1 to 3 Cells Li-Ion Battery Protection IC for Secondary Protection

No.EA-613-211206

OVERVIEW

The R5642L is an overcharge protection IC for 1 to 3 serial cells Li-ion / Li-polymer rechargeable battery. This IC provides the high-accuracy voltage detection function and the shutdown function can reduce the supply current to the minimum when all cell's voltage becomes less than the shutdown detection voltage.

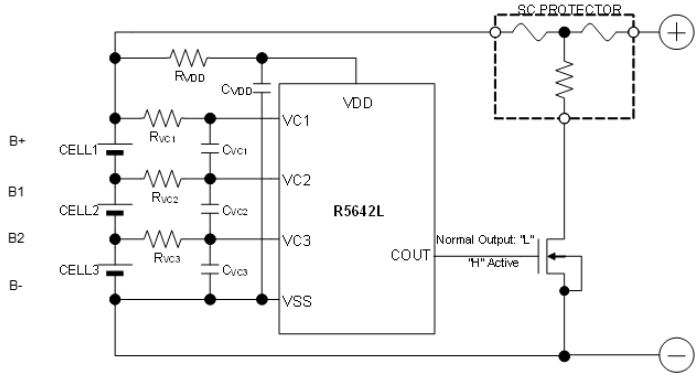
KEY BENEFITS

- Low consumption current and low shutdown current: achieving longer driving time with a battery of small capacity

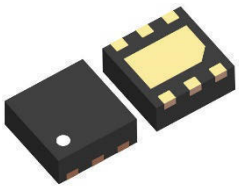
KEY SPECIFICATIONS

- High Voltage Tolerant Process
  Absolute maximum rating: 26 V
- Low Supply Current
  Normal mode: Typ. 0.85 µA (V_{CELLn} (1): 3.9 V, for 3-cell)
- Overcharge Voltage Detector with High Accuracy
  Detection voltage (V_{DET1n}) and accuracy: 4.10 V to 4.65 V, ± 0.015 V (Ta = 25°C)
  Release voltage (V_{REL1n}): V_{DET1n} – 0 V to V_{DET1n} – 0.5 V
  Delay time selectable (t_{VDET1}): 2, 4, 6 sec, with delay shortening function (2)
  Release condition: Auto release
- COUT Output (CMOS Output, Active-high): Typ. 4.7 V
- Shutdown Function
  Detection voltage: Typ. 3.5 V ±0.3 V
  Shutdown current: Max.0.1µA
- 1 to 3 Cells Selectable Battery Protection

TYPICAL APPLICATION CIRCUIT for 3-cell



PACKAGE



DFN2020-6

2.0 x 2.0 x 0.8 [mm]

APPLICATIONS

Smart Phone, Tablet PC, Game, Hearing Aid

(1) CELLn voltage (Ex. V_{CELL1} is a voltage difference between VC1 and VC2), n = 1, 2, 3

(2) By applying a voltage of 4 V ± 0.2 V to between the VDD and VC1 pins, a delay time is reduced down to approx.1/90.

SELECTION GUIDE

The overcharge and the delay time are user-selectable options. Set Voltage, Delay Time and Optional Function are user selectable. Refer to *Product Code List* for major lineup.

Selection Guide

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5642Lxxx$∗-TR	DFN2020-6	3,000 pcs	Yes	Yes

xxx: Specify a code that combines the following set voltages. Refer to *Set Voltage Code in Product Code List* for major codes.

V_{DET1n}(1): 4.10 V to 4.65 V in 5 mV step
V_{REL1n}(2): V_{DET1n} – 0 V to V_{DET1n} – 0.5 V in 50 mV step

$: Specify a code that combines the following delay times. Refer to *Delay Time Code Table* for details.

Delay Time Code Table (Code Option (2))

Code	t_{VDET1} [s]	t_{VREL1} [ms]
A	2	16
B	4	16
C	6	16

∗: Specify a code that combines the following functions. Refer to *Function Code Table* for details.

