RICOH

R5443Z Series

1-Cell Li-ion Battery Protection IC with High-accuracy Overcharge Protection

NO.EA-507-210730

OUTLINE

The R5443Z is a one-cell Li-ion / polymer battery protection IC provides overcharge, overdischarge, and discharge / charge overcurrent detections. One of the features of this device is a high-accuracy detection at overcharge and overcurrent. The supply current after overdischarge detection can be reduced to a minimum by stopping the internal circuits. The small WLCSP package is available.

FEATURES

- Absolute Maximum Rating ········ 12 V
- Supply Current at Normal Mode ········ Typ.2.5 μA
- Standby Current ········ Max.0.04 μA

Detector Selectable Range and Accuracy (Unless otherwise provided, Ta=25°C)

- Overcharge Detection Voltage ········ 4.2 V to 4.6 V (in 0.005 V step, ±10 mV [1])
- Overdischarge Detection Voltage ········ 2.0 V to 3.4 V (in 0.050 V step, ±2.0%)
- Discharge Overcurrent Detection Voltage ········ 0.015 V to 0.150 V
(0.015 V to 0.050 V in 0.001 V step /
0.050 V to 0.150 V in 0.005 V step,
0.015 V to 0.030 V: ±3mV / 0.030 V to 0.050 V: ±10% / 0.050 V to 0.150 V: ±5mV)
- Charge Overcurrent Detection Voltage ········ –0.150 V to –0.015V
(–0.030 V to –0.015 V in 0.001 V step /
–0.150 V to –0.030 V in 0.005 V step,
–0.020 V to –0.015 V: ±4mV /
–0.040 V to –0.020 V: ±20% /
–0.150 V to –0.040 V: ±8mV)
- Short-circuit Detection Voltage ········ 0.040 V to 0.300 V (in 5mV step, ±5 mV)

Internal Fixed Output Delay Time

- Overcharge Detection Delay Time (t_{VDET1}) ········ 1.0 s
- Overdischarge Detection Delay Time (t_{VDET2}) ········ 16 ms / 32 ms / 128 ms
- Discharge Overcurrent Detection Delay Time (t_{VDET3}) ·· 8 ms /16 ms / 32 ms / 128 ms / 512 ms
- Short-circuit Detection Delay Time (t_{SHORT}) ········ 280 μs
- Charge Overcurrent Detection Delay Time (t_{VDET4}) ····· 8 ms

(1) When 0°C ≤ Ta ≤ 50°C

Functions

- 0 V-battery Charge Option ······························ Available / Unavilable
- Discharge Overcurrent Release Option ············ Auto Release Type / Latch Type

APPLICATIONS

- Li+ / Li- Polymer protector of Overcharge, Overdischarge, and Overcurrent for Battery pack
- High precision protectors for smart-phones and any other electronic gadgets using on-board Li+ / Li-Polymer battery

SELECTION GUIDE

Overcharge and Overdischarge voltages, and Discharge overcurrent are user-selectable.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5443Zxxx$∗-E2-F	WLCSP-6-P7	5,000 pcs	Yes	Yes

xxx: Specify a code combined the set output voltages. Refer to *"Product Code List"* for details.

$: Specify a delay time version from the table below.

ςεр.	t_{VDET1} [s]	t_{VDET2} [ms]	t_{VDET3} [ms]	t_{VDET4} [ms]	t_{VR1} [ms]	$t_{VR2/3}$ [ms]	t_{VR4} [ms]	t_{SHORT} [ms]
A	1.0	128	512	8	16	1.1	1.1	0.28
B	1.0	32	512	8	16	1.1	1.1	0.28
C	1.0	32	16	8	16	1.1	1.1	0.28
D	1.0	16	16	8	16	1.1	1.1	0.28
J	1.0	128	128	8	16	1.1	1.1	0.28
L	1.0	32	32	8	16	1.1	1.1	0.28
P	1.0	128	16	8	16	1.1	1.1	0.28
Q	1.0	128	32	8	16	1.1	1.1	0.28

∗: Specify a version combined following functions from the table below.

Ver.	Overcharge Release	Overdischarge Release	Discharge Overcurrent Release	0-V Charge	V_{DET4}
A	Latch	Latch	Auto Release	Available	Enable
C	Latch	Latch	Latch	Available	Enable
G	Latch	Latch	Auto Release	Unavilable	Enable
H	Latch	Latch	Latch	Unavilable	Enable

