R5463Kxxxxx SERIES

EA-262-120711

OUTLINE

The R5463Kxxxxx Series are high voltage CMOS-based protection ICs for over-charge/discharge of two-cell Lithium-ion (Li+) / Lithium polymer, further include a short circuit protection circuit for preventing large external short circuit current and the protection circuits against the excess discharge-current and excess charge current.

Each of these ICs is composed of six 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 threshold or 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 "L" level after internal fixed delay time. To release over-charge detector after detecting over-charge, the detector 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 dis-connected from the battery pack and the cell voltage becomes lower than over-charge detector threshold. In case that a charger is continuously connected to the battery pack, if the cell voltage becomes lower than the over-charge released voltage, over-charge state is also released.

The output of D_{OUT} pin, the output of the over-discharge detector and the 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}. To release over-discharge detector, after detecting over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than the over-discharge detector threshold, the over-discharge detector is released and the voltage of DOUT pin becomes "H".

If the battery is discharged lower than maximum voltage for inhibition of charger, recharge current is not ac-ceptable.

After detecting excess-discharge current or short current, when the load is disconnected, the excess discharged or short condition is released and DOUT becomes "H".

After detecting over-discharge voltage, supply current will be kept extremely low by halting internal circuits' operation.

When the output of COUT is "H", if V- pin level is set at -1.6V, the delay time of over-charge and over-discharge detector can be shortened. Especially, the delay time of the over-charge detector can be reduced into approxi-mately 1/60 and test time for protection circuit PCB can be reduced. The output type of COUT and DOUT is CMOS.

FEATURES

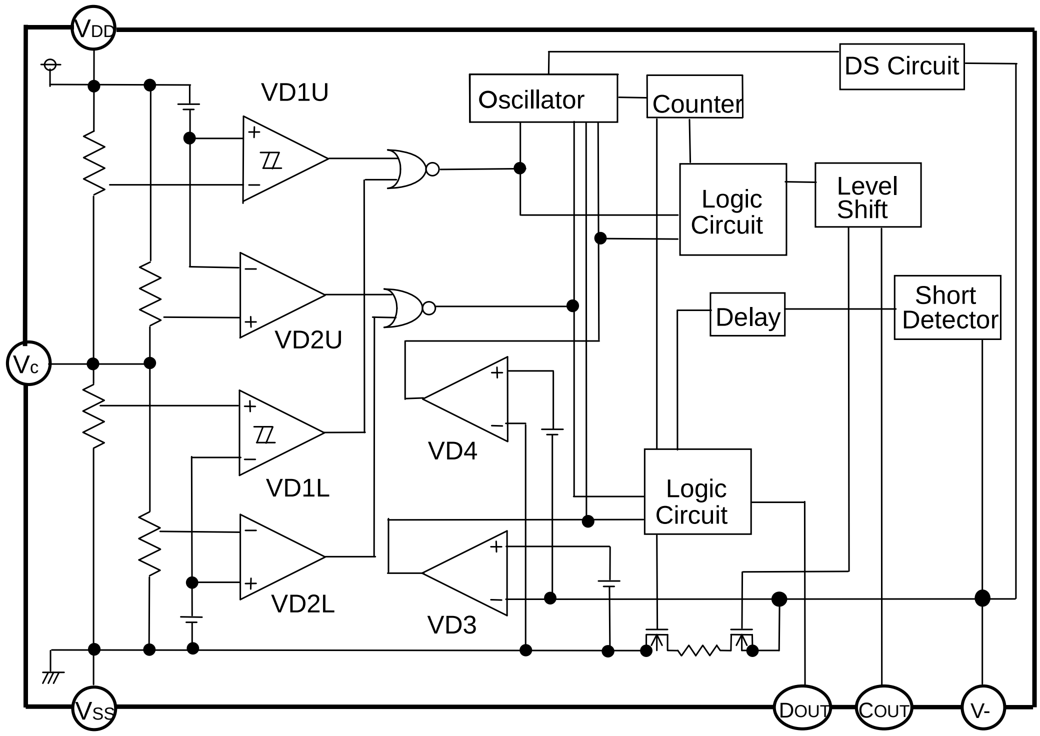
• Manufactured with High Voltage Tolerant Process...	Absolute Maximum Rating		30V
• Low supply current	Supply current (At normal mode)		Typ. 4.0µA
	Standby current		Max. 0.1µA
• High accuracy detector threshold.................	Over-charge detector	(Ta=25°C)	±20mV
		(Ta=-5°C to 55°C)	±25mV
	Over-discharge detector		±1.0%
	Excess discharge-current detector	(G ver.)	±10mV
		(J ver.)	±10%
	Excess charge-current detector		±20mV
• Variety of detector threshold	Over-charge detector threshold		3.65V-4.32V step of 0.005V
	Over-discharge detector threshold		2.0V-3.2V step of 0.005V
	Excess discharge-current threshold	(G ver.)	0.05V-0.20V step of 0.005V
		(J ver.)	0.20V-0.40V step of 0.005V
	Excess charge-current threshold		-0.2V--0.1V step of 0.005V
• Internal fixed Output delay time	Over-charge detector Output Delay		1s
	Over-discharge detector Output Delay		128ms
	Excess discharge-current detector Output Delay		12ms
	Excess charge-current detector Output Delay		8ms
	Short Circuit detector Output Delay		300µs

- Output Delay Time Shortening Function ..... At COUT is "H", if V- level is set at –1.6V, the Output Delay time of detect the over-charge and over-discharge can be reduced. (Delay Time for over-charge becomes about 1/60 of normal state.)
- 0V-battery charge... Unacceptable
- Ultra Small package .... DFN(PLP)1820-6B

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



SELECTION GUIDE

In the R5463Kxxxxx Series, input threshold of over-charge, over-discharge, excess discharge current, and the package and taping can be designated.

Part Number is designated as follows:

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5463K2xx$∗-TR	DFN(PLP)1820-6B	5,000pcs	Yes	Yes

xx :Serial Number for the R5463K Series designating voltages such as over-charge threshold, over-charge, over-discharge threshold, over-discharge current, over-charge current, short voltage.

$: Designation of Output delay time option.

	Over-charge Delay time (s)	Over-discharge Delay time (ms)	Over-discharge Current Delay time (ms)	Over-charge Current Delay time (ms)	Short Delay time (μs)
R5463KxxxA∗	1.0	128	12	8	300

∗ : Designation of protection type.

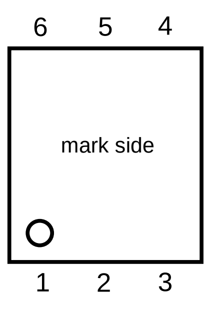
	Over-charge Released condition	Over-discharge Released condition	0V battery Charge	Adustable Range of Excess Charge-current Threshold
R5463Kxxx$G	Auto Release	Latch	NG	0.05 to 0.20V
R5463Kxxx$J	Auto Release	Latch	NG	0.20 to 0.40V

PRODUCT NAME LIST

Code	VDET1 (V)	VREL1 (V)	VDET2 (V)	VREL2 (V)	VDET3 (V)	VDET4 (V)
R5463K217AG	4.280	4.080	2.000	−	0.200	−0.100
R5463K221AJ	4.300	4.100	2.600	−	0.370	−0.160
R5463K224AG	4.280	4.080	2.000	−	0.110	−0.100

PIN CONFIGURATIONS

DFN(PLP)1820-6B



PIN DESCRIPTION

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

The backside tab of DFN(PLP)1820-6B package is connected to the substrate level. (V_{DD}) Note that avoiding short with other level.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Ratings	Unit
V_{DD}	Supply voltage	-0.3 to 12	V
	Input Voltage		
V_C	Center pin voltage between two-cell	V_{SS} -0.3 to V_{DD}+0.3	V
V-	Charger negative input V- pin	V_{DD} -30 to V_{DD}+0.3	V
	Output voltage		
VC_{OUT}	C_{OUT} pin	V_{DD} -30 to V_{DD} +0.3	V
VD_{OUT}	D_{OUT} pin	V_{SS} -0.3 to V_{DD} +0.3	V
P_D	Power dissipation	150	mW
Ta	Operating temperature range	-40 to 85	°C
Tstg	Storage temperature range	-55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time 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 (ELECTRICAL CHARACTERISTICS)

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 when 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

R5463KxxxAG

Unless otherwise specified Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V_{DD1}	V_{DD}-V_{SS}	1.5		10	V
Maximum Operating Voltage for Inhibition of Charger	V_{nochg}	V_{DD}-V_C or V_C-V_{SS}	0.6	0.8	1.0	V
Cell1 Over-charge Detector Threshold	V_{DET1U}	R1=330Ω R1=330Ω, (Ta=-5°C to 55°C)*Note1	V_{DET1U}-0.020 V_{DET1U}-0.025	V_{DET1U}	V_{DET1U}+0.020 V_{DET1U}+0.025	V
Cell1 Over-charge Released Voltage	V_{REL1U}	R1=330Ω	V_{REL1U}-0.050	V_{REL1U}	V_{REL1U}+0.050	V
Cell2 Over-charge Detector threshold	V_{DET1L}	R2=330Ω R2=330Ω, (Ta=-5°C to 55°C)*Note1	V_{DET1L}-0.020 V_{DET1L}-0.025	V_{DET1L}	V_{DET1L}+0.020 V_{DET1L}+0.025	V
Cell2 Over-charge Released Voltage	V_{REL1L}	R2=330Ω	V_{REL1L}-0.050	V_{REL1L}	V_{REL1L}+0.050	V
Output Delay of Over-charge	tV_{DET1}	V_{DD}-V_C=3.5V to 4.5V V_C-V_{SS}=3.5V	0.7	1.0	1.3	s
Output Delay of Release from Over-charge	tV_{REL1}	V_{DD}-V_C=4.5V to 3.5V, V_C-V_{SS}=3.5V	11	16	21	ms
Cell1 Over-discharge Threshold	V_{DET2U}	Detect falling edge of the input voltage	V_{DET2U} × 0.990	V_{DET2U}	V_{DET2U} × 1.010	V
Cell2 Over-discharge Threshold	V_{DET2L}	Detect falling edge of the input voltage	V_{DET2L} × 0.990	V_{DET2L}	V_{DET2L} × 1.010	V
Output Delay of Over-discharge	tV_{DET2}	V_{DD}-V_C=3.5V to 1.5V V_C-V_{SS} =3.5V	89	128	167	ms
Output Delay of Release from Over-discharge	tV_{REL2}	V_{DD}-V_C =1.5V to 3.5V V_C-V_{SS} =3.5V	0.7	1.2	1.7	ms
Excess Discharge-current Threshold	V_{DET3}	Detect rising edge of 'V-' pin voltage	V_{DET3}-0.010	V_{DET3}	V_{DET3}+0.010	V
Output Delay of Excess Discharge-current	tV_{DET3}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=0V to 0.5V	8	12	16	ms
Output Delay of Release from Excess Discharge-current	tV_{REL3}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=3V to 0V	0.7	1.2	1.7	ms
Short Protection Voltage	V_{SHORT}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V	0.6	1.0	1.4	V
Delay Time for Short Protection	t_{SHORT}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=0V to 1.5V	150	300	500	μs
Reset Resistance for Excess Current Protection	R_{SHORT}	V_{DD}-V_C=3.6V,V_C-V_{SS}=3.6V V-=1V	25	40	75	kΩ
Excess Charge-current Threshold	V_{DET4}	Detect falling edge of 'V-' pin voltage	V_{DET4}-0.020	V_{DET4}	V_{DET4}+0.020	V
Output Delay of Excess Charge-current	tV_{DET4}	V_{DD}-V_C=3.5V, V_C-V_{SS}=3.5V V-=0V to -1V	5	8	11	ms
Output Delay of Release from Excess Charge-current	tV_{REL4}	V_{DD}-V_C=3.5V, V_C-V_{SS}=3.5V V-=-1V to 0V	0.7	1.2	1.7	ms
Delay Shortening Mode Voltage	V_{DS}	V_{DD}-V_C=4.4V, V_C-V_{SS}=4.4V	-2.2	-1.6	-1.0	V
Nch ON-Voltage of C_{OUT}	V_{OL1}	Iol=50μA, V_{DD}-V_C=4.5V V_C-V_{SS}=4.5V		0.4	0.5	V
Pch ON-Voltage of C_{OUT}	V_{OH1}	Ioh=-50μA, V_{DD}-V_C=3.9V V_C-V_{SS}=3.9V	6.8	7.4		V
Nch ON-Voltage of D_{OUT}	V_{OL2}	Iol=50μA, V_{DD}-V_C=1.9V V_C-V_{SS}=1.9V		0.2	0.5	V
Pch ON-Voltage of D_{OUT}	V_{OH2}	Ioh=-50μA, V_{DD}-V_C=3.9V V_C-V_{SS}=3.9V	6.8	7.4		V
Supply Current	I_{DD}	V_{DD}-V_C=3.9V, V_C-V_{SS}=3.9V V-=0V		4.0	8.0	μA
Standby Current	I_{STB}	V_{DD}-V_C=1.9V, V_C-V_{SS}=1.9V			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 tested.