Function Code Table

Code	Overcharge Released Condition	COUT Output	
A	Auto Release	CMOS	High-active

Product Code Table

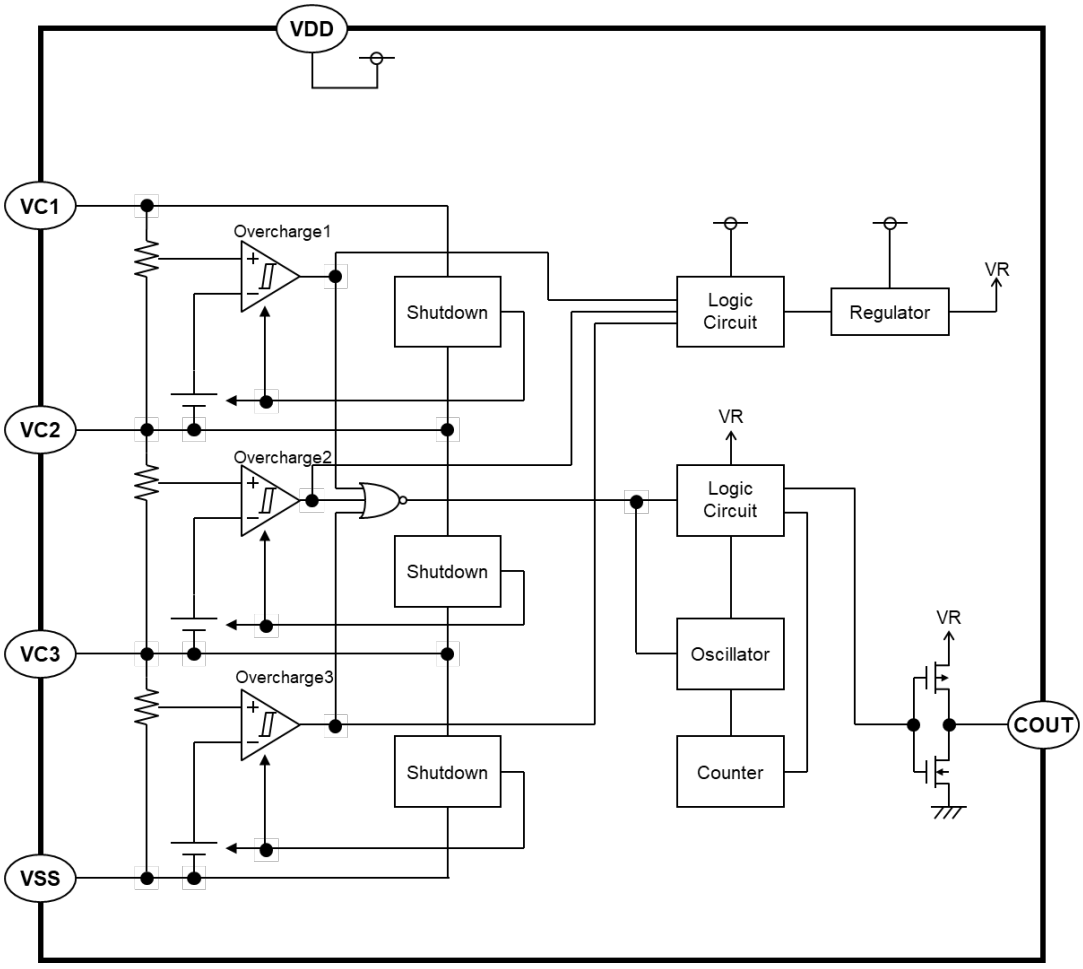
Product Name (Set Voltage Code (3))	Set Voltage [V]		Delay Time	
	V_{DET1}	V_{REL1}	t_{VDET1} [s]	t_{VREL1} [ms]
R5642L**317**BA	4.500	4.200	4	16
R5642L**326**BA	4.550	4.200	4	16

(1) V_{DET1n}, V_{REL1n}: n = 1, 2, 3

(2) For more information on other code options, please contact our company's sales department.

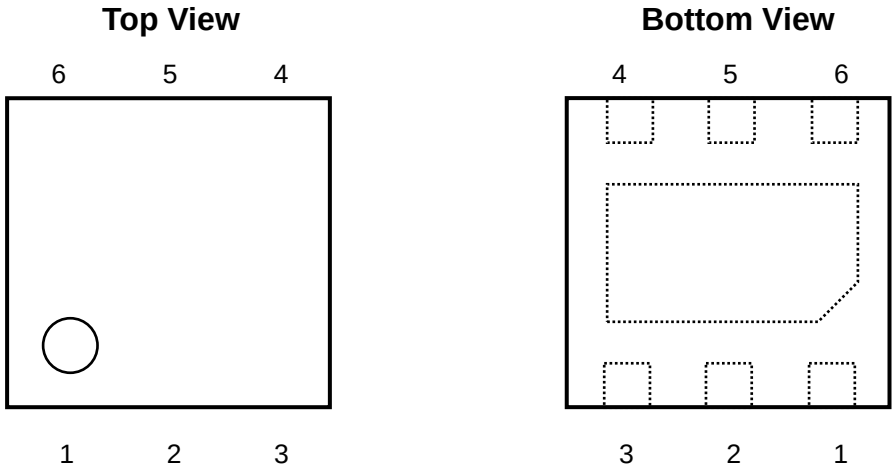
(3) Indicated with the numbers in bold type.

BLOCK DIAGRAM



R5642L Block Diagram

PIN DESCRIPTIONS



R5642L (DFN2020-6) Pin Configuration

R5642L Pin Description

Pin No.	Symbol	Description
1	VC1	CELL1 Plus Pin
2	VC2	CELL2 Plus Pin
3	VSS	IC Ground Pin
4	VC3	CELL3 Plus Pin
5	VDD	Power Supply Pin
6	COUT	Overcharge Detection Output Pin

ABSOLUTE MAXIMUM RATINGS

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

Symbol	Parameter	Rating	Unit
V_{DD}	Power Supply Voltage	V_{C1} – 0.3 to V_{C1} + 6.5 V_{C1} – 0.3 to 26	V V
V_{C1}	CELL1 Plus Pin Input Voltage	V_{C2} – 0.3 to V_{C2} + 6.5	V
V_{C2}	CELL2 Plus Pin Input Voltage	V_{C3} – 0.3 to V_{C3} + 6.5	V
V_{C3}	CELL3 Plus Pin Input Voltage	–0.3 to 6.5	V
V_{COUT}	COUT Pin Output Voltage	–0.3 to V_{OH1} + 0.3	V
P_D	Power Dissipation	150	mW
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 CONDITION

Symbol	Parameter	Rating	Unit
V_{DD}	Operating Input Voltage	1.5 to 20 / V_{C1} +5 V	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

