

### 1-Cell Li-Ion or Polymer Battery Secondary Protection IC

NO.EA-380-181015

#### OUTLINE

The R5458L is a high voltage tolerant CMOS-based overcharge secondary protection IC for 1-Cell Li-ion or Li-polymer battery. The R5458L monitors the cell batteries and protects them from overcharge conditions. Internally, the R5458L consists of a voltage detector, a voltage reference unit, an oscillator, a counter, a delay circuit, and a logic circuit.

The cell is monitored for overcharging condition and triggers an internal counter once the overcharge threshold is exceeded. After the overcharge detection delay time, the output of COUT is transitioned to a high level. The output of COUT goes low if the cell voltage drops below the overcharge release voltage. The output type of the COUT pin is CMOS. The R5458L is offered in a small 6-pin DFN1814-6C package.

#### FEATURES

- **High Voltage Tolerant Process**

Absolute Maximum Ratings .....30 V

- **Low Supply Current**

Operating at 3.9 V Cell Voltage.....Typ. 1.5  $\mu$ A

Standby Current.....Max. 0.5  $\mu$ A

- **Output Voltage**

COUT Pin Output.....VDD Power Supply CMOS Output, Active-high

- **High Accuracy Voltage Detection**

Overcharge Detector Threshold ( $V_{DET1}$ ).....4.0 V to 4.7 V in 0.005 V step

Overcharge Release Voltage ( $V_{REL1}$ ) ..... $V_{DET1}-0$  V to  $V_{DET1}-0.4$  V in 0.05 V step

Overcharge Detector Threshold Accuracy ..... $\pm 20$  mV,  $T_a = 25^\circ\text{C}$

$\pm 25$  mV,  $T_a = 0$  to  $60^\circ\text{C}$

Overcharge Release Type .....Voltage Release Type

- **Overcharge Output Delay Function**

Overcharge Detection Delay Time .....2 s

Overcharge Release Delay Time .....16 ms

Overcharge Detection Delay Time Shortening .....Overcharge detection delay time can be shortened by short-circuiting the VSS pin and the DS pin.

- **Compact Package**

DFN1814-6C ..... 1.4 mm x 1.8 mm

#### APPLICATIONS

- 1-Cell Li-Ion or Li-Polymer Battery Pack

## R5458L

NO.EA-380-181015

## SELECTION GUIDE

The overcharge detector threshold and overcharge release voltage, the overcharge detection delay time and overcharge release delay time, and the overcharge release type are user-selectable options.

### Selection Guide

| Product Name      | Package    | Quantity per Reel | Pb Free | Halogen Free |
|-------------------|------------|-------------------|---------|--------------|
| R5458Lxxx*\$\$-TR | DFN1814-6C | 5,000 pcs         | Yes     | Yes          |

xxx: Specify the combination of overcharge detector threshold ( $V_{DET1}$ ) and overcharge release voltage ( $V_{REL1}$ ). Refer to *Product Code Table* for details.

$V_{DET1}$ : 4.0 V to 4.7 V in 5 mV step

$V_{REL1}$ :  $V_{DET1}$  - 0 V to 0.4 V in 50 mV step

\*: Specify the combination of overcharge detection delay time ( $t_{VDET1}$ ) and overcharge release delay time ( $t_{VREL1}$ ). Refer to the table below.

### Delay Time Code

| Code | $t_{VDET1}$ [s] | $t_{VREL1}$ [ms] |
|------|-----------------|------------------|
| A    | 2               | 16               |

\$\$: Specify the overcharge release type. Refer to the table below.

### Overcharge Release Code

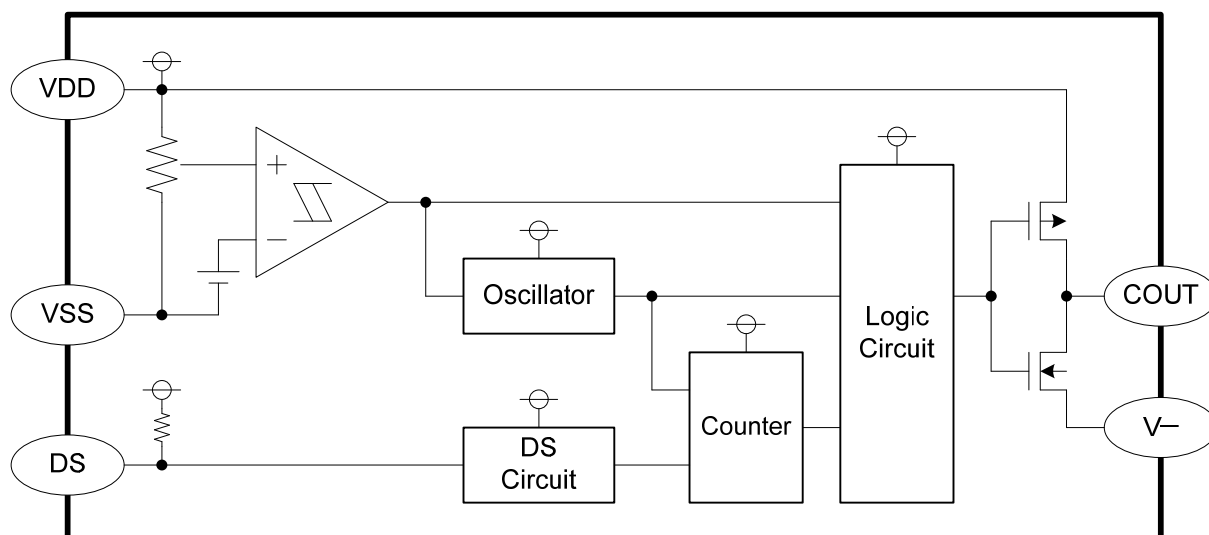
| Code | Overcharge Release Type |
|------|-------------------------|
| A    | Voltage Release Type    |

