

The S-8211E Series has high-accuracy voltage detections circuit and delay circuits.

The S-8211E Series is suitable for monitoring overcharge and overdischarge of 1-cell lithium ion / lithium polymer rechargeable battery pack.

## ■ Features

- |                                                                                                         |                                            |                                                                      |
|---------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------------------------------------------------------------|
| (1) High-accuracy voltage detection circuit                                                             |                                            |                                                                      |
| • Overcharge detection voltage                                                                          | 3.6 V to 4.5 V (5 mV step)                 | Accuracy $\pm 25$ mV (+25°C)<br>Accuracy $\pm 30$ mV (–5°C to +55°C) |
| • Overcharge release voltage                                                                            | 3.5 V to 4.4 V <sup>*1</sup>               | Accuracy $\pm 50$ mV                                                 |
| • Overdischarge detection voltage                                                                       | 2.0 V to 3.0 V (10 mV step)                | Accuracy $\pm 50$ mV                                                 |
| • Overdischarge release voltage                                                                         | 2.0 V to 3.4 V <sup>*2</sup>               | Accuracy $\pm 100$ mV                                                |
| (2) Detection delay times are generated by an internal circuit<br>(external capacitors are unnecessary) |                                            | Accuracy $\pm 20\%$                                                  |
| (3) Wide operating temperature range                                                                    | –40°C to +85°C                             |                                                                      |
| (4) Low current consumption                                                                             |                                            |                                                                      |
| • During operation                                                                                      | 3.0 $\mu$ A typ., 5.5 $\mu$ A max. (+25°C) |                                                                      |
| • During overdischarge                                                                                  | 2.0 $\mu$ A typ., 3.5 $\mu$ A max. (+25°C) |                                                                      |
| (5) Output logic of CO pin is selectable.                                                               | Active “H”, Active “L”                     |                                                                      |
| (6) Lead-free, Sn 100%, halogen-free <sup>*3</sup>                                                      |                                            |                                                                      |

\*1. Overcharge release voltage = Overcharge detection voltage – Overcharge hysteresis voltage  
(Overcharge hysteresis voltage can be selected as 0 V or from a range of 0.1 V to 0.4 V in 50 mV step.)

\*2. Overdischarge release voltage = Overdischarge detection voltage + Overdischarge hysteresis voltage  
(Overdischarge hysteresis voltage can be selected as 0 V or from a range of 0.1 V to 0.7 V in 100 mV step.)

\*3. Refer to “■ Product Name Structure” for details.