R5463KxxxAJ

Unless otherwise specified Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Operating Input Voltage	V_{DD1}	V_{DD}-V_{SS}	1.5		10	V
Maximum Operating Voltage for Inhibition of Charger	Vnochg	V_{DD}-V_C or V_C-V_{SS}	0.6	0.8	1.0	V
Cell1 Over-charge Detector Threshold	V_{DET1U}	R1=330Ω R1=330Ω, (Ta=-5°C to 55°C)*Note1	V_{DET1U}-0.020 V_{DET1U}-0.025	V_{DET1U}	V_{DET1U}+0.020 V_{DET1U}+0.025	V
Cell1 Over-charge Released Voltage	V_{REL1U}	R1=330Ω	V_{REL1U}-0.050	V_{REL1U}	V_{REL1U}+0.050	V
Cell2 Over-charge Detector threshold	V_{DET1L}	R2=330Ω R2=330Ω, (Ta=-5°C to 55°C)*Note1	V_{DET1L}-0.020 V_{DET1L}-0.025	V_{DET1L}	V_{DET1L}+0.020 V_{DET1L}+0.025	V
Cell2 Over-charge Released Voltage	V_{REL1L}	R2=330Ω	V_{REL1L}-0.050	V_{REL1L}	V_{REL1L}+0.050	V
Output Delay of Over-charge	tV_{DET1}	V_{DD}-V_C=3.5V to 4.5V V_C-V_{SS}=3.5V	0.7	1.0	1.3	s
Output Delay of Release from Over-charge	tV_{REL1}	V_{DD}-V_C=4.5V to 3.5V, V_C-V_{SS}=3.5V	11	16	21	ms
Cell1 Over-discharge Threshold	V_{DET2U}	Detect falling edge of the input voltage	V_{DET2U}×0.990	V_{DET2U}	V_{DET2U}×1.010	V
Cell2 Over-discharge Threshold	V_{DET2L}	Detect falling edge of the input voltage	V_{DET2L}×0.990	V_{DET2L}	V_{DET2L}×1.010	V
Output Delay of Over-discharge	tV_{DET2}	V_{DD}-V_C=3.5V to 1.5V V_C-V_{SS} =3.5V	89	128	167	ms
Output Delay of Release from Over-discharge	tV_{REL2}	V_{DD}-V_C =1.5V to 3.5V V_C-V_{SS} =3.5V	0.7	1.2	1.7	ms
Excess Discharge-current Threshold	V_{DET3}	Detect rising edge of 'V-' pin voltage	V_{DET3}×0.900	V_{DET3}	V_{DET3}×1.100	V
Output Delay of Excess Discharge-current	tV_{DET3}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=0V to 0.5V	8	12	16	ms
Output Delay of Release from Excess Discharge-current	tV_{REL3}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=3V to 0V	0.7	1.2	1.7	ms
Short Protection Voltage	V_{SHORT}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V	0.6	1.0	1.4	V
Delay Time for Short Protection	t_{SHORT}	V_{DD}-V_C=3.5V,V_C-V_{SS}=3.5V V-=0V to 1.5V	150	300	500	µs
Reset Resistance for Excess Current Protection	R_{SHORT}	V_{DD}-V_C=3.6V,V_C-V_{SS}=3.6V V-=1V	25	40	75	kΩ
Excess Charge-current Threshold	V_{DET4}	Detect falling edge of 'V-' pin voltage	V_{DET4}-0.020	V_{DET4}	V_{DET4}+0.020	V
Output Delay of Excess Charge-current	tV_{DET4}	V_{DD}-V_C=3.5V, V_C-V_{SS}=3.5V V-=0V to -1V	5	8	11	ms
Output Delay of Release from Excess Charge-current	tV_{REL4}	V_{DD}-V_C=3.5V, V_C-V_{SS}=3.5V V-=-1V to 0V	0.7	1.2	1.7	ms
Delay Shortening Mode Voltage	V_{DS}	V_{DD}-V_C=4.4V, V_C-V_{SS}=4.4V	-2.2	-1.6	-1.0	V
Nch ON-Voltage of C_{OUT}	V_{OL1}	Iol=50µA, V_{DD}-V_C=4.5V V_C-V_{SS}=4.5V		0.4	0.5	V
Pch ON-Voltage of C_{OUT}	V_{OH1}	Ioh=-50µA, V_{DD}-V_C=3.9V V_C-V_{SS}=3.9V	6.8	7.4		V
Nch ON-Voltage of D_{OUT}	V_{OL2}	Iol=50µA, V_{DD}-V_C=1.9V V_C-V_{SS}=1.9V		0.2	0.5	V
Pch ON-Voltage of D_{OUT}	V_{OH2}	Ioh=-50µA, V_{DD}-V_C=3.9V V_C-V_{SS}=3.9V	6.8	7.4		V
Supply Current	I_{DD}	V_{DD}-V_C=3.9V, V_C-V_{SS}=3.9V V-=0V		4.0	8.0	µA
Standby Current	I_{STB}	V_{DD}-V_C=1.9V, V_C-V_{SS}=1.9V			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 tested.

OPERATION

- **VDET1U, VDET1L / Over-Charge Detectors**

The VDET1U and VDET1L monitor the voltage between V_{DD} pin and V_C pin (the voltage of Cell1) and the voltage between V_C pin and V_{SS} pin (the voltage of Cell2), if either voltage becomes equal or more than the over-charge detector threshold, the over-charge is detected, and an external charge control Nch MOSFET turns off with C_{OUT} pin being at "L" level.

VDET1U is the detector of Cell1, and the VDET1L is the detector of Cell2.

To reset the over-charge and make the C_{OUT} pin level to "H" again after detecting over-charge, in such conditions that a time when the both Cell1 and Cell2 are down to a level lower than over-charge voltage, by connecting a kind of load to V_{DD} after disconnecting a charger from the battery pack. Then, the output voltage of C_{OUT} pin becomes "H", and it makes an external Nch MOSFET turn on, and charge cycle is available. In case of the charger is continuously connected and over-charge is detected, both battery voltages of Cell1 and Cell2 become lower than the released voltage from over-charge, charge becomes possible. Therefore there is a specific hysteresis for over-charge detectors. To judge whether or not load is connected, the built-in excess-discharge current detector is used. By connecting some load, V- pin voltage becomes equal or more than excess-discharge current detector threshold, and reset the over-charge detecting state.

Further, either or both voltage of Cell1 and Cell2 is higher than the over-charge detector threshold, if a charger is removed and some load is connected, COUT outputs “L”, however, load current can flow through the parasitic diode of the external charge control Nch MOSFET. After that, when both voltages of Cell1 and Cell2 become lower than the over-charge detector threshold, COUT becomes “H”.

Internal fixed output delay times for over-charge detection and release from over-charge exist. If either or both of the voltage of Cell1 or Cell2 keeps its level more than the over-charge detector threshold, and output delay time passes, over-charge voltage is detected. Even when the voltage of Cell1 or Cell2 pin level becomes equal or higher level than V_{DET1} if these voltages would be back to a level lower than the over-charge detector threshold within a time period of the output delay time, the over-charge is not detected. Besides, after detecting over-charge, while the both of Cell1 and Cell2 voltages are lower than the over-charge detector threshold, 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.

- **VDET2U, VDET2L / Over-Discharge Detectors**

The VDET2U and VDET2L monitor the voltage between V_{DD} pin and VC pin (Cell1 voltage) and the voltage between VC pin and VSS pin (Cell2 Voltage). When either of the Cell1 or Cell2 voltage becomes equal or less than the over-discharge detector threshold, the over-discharge is detected and discharge stops by the external discharge control Nch MOSFET turning off with the D_{OUT} pin being at "L" level.

To reset the over-discharge detector, connecting a charger is the only method. When the charger is connected, if Cell1 or Cell2 is less than the over-discharge detector threshold, a charge current flows through the parasitic diode of the external MOSFET. Then, the voltages of Cell1 and Cell2 become higher than the released voltage from over-discharge, D_{OUT} becomes “H” and the external MOSFET turns on and discharge will be possible. When a charger is connected, when the Cell1 and Cell2 voltages become equal or more than the over-discharge detector threshold, the over-discharge is released and the voltage of the D_{OUT} pin becomes “H” after the delay time.

When either Cell1 or Cell2 voltage is equal or less than the maximum voltage for inhibition of charger (Vnochg), even if a charger is connected to the battery pack, C_{OUT} pin is stacked with "L" and the system is not allowable for charge.

The output delay time for over-discharge detect is fixed internally. Even if the voltage of Cell1 or Cell2 is down to equal or lower than the over-discharge detector threshold, if the both voltages of Cell1 and Cell2 would be back to a level higher than the over-discharge detector threshold within a time period of the output delay time, the over-discharge is not detected. Output delay time for release from over-discharge is also set.

After detecting over-discharge, supply current would be reduced and be into standby by halting all the circuits and consumption current of the IC itself is made extremely low.

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

- **VDET3 /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 and excess discharge-current threshold V_{DET3}, VDET3 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 the 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 R5463Kxxxxx is at excess discharge-current detection mode. By disconnecting a load, VDET3 is automatically released from excess discharge-current.

- **VDET4/ Excess charge-current detector**

When the battery pack is chargeable and discharge is also possible, VDET4 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 VDET4 threshold within the delay time, the excess charge current is not detected. Output delay for the release from excess charge current is also set.

VDET4 can be released with disconnecting a charger and connecting a load.

- **DS (Delay Shorten) function**

Output delay time of over-charge, over-discharge can be shorter than those setting value by forcing equal or less than the delay shortening mode voltage to V- pin when the COUT is “H”.