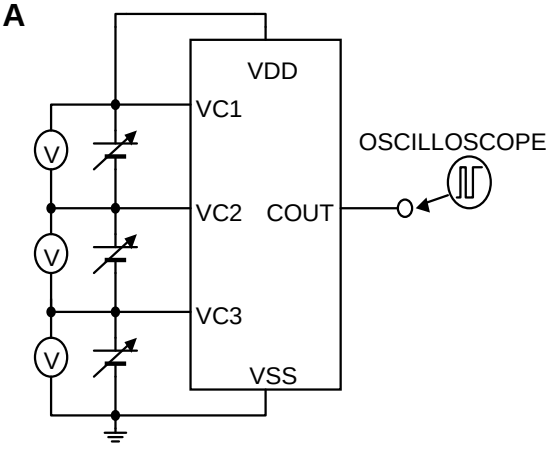
V_{CELLn} = CELLn (Ex. V_{CELL1} is a voltage difference between VC1 and VC2), n = 1, 2, 3, unless otherwise noted.

R5642Lxxxxx Electrical Characteristics (Ta = 25°C)

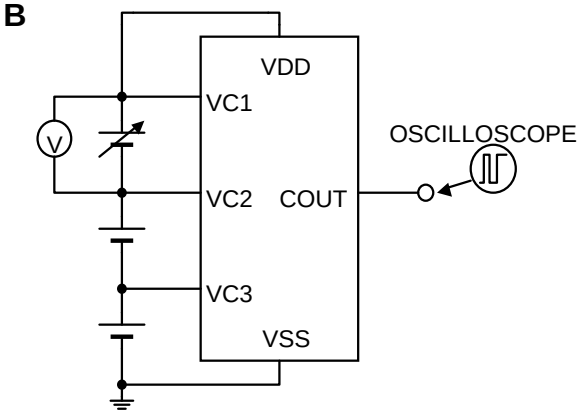
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit	Circuit (1)
V_{DET1n}	CELLn overcharge detection voltage	Detect rising edge of supply voltage	V_{DET1n} – 0.015	V_{DET1n}	V_{DET1n} + 0.015	V	A
V_{REL1n}	CELLn overcharge release voltage	Detect falling edge of supply voltage	V_{REL1n} – 0.050	V_{REL1n}	V_{REL1n} + 0.050	V	A
t_{VDET1}	Overcharge detection delay time	V_{CELLn} = 3.9 V (n = 2,3), V_{CELL1} = 3.9 V → 4.7 V	t_{VDET1} x 0.8	t_{VDET1}	t_{VDET1} x 1.2	s	B
t_{VREL1}	Overcharge release delay time	V_{CELLn} = 3.9 V (n = 2,3), V_{CELL1} = 4.7 V → 3.9 V	12.8	16	19.2	ms	B
V_{SHT}	Shutdown detection voltage	Detect falling edge of supply voltage	3.2	3.5	3.8	V	C
V_{OH1}	COUT pin PMOS ON voltage1	I_{OH} = 0µA,V_{CELLn} = 4.7 V	4.0	4.7	5.4	V	D
		I_{OH} = 0µA,V_{CELLn} = 4.7 V (n = 1, at 1 cell protection)		V_{DD}			
V_{OH2}	COUT pin PMOS ON voltage2	I_{OH}= –50µA, V_{CELLn} = 4.7 V	V_{OH1} – 0.5	V_{OH1} – 0.1		V	E
V_{OL}	COUT pin NMOS ON voltlage	I_{OL} = 50µA,V_{CELLn} = 3.9 V		0.1	0.5	V	F
I_{SHT}	Shutdown current	V_{CELLn} = 3.1 V			0.1	µA	G
I_{SS}	Supply current	V_{CELLn} = 3.9 V		0.85	1.7	µA	G

Test Circuits

A

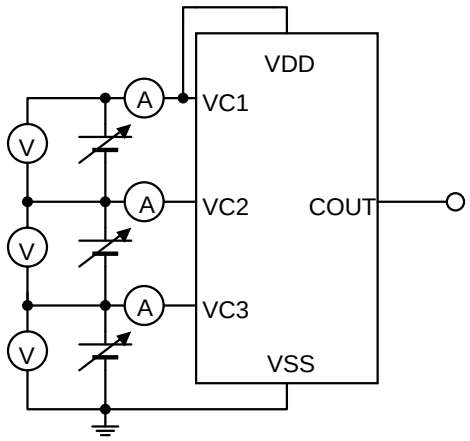


B

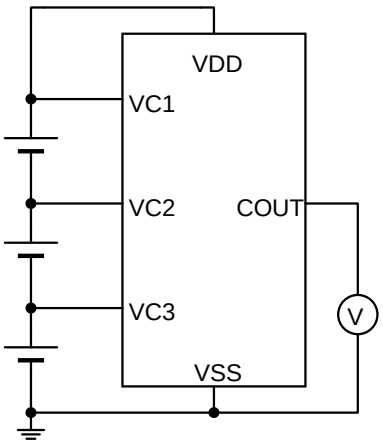


(1) Refer to *Test Circuits* for detail information.

