

PRODUCT SPECIFICATIONS

R5429D110DA-TR-FA

contents

- [1] Outline
- [2] Block Diagram
- [3] Pin Description
- [4] Absolute Maximum Ratings
- [5] Electrical Characteristics
- [6] Test Circuits
- [7] Operation
- [8] Technical Notes
- [9] Timing Diagrams
- [10] Package Dimensions
- [11] Pin Configuration
- [12] Mark Specification

[1] Outline

The R5429D110DA is high voltage tolerant CMOS-based protection IC for over-charge/discharge and over-current of rechargeable one-cell Lithium-ion (Li+)/Lithium polymer battery. The R5429D110DA can detect over-charge/discharge of Li+ one-cell, further include a short circuit protector for preventing large external short circuit current, and excess charge/discharge-current. The R5429D110DA consists of four voltage detectors, a reference unit, delay circuits, a short circuit protector, an oscillator, a counter, and a logic circuit.

When the R5429D110DA detects over-charge or excess 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 R5429D110DA detects over-discharge or excess discharge current, the output of DOUT pin switches to "L" level after the internal fixed delay time.

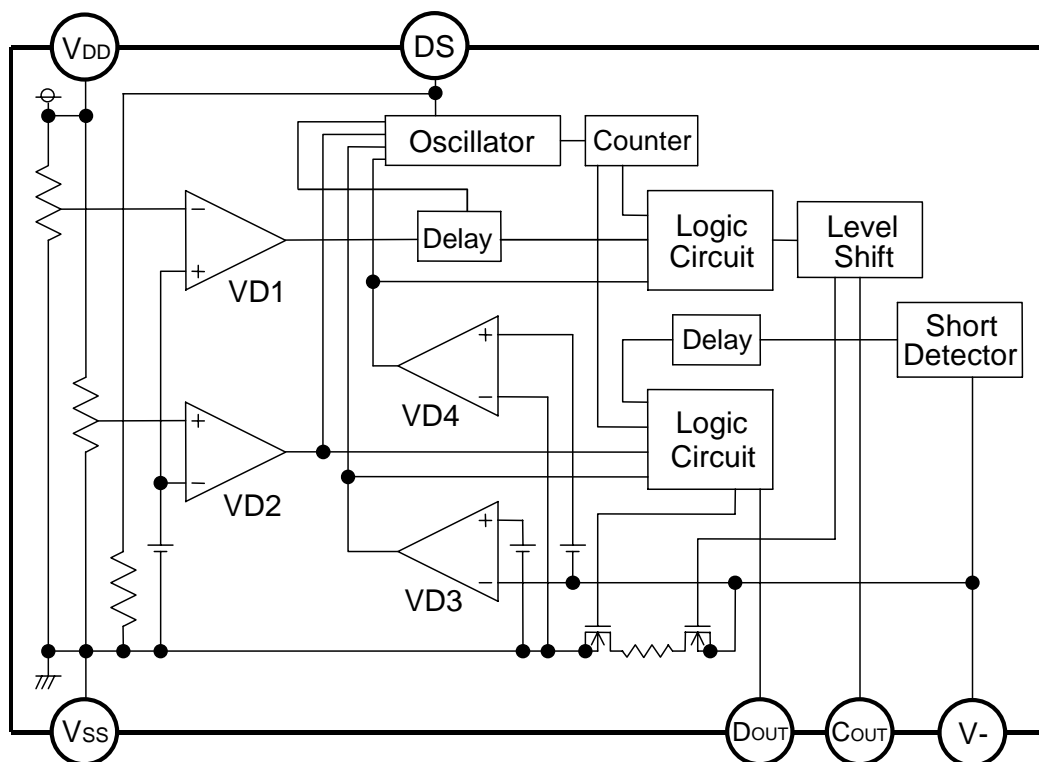
After detecting over-charge or excess charge current, the R5429D110DA can be reset and the output of COUT becomes "H" when a kind of loading is connected to VDD after a charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold. If a charger is continuously connected to the battery pack, even 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 R5429D110DA is released and the voltage of DOUT pin becomes "H". Even if the battery is discharged to 0V, recharge current is acceptable. Once after detecting excess discharge-current or short circuit, the R5429D110DA 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.

With setting the DS pin at VDD level, the output delay of all items except short circuit detector can be shortened. Especially, the delay time of over charge detector can be reduced into approximately 1/60. Thus, testing time of protector circuit board can be reduced.

Output type of COUT and DOUT is CMOS.