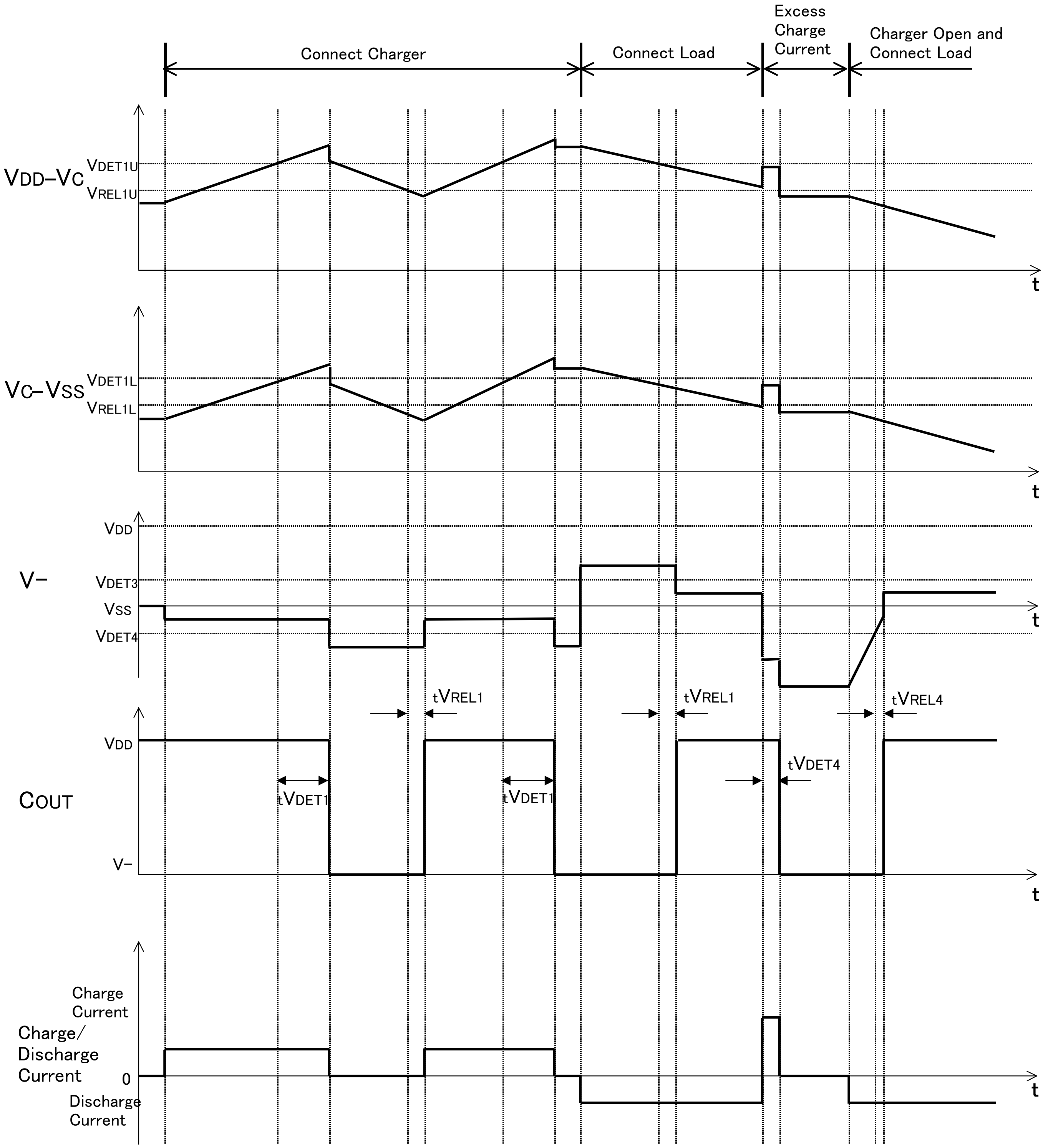
- **Operation against 2-Cell Unbalance**

If one of the cells detects over-charge, and when the COUT becomes "L", even if the other cell would detect over-discharge, the over-charge detector will be dominant and COUT keeps the "L" level. If one of the cells detects the over-discharge, and when the DOUT becomes "L", in case that a charger is connected to the battery pack and the other cell detects over-charge, the internal counter will start and after the delay time of over-discharge detector, DOUT will become "H". After the delay time of over-charge release from when the internal counter starts, COUT will be "L". If the over-discharge is detected, internal unnecessary circuits will be cut off and the standby mode will be realized. (Standby current Max. 0.1μA)

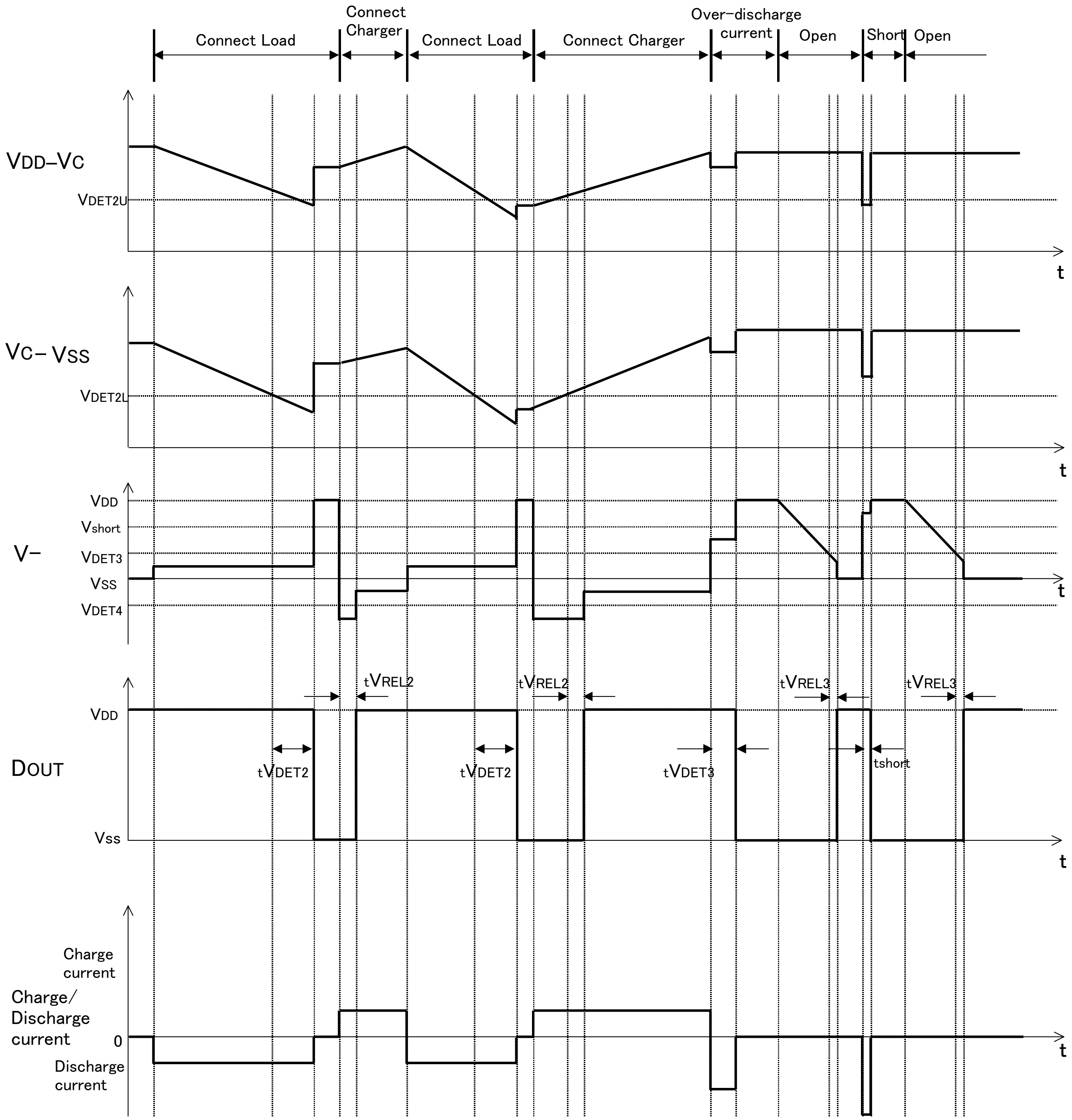
In any versions, the external FETs do not turn off at the same time.

TIMING CHART

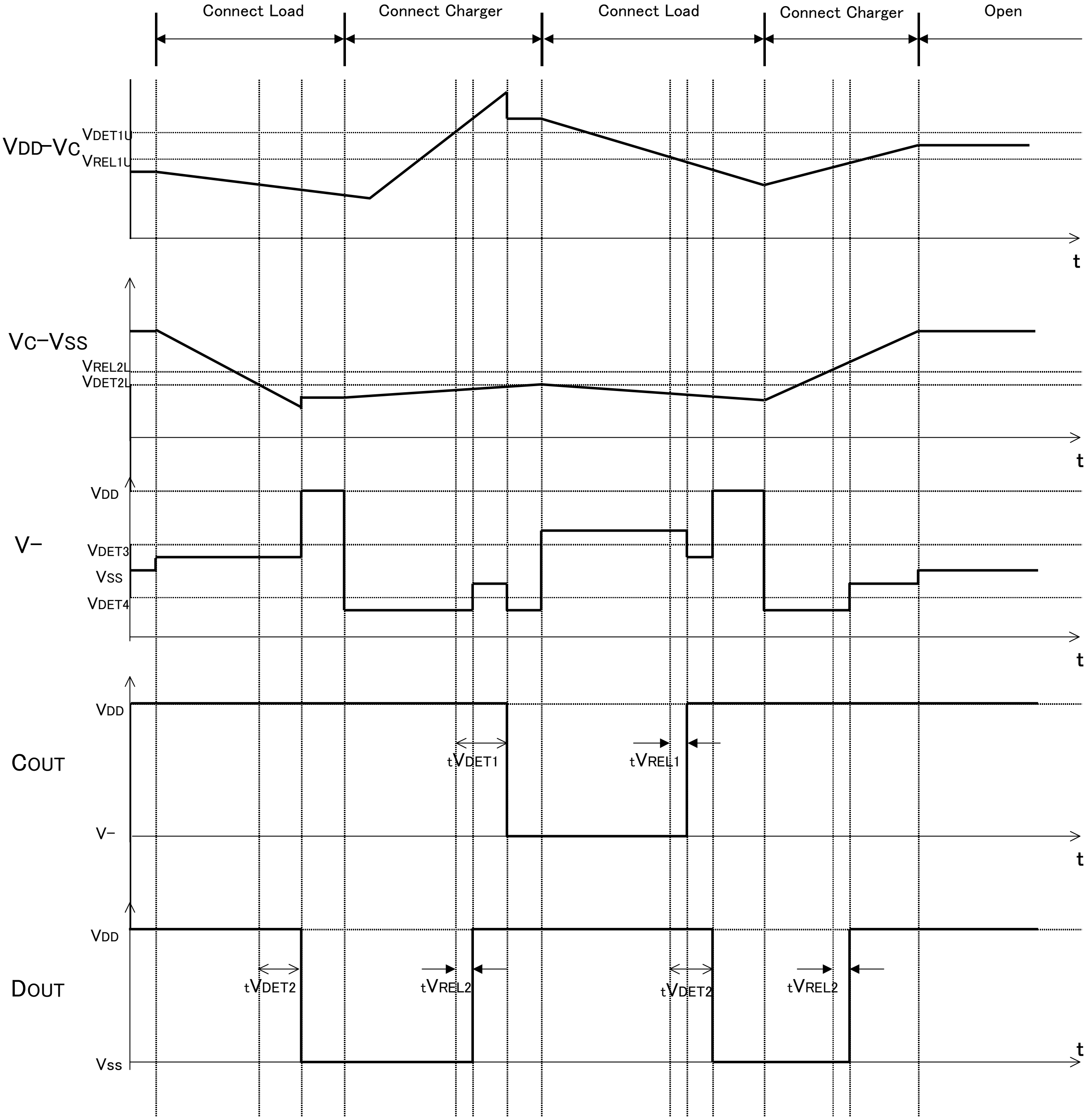
(1) Timing diagram of Over-charge, Excess charge current



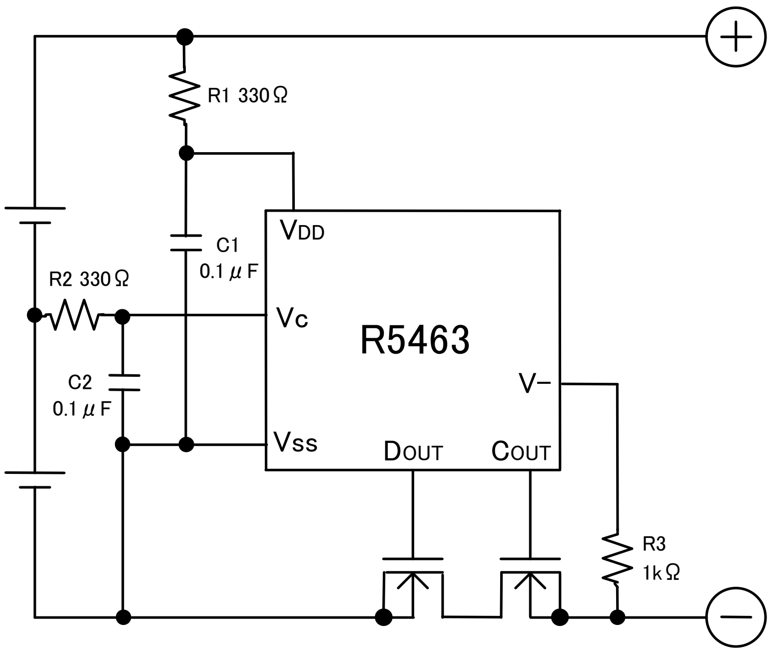
(2) Over-discharge, Excess discharge current, Short circuit