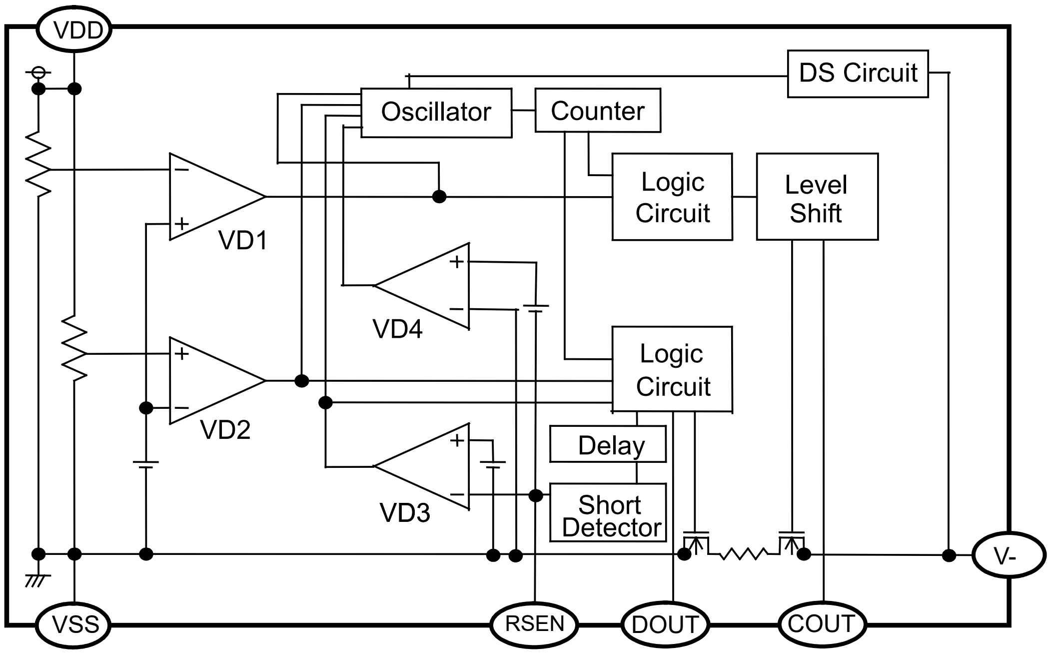
Product Code List

Product Code Table

Code	V_{DET1} (V)	V_{DET2} (V)	V_{DET3} (V)	V_{DET4} (V)	V_{SHORT} (V)	t_{VDET1} (s)	t_{VDET2} (ms)	t_{VDET3} (ms)	t_{VDET4} (ms)	t_{SHORT} (ms)	Discharge Overcurrent Release	0-V Charge (Yes/No[1])
R5443Z207PH	4.280	3.100	0.015	–0.015	0.040	1.00	128	16	8	0.28	Latch	No
R5443Z210CA	4.430	2.600	0.035	–0.030	0.060	1.00	32	16	8	0.28	Auto-Release	Yes
R5443Z211CG	4.460	2.500	0.035	–0.030	0.060	1.00	32	16	8	0.28	Auto-Release	No
R5443Z212PH	4.450	3.100	0.015	–0.015	0.040	1.00	128	16	8	0.28	Latch	No
R5443Z214LH	4.475	2.300	0.020	–0.021	0.045	1.00	32	32	8	0.28	Latch	No
R5443Z215CA	4.430	3.100	0.035	–0.030	0.060	1.00	32	16	8	0.28	Auto-Release	Yes
R5443Z216JA	4.370	2.300	0.120	–0.015	0.200	1.00	128	128	8	0.28	Auto-Release	Yes
R5443Z217AG	4.395	2.200	0.080	–0.015	0.120	1.00	128	512	8	0.28	Auto-Release	No
R5443Z218AA	4.430	2.600	0.035	–0.031	0.060	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z219AA	4.430	2.300	0.035	–0.031	0.060	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z220AA	4.450	2.500	0.020	–0.020	0.040	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z221AG	4.475	2.400	0.015	–0.016	0.040	1.00	128	512	8	0.28	Auto-Release	No
R5443Z222CA	4.485	2.500	0.035	–0.030	0.060	1.00	32	16	8	0.28	Auto-Release	Yes
R5443Z223AA	4.250	2.500	0.024	–0.020	0.060	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z224AA	4.485	2.500	0.024	–0.020	0.060	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z226AA	4.320	2.100	0.020	–0.019	0.100	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z227CA	4.275	2.600	0.035	–0.030	0.060	1.00	32	16	8	0.28	Auto-Release	Yes
R5443Z228AA	4.430	2.300	0.035	–0.042	0.060	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z229AA	4.450	3.200	0.020	–0.020	0.040	1.00	128	512	8	0.28	Auto-Release	Yes
R5443Z230AG	4.475	3.100	0.015	–0.016	0.040	1.00	128	512	8	0.28	Auto-Release	No
R5443Z231JA	4.190	2.500	0.024	–0.020	0.060	1.00	128	128	8	0.28	Auto-Release	Yes
R5443Z232JG	4.350	2.200	0.058	–0.046	0.160	1.00	128	128	8	0.28	Auto-Release	No
R5443Z233QG	4.300	2.500	0.054	–0.043	0.140	1.00	128	32	8	0.28	Auto-Release	No
R5443Z234AA	4.480	2.300	0.035	–0.035	0.060	1.00	128	512	8	0.28	Auto-Release	Yes

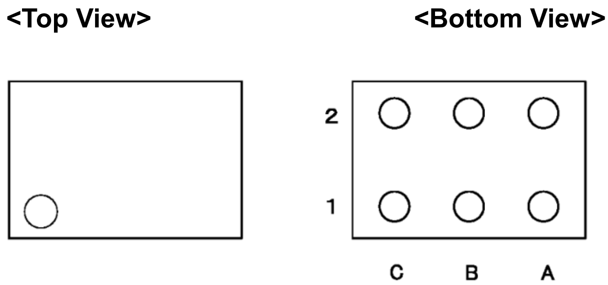
[1] "No" means the timer reset delay time option is unavailable.

Block Diagram



R5443Z Block Diagram

PIN DESCRIPTION



R5443Z (WLCSP-6-P7) Pin Configuration

R5443Z Pin Description

Pin No.	Symbol	Pin Description
A1	V-	Charger negative input pin
B1	VDD	Power supply pin, Substrate level in IC
C1	VSS	Ground pin
A2	COUT	Overcharge detection pin, CMOS output
B2	RSENS	Overcurrent detection input pin
C2	DOUT	Overdischarge detection pin, CMOS output

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings (Ta = 25°C, V_{SS} = 0 V)