[2] Block Diagram



[3] Pin Description

Pad No.	Symbol	Pin description
1	DOUT	Output pin of over-discharge detection, CMOS output
2	VDD	Power Supply pin. Substrate level of the IC.
3	Vss	Ground pin. (of the IC)
4	DS	Pin for reduce pre-set output delay time
5	COUT	Output pin of Over-charge detection, CMOS output
6	V-	Charger negative Input pin

[4] Absolute Maximum Rating

Topt=25°C, Vss=0V

Item	Symbol	Ratings	Unit
Supply Voltage	VDD	-0.3 to 12	V
Input Voltage			
V- pin Voltage	V-	VDD-28 to VDD+0.3	V
DS pin Voltage	VDS	Vss-0.3 to VDD+0.3	V
Output Voltage			
COUT pin Voltage	VCOUT	VDD-28 to VDD+0.3	V
DOUT pin Voltage	VDOUT	Vss-0.3 to VDD+0.3	V
Power Dissipation (*)	PD	150	mW
Operating Temperature	Topt	-40 to 85	°C
Storage Temperature	Tstg	-55 to 125	°C

(*) Reference value of SON-6 package

[5] Electrical Characteristics

● R5429D110DA

T_{opt}=25°C

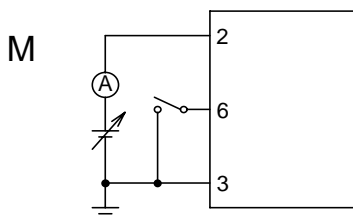
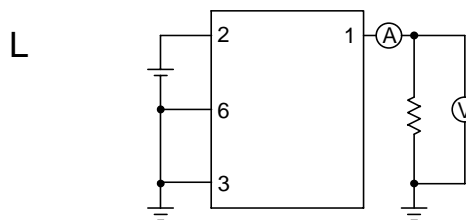
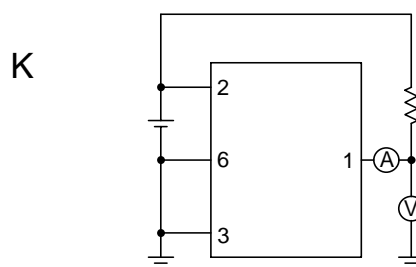
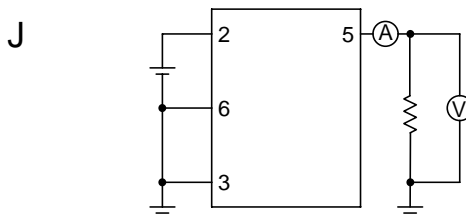
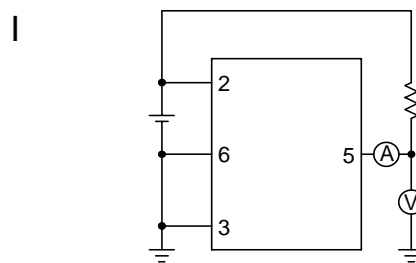
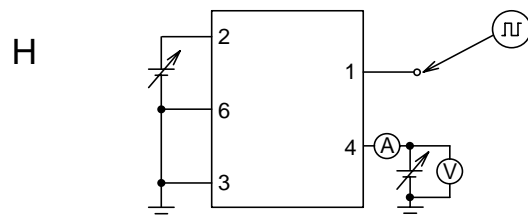
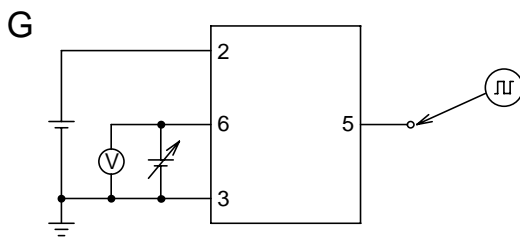
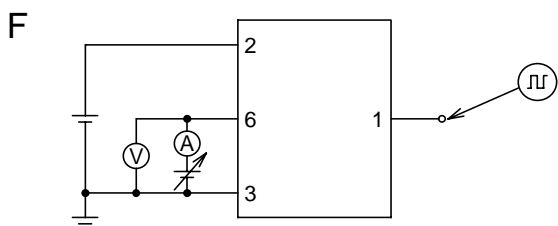
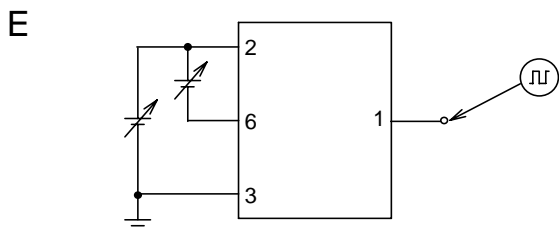
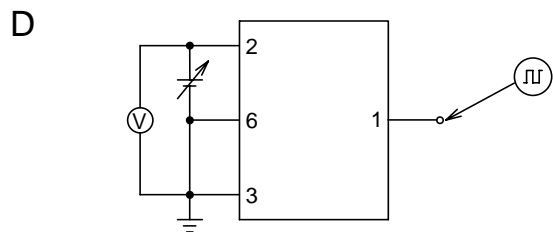
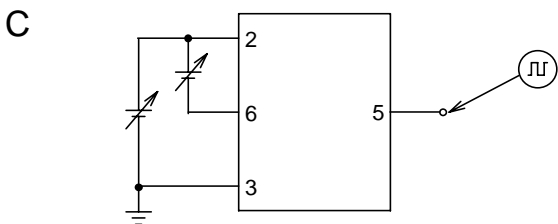
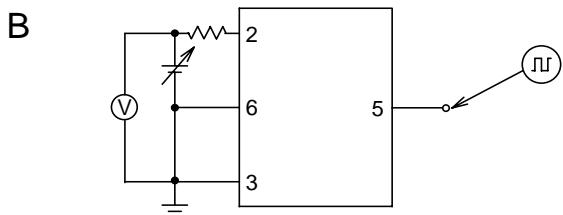
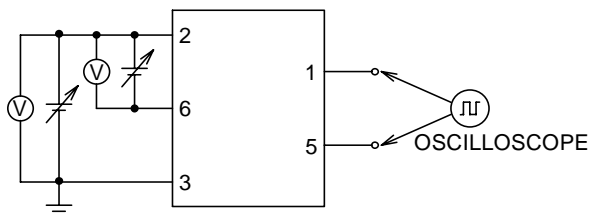
Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note1
Operating Input Voltage	V _{DD1}	V _{DD} - V _{SS}	1.5		5.0	V	A
Minimum Operating Voltage for 0V Charge	V _{st}	Voltage Defined as V _{DD} -V _{SS} , V _{DD} -V=0V			1.5	V	A
Over-charge Threshold Voltage	V _{DET1}	R1=330Ω R1=330Ω, T _{opt} =-5°C to 55°C *Note2	4.255 4.250	4.280 4.280	4.305 4.310	V V	B B
Output Delay of Over-charge	t _{VDET1}	V _{DD} =3.6V→4.4V	3.5	5.0	6.5	s	B