(3) Operation with unbalanced cells



TYPICAL APPLICATION AND TECHNICAL NOTES



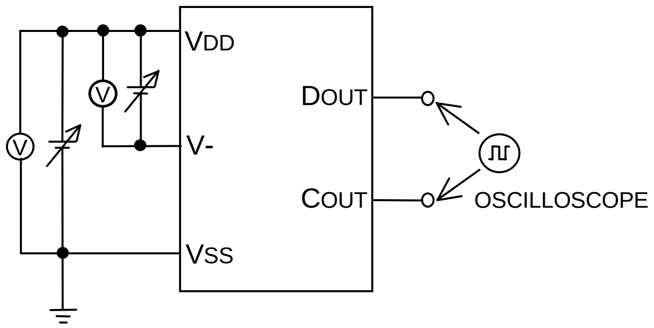
TECHNICAL NOTES

R1, R2, C1 and C2 stabilize a supply voltage to the R5463. A recommended R1, R2 value is less than 1kΩ. A larger value of R1 and R2 makes the detection voltage shift higher because of some conduction current in the R5463.
To stabilize the operation, the value of C1 and C2 should be equal or more than 0.01μF.
R1 and R3 can operate also as parts for current limit circuit against reverse charge or applying a charger with excess charging voltage beyond the absolute maximum rating of the R5463, the battery pack. Small value of R1 and R3 may cause over-power consumption rating of power dissipation of the R5463. Thus, the total value of 'R1+R3' should be equal or more than 1kΩ. If a large value of R3 is set, after detecting over-discharge, the release by connecting a charger may not be possible. Therefore, recommendation value of R3 is equal or less than 3kΩ.

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. 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.
We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire-containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.

TEST CIRCUITS

A



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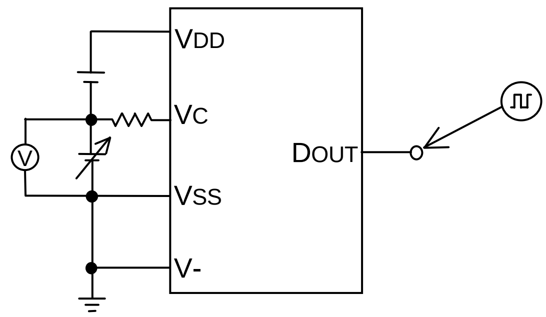

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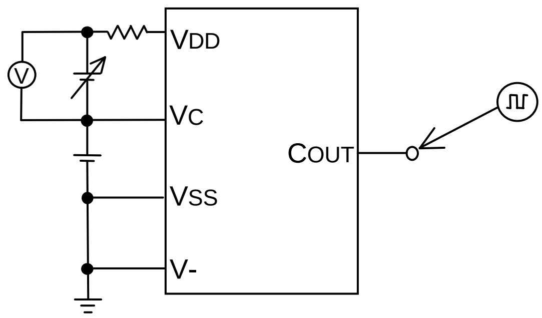

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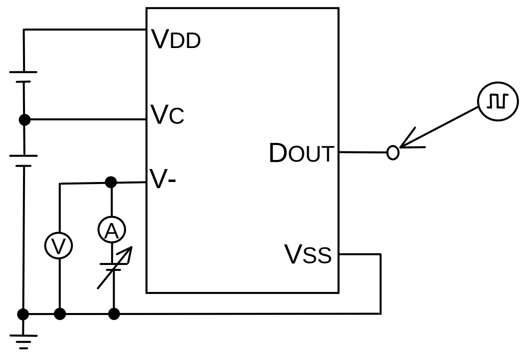
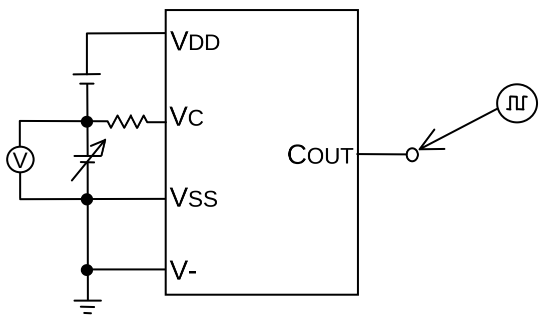
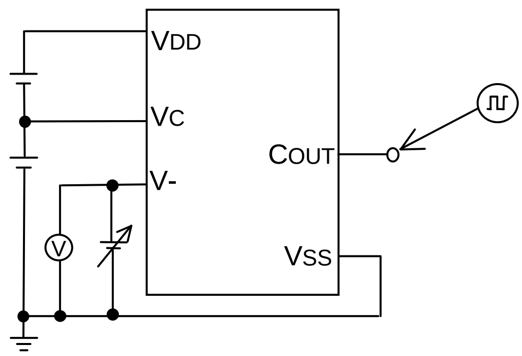


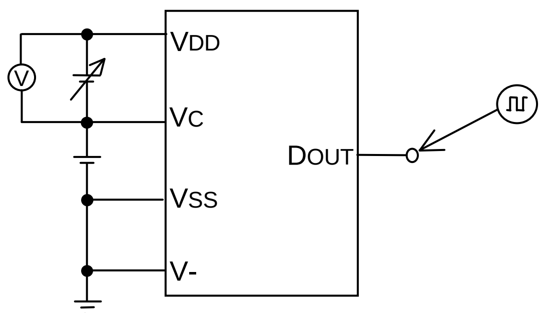
C



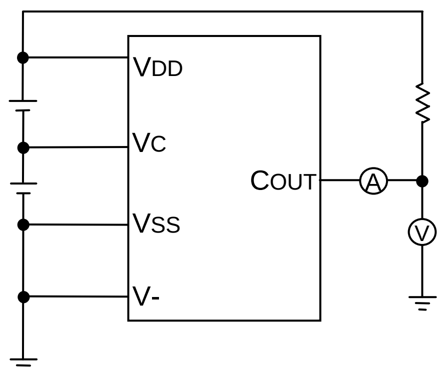
G



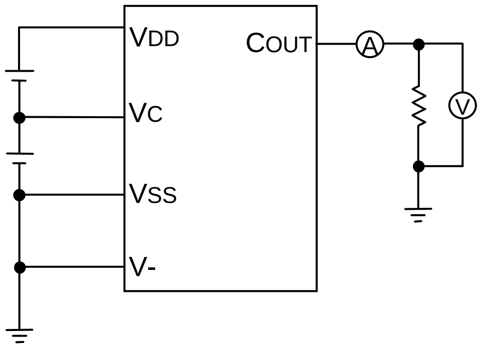
D



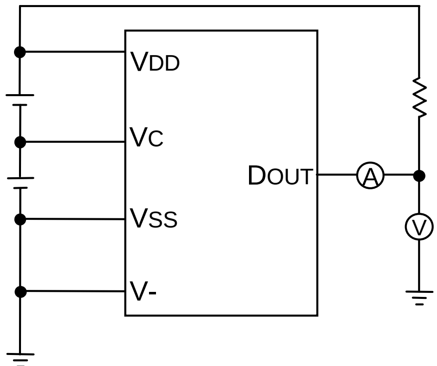
H



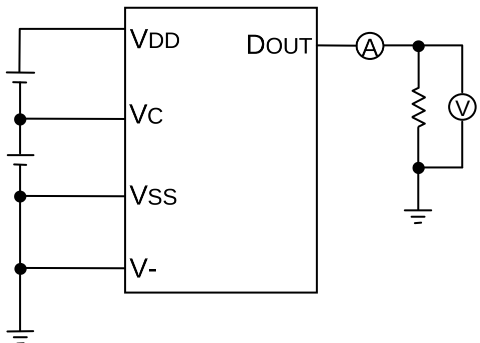
I



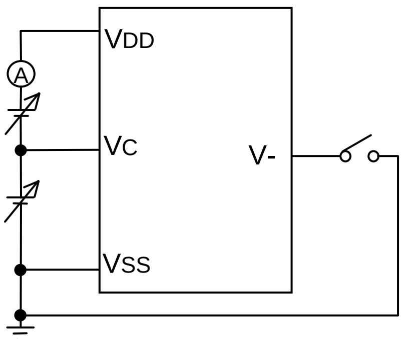
J



K



L



Typical Characteristics were obtained with using those above circuits:

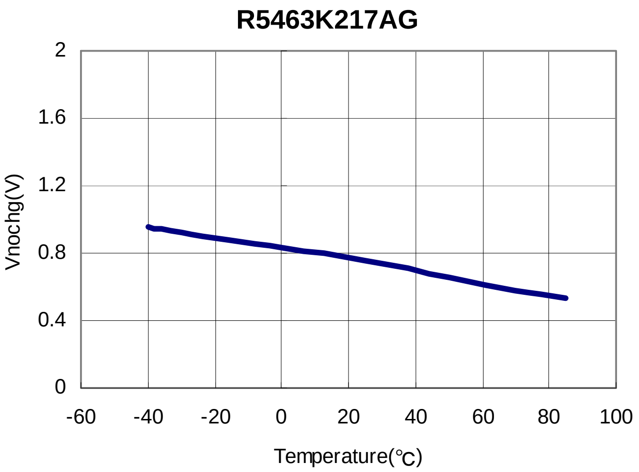
Test Circuit A: Typical characteristics 1)

Test Circuit B:	Typical characteristics 2) 4) 6) 7)
Test Circuit C:	Typical characteristics 3) 5)
Test Circuit D:	Typical characteristics 8) 10) 11)
Test Circuit E:	Typical characteristics 9)
Test Circuit F:	Typical characteristics 12) 13) 14) 15) 16) 17)
Test Circuit G:	Typical characteristics 18) 19) 20) 21)
Test Circuit H:	Typical characteristics 22)
Test Circuit I:	Typical characteristics 23)
Test Circuit J:	Typical characteristics 24)
Test Circuit K:	Typical characteristics 25)
Test Circuit L:	Typical characteristics 26) 27)

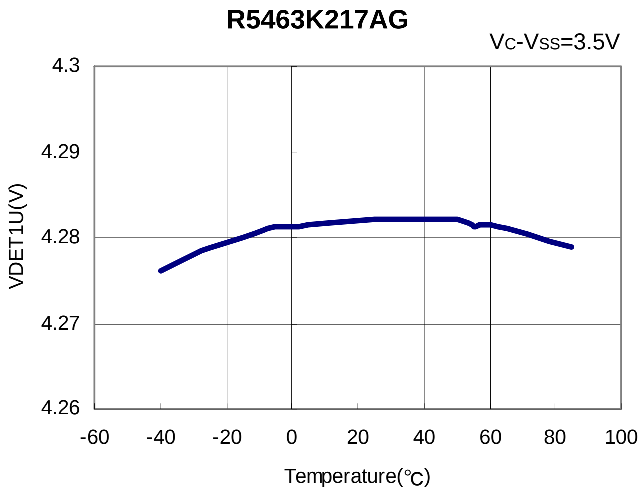
TYPICAL CHARACTERISTICS

Part 1

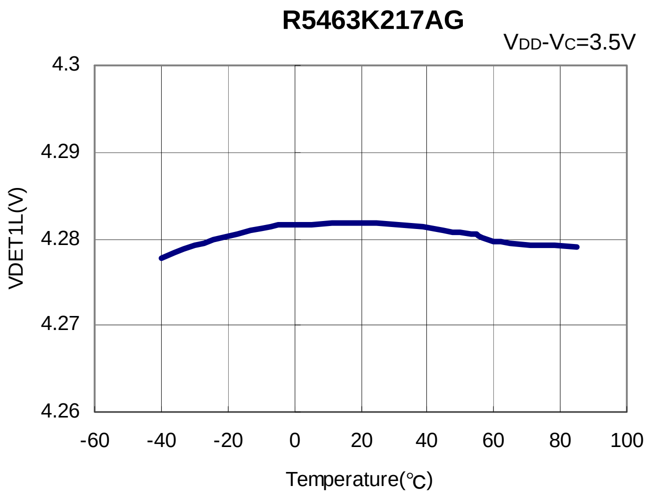
1) Maximum Operating Voltage for Inhibition of Charger vs. Temperature