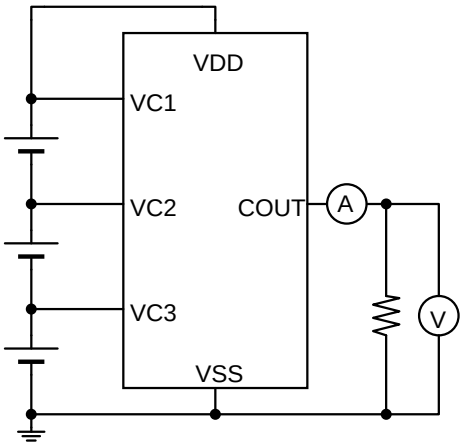
C


VDD
VC1
VC2
VC3
COUT
VSS
A
A
A
V
V
V

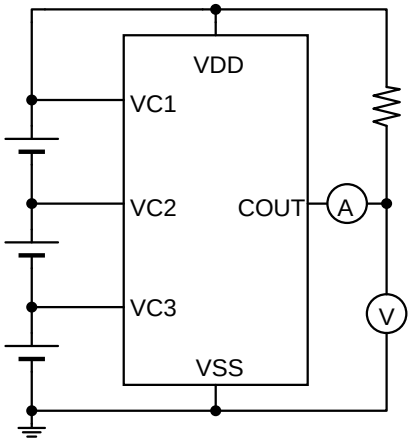
D


VDD
VC1
VC2
VC3
COUT
VSS
V

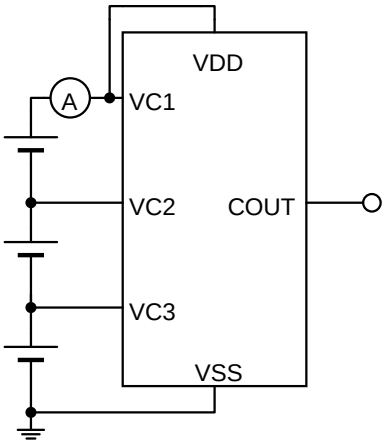
E


VDD
VC1
VC2
VC3
COUT
VSS
A
V

F


VDD
VC1
VC2
VC3
COUT
VSS
A
V

G


VDD
VC1
VC2
VC3
COUT
VSS
A

THEORY OF OPERATION

Overcharge Protection-n (n = 1, 2, 3)

While monitoring each cell voltage (V_{CELLn}): V_{CELL1} between VC1 and VC2 pins, V_{CELL2} between VC2 and VC3 pins, and V_{CELL3} between VC3 and VSS pins, this IC enters the overcharge state when the overcharge detection delay time (t_{VDET1}) passes under the condition that at least one of the cell voltages exceeds the overcharge detection voltage (V_{DET1n}). In this state, that is, when the COUT pin is High, turning on the N-channel FET for charger control to blow the fuse in the charger path stops charging.
The COUT pin outputs a CMOS output between the VSS pin and the built-in regulator as its high- level voltage.

A release from the overcharge state must meet the following pin conditions and delay time.

Pin Conditions	Delay Time
$V_{CELLn} < V_{REL1n}$ (n = 1,2,3) in all cell voltages Note	t_{VREL1}

Note: Even if all cell voltages fall below V_{REL1n}, the overcharge state is not released when at least one of them exceeds the V_{REL1n} for a duration of t_{VREL1}.

Shutdown Function

This function is controlled by monitoring each cell voltage (V_{CELLn}): V_{CELL1} between VC1 and VC2 pins, V_{CELL2} between VC2 and VC3 pins, and V_{CELL3} between VC3 and VSS pins.
When V_{CELLn} falls below the shutdown detection voltage (V_{SHT}), the overcharge detector for Celln shuts down and the shutdown current (I_{SHT}) is extremely reduced. That is, the IC's consumption current, is extremely reduced. The shutdown detection is released when at least one of the cell voltages exceeds V_{SHT}.

Delay Shortening (DS) Function

Applying a voltage of 4 V ± 0.2 V to between VDD and VC1 can shorten the overcharge detection delay time (t_{VDET1}) into approximately 1/90, likewise, the overcharge release delay time (t_{VREL1}) into approximately 1/60.