Timer Reset Delay for Over-charge	t _{VDTR1}	V _{DD} =3.6V→4.4V→3.6V→4.4V	8	16	24	ms	B
Release Delay for VD1	t _{VREL1}	V _{DD} =4V, V ₋ =0V→1V	11	16	21	ms	C
Over-discharge Threshold	V _{DET2}	Detect falling edge of supply voltage	2.242	2.300	2.358	V	D
Output Delay of Over-discharge	t _{VDET2}	V _{DD} =3.6V→2.2V	16	22	28	ms	D
Release Delay for VD2	t _{VREL2}	V _{DD} =3V, V ₋ =3V→0V	0.7	1.2	1.7	ms	E
Excess discharge-current threshold	V _{DET3}	Detect rising edge of 'V-' pin voltage	0.105	0.125	0.145	V	F
Output delay of excess discharge-current	t _{VDET3}	V _{DD} =3V, V ₋ =0V to 1V	8	12	16	ms	F
Output delay of release from excess discharge-current	t _{VREL3}	V _{DD} =3V, V ₋ =3V to 0V	0.7	1.2	1.7	ms	F
Short Protection Voltage	V _{short}	V _{DD} =3V	V _{DD} -1.4	V _{DD} -1.1	V _{DD} -0.8	V	F
Delay Time for Short Protection	t _{short}	V _{DD} =3V, V ₋ =0V to 3V	250	400	600	μs	F
Reset Resistance for Excess Current Protection	R _{short}	V _{DD} =3.6V, V ₋ =1.0V	15	30	45	kΩ	F
Excess charge-current threshold	V _{DET4}	Detect falling edge of 'V-' pin voltage	-0.130	-0.100	-0.070	V	G
Output delay of excess charge-current	t _{VDET4}	V _{DD} =3V, V ₋ =0V to -1V	11	16	21	ms	G
Output delay of release from excess charge-current	t _{VREL4}	V _{DD} =3V, V ₋ =-1V to 0V	0.7	1.2	1.7	ms	G
DS pin "H" input voltage	V _{IH}		V _{DD} -0.5		V _{DD} +0.3	V	H
DS pin pull-down resistance	R _{DS}	V _{DD} =3.6V	0.5	1.3	2.5	MΩ	H
Nch ON-Voltage of COUT	V _{OL1}	I _{ol} =50μA, V _{DD} =4.5V		0.4	0.5	V	I
Pch ON-Voltage of COUT	V _{OH1}	I _{oh} =-50μA, V _{DD} =3.9V	3.4	3.7		V	J
Nch ON-Voltage of DOUT	V _{OL2}	I _{ol} =50μA, V _{DD} =2.0V		0.2	0.5	V	K
Pch ON-Voltage of DOUT	V _{OH2}	I _{oh} =-50μA, V _{DD} =3.9V	3.4	3.7		V	L
Supply Current	I _{DD}	V _{DD} =3.9V, V ₋ =0V		3.0	6.0	μA	M
Standby CUREnt	I _{standby}	V _{DD} =2V			0.1	μA	M

● 'Note1' indicates test circuits shown in next page.