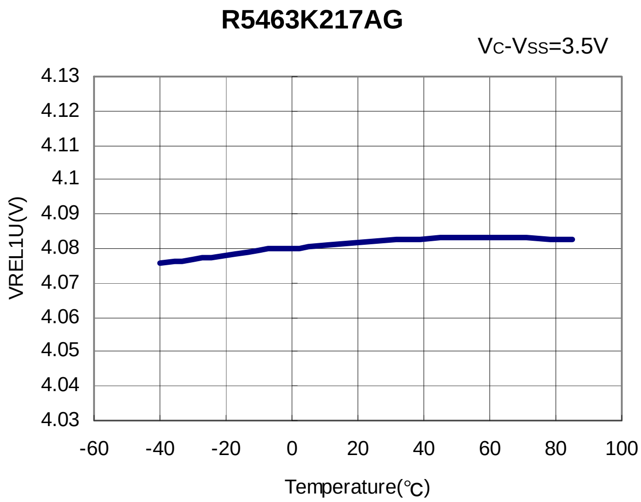
2) Over-charge Detector Threshold (Cell1) vs. Temperature



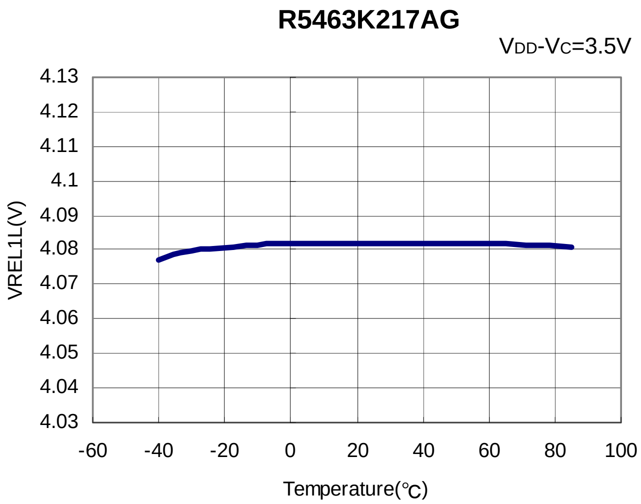
3) Over-charge Detector Threshold (Cell2) vs. Temperature



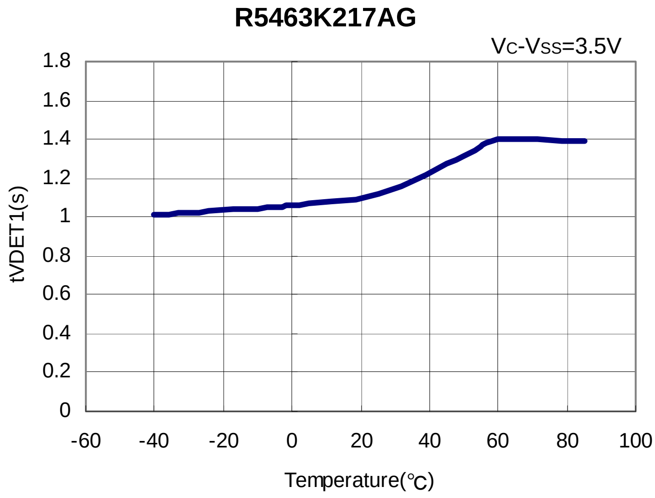
4) Over-charge Released Voltage (Cell1) vs. Temperature



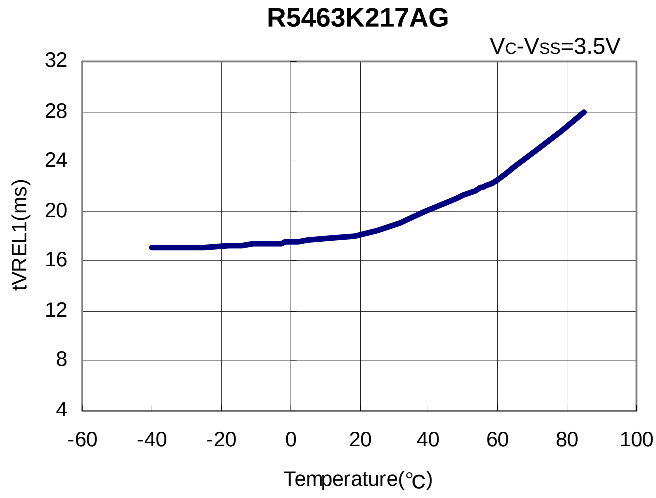
5) Over-charge Released Voltage (Cell2) vs. Temperature



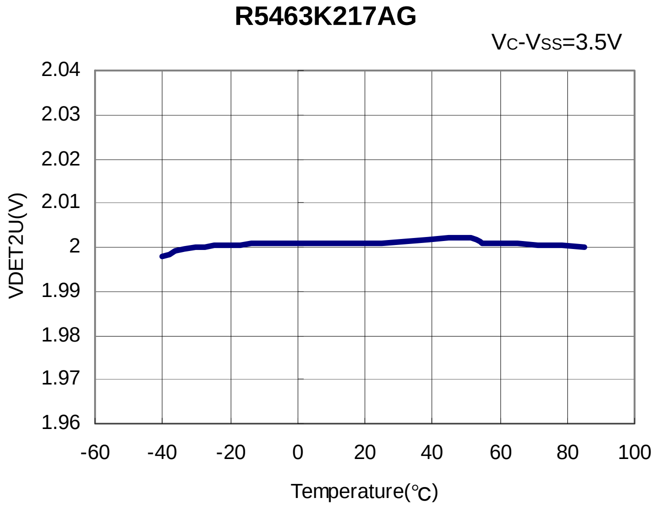
6) Output Delay of Over-charge vs. Temperature



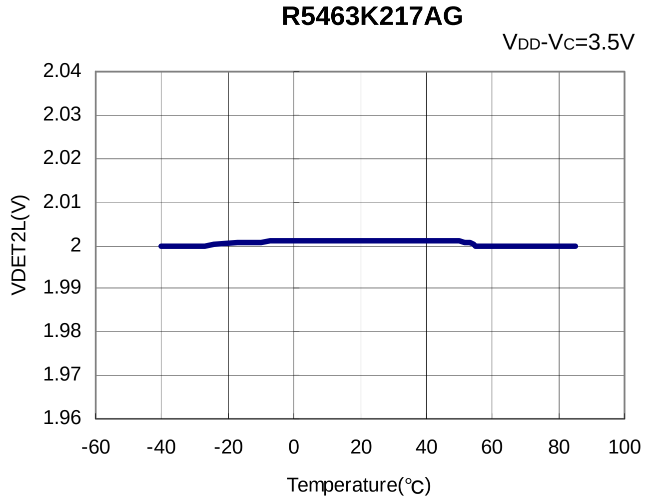
7) Output Delay of Release from Over-charge vs. Temperature



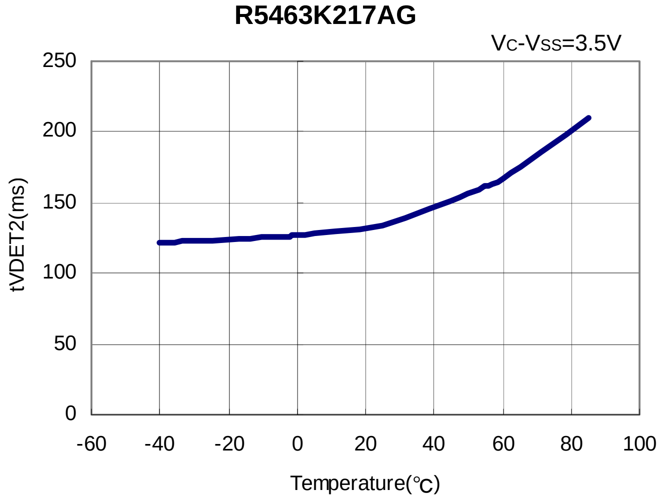
8) Over-discharge Detector Threshold (Cell1) vs. Temperature



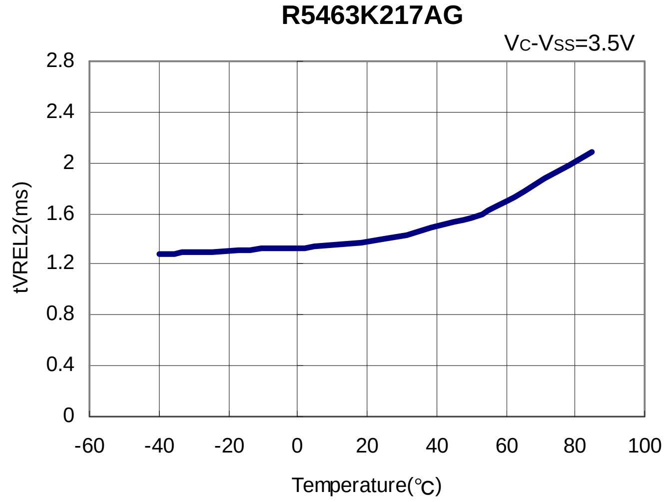
9) Over-discharge Detector Threshold (Cell2) vs. Temperature



10) Output Delay of Over-discharge vs. Temperature

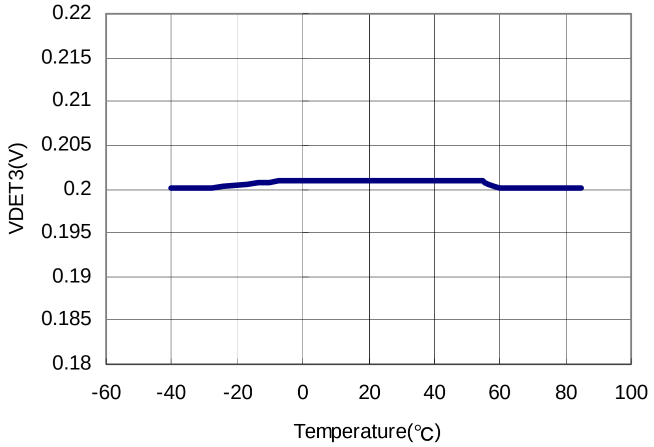


11) Output Delay of Release from Over-discharge vs. Temperature



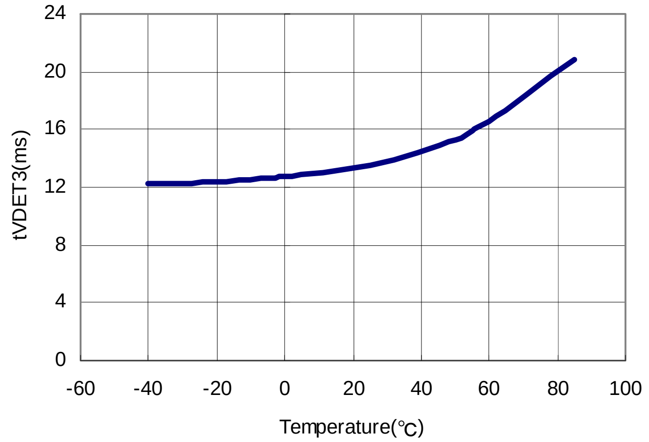
12) Excess Discharge-current Threshold vs. Temperature

R5463K217AG



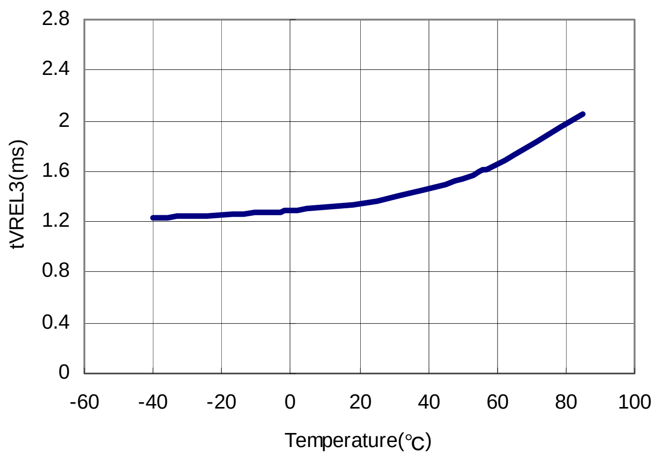
13) Output Delay of Excess Discharge-current vs. Temperature