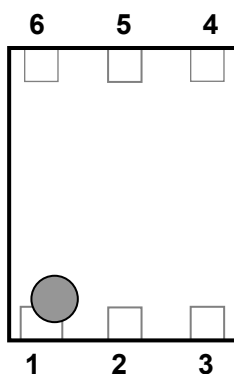
## Product Code Table

The product code is determined by the combination of set output voltage (overcharge detector threshold:  $V_{DET1}$ , overcharge release voltage:  $V_{REL1}$ ) and delay time (overcharge detection delay time:  $t_{VDET1}$ , overcharge release delay time:  $t_{VREL1}$ ) and overcharge release type.

### Product Code Table

| Product Name | Set Output Voltage [V] |            | Delay Time      |                  | Overcharge Release Type |
|--------------|------------------------|------------|-----------------|------------------|-------------------------|
|              | $V_{DET1}$             | $V_{REL1}$ | $t_{VDET1}$ [s] | $t_{VREL1}$ [ms] |                         |
| R5458L101AA  | 4.500                  | 4.150      | 2               | 16               | Voltage Release Type    |
| R5458L102AA  | 4.550                  | 4.200      | 2               | 16               | Voltage Release Type    |
| R5458L103AA  | 4.650                  | 4.300      | 2               | 16               | Voltage Release Type    |
| R5458L104AA  | 4.600                  | 4.300      | 2               | 16               | Voltage Release Type    |

**BLOCK DIAGRAMS****R5458L Block Diagram**

**PIN DESCRIPTIONS****DFN1814-6C Pin Configuration****DFN1814-6C Pin Description**

| Pin No. | Symbol | Description                             |
|---------|--------|---|
| 1       | NC     | No Connection                           |
| 2       | COUT   | Output of Overcharge Detection          |
| 3       | DS     | Delay Shortening                        |
| 4       | VSS    | Ground                                  |
| 5       | VDD    | Power Supply, substrate level of the IC |
| 6       | V-     | Negative Power Supply of COUT Pin       |

## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

(Ta = 25°C, V<sub>SS</sub> = 0 V)

| Symbol            | Item                             | Ratings                                      | Unit |
|-------------------|----------------------------------|--|------|
| V <sub>DD</sub>   | Power Supply Voltage             | -0.3 to 12                                   | V    |
| V <sub>-</sub>    | V <sub>-</sub> Pin Input Voltage | V <sub>DD</sub> -30 to V <sub>DD</sub> +0.3  | V    |
| DS                | DS Pin Input Voltage             | V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3 | V    |
| V <sub>COUT</sub> | COUT Pin Output Voltage          | V <sub>-</sub> -0.3 to V <sub>DD</sub> +0.3  | V    |
| P <sub>D</sub>    | Power Dissipation                | 150  | mW   |
| T <sub>j</sub>    | Junction Temperature Range       | -40 to 125                                   | °C   |
| T <sub>stg</sub>  | 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

### Recommended Operating Conditions

| Symbol          | Item                        | Ratings    | Unit |
|-----------------|-----------------------------|------------|------|
| V <sub>DD</sub> | 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 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.

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**R5458L**

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NO.EA-380-181015

**ELECTRICAL CHARACTERISTICS**

Ta = 25°C, unless otherwise specified.