● Note2: 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.

[6] Test Circuits

A ← Describes as in Note in Electrical Characteristics



[7] Operation

● VD1 / Over-charge Detector

The VD1 monitors VDD pin voltage during charge. When the VDD voltage crosses over-charge detector threshold VDET1 (Typ. 4.280V), the VD1 can sense over-charge and the output of COUT pin becomes “L” and stop charging with turning off the external Nch-MOSFET.

After detecting over-charge, when the voltage of VDD pin is less than over-charge detector threshold, and after disconnecting a charger, VD1 is released with connecting a load system. The output level of COUT becomes “H” and with turning on the external Nch-MOSFET, the battery charger is ready to work again. In other words, once detecting over-charge, even if the cell voltage would become lower than VDET1, if a charger is kept on set, recharge is impossible. Therefore, there is no hysteresis for VD1. To judge whether or not load is connected, the excess-discharge current detector is used. In other words, with connecting some load, V- pin voltage becomes equal or more than Excess-discharge current detector threshold, and the pack is released from over-charge detecting state.

When the input level of VDD pin is equal or more than over-charge detector threshold, and while a charger is disconnected from the battery pack, if a load system is connected to the battery pack, the output level of COUT pin is “L”. However, load current can be flown through a parasitic diode of an external Nch-MOSFET. Then, when the voltage level of VDD pin becomes lower than over-charge detector threshold, the output level of COUT pin becomes “H”.

Output delay time for over-charge detection, timer reset, and released from over-charge is internally fixed respectively. The VDD voltage goes up to a higher level than over-charge detector threshold, then after the output delay time (Typ. 5.0s) would pass, VD1 would detect over-charge. Even if VDD would become lower than detector threshold within output delay time with some noise or something, if the time is shorter than timer reset delay time (Typ. 16ms), counter timer is accumulated, and when the total time becomes output delay time, VD1 detects over-charge. However, even if VDD pin voltage would become equal or more than detector threshold voltage, if the time interval for VDD pin being lower than over-charge detector threshold is equal or more than timer reset delay time, the accumulated time is cleared. After detecting over-charge, while the VDD pin voltage is lower than over-charge detector threshold, and the charger is removed and load is connected, if over-charge is realized within the output delay time of release from over-charge (Typ. 16ms) again, VD1 is not released.

A level shifter is built in a buffer driver for the COUT pin, because of this, 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 VDD and V-.)

● VD2/Over-discharge Detector

The VD2 monitors a VDD pin voltage during discharge. When the VDD voltage crosses the over-discharge detector threshold VDET2 (Typ. 2.30V) from a high level to a lower level than VDET2, the VD2 senses over-discharge 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, connecting a charger to the battery pack is the only method. When a charger is connected to the battery pack, and VDD level is equal or less than over-discharge detector threshold, charge current flows through a parasitic diode of an external Nch MOSFET. When the voltage of VDD becomes higher than the over-discharge detector threshold level, the output level of DOUT becomes “H” and with turning on an external Nch MOSFET, the battery pack can be discharged. When a charger is connected to the battery pack, if VDD level is higher than over-discharge voltage threshold, the output level of DOUT becomes “H” immediately.

Even if the battery voltage would be 0V, when the charger voltage is higher than maximum voltage of minimum operating voltage (Vst) for 0V charge, COUT becomes “H” and charge current can be flown.

An output delay for over-discharge detection is fixed internally. (Typ. 22ms) Although the voltage of VDD becomes equal or less than over-discharge detector threshold and if it becomes higher than over-discharge detector threshold within output delay time, over-discharge detector does not work. Output delay time for release from over-discharge is also set internally. (Typ. 1.2ms)

After detecting over-discharge by VD2, supply current would decrease, (VDD=2.0V, 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 VDD and VSS.

● VD3/ Excess Discharge Current Detector, Short Circuit Protector

While charge and discharge are acceptable with the battery pack, VD3 monitors the voltage level of V- pin. In the cause of such as the external short-circuit, if the voltage level of V- pin may become equal or more than the excess discharge current threshold voltage (Typ. 0.125V) and less than the short detector threshold (Typ. $V_{DD} - 1.1V$), the excess discharge current detector works. When the voltage level of V- pin becomes equal or more than short detector threshold voltage, the short circuit protector works and the output level of DOUT becomes “L”, and with turning off an external Nch MOSFET, VD3 protects against flowing extremely large current into the circuit.

An output delay time for the excess discharge current detector is internally fixed at 12ms typical. Although the voltage of V- pin becomes equal or more than the excess discharge current threshold voltage and less than short detector threshold, if it becomes less than the excess current detector threshold voltage within the output delay time, the excess current detector does not work. Output delay time for release from excess discharge current is also set internally (Typ. 1.2ms).

In terms of short circuit protector, output delay time is typically 400 μ s.