R5463K217AG



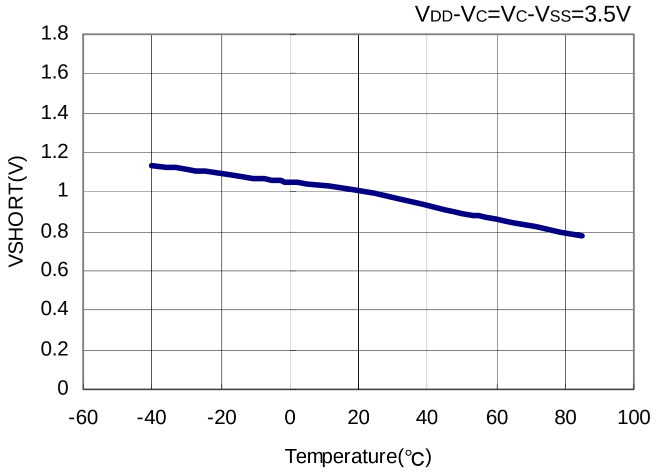
14) Output Delay of Release from Excess Discharge-current vs. Temperature

R5463K217AG



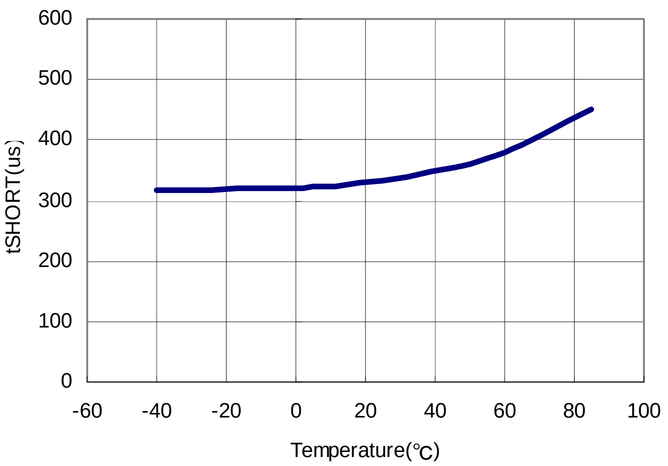
15) Short Protection Voltage vs. Temperature

R5463K217AG



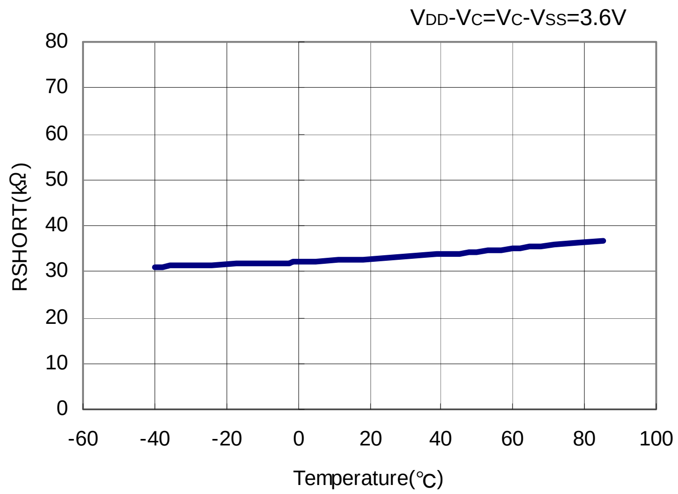
16) Delay Time for Short Protection vs. Temperature

R5463K217AG

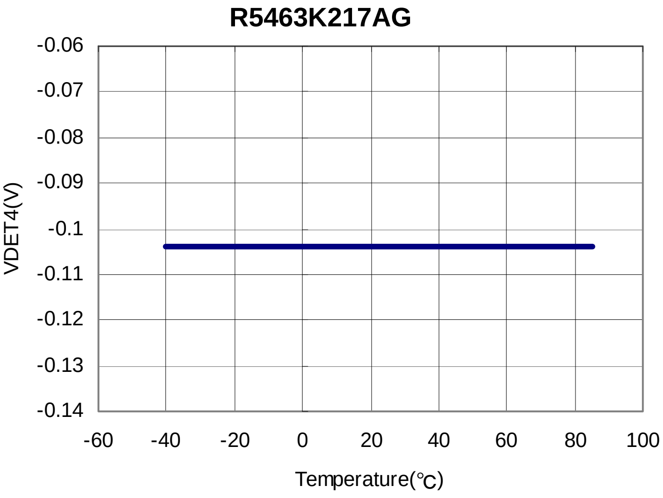


17) Reset Resistance for Excess Current Protection vs. Temperature

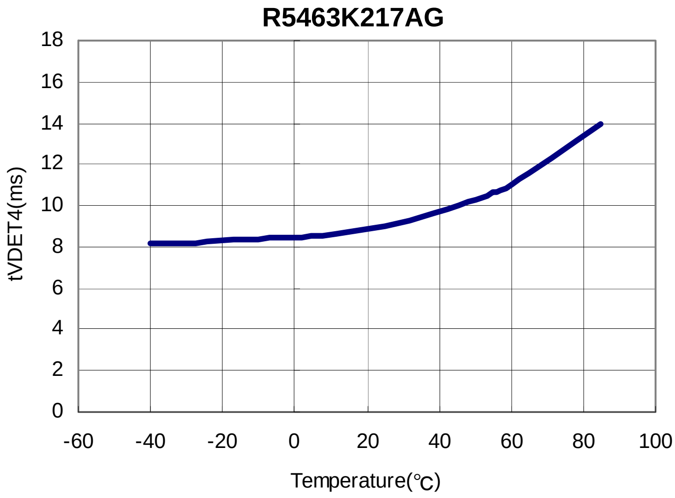
R5463K217AG



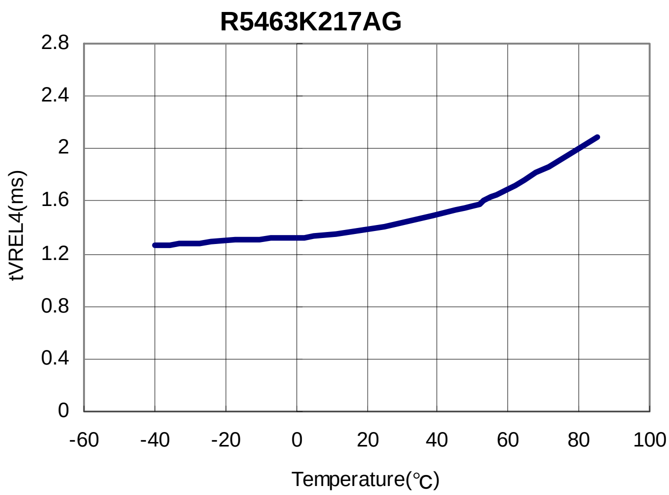
18) Excess Charge-current Threshold vs. Temperature



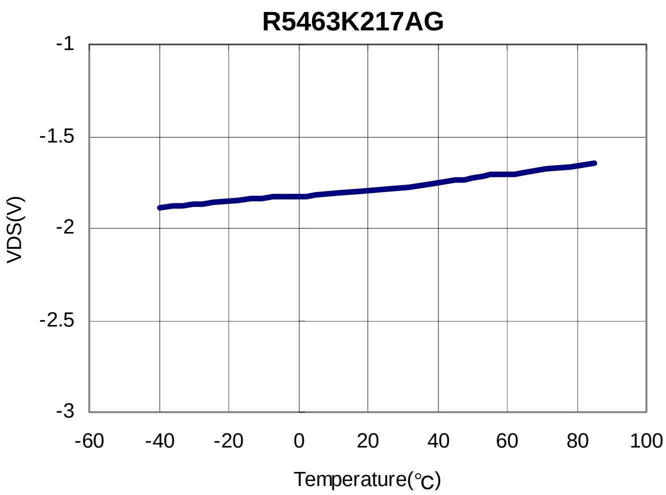
19) Output Delay of Excess Charge-current vs. Temperature



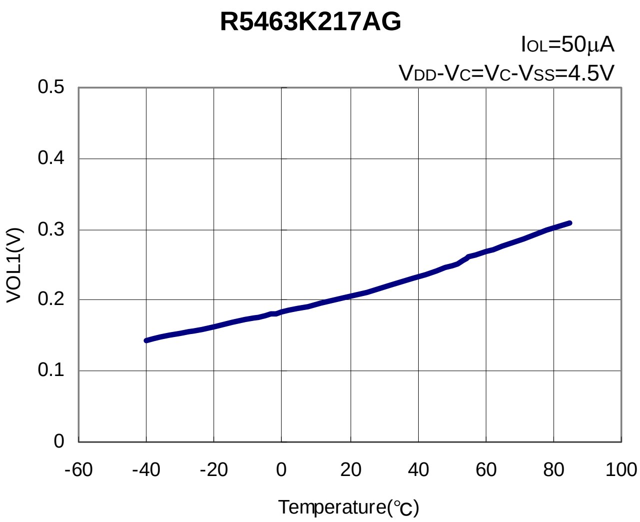
20) Output Delay of Release from Excess Charge-current vs. Temperature



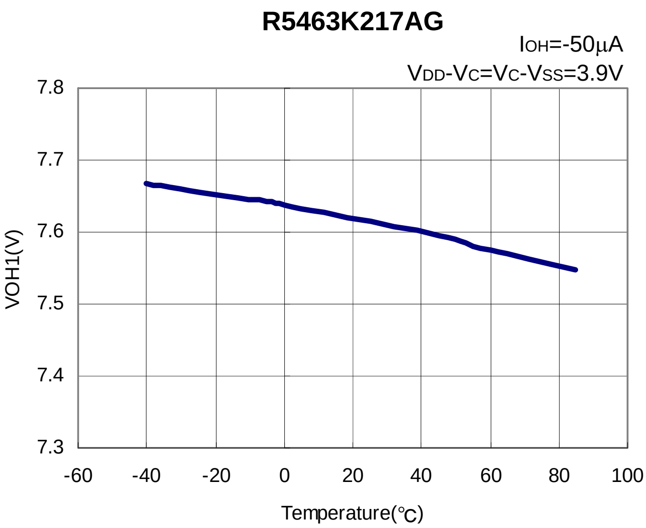
21) Delay Shortening Mode Voltage vs. Temperature



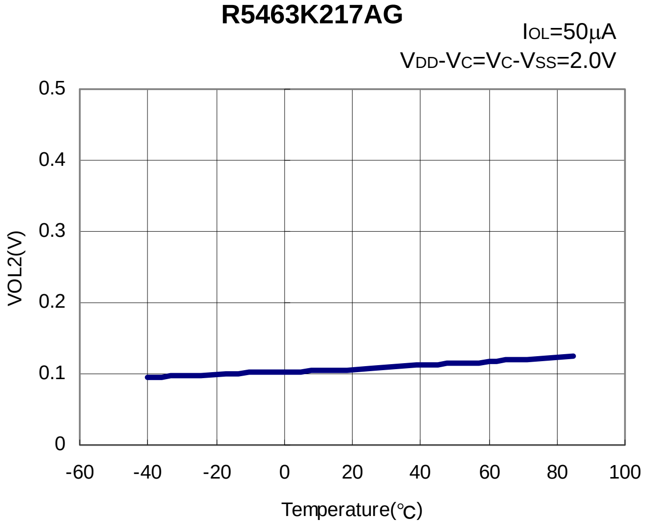
22) Nch ON-Voltage of C_{OUT} vs. Temperature