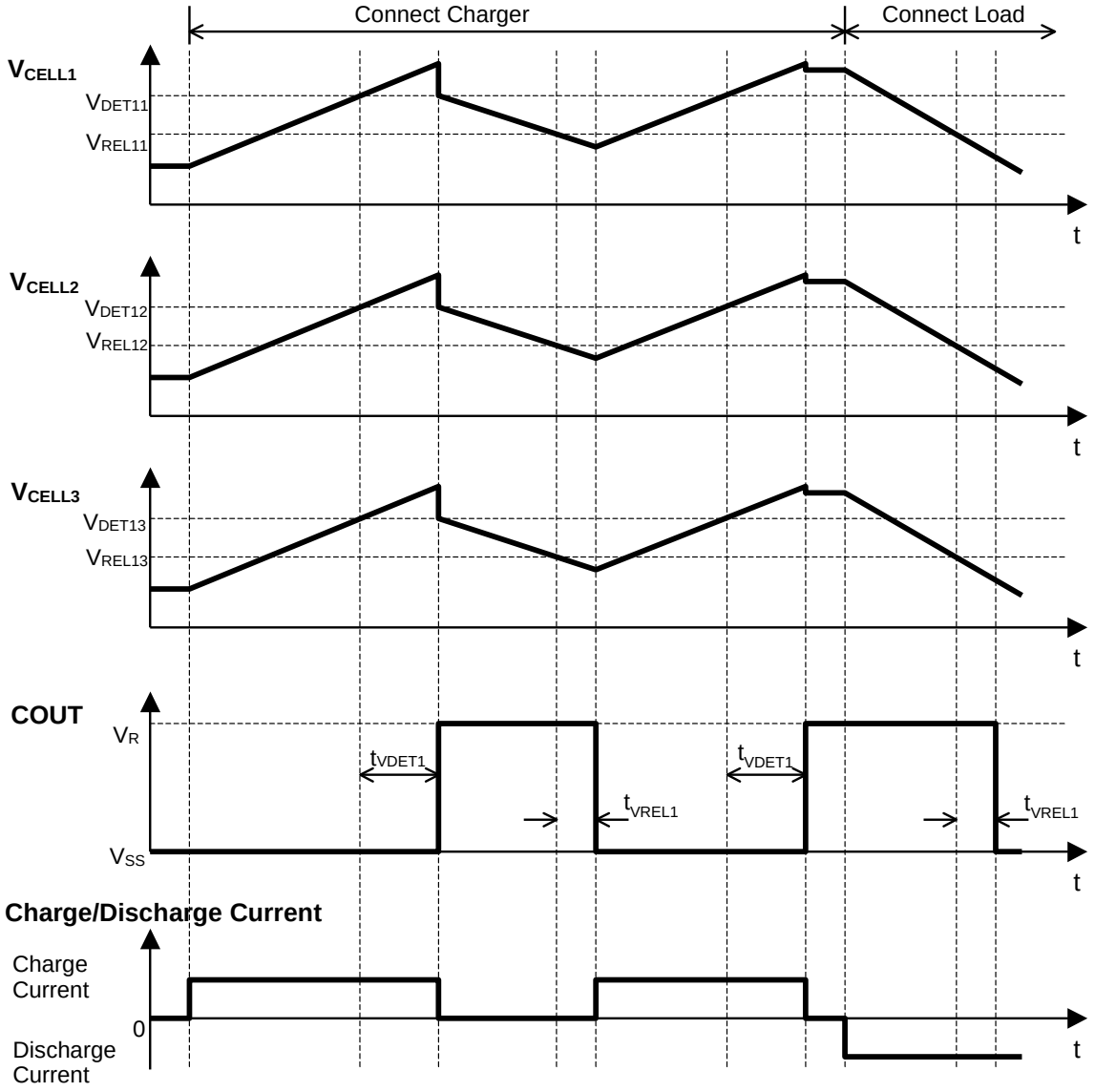
1-cell/ 2-cell Protection Alternative

By short-circuiting between cells, this device can meet as a protection IC for 1 or 3 cells placed in series.
The following table indicates pins to short-circuit depending on protected cell(s).

Protected Cells	Pins to Short-circuit
1-cell protection	VC1 and VC2 pins, and VC3 and VSS pins
2-cell protection	VC1 and VC2 pins, or VC3 and VSS pins

If providing other connections except above short-circuit for 1 or 2 cells protection, perform thorough evaluation using the actual devices.