**R5458L Electrical Characteristics**

(Ta = 25°C)

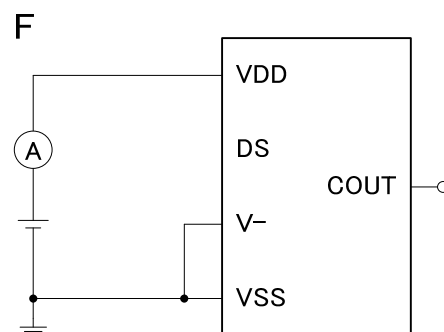
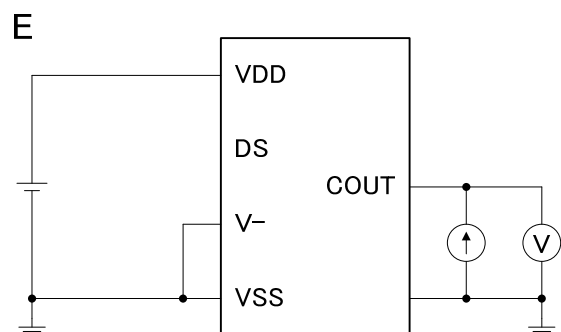
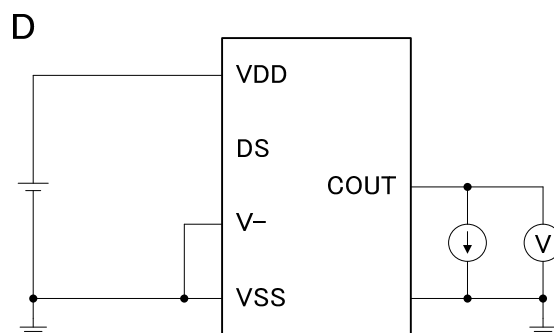
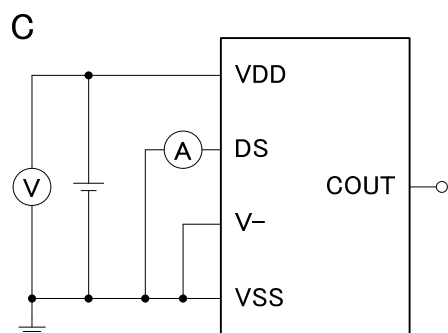
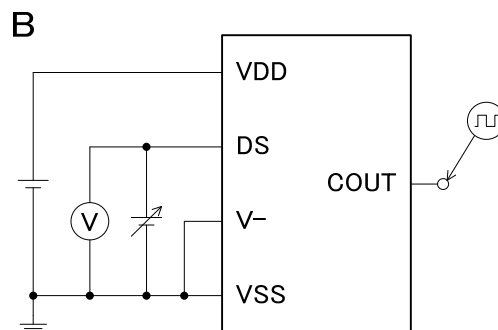
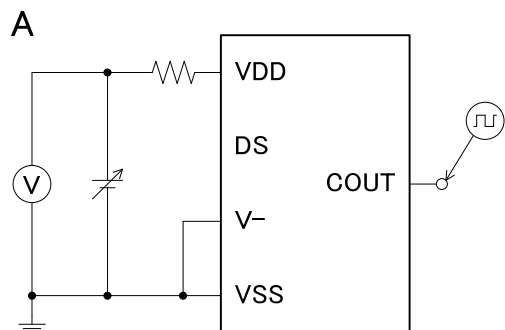
| Symbol               | Item                                    | Conditions  | Min.                        | Typ.               | Max.                        | Unit | Test Circuit |
|----------------------|---|---|-----------------------------|--------------------|-----------------------------|------|--------------|
| V <sub>DET1</sub>    | Overcharge Detector Threshold           | Detect rising edge of supply voltage (25°C)<br>R1 = 330 Ω                   | V <sub>DET1</sub><br>-0.020 | V <sub>DET1</sub>  | V <sub>DET1</sub><br>+0.020 | V    | A            |
|                      |   | Detect rising edge of supply voltage (0 to 60°C) <sup>1</sup><br>R1 = 330 Ω | V <sub>DET1</sub><br>-0.025 |                    | V <sub>DET1</sub><br>+0.025 |      |              |
| V <sub>REL1</sub>    | Overcharge Release Voltage              | Detect falling edge of supply voltage<br>R1 = 330 Ω                         | V <sub>REL1</sub><br>-0.050 | V <sub>REL1</sub>  | V <sub>REL1</sub><br>+0.050 | V    | A            |
| t <sub>VDET1</sub>   | Output Delay of Overcharge              | V <sub>DD</sub> = 3.5 V to 4.8 V  | t <sub>VDET1</sub><br>×0.8  | t <sub>VDET1</sub> | t <sub>VDET1</sub><br>×1.2  | s    | A            |
| t <sub>VREL1</sub>   | Output Delay of Release from Overcharge | V <sub>DD</sub> = 4.8 V to 3.5 V  | t <sub>VREL1</sub><br>×0.8  | t <sub>VREL1</sub> | t <sub>VREL1</sub><br>×1.2  | ms   | A            |
| V <sub>DS</sub>      | Delay Time Shortening Mode Voltage      | V <sub>DD</sub> = 4.8 V   |                             |                    | 0.4                         | V    | B            |
| R <sub>DS</sub>      | DS Pin Pull-up Resistances              | V <sub>DD</sub> = 3.9 V   | 200                         | 500                | 1000                        | kΩ   | C            |
| V <sub>OH</sub>      | COUT Pch On Voltage                     | I <sub>OH</sub> = -50 μA, V <sub>DD</sub> = 4.8 V                           | 4.3                         | 4.6                |                             | V    | D            |
| V <sub>OL</sub>      | COUT Nch On Voltage                     | I <sub>OL</sub> = 50 μA, V <sub>DD</sub> = 3.9 V                            |                             | 0.4                | 0.5                         | V    | E            |
| I <sub>standby</sub> | Standby Current                         | V <sub>DD</sub> = 1.9 V   |                             | 0                  | 0.5                         | μA   | F            |
| I <sub>SS</sub>      | Supply Current                          | V <sub>DD</sub> = 3.9 V   |                             | 1.5                | 3.0                         | μA   | F            |

