSHORT	tVdet1 (s)	tVdet2 (ms)	tVdet3 (ms)	tVdet4 (ms)	tShort (μs)	0V Charge
R5499Z xxx AC	Latch	Latch	0.055V ~0.080V	0.150V /0.230V	1	32	128	8	250	OK
R5499Z xxx AD	Latch	Latch	0.030V ~0.050V	0.150V /0.230V	1	32	128	8	250	OK

Package Dimensions

R5499Z : WLCSP-6-P4



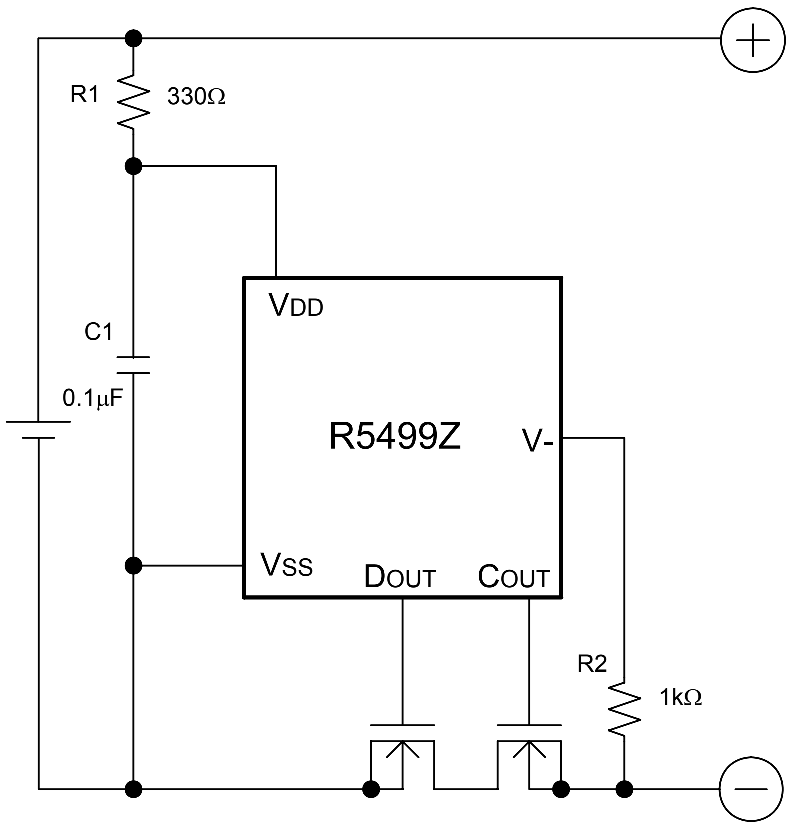
Mark Specification



①②: Series Code Name … XX

③④:Lot Number (Alphanumeric serial number)

Technical Notes



*R1 and C1 stabilize a supply voltage to the R5499. A recommended R1 value is less than 1kΩ. A large value of R1 makes detection voltage shift higher because of conduction current flowed in the R5499.
Further, to stabilize the operation of R5499, use the C1 with the value of 0.01μF or more.

*R1 and R2 can operate as a current limit against setting cell reverse direction or applying excess charge voltage to the R5499. While small value of R1 and R2 may cause over power dissipation rating of the R5499, therefore a total of "R1+R2" should be 1kΩ or more. Besides, 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.

The typical application circuit diagram is just an example. This circuit performance largely depends on the PCB layout and external components. In the actual application, fully evaluation is necessary.

Over-voltage and the over current beyond the absolute maximum rating should not be forced to the protection IC and external components.

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