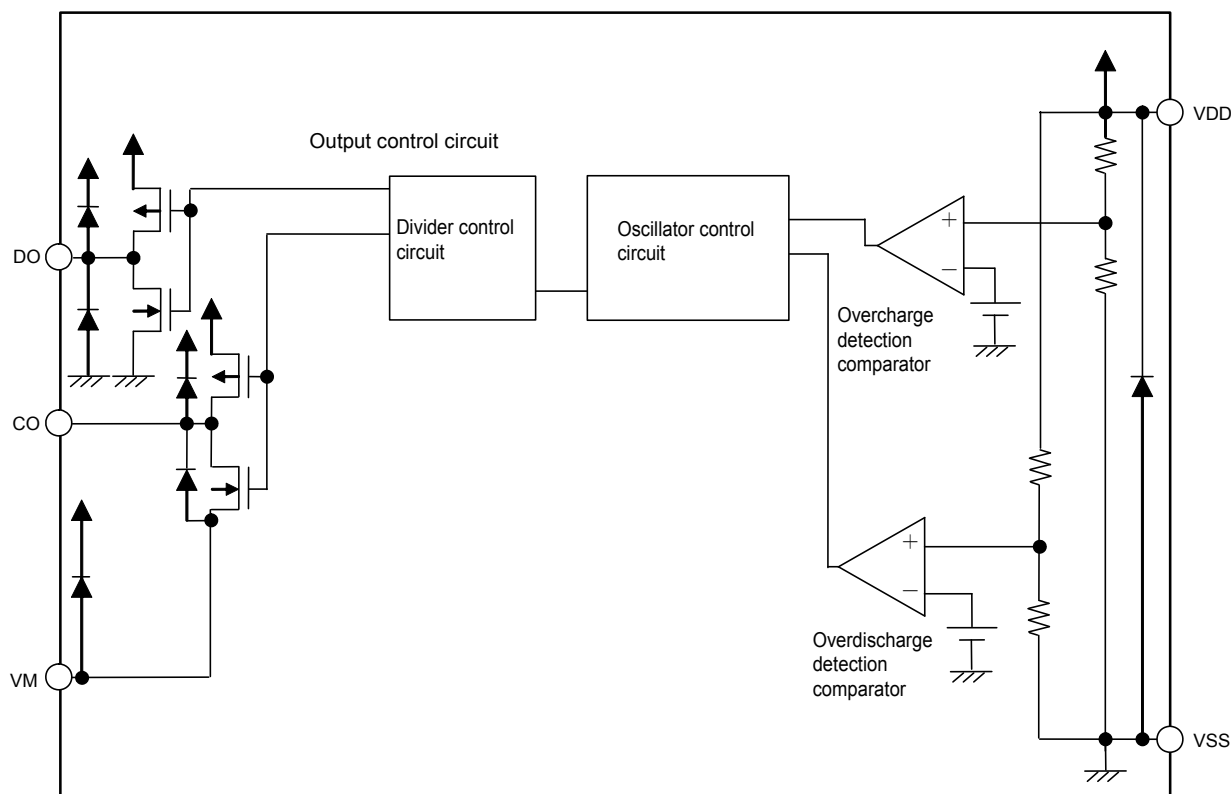
## ■ Applications

- Lithium-ion rechargeable battery pack
- Lithium-polymer rechargeable battery pack

## ■ Packages

- SOT-23-5
- SNT-6A

■ **Block Diagram**

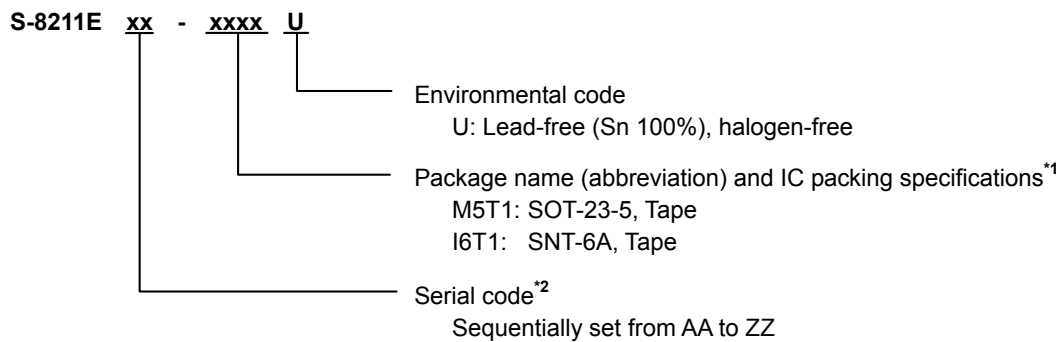


**Remark** All diodes shown in figure are parasitic diodes.

**Figure 1**

### ■ Product Name Structure

#### 1. Product Name



\*1. Refer to the tape drawing.

\*2. Refer to “3. Product Name List”.