Symbol	Parameter	Rating	Unit
V_{DD}	Supply Voltage	–0.3 to 12	V
V−	V− Pin Voltage	V_{DD} – 30 to V_{DD} + 0.3	V
R_{SENSE}	RSENSE Pin Voltage	V_{DD} – 30 to V_{DD} + 0.3	V
V_{COUT}	COUT Pin Voltage	V_{DD} – 30 to V_{DD} + 0.3	V
V_{DOUT}	DOUT Pin Voltage	V_{SS} – 0.3 to V_{DD} + 0.3	V
P_D	Power Dissipation	Refer to Appendix "Power Dissipation"	
Tj	Junction Temperature Range	−40 to 125	°C
Tstg	Storage Temperature Range	−55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Parameter	Rating	Unit
V_{DD1}	Operating Input Voltage	1.5 to 5.0	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

R5443Zxxxxx Electrical Characteristics (Ta = 25° C)

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit	Test Circuit[1]
V_{DD1}	Operating Input Voltage	$V_{DD} – V_{SS}$		1.5		5.0	V	A
V_{ST}	Minimum Operating Voltage at 0 V Charging [2]	Voltage Defined as V_{DD}–V-, $V_{DD} – V_{SS}$ = 0 V				1.8	V	A
V_{NOCHG}	Maximum Operating Voltage at Charging Inhibition (Disabled 0 V Charging) [3]	Voltage Defined as V_{DD}–V_{SS}, V_{DD} – V- = 4 V		1.00	1.25	1.50	V	A
V_{DET1}	Overcharge Detection Voltage	R1 = 330 Ω, 0 °C ≤ Ta ≤ 50 °C [4]		V_{DET1} − 0.010	V_{DET1}	V_{DET1} + 0.010	V	B
t_{VDET1}	Overcharge Detection Delay Time	V_{DD} = 3.6 V → 4.6 V		0.80	1.00	1.20	s	B
t_{VREL1}	Overcharge Release Delay Time	V_{DD} = 4 V, V- = 0 V → 1 V		12.0	16.0	20.0	ms	C
V_{DET2}	Overdischarge Detection Voltage	Detect falling edge of supply voltage		V_{DET2} × 0.98	V_{DET2}	V_{DET2} × 1.02	V	D
t_{VDET2}	Overdischarge Detection Delay Time	V_{DD} = 3.6 V → 2.0 V		t_{VDET2} × 0.80	t_{VDET2}	t_{VDET2} × 1.20	ms	D
t_{VREL2}	Overdischarge Release Delay Time	V_{DD} = 3.6V, V- = 3.6V → 0V		0.85	1.10	1.35	ms	E
V_{DET3}	Discharge Overcurrent Detection Voltage	Detect rising edge of RSENSE pin voltage	0.015 V to 0.030 V	V_{DET3} – 0.003	V_{DET3}	V_{DET3} + 0.003	V	F
			0.031 V to 0.050 V	V_{DET3} × 0.900		V_{DET3} × 1.100	V	F
			0.051 V to 0.150 V	V_{DET3} – 0.005		V_{DET3} + 0.005	V	F
V_{REL3}	Discharge Overcurrent Released Voltage	V_{DD} = 3.6 V, Detect falling edge of V- pin voltage		0.050	0.200	0.350	V	F
t_{VDET3}	Discharge Overcurrent Detection Delay Time	V_{DD} = 3.6V, V- = 0 V, V_{RSENS} = 0 V → V_{DET3} + 0.010		t_{VDET3} × 0.80	t_{VDET3}	t_{VDET3} × 1.20	ms	F
t_{VREL3}	Discharge Overcurrent Release Delay Time	V_{DD} = 3.6 V, V_{RSENS} = V- = 3 V → 0 V		0.85	1.10	1.35	ms	F
V_{SHORT}	Short Protection Voltage	Detect rising edge of RSENS pin voltage		V_{SHORT} – 0.005	V_{SHORT}	V_{SHORT} + 0.005	V	F
t_{SHORT}	Short Protection Delay Time	V_{DD} = 3.6 V, V- = 0 V, V_{RSENS}=0V → V_{SHORT}+0.010		210	280	350	µs	F
R_{SHORT}	Reset Resistance for Discharge Overcurrent Protection [5]	V_{DD} = 3.6 V, V- = 1.0 V, V_{RSENS} = V- = 0 V		20	45	70	kΩ	F

[1] Refer to *Test Circuit* diagrams.
[2] R5443ZxxxxA/C only
[3] R5443ZxxxxG/H only
[4] This temperature characteristic can be corrected by laser-trimming with consideration given to variation in process parameters. This specification is guaranteed by design, not mass production tested.
[5] Appropriate products except for R5443ZxxxxH.

R5443Zxxxxx Electrical Characteristics (Continued) (Ta = 25° C)