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<sup>1</sup> This specification is guaranteed by design, not tested in mass-production.

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## TEST CIRCUITS



## THEORY OF OPERATION

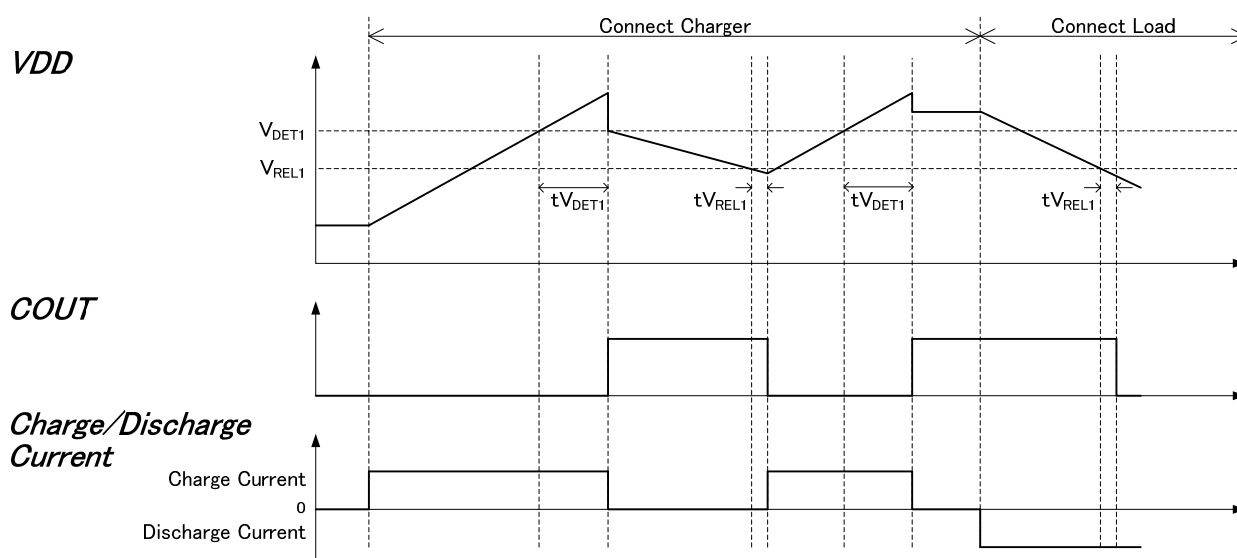
### $V_{DET1}$ / Overcharge Detector

The voltage between the VDD pin and the VSS pin is monitored while the cell is charged. The cell is monitored for overcharging condition and triggers an internal counter once the cell voltage exceeds the overcharge detector threshold. After the overcharge detection delay time, an external charging control Nch MOSFET turns on, which means the output of COUT is transitioned to a high level, a fuse on the charger path is cut, and the charging stops. The output of COUT goes low if the cell voltage drops below the overcharge release voltage. During the overcharge detection/ release delay time, the cell voltage needs to be kept more than the overcharge detector threshold/ release voltage level to make the output of COUT high/ low. The output type of the COUT pin is CMOS output between V- and VDD.

### Delay Shortening Function

The overcharge detection delay time can be shortened to approx. 4 ms by short-circuiting the VSS pin and the DS pin (Max. 0.4 V).