Timing Diagrams

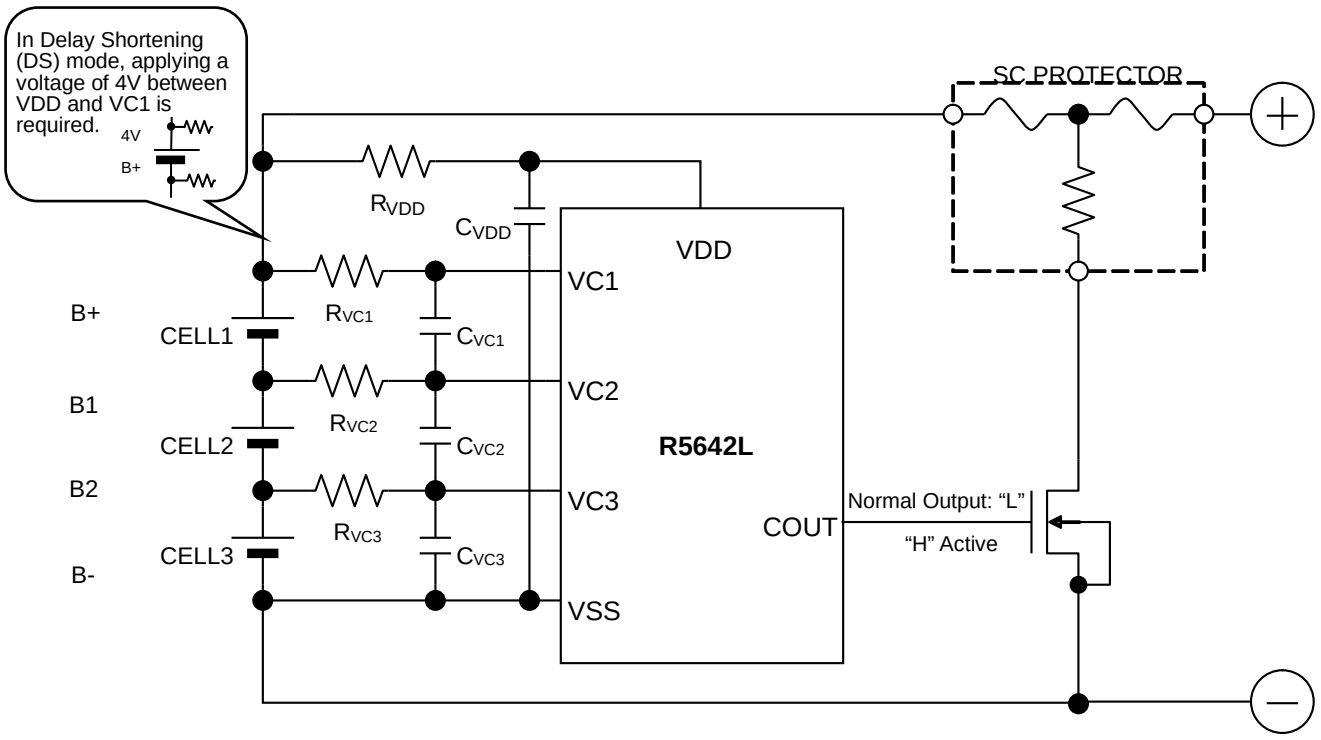


Overcharge Protection Timing Diagram

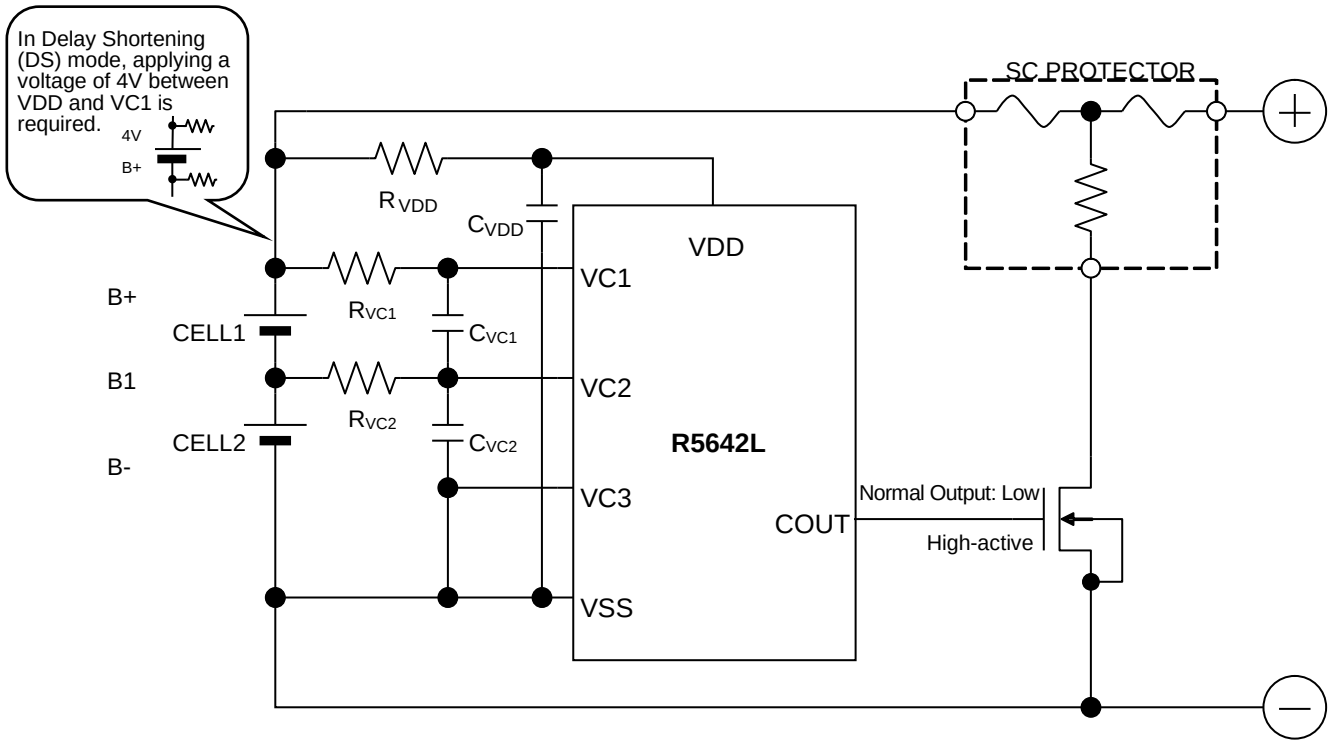
APPLICATION INFORMATION

Typical Application Circuits in Normal Mode (CMOS Output, Active-high)