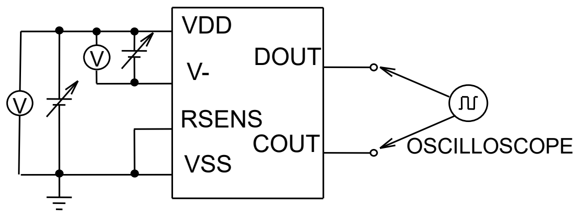
Symbol	Parameter	Conditions		Min.	Typ.	Max.	Unit	Test Circuit[1]
V_{DET4}	Charge Overcurrent Detection Voltage	Detect falling edge of 'RSENS' pin voltage	–0.020 V to –0.015 V	V_{DET4} – 0.004	V_{DET4}	V_{DET4} + 0.004	V	F
			–0.040 V to –0.021 V	V_{DET4} × 0.800		V_{DET4} × 1.200	V	F
			–0.150 V to –0.040 V	V_{DET4} – 0.008		V_{DET4} + 0.008	V	F
t_{VDET4}	Charge Overcurrent Detection Delay Time	V_{DD} = 3.6 V, V- = 0 V, V_{RSENS} = 0 V → –1 V		6	8	10	ms	F
t_{VREL4}	Charge Overcurrent Release Delay Time	V_{DD} = 3.6 V, V_{RSENS} = V- = –1 V → 1 V		0.85	1.10	1.35	ms	F
V_{DS}	Delay Time Shortening Mode Voltage	V_{DD} = 3.6 V		−2.6	−2.0	−1.4	V	G
V_{OL1}	Nch ON-Voltage of C_{OUT}	I_{OL} = 50 μA, V_{DD} = 4.55 V			0.4	0.5	V	H
V_{OH1}	Pch ON-Voltage of C_{OUT}	I_{OH} = –50 μA, V_{DD} = 3.9 V		3.4	3.7		V	I
V_{OL2}	Nch ON-Voltage of D_{OUT}	I_{OL} = 50 μA, V_{DD} = 2.0 V			0.2	0.5	V	J
V_{OH2}	Pch ON-Voltage of D_{OUT}	I_{OH} = –50 μA, V_{DD} = 3.9 V		3.4	3.7		V	K
I_{DD}	Supply Current	V_{DD} = 3.9 V, V- = V_{RSENS} = 0 V			2.5	6.0	μA	L
$I_{STANDBY}$	Standby Current	V_{DD} = 1.9 V				0.04	μA	L

All of these specifications are guaranteed by design, not tested in mass production.

[1] Refer to *Test Circuit* diagrams.

Test Circuits

A



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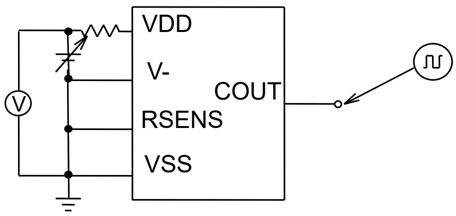

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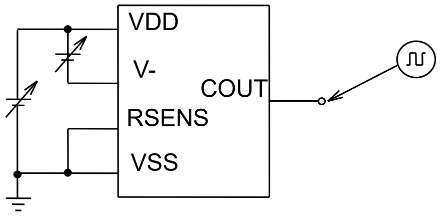

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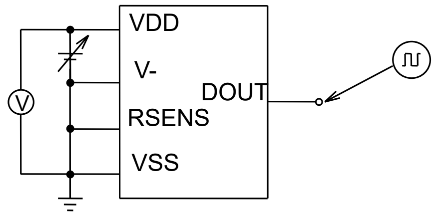

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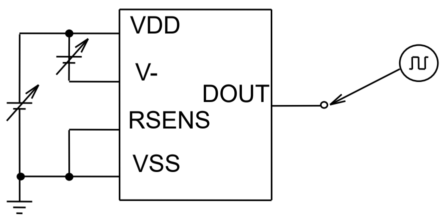

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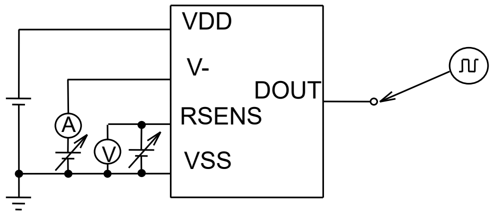

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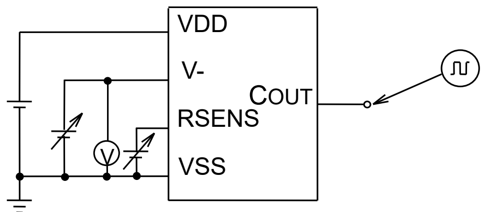

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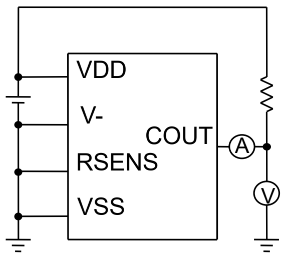

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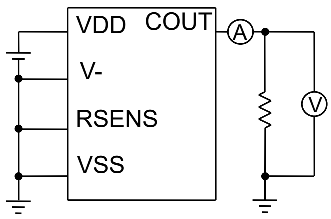

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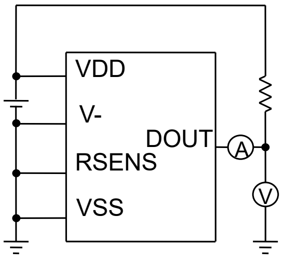

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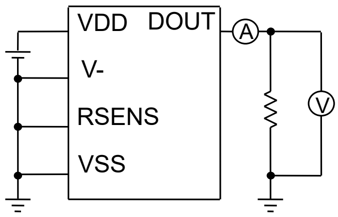

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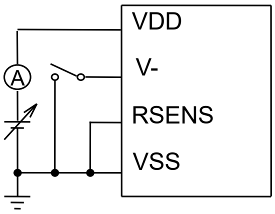