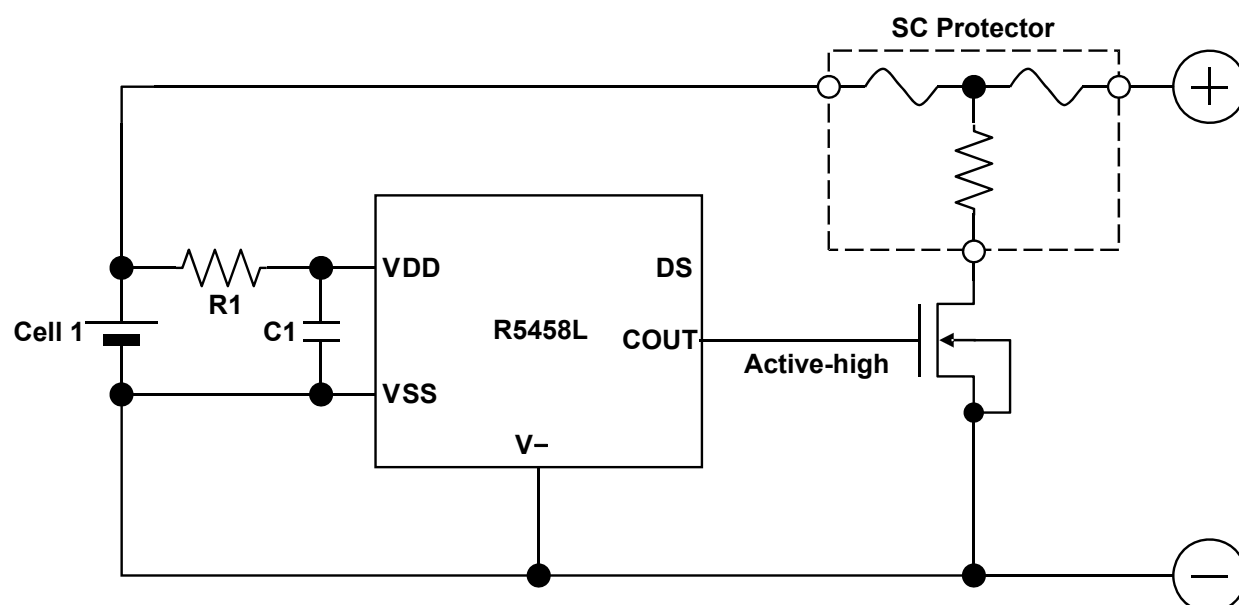
### Timing Chart



Overcharge Operation Timing Chart



## APPLICATION INFORMATION



R5458L Typical Application Circuit

## Recommended External Components

| Symbol | Typ. | Unit          | Range       |
|--------|------|---------------|-------------|
| R1     | 330  | $\Omega$      | 330 to 1000 |
| C1     | 0.1  | $\mu\text{F}$ | 0.01 to 0.1 |

**Technical Notes on the Selection of Components**

- R1 and C1 stabilize a supply voltage to the IC. A recommended R1 value is equal or less than 1 k $\Omega$ . A large value of R1 makes detection voltage shift higher because of the conduction current flowed in the IC.
- To stabilize the operation of the IC, use the C1 with the value in the range from 0.01  $\mu$ F to 0.1  $\mu$ F. To choose the most suitable value of C1, fully evaluation is necessary.
- 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 overcurrent 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.
- Ricoh cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Ricoh product. If technical notes are not complied with the circuit which is used Ricoh product, Ricoh is not responsible for any damages and any accidents.
- 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

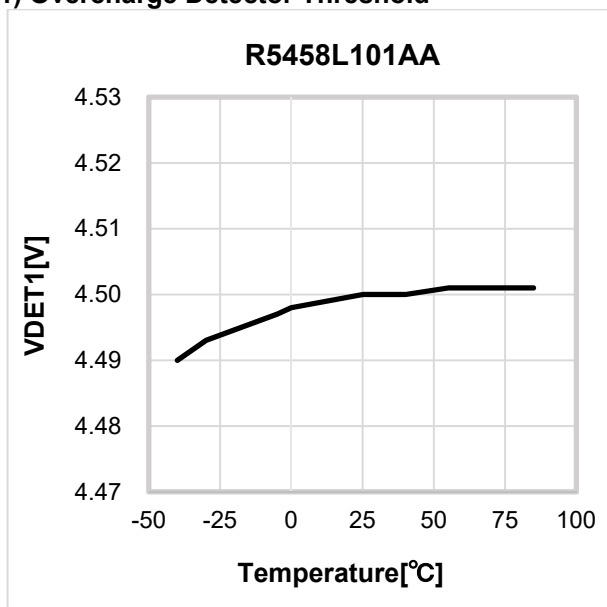
TEL: 03-5435-3946

URL: <http://www.dexerials.jp>

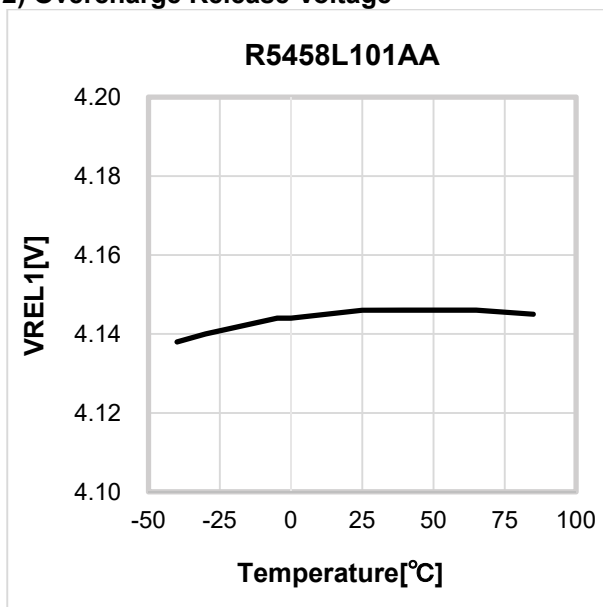
## TYPICAL CHARACTERISTICS (vs. Ambient Temperature)

Note: Typical Characteristics are intended to be used as reference data, they are not guaranteed.