#### 2. Packages

| Package Name | Drawing Code |              |              |              |
|--------------|--------------|--------------|--------------|--------------|
|              | Package      | Tape         | Reel         | Land         |
| SOT-23-5     | MP005-A-P-SD | MP005-A-C-SD | MP005-A-R-SD | –            |
| SNT-6A       | PG006-A-P-SD | PG006-A-C-SD | PG006-A-R-SD | PG006-A-L-SD |

### 3. Product Name List

#### 3.1 SOT-23-5

**Table 1**

| Product Name    | Overcharge Detection Voltage [V <sub>CU</sub> ] | Overcharge Release Voltage [V <sub>CL</sub> ] | Overdischarge Detection Voltage [V <sub>DL</sub> ] | Overdischarge Release Voltage [V <sub>DU</sub> ] | Delay Time Combination <sup>*1</sup> | CO Pin Output Form     |
|-----------------|-------------------------------------------------|-----------------------------------------------|----------------------------------------------------|--------------------------------------------------|--------------------------------------|------------------------|
| S-8211EAC-M5T1U | 3.600 V                                         | 3.600 V                                       | 2.00 V                                             | 2.00 V                                           | (1)                                  | CMOS output active "L" |
| S-8211EAF-M5T1U | 3.650 V                                         | 3.550 V                                       | 2.00 V                                             | 2.30 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAG-M5T1U | 3.800 V                                         | 3.600 V                                       | 2.00 V                                             | 2.30 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAJ-M5T1U | 4.180 V                                         | 4.180 V                                       | 2.50 V                                             | 3.00 V                                           | (1)                                  | CMOS output active "H" |
| S-8211EAK-M5T1U | 3.600 V                                         | 3.600 V                                       | 2.00 V                                             | 2.30 V                                           | (1)                                  | CMOS output active "H" |

<sup>\*1</sup>. Refer to the **Table 3** about the details of the delay time combinations (1), (2).

**Remark** Please contact our sales office for the products with detection voltage value other than those specified above.

#### 3.2 SNT-6A

**Table 2**

| Product Name    | Overcharge Detection Voltage [V <sub>CU</sub> ] | Overcharge Release Voltage [V <sub>CL</sub> ] | Overdischarge Detection Voltage [V <sub>DL</sub> ] | Overdischarge Release Voltage [V <sub>DU</sub> ] | Delay Time Combination <sup>*1</sup> | CO Pin Output Form     |
|-----------------|-------------------------------------------------|-----------------------------------------------|----------------------------------------------------|--------------------------------------------------|--------------------------------------|------------------------|
| S-8211EAA-I6T1U | 4.220 V                                         | 4.220 V                                       | 2.00 V                                             | 2.00 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAB-I6T1U | 4.270 V                                         | 4.270 V                                       | 2.00 V                                             | 2.00 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAD-I6T1U | 4.220 V                                         | 4.220 V                                       | 2.50 V                                             | 2.50 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAE-I6T1U | 4.220 V                                         | 4.220 V                                       | 2.30 V                                             | 2.30 V                                           | (2)                                  | CMOS output active "L" |
| S-8211EAH-I6T1U | 4.000 V                                         | 3.800 V                                       | 3.00 V                                             | 3.20 V                                           | (1)                                  | CMOS output active "L" |
| S-8211EAI-I6T1U | 3.800 V                                         | 3.700 V                                       | 2.30 V                                             | 2.40 V                                           | (1)                                  | CMOS output active "L" |
| S-8211EAP-I6T1U | 4.280 V                                         | 4.080 V                                       | 2.50 V                                             | 2.50 V                                           | (1)                                  | CMOS output active "L" |

<sup>\*1</sup>. Refer to the **Table 3** about the details of the delay time combinations (1), (2).

**Remark** Please contact our sales office for the products with detection voltage value other than those specified above.

**Table 3**

| Delay Time Combination | Overcharge Detection Delay Time [t <sub>CU</sub> ] | Overdischarge Detection Delay Time [t <sub>DL</sub> ] |
|------------------------|----------------------------------------------------|-------------------------------------------------------|
| (1)                    | 1.2 s                                              | 150 ms                                                |
| (2)                    | 573 ms                                             | 300 ms                                                |

**Remark** The delay times can be changed within the range listed **Table 4**. For details, please contact our sales office.