THEORY OF OPERATION

VD1: Overcharge Detector

The VD1 monitors VDD pin voltage during charge. When the V_{DD} voltage crosses overcharge detector threshold V_{DET1}, the VD1 can sense overcharge and the output of COUT pin becomes “L” and stop charging by turning off the external Nch. MOSFET. After detecting overcharge, when the voltage of VDD pin is less than overcharge detection voltage, depending on the characteristics of external components such as MOSFETs, release conditions may be not enough and a kind of load must be set to release the overcharge. Then, the output level of COUT becomes “H” and by turning on the external Nch. MOSFET, the battery charger is ready to work again. In other words, once detecting overcharge, even if the cell voltage would become lower than $V_{DET}1$, if a charger were being set, recharge is impossible. Therefore, there is no hysteresis for VD1. To judge whether or not load is connected, the discharge overcurrent detector is used. In other words, by connecting some load, V- pin voltage becomes equal or more than the discharge overcurrent detection voltage, and reset the overcharge detecting state. When the Input level of VDD pin is equal or more than overcharge detection voltage, and while a charger is disconnected from the battery pack, if a load is connected to the battery pack, the output level of COUT pin is “L”. However, load current can be drawn through a parasitic diode of an external Nch. MOSFET. Then, when the voltage level of VDD pin becomes lower than overcharge detection voltage, the output level of COUT pin becomes “H”. Output delay time for overcharge detection and released overcharge is internally fixed respectively. If V_{DD} decreases under V_{DET1} within the overcharge release delay time (t_{VDET1}) after exceeding V_{DET1}, the VD1 will not work. A level shifter is built in a buffer driver for the COUT pin, therefore, the “L” level is equal to the voltage level of V- pin. The output type of COUT pin is CMOS type. The Output level is between V_{DD} and V-.

VD2: Overdischarge Detector

The VD2 monitors a VDD pin voltage during discharge. When the V_{DD} voltage crosses the overdischarge detector threshold V_{DET2} from a high level to a lower level than V_{DET2}, the VD2 senses overdischarge and stop discharge by turning off an external Nch. MOSFET. To reset the VD2 with the DOUT pin level being “H” again after detecting over-discharge, if V_{DD} voltage is equal or less than overcharge detector threshold, a charge current flows through a parasitic diode of the external Nch. MOSFET. After that, when V_{DD} voltage is more than overdischarge threshold, DOUT pin becomes "H", and by tuning on the external Nch. MOSFET, discharge is possible. A charge operation when a cell voltage equals to zero is different according to the function version.

R5443ZxxxA/C: When a cell voltage is equal to 0V, connecting a charger to the battery pack makes COUT pin become "H" and the system is allowable for charge while the voltage of the charger is more than the maximum limit of the minimum operating voltage (V_{ST}) for 0V charge.
R5443ZxxxG/H: When the VDD pin voltage is equal or less than the maximum voltage for inhibition of charger (V_{NOCHG}), even if a charger is connected to the battery pack, COUT pin is stacked with "L" and the system is not allowable for charge.

Output delay for overdischarge detection is fixed internally. Although the voltage of VDD becomes equal or less than overdischarge detector threshold and if it becomes higher than overdischarge detector threshold within output delay time, overdischarge detector does not work. Output delay time for release from over-discharge is also set internally. After detecting overdischarge by VD2, supply current would decrease, (V_{DD} = 1.9V, Max. 0.1μA.) because all circuits are halted and being standby. The output type of DOUT pin is CMOS type and its output level is in between V_{DD} and V_{SS}.

VD3: Discharge Overcurrent Detector, Short Circuit Protector

While charge and discharge are acceptable with the battery pack, VD3 monitors the voltage level between VSS pin and RSENS pin. In the cause of such as the external short circuit, if the voltage level between VSS pin and RSENS pin may become equal or more than the discharge overcurrent threshold and less than the short detector threshold, the discharge overcurrent detector works. When the voltage level between VSS pin and RSENS pin becomes equal or more than short detector threshold voltage, the short circuit protector works and the output level of DOUT becomes “L”, and by turning off an external Nch MOSFET, VD3 protects against flowing extremely large current into the circuit. Output delay time for the discharge overcurrent detector is internally fixed. When the voltage between V- pin and RSENSE pin becomes less than V_{DET3} within the output delay time, the overcurrent detector does not work. In the case of the discharge overcurrent of the auto release type, a pulldown resistor of 45kΩ (typ.) is connected between the V- and the VSS pins. After a discharge overcurrent or short circuit protection is detected, by removing a cause of overcurrent or external short circuit, the voltage level of V- is pulled down through the resistor for release from overcurrent to the V_{SS} level. Then, when the voltage level between V- pin and VSS pin becomes equal or less than the overcurrent threshold voltage, both protection circuits are released automatically. Resistor for release from discharge overcurrent is active when discharge overcurrent or short circuit is detected. The resistor is inactive in the normal mode.