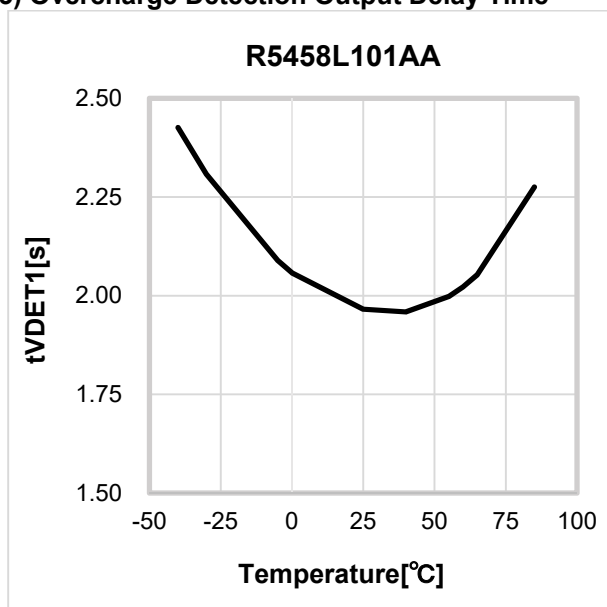
### 1) Overcharge Detector Threshold



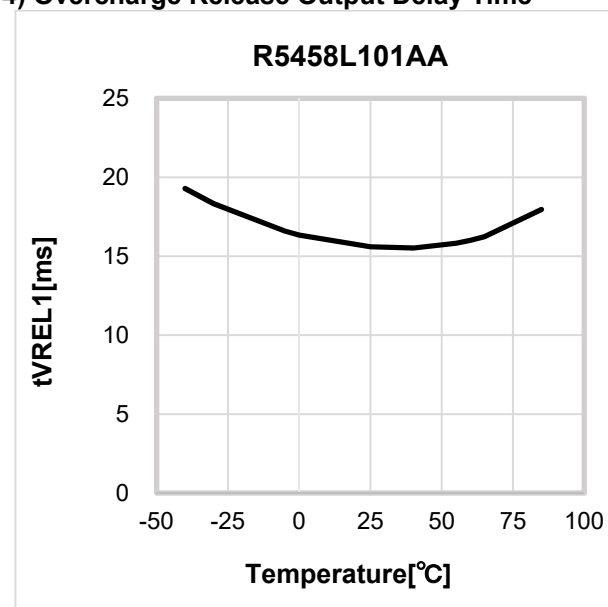
### 2) Overcharge Release Voltage



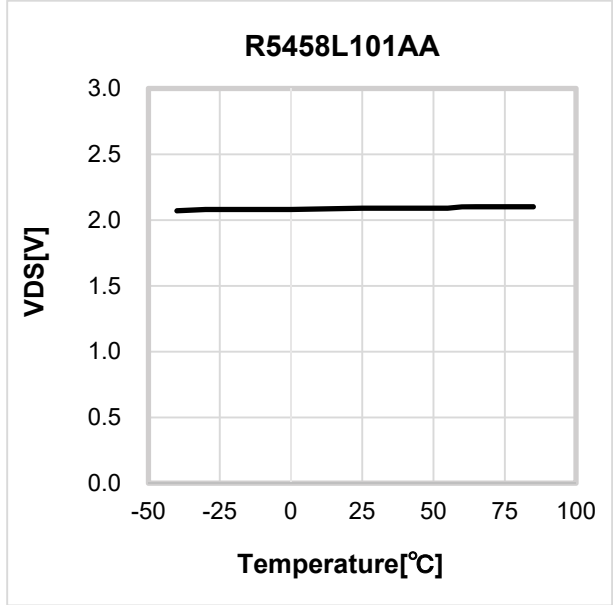
### 3) Overcharge Detection Output Delay Time