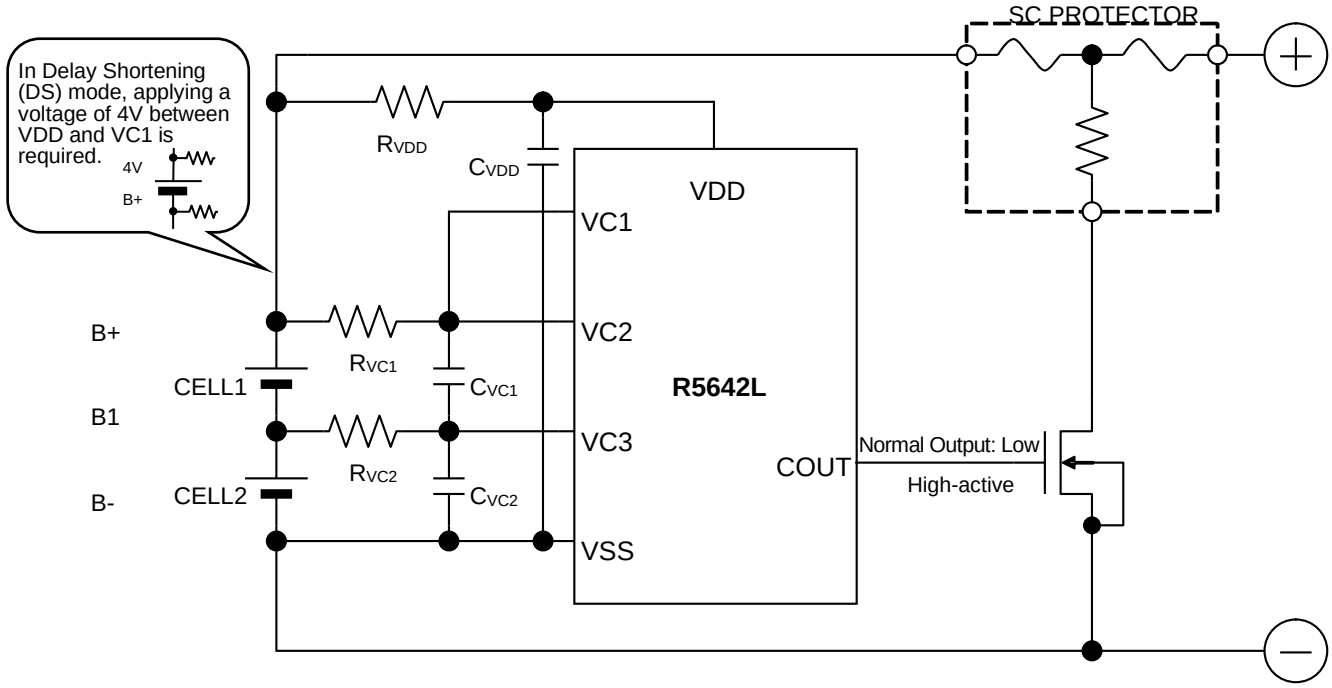
As for the order of cell's connection, connect a positive terminal of CELL1 as the end terminal. If connected another terminal, a fuse blowout might be caused by transiently High output of the COUT pin.



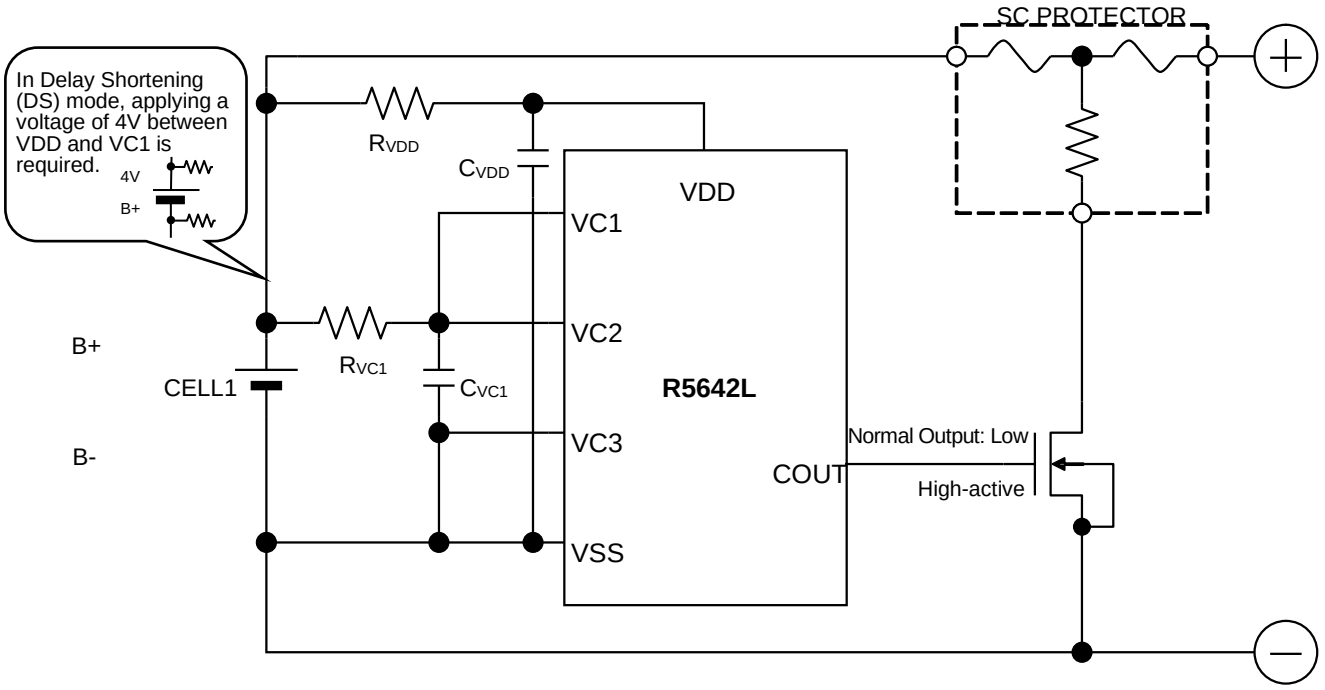
Typical Application Circuit for 3-cell Protection