VD4: Charge Overcurrent Detector

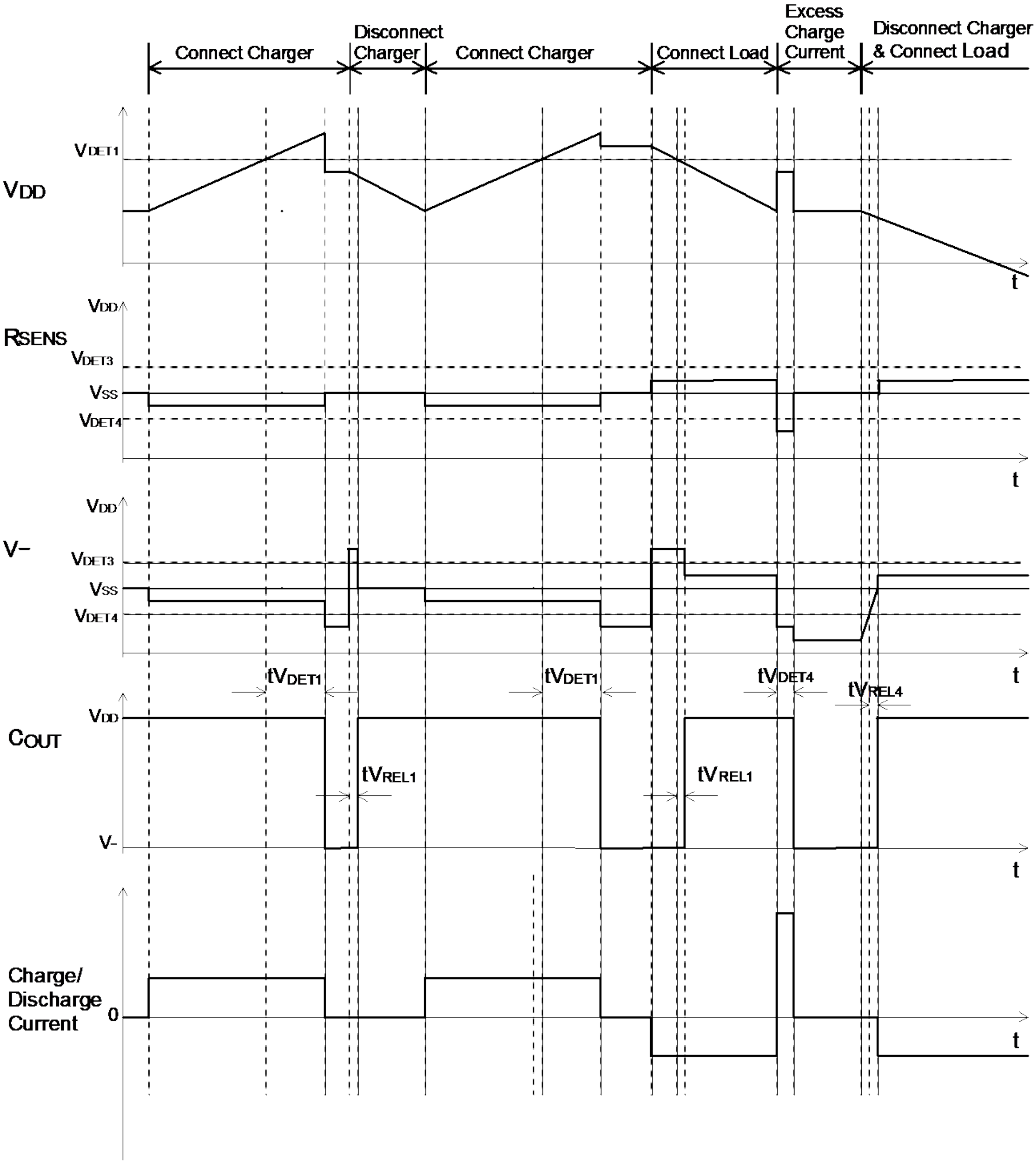
While charge and discharge are acceptable with the battery pack, VD4 monitors the voltage level between VSS pin and RSENS pin. For example, if the voltage level between VSS pin and RSENS pin may become equal or less than the charge overcurrent threshold, the charge overcurrent detector works and the output level of COUT becomes “L”, and by turning off an external Nch. MOSFET, VD4 protects against flowing extremely large current into the circuit.

Output delay of the charge overcurrent is internally fixed. Even the voltage level of between VSS pin and RSENS pin becomes equal or lower than the charge overcurrent detector threshold, if the voltage is higher than the VD4 threshold within the delay time, the charge overcurrent state is not detected. Output delay time for release from the charge overcurrent is also set internally. VD4 can be released with disconnecting a charger.