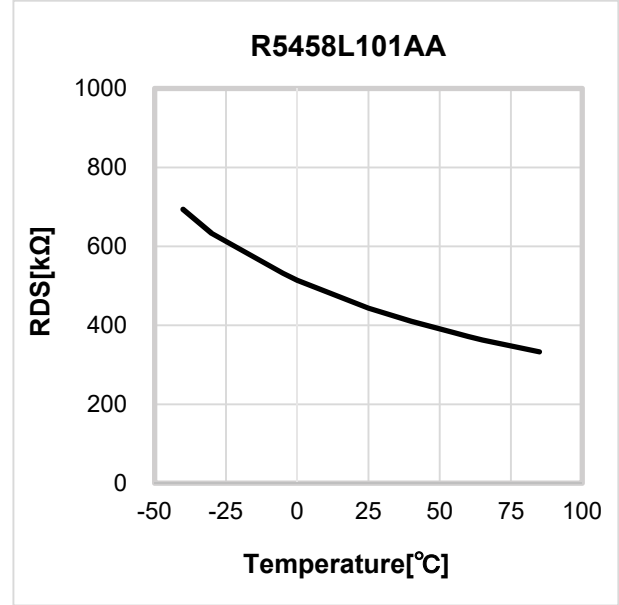
### 4) Overcharge Release Output Delay Time