The V- pin has a built-in pull down resistor, Typ. 30k Ω connected to the Vss pin.

After an excess discharge current or short circuit protection is detected, by removing a cause of excess current or external short circuit, the voltage level of V- is pulled down through the resistor for release from excess current to the Vss level. Then, when the voltage level of V- pin becomes equal or less than the excess current threshold voltage, both protection circuits are released automatically. Resistor for release from excess discharge current is active when excess discharge current or short circuit is detected. While charge and discharge are acceptable for the battery pack, or normal mode, the resistor is inactive.

Output delay time for excess discharge current is necessarily set shorter than output delay time for over-discharge. Therefore, if excess discharge current is detected, and at the same time, VDD pin voltage becomes lower than over-discharge detector threshold level, excess discharge current detector is predominant. By disconnecting load from the battery pack, the battery pack is automatically released from excess current state.

● VD4/ Excess charge-current detector

While charge and discharge are acceptable with the battery pack, VD4 senses V- pin voltage. For example, if the battery pack is charged by an inappropriate charger, excess current flows, then the voltage of V- pin becomes equal or less than excess charge-current detector threshold (Typ. $-0.10V$). Then, the output of COUT becomes “L”, and protects against flowing excess current in the circuit by turning off the external Nch MOSFET.

Output delay of excess charge current is internally fixed. (Typ. 16ms) Even the voltage level of V- pin becomes equal or lower than excess charge-current detector threshold, if the voltage is higher than the VD4 threshold within the delay time, excess charge-current state is not detected. Output delay time for release from excess charge current is also set internally. (Typ. 1.2ms)

VD4 can be released by disconnecting a charger and setting a load.

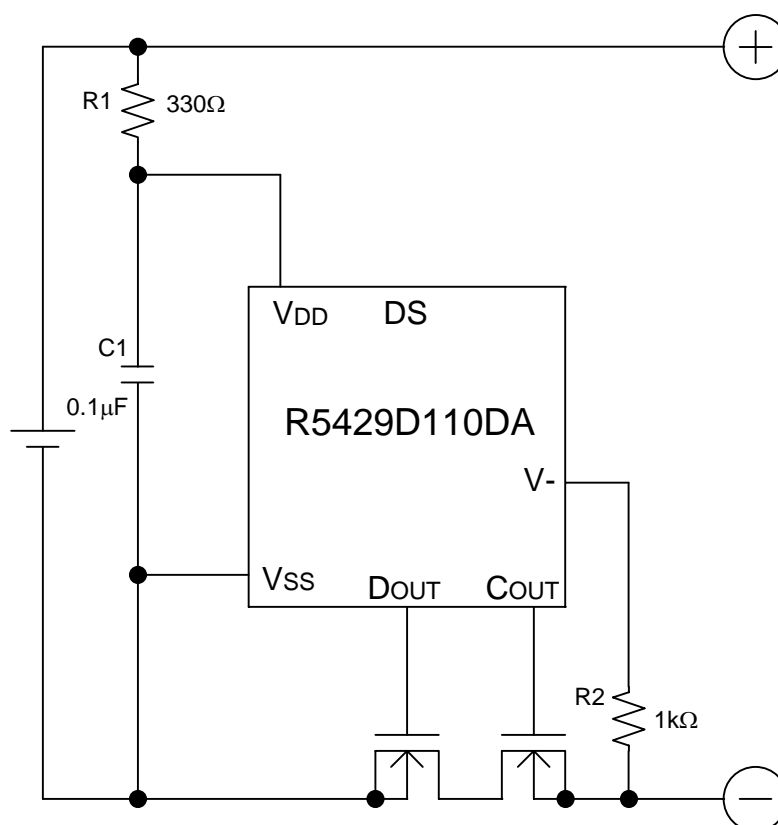
● DS(Delay Shorter) function

Output delay time of over-charge, over-discharge, excess discharge-current, excess charge-current, and release from those detecting modes can be shorter than those setting value by forcing VDD voltage to DS pin.

1.3M Ω pull-down resistor is connected between DS pin and Vss internally.

At the normal operation, DS pin should be at no connection state.