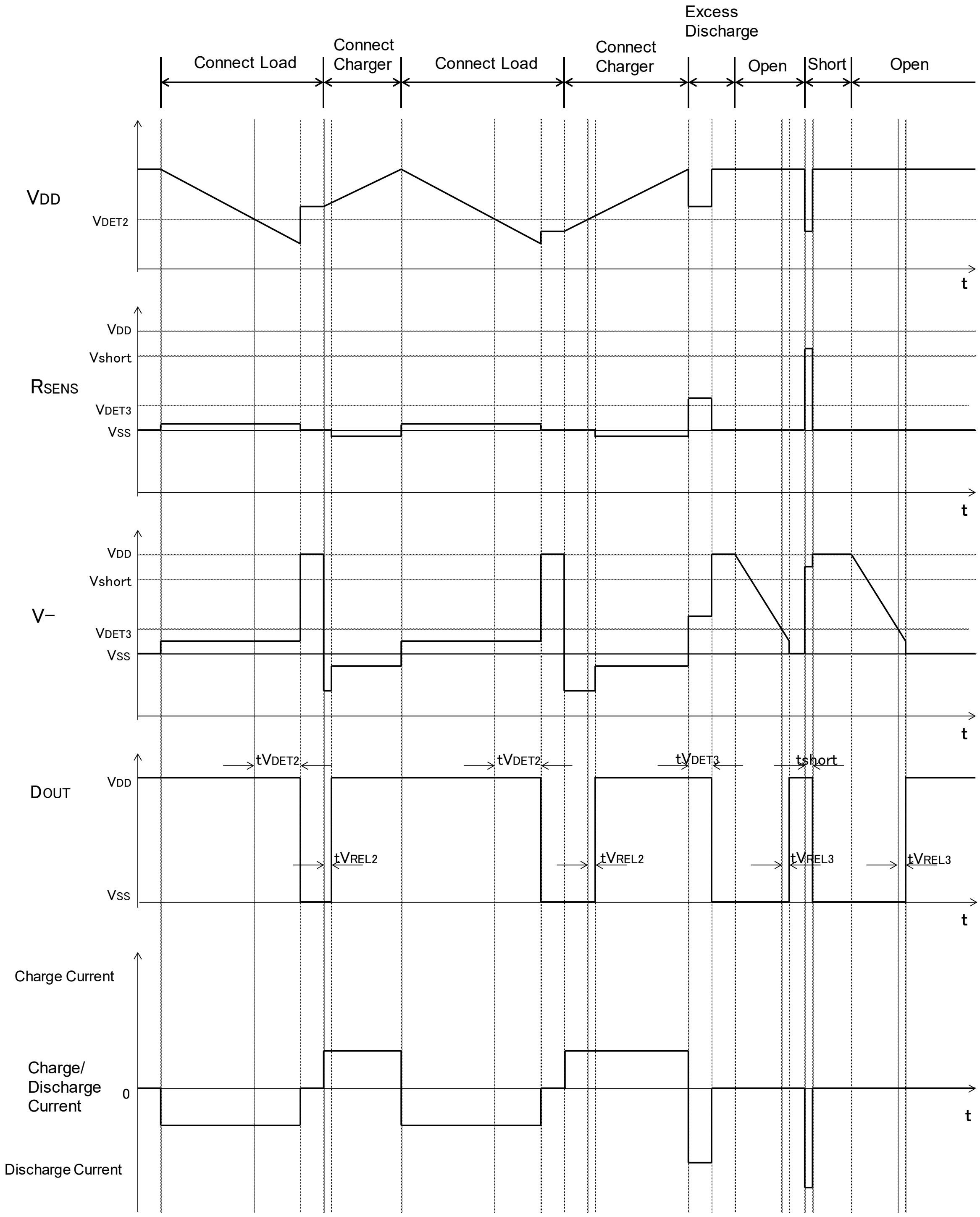
DS (Delay Shortening) Function

Output delay time of overcharge and overdischarge can be shorter than those setting values by forcing equal or lower than the test shortening mode voltage (Typ. -2.0V) to V- pin.

Timing Diagrams



Overcharge Voltage / Current Timing Diagram

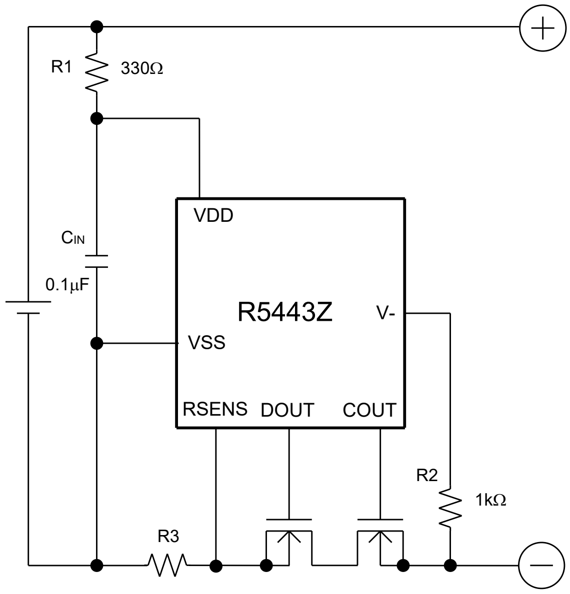


Overdischarge/ Discharge Overcurrent [(1)] / Short Circuit Timing Diagrams

(1) Auto release type only

APPLICATION INFORMATION

Typical Application Circuit



R5443Z Typical Application Circuit

R1 and C_{IN} stabilize a supply voltage to the R5443Z. 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 R5443Z. Further, to stabilize the operation of R5443Z, use the C_{IN} with the value of 0.01μF or more.

R1 and R2 can operate also as parts for current limit circuit against reverse charge or applying a charger with overcharging voltage to the R5443Z, battery pack. While small value of R1 and R2 may cause over power dissipation rating of the R5443Z, therefore a total of “R1+R2” should be 1kΩ or more. Besides, if large value of R2 is set, release from overdischarge by connecting a charger might not be possible. Recommended R2 value is equal or less than 10kΩ.

R3 is a resistor for sensing an overcurrent. If the resistance value is too large, power loss becomes also large. By the overcurrent, if the R3 is not appropriate, the power loss may be beyond the power dissipation of R3. Choose an appropriate R3 according to the cell specification.

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. Overvoltage and overcurrent beyond the absolute maximum rating should not be forced to the protection IC and external components. Although the short protection circuit is built in the IC, if the positive terminal and the negative terminal of the battery pack are short, during the delay time of short limit detector, large current flows through the FET. Select an appropriate FET with large enough current capacity to prevent the IC from burning damage.

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51.

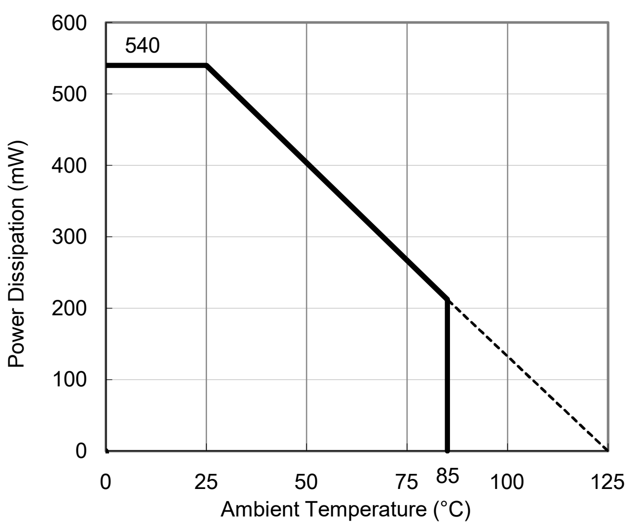
Measurement Conditions

Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	101.5 mm x 114.5 mm x 1.6 mm
Copper Ratio	Outer Layer (First Layer): 10% Inner Layers (Second and Third Layers): 99.5 x 99.5mm 100% Outer Layer (Fourth Layer): 10%