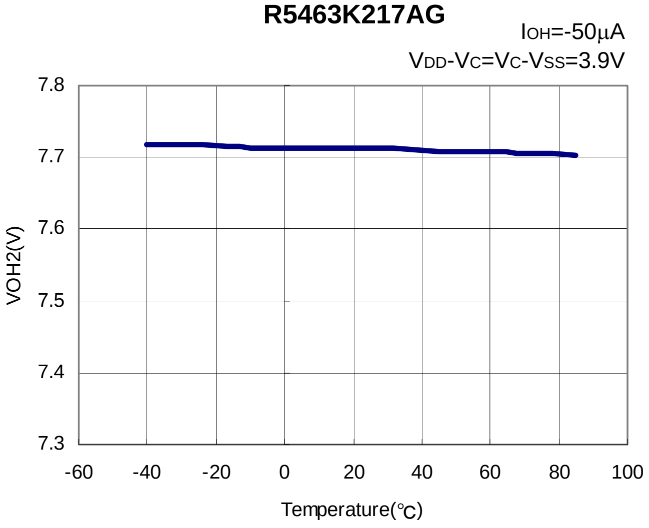
23) Pch ON-Voltage of C_{OUT} vs. Temperature



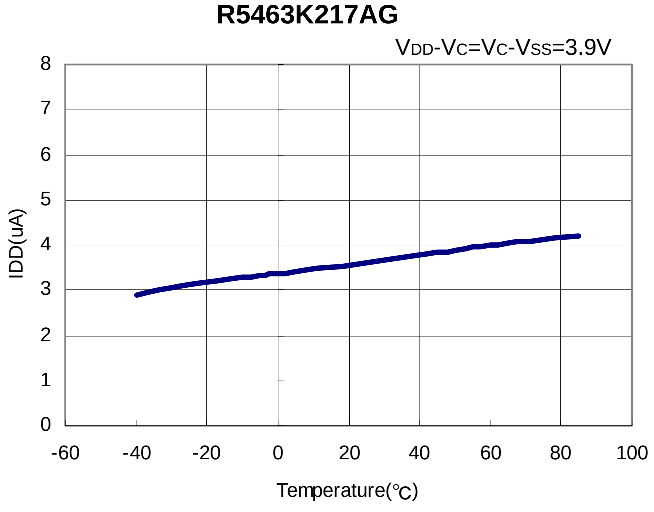
24) Nch ON-Voltage of D_{OUT} vs. Temperature



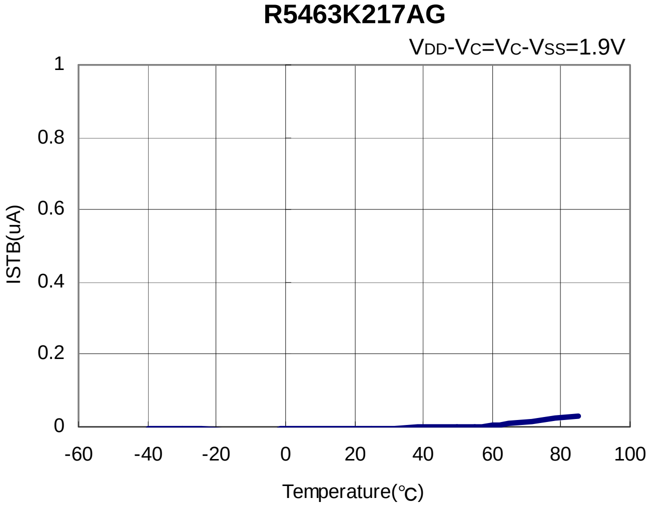
25) Pch ON-Voltage of D_{OUT} vs. Temperature



26) Supply Current vs. Temperature



27) Standby Current vs. Temperature



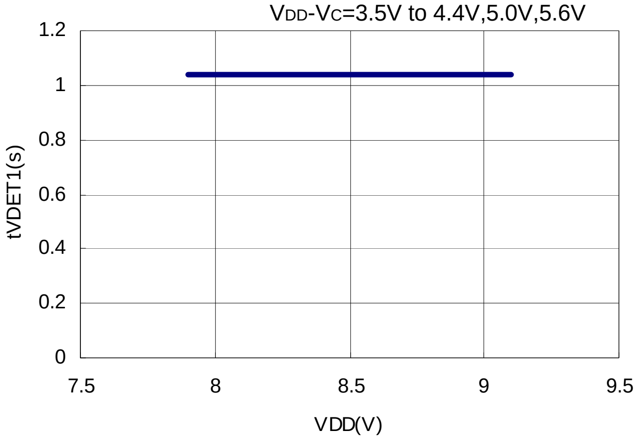
Part 2 Delay Time dependence on V_{DD}

1) Output Delay of Over-charge vs. V_{DD}

R5463K217AG

$V-$=0V, V_C-V_{SS}=3.5V

V_{DD}-V_C=3.5V to 4.4V,5.0V,5.6V

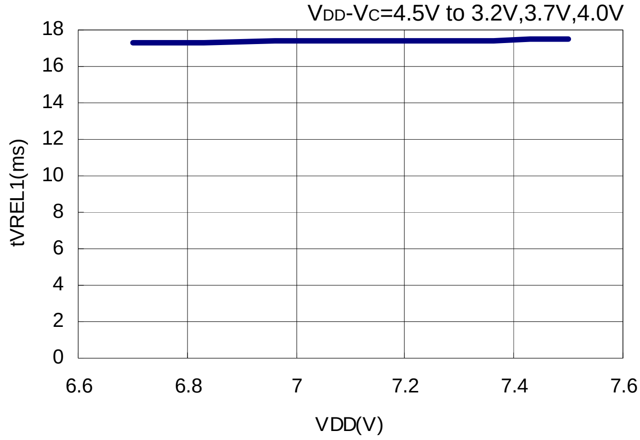


2) Output Delay of Release from Over-charge vs. V_{DD}

R5463K217AG

$V-$=0V, V_C-V_{SS}=3.5V

V_{DD}-V_C=4.5V to 3.2V,3.7V,4.0V

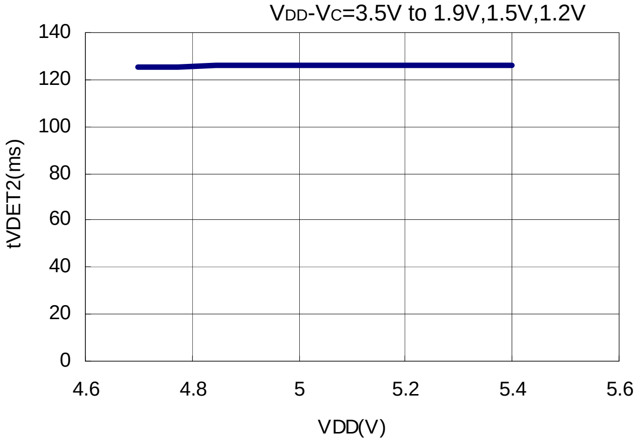


3) Output Delay of Over-discharge vs. V_{DD}

R5463K217AG

$V-$=0V, V_C-V_{SS}=3.5V

V_{DD}-V_C=3.5V to 1.9V,1.5V,1.2V

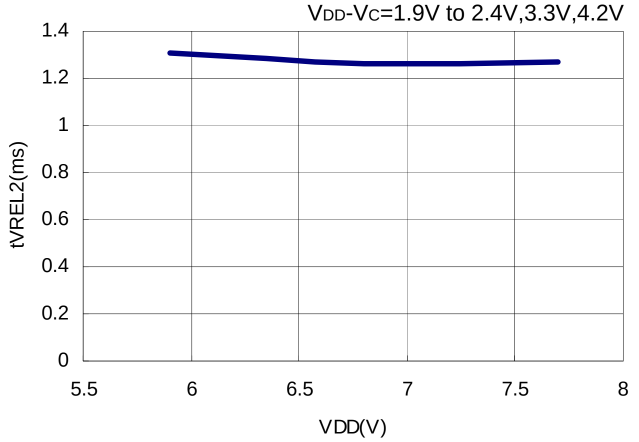


4) Output Delay of Release from Over-discharge vs. V_{DD}

R5463K217AG

$V-$=0V, V_C-V_{SS}=3.5V

V_{DD}-V_C=1.9V to 2.4V,3.3V,4.2V

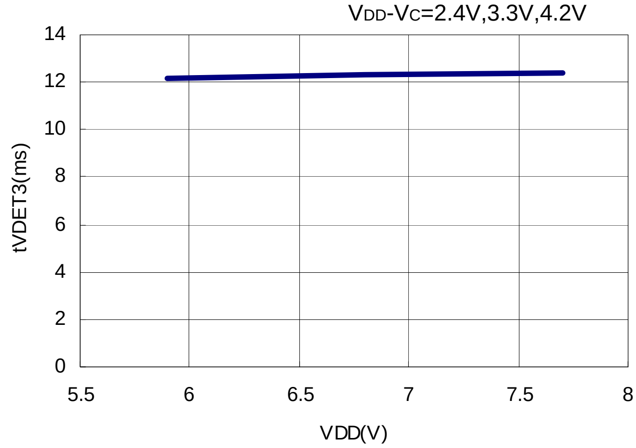


5) Output Delay of Excess Discharge-current vs. V_{DD}

R5463K217AG

$V-$=0V to 0.5V, V_C-V_{SS}=3.5V

V_{DD}-V_C=2.4V,3.3V,4.2V

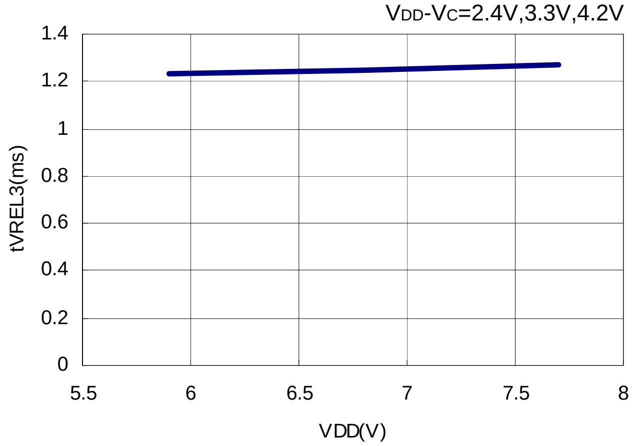


6) Output Delay of Release from Excess Discharge-current vs. V_{DD}

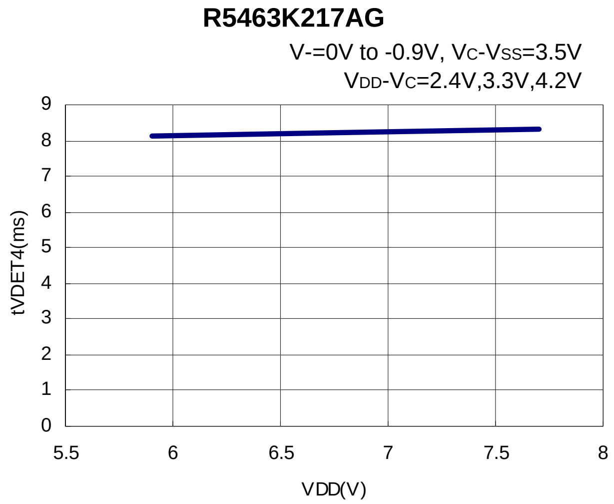
R5463K217AG

$V-$=3V to 0V, V_C-V_{SS}=3.5V

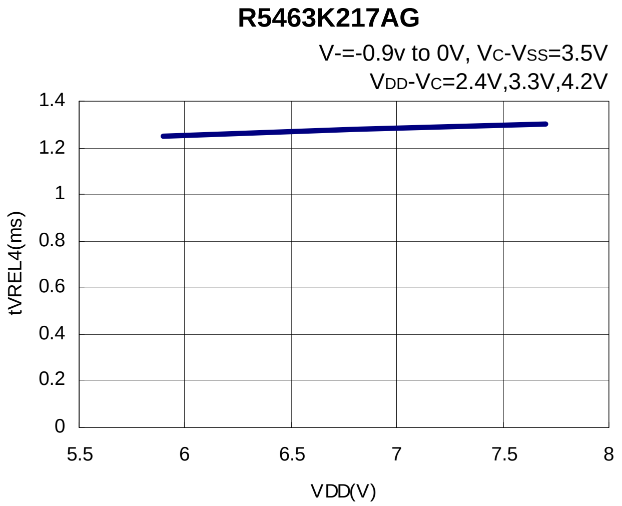
V_{DD}-V_C=2.4V,3.3V,4.2V



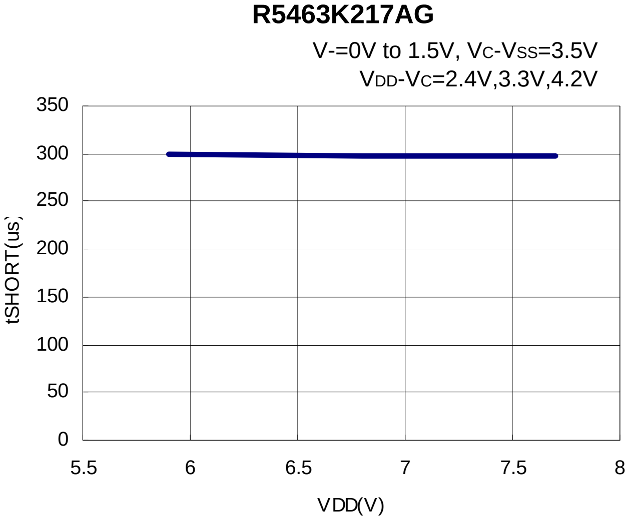
7) Output Delay of Excess Charge-current vs. V_{DD}