[8] Technical Notes

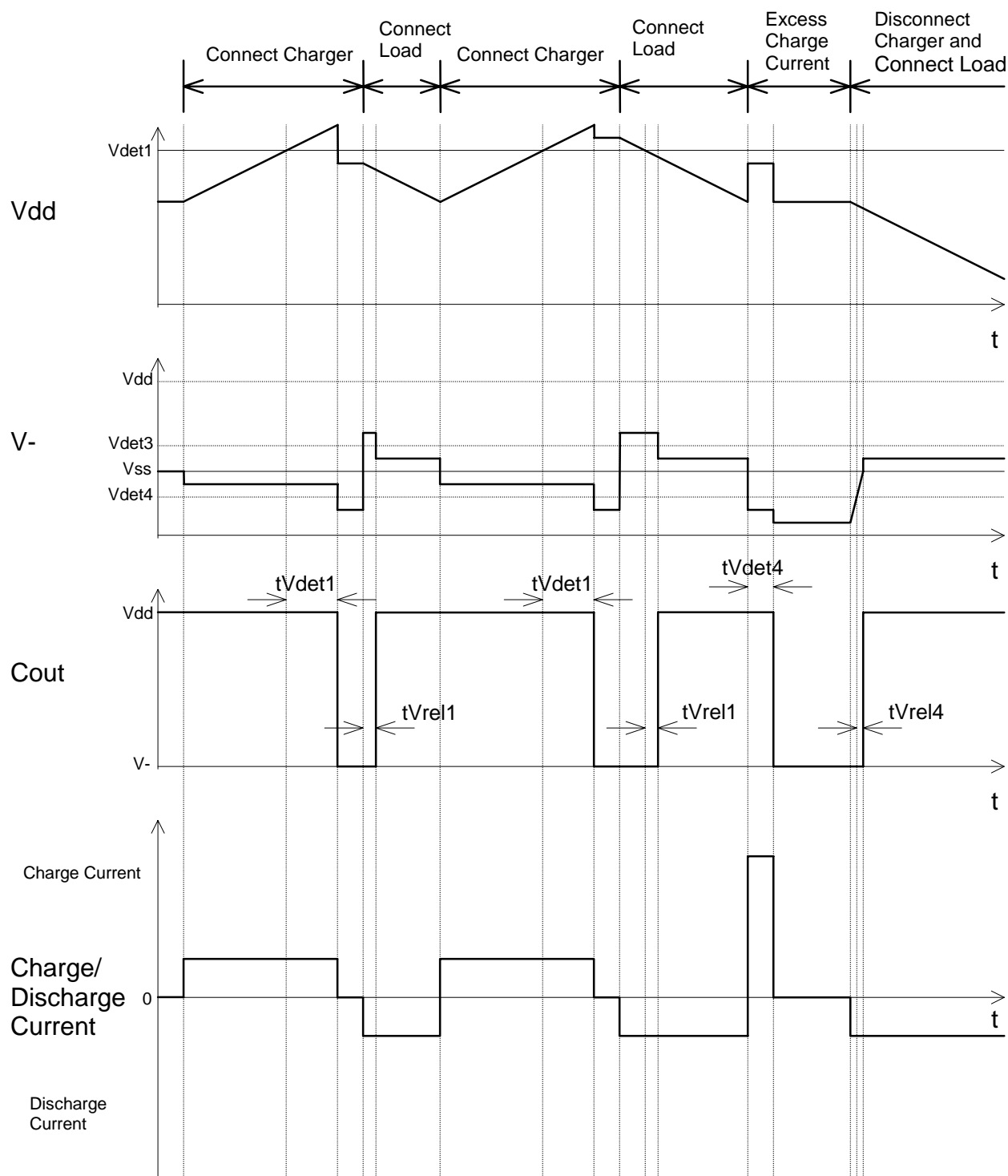


*R1 and C1 stabilize a supply voltage to the R5429D110DA. A recommended R1 value is less than $1\text{k}\Omega$. A large value of R1 makes detection voltage shift higher because of conduction current flow in the R5429D110DA. Further, to stabilize the operation of R5429D110DA, use the C1 with the value of $0.01\mu\text{F}$ or more.