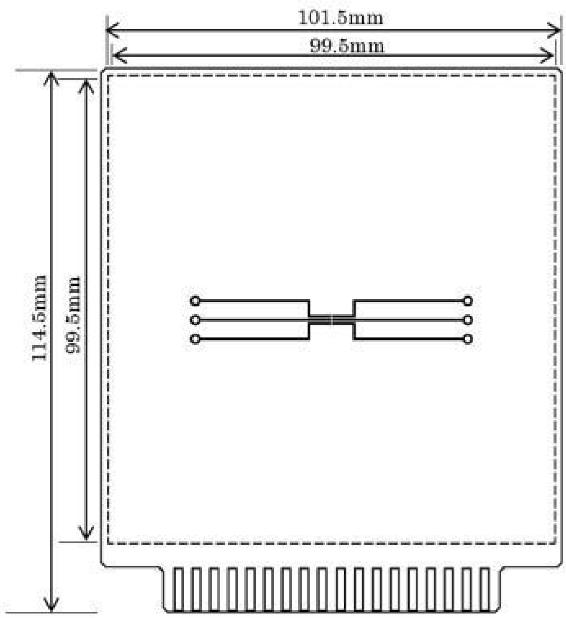
Measurement Result (Ta = 25°C, Tjmax = 125°C)

Item	Measurement Result
Power Dissipation	540 mW
Thermal Resistance (θja)	θja = 183 °C/W

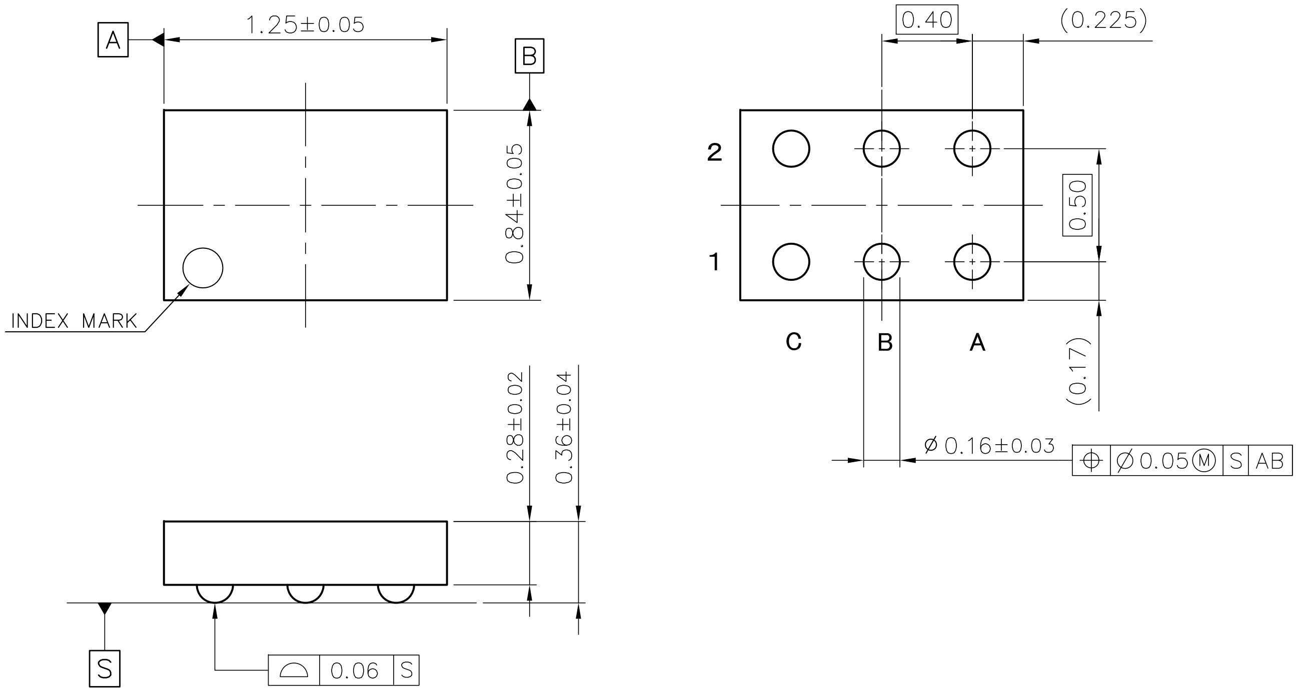
θja: Junction-to-Ambient Thermal Resistance



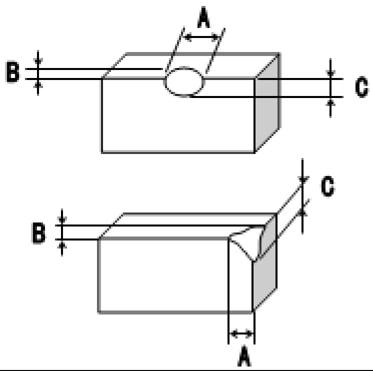
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



WLCSP-6-P7 Package Dimensions (Unit: mm)

No.	Inspection Items	Inspection Criteria	Figure
1	Package chipping	A≥0.2mm is rejected B≥0.2mm is rejected C≥0.2mm is rejected And, Package chipping to Si surface and to bump is rejected.	
2	Si surface chipping	A≥0.2mm is rejected B≥0.2mm is rejected C≥0.2mm is rejected But, even if A≥0.2mm, B≤0.1mm is acceptable.	
3	No bump	No bump is rejected.	
4	Marking miss	To reject incorrect marking, such as another product name marking or another lot No. marking.	
5	No marking	To reject no marking on the package.	
6	Reverse direction of marking	To reject reverse direction of marking character.	
7	Defective marking	To reject unreadable marking. (Microscope: X15/ White LED/ Viewed from vertical direction)	
8	Scratch	To reject unreadable marking character by scratch. (Microscope: X15/ White LED/ Viewed from vertical direction)	
9	Stain and Foreign material	To reject unreadable marking character by stain and foreign material. (Microscope: X15/ White LED/ Viewed from vertical direction)	

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