8) Output Delay of Release from Excess Charge-current vs. V_{DD}

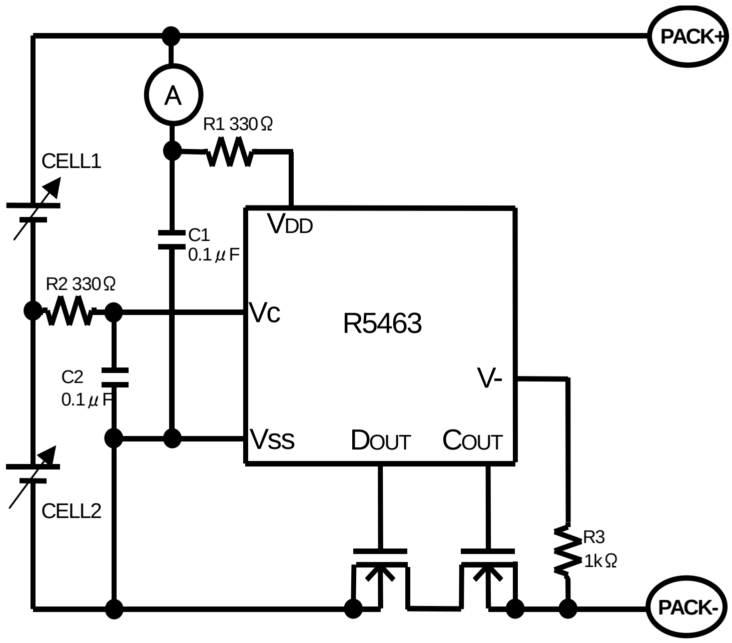


9) Delay Time for Short Protection vs. V_{DD}

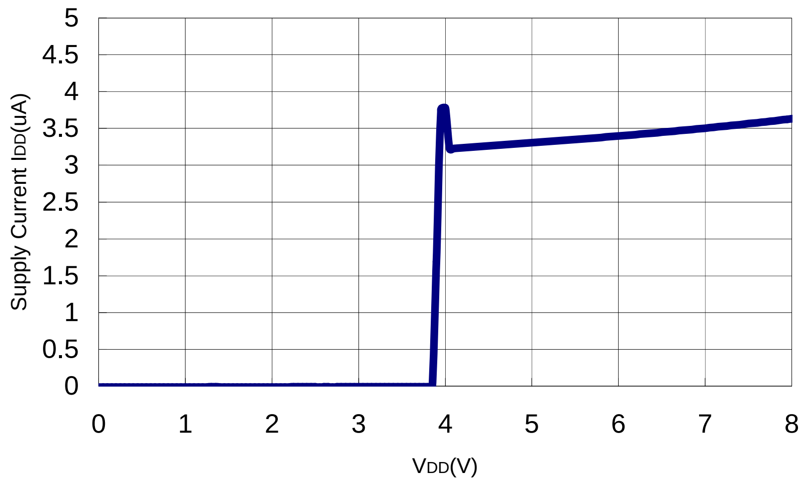


Part 3 Supply Current dependence on V_{DD}

Test Circuit

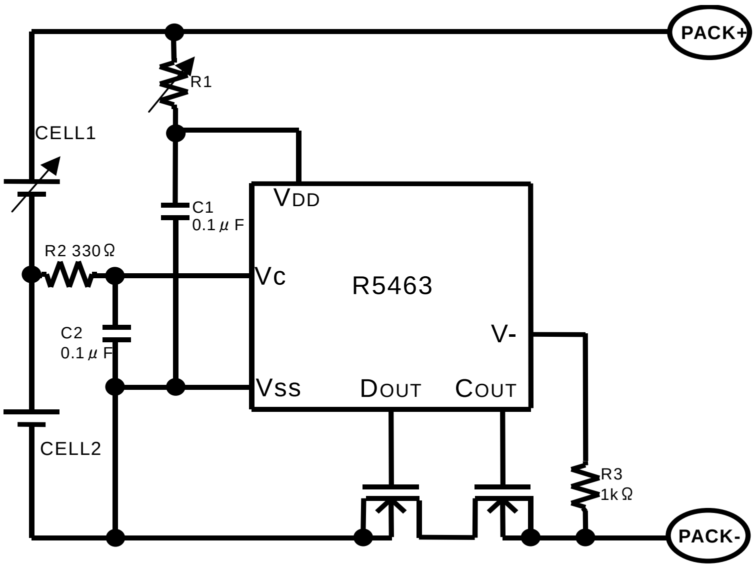


Supply Current vs. V_{DD}

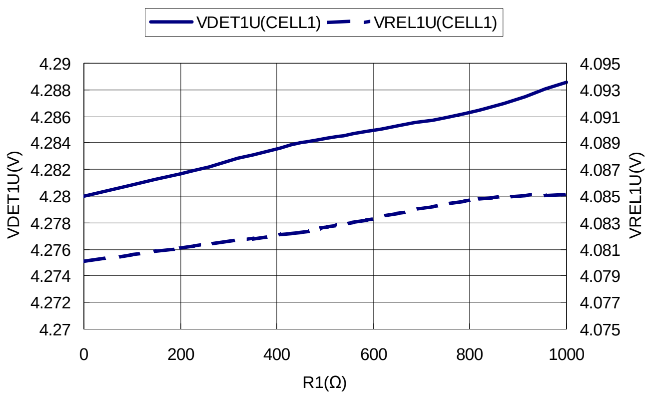


Part 4 Over-charge detector, Release voltage from Over-charge, Over-discharge detector, Release voltage from Over-discharge dependence on External Resistance value

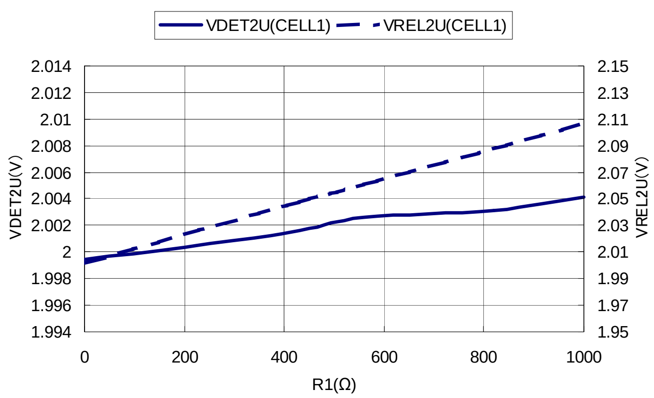
Test Circuit



Over-charge Detector Threshold / Released Voltage from Over-charge vs. R1
R5463K217AG

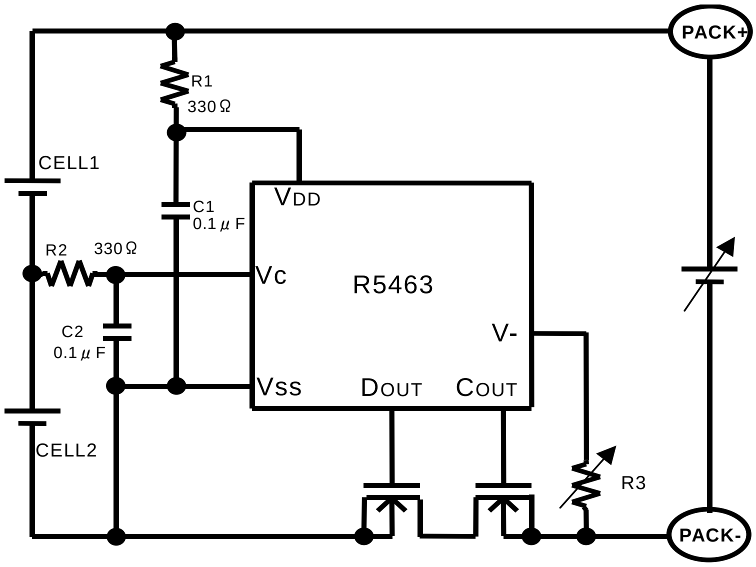


Over-discharge Detector Threshold / Released from Over-discharge Threshold vs. R1
R5463K217AG



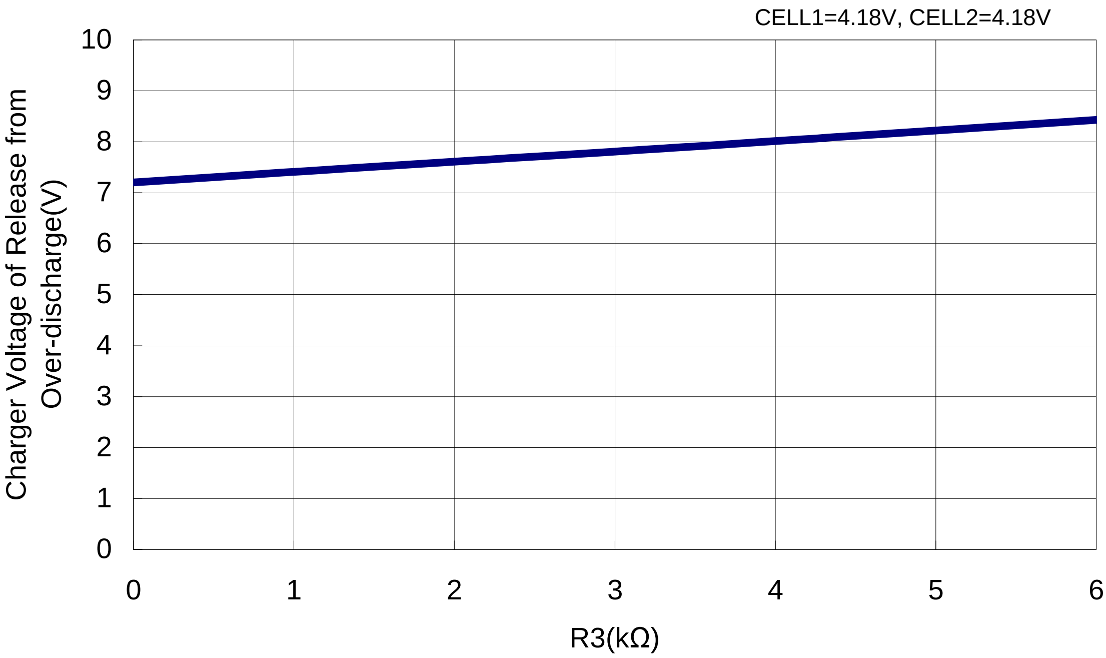
Part 5 Charger Voltage at Released from Over-discharge with a Charger dependence on R2

Test Circuit



Charger Voltage at Release from Over-discharge with a charger vs. R2

R5463K217AG



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