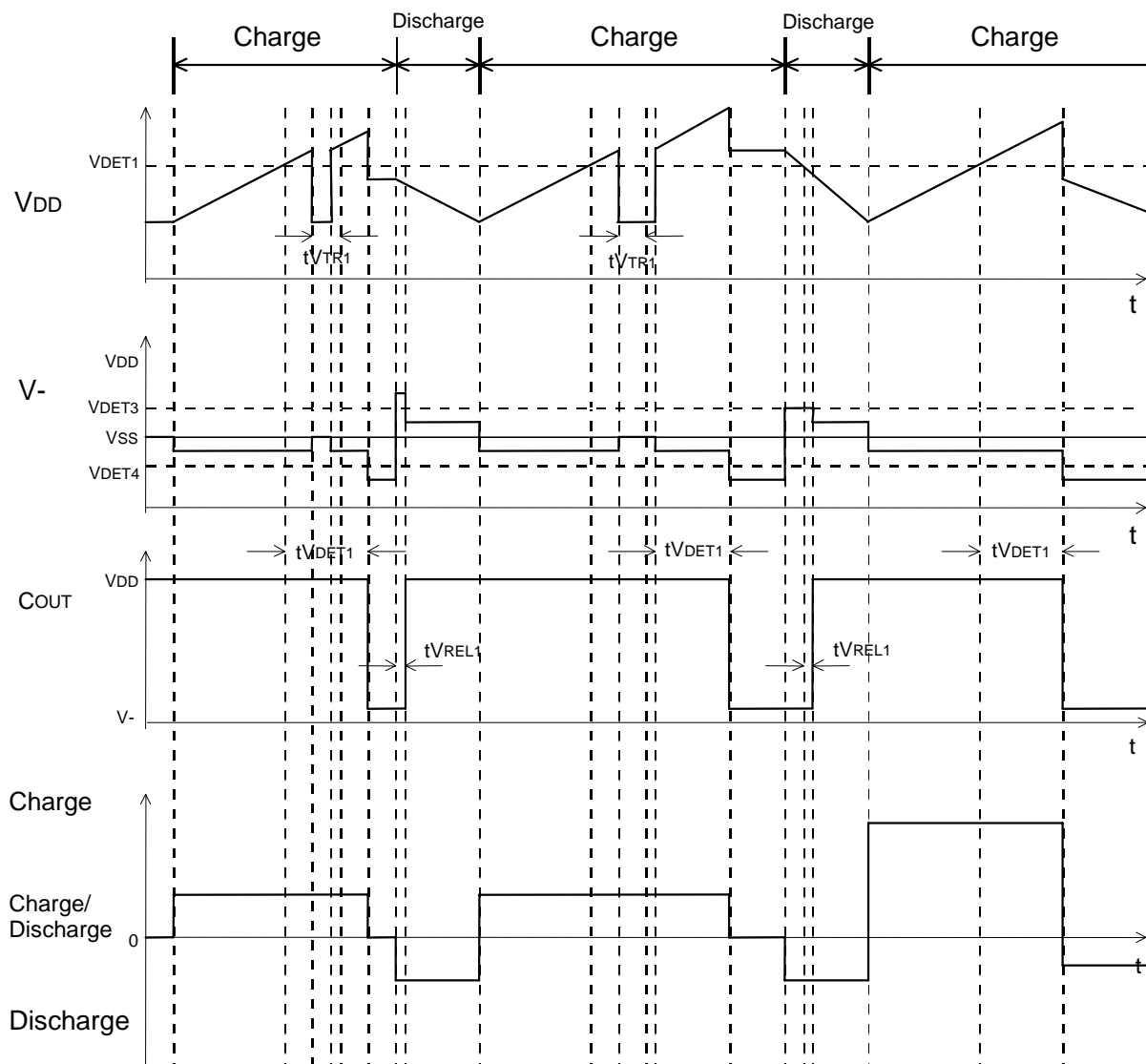
*R1 and R2 can operate as a current limit resistors against setting cell reverse direction or applying excess charge voltage to the R5429D110DA. While small value of R1 and R2 may cause over power dissipation rating of the R5429D110DA, therefore a total of "R1+R2" should be $1\text{k}\Omega$ or more. 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 $30\text{k}\Omega$.

[9] Timing Diagram

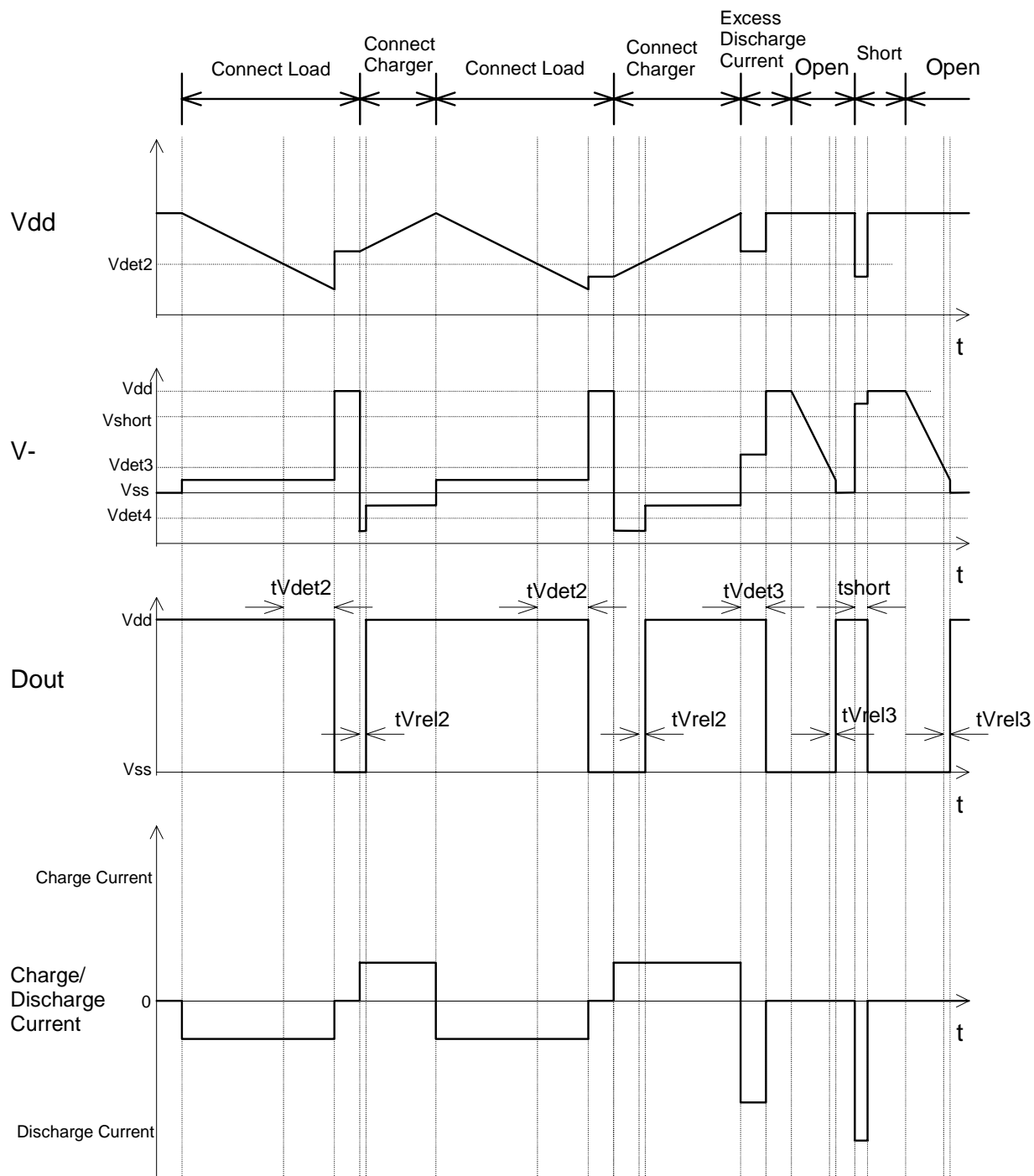
(1) Timing diagram of Over-charge, Excess charge current