Typical Application Circuit for 2-cell Protection -1



Typical Application Circuit for 2-cell Protection -2



Typical Application Circuit for 1-cell Protection

External Components

Symbol	Typ.	Range	Unit
Resistor			
R_{VDD}	100		Ω
R_{VC1}	1000	330 to 1000	Ω
R_{VC2}	1000	330 to 1000	Ω
R_{VC3}	1000	330 to 1000	Ω
Capacitor			
C_{VDD}	0.1	0.01 to 1.00	µF
C_{VC1}	0.1	0.01 to 1.00	µF
C_{VC2}	0.1	0.01 to 1.00	µF
C_{VC3}	0.1	0.01 to 1.00	µF

Technical Notes on the Selection Components

- The voltage fluctuation is stabilized with R_{VDD} and C_{VDD}. If a small R_{VDD} is set, in the case of the large transient may happen to the cell voltage, by the flowing current, the IC may be unstable. If a large R_{VDD} is set, by the consumption current of the IC itself, the voltage difference between VDD pin and VC1 pin is generated, and unexpected operation may result. Therefore, the appropriate value range of R_{VDD} is from 100 Ω to 1 kΩ. To make a stable operation of the IC, the appropriate value range of C_{VDD} is from 0.01 µF to 1.0 µF.

- The voltage fluctuation is stabilized with R_{VC1} to R_{VC3} and C1 to C3. If a R_{VC1} to R_{VC3} is too large, by the conduction current at detection, the detector threshold may shift higher. Therefore, the appropriate value range of R_{VC1} to R_{VC3} is equal or less than 1 kΩ. To make a stable operation of the IC, the appropriate value range of C_{VC1} to C_{VC3} is 0.01 µF or more.

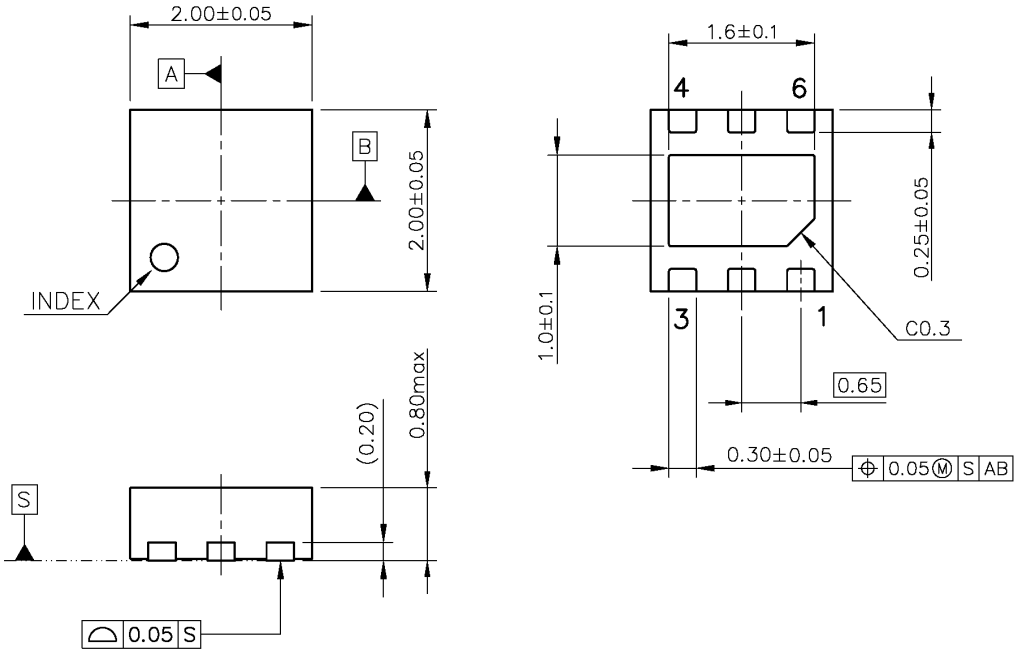
- The typical application circuit diagrams are just examples. This circuit performance largely depends on the PCB layout and external components. In the actual application, fully evaluation is necessary.

- Overvoltage and the over current beyond the absolute maximum rating should not be forced to the protection IC and external components. During the time until the fuse is open after detecting overcharge, a large current may flow through the FET. Select an FET with large enough current capacity in order to endure the large current.

- To connect the SC protector, connect the SC protector to the cell must be the last.

Contact Information for Inquiries regarding SC PROTECTOR

Dexerials Corporation (Sony Chemical & Information Device Company Ltd.)
Gate-city Osaki East Tower 8F, 1-11-2 Osaki, Shinagawa, Tokyo, 141-0032
TEL: 03-5435-3946
URL: http://www.dexerials.jp

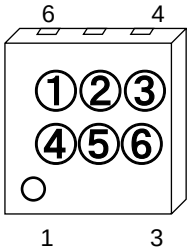


DFN2020-6 Package Dimensions (Unit: mm)

Ver. B

①②③④: Product Code ⋯ Refer to *Part Marking List*

⑤⑥: Lot Number ⋯ Alphanumeric Serial Number



R5642L (DFN2020-6) Part Markings

NOTICE
There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

R5642L Part Marking List

Product Name	①②③④
R5642L317BA	H B 0 1
R5642L326BA	H B 0 2

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
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6. 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 to 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.
7. Anti-radiation design is not implemented in the products described in this document.
8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
9. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI.
11. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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