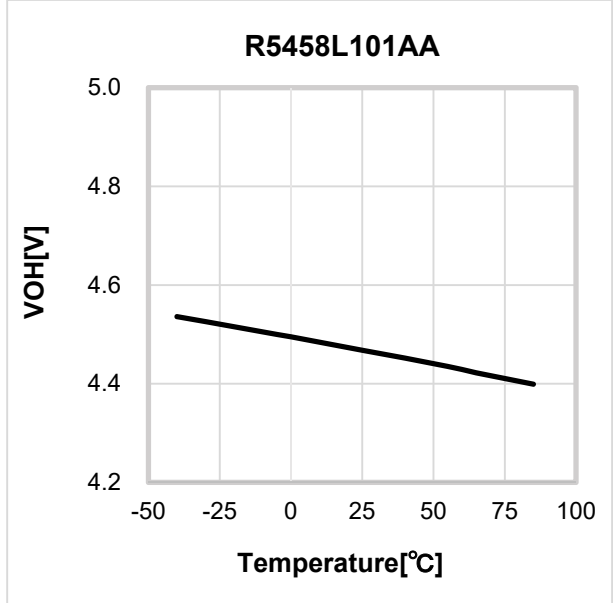
5) Delay Time Shortening Mode Voltage



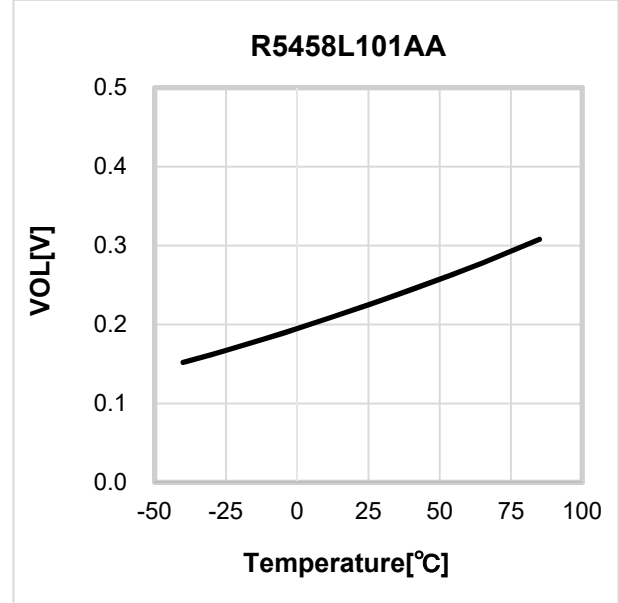
6) DS Pin Pull-up Resistance



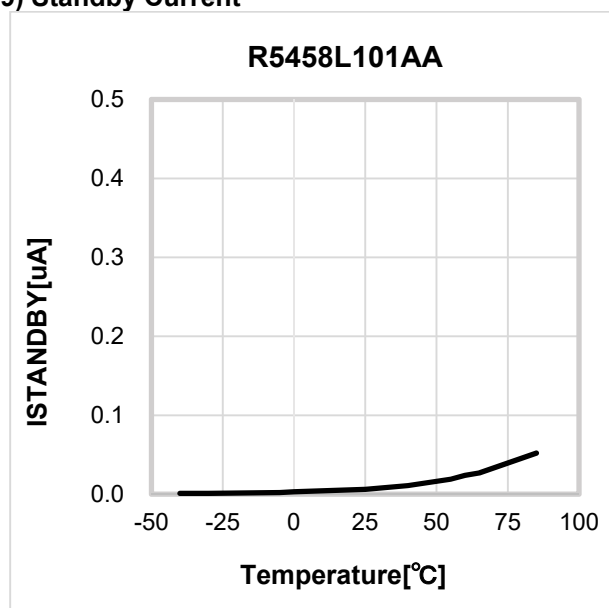
7) C<sub>OUT</sub> Pch ON Voltage



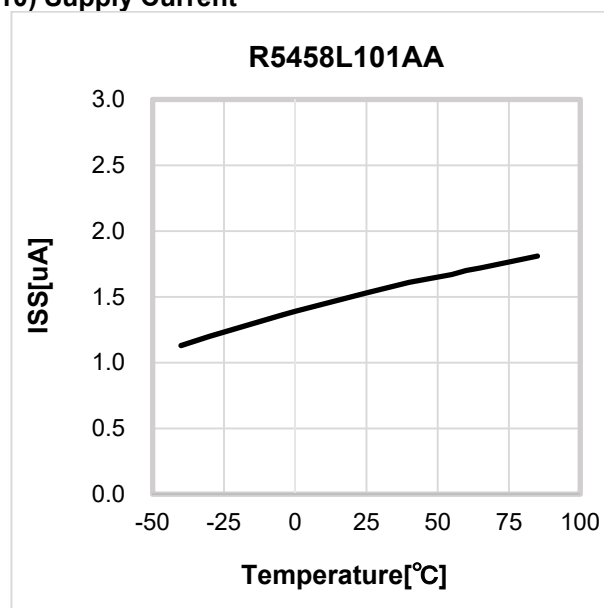
8) C<sub>OUT</sub> Nch ON Voltage

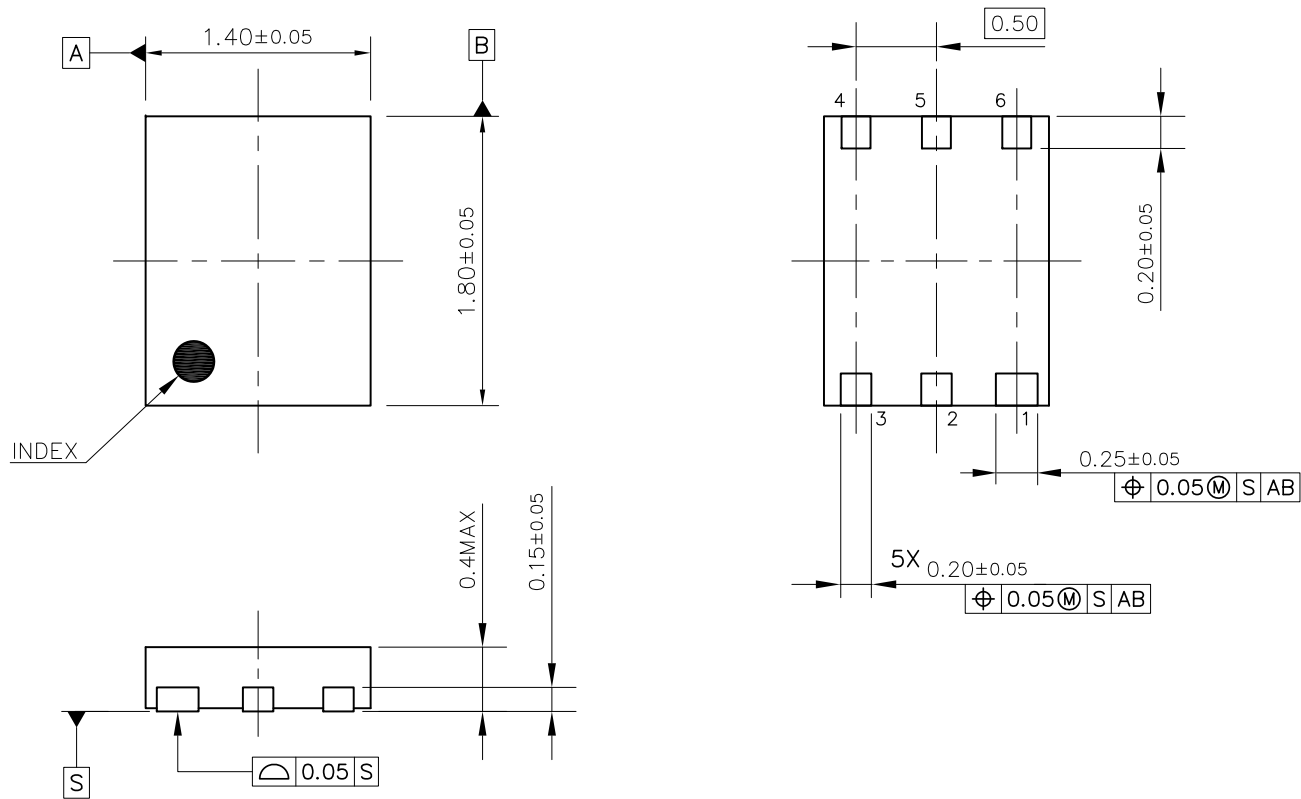


## 9) Standby Current



## 10) Supply Current





DFN1814-6C Package Dimensions (Unit: mm)



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