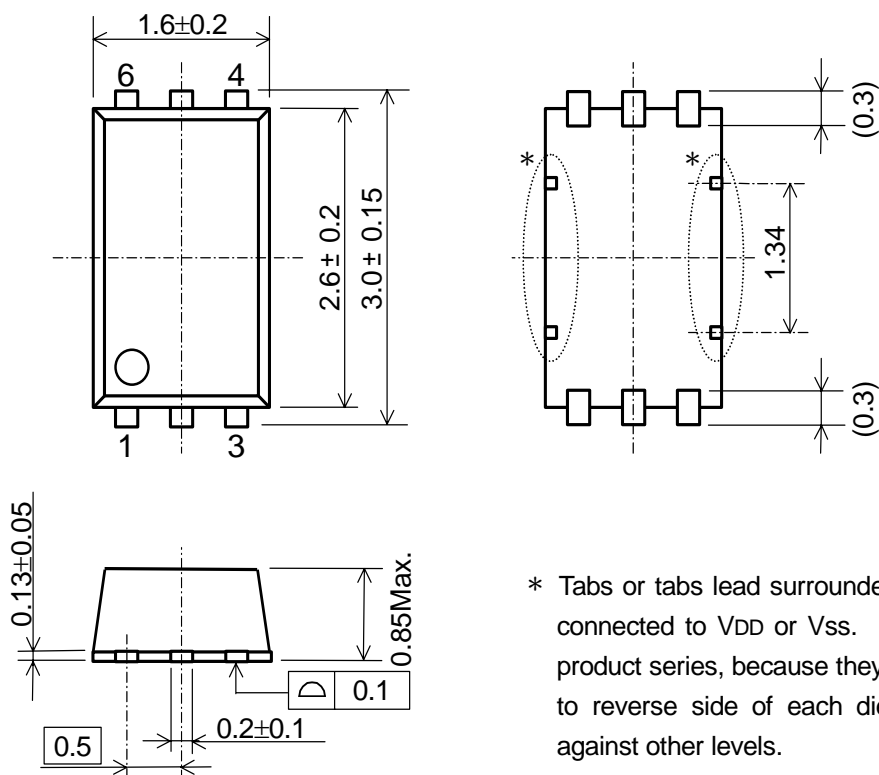
(2) Over-charge, Timer Reset for Over-charge



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



[10] Package Dimensions (SON-6pin)



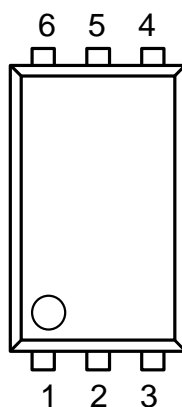
Unit: mm

[11] Pin Configuration

- | | |
|---------------------|----------|
| 1 : DOUT | 4 : DS |
| 2 : V _{DD} | 5 : COUT |
| 3 : V _{SS} | 6 : V- |

[12] Mark Specification

- ①② : Series Code Name ... **M2**
- ③④ : Lot Number



(R5429D110DA)