**Table 4**

| Delay Time                         | Symbol          | Selection Range |        |        | Remark                        |
|------------------------------------|-----------------|-----------------|--------|--------|-------------------------------|
| Overcharge detection delay time    | t <sub>CU</sub> | 143 ms          | 573 ms | 1.2 s  | Select a value from the left. |
| Overdischarge detection delay time | t <sub>DL</sub> | 38 ms           | 150 ms | 300 ms | Select a value from the left. |

**Remark** The value surrounded by bold lines is the delay time of the standard products.

### ■ Pin Configurations

#### 1. SOT-23-5

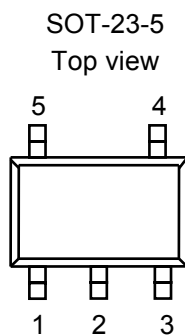


Figure 2

Table 5

| Pin No. | Symbol | Description                                          |
|---------|--------|------------------------------------------------------|
| 1       | VM     | Negative power supply input pin for CO pin           |
| 2       | VDD    | Input pin for positive power supply                  |
| 3       | VSS    | Input pin for negative power supply                  |
| 4       | DO     | Output pin for overdischarge detection (CMOS output) |
| 5       | CO     | Output pin for overcharge detection (CMOS output)    |

#### 2. SNT-6A

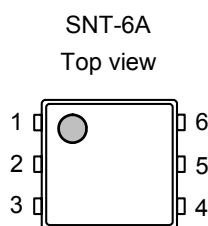


Figure 3

Table 6

| Pin No. | Symbol           | Description                                          |
|---------|------------------|------------------------------------------------------|
| 1       | NC <sup>*1</sup> | No connection                                        |
| 2       | CO               | Output pin for overcharge detection (CMOS output)    |
| 3       | DO               | Output pin for overdischarge detection (CMOS output) |
| 4       | VSS              | Input pin for negative power supply                  |
| 5       | VDD              | Input pin for positive power supply                  |
| 6       | VM               | Negative power supply input pin for CO pin           |

<sup>\*1</sup>. The NC pin is electrically open.

The NC pin can be connected to VDD pin or VSS pin.

## ■ Absolute Maximum Ratings

**Table 7**

(Ta = +25°C unless otherwise specified)

| Item                                      | Symbol    | Applied pin | Absolute Maximum Ratings         | Unit |
|-------------------------------------------|-----------|-------------|----------------------------------|------|
| Input voltage between VDD pin and VSS pin | $V_{DS}$  | VDD         | $V_{SS} - 0.3$ to $V_{SS} + 12$  | V    |
| VM pin input voltage                      | $V_{VM}$  | VM          | $V_{DD} - 28$ to $V_{DD} + 0.3$  | V    |
| DO pin output voltage                     | $V_{DO}$  | DO          | $V_{SS} - 0.3$ to $V_{DD} + 0.3$ | V    |
| CO pin output voltage                     | $V_{CO}$  | CO          | $V_{VM} - 0.3$ to $V_{DD} + 0.3$ | V    |
| Power dissipation                         | SOT-23-5  | $P_D$       | 600 <sup>*1</sup>                | mW   |
|                                           | SNT-6A    |             | 400 <sup>*1</sup>                | mW   |
| Operating ambient temperature             | $T_{opr}$ | —           | −40 to +85                       | °C   |
| Storage temperature                       | $T_{stg}$ | —           | −55 to +125                      | °C   |

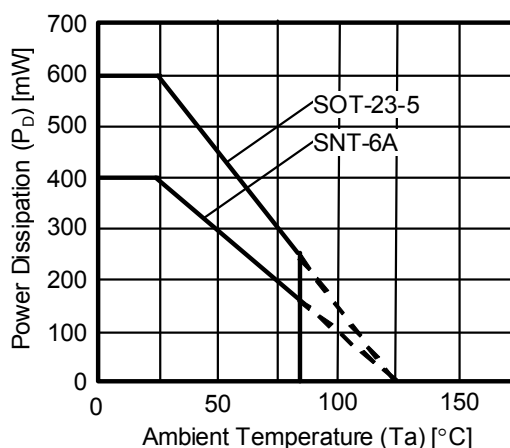
\*1. When mounted on board

[Mounted board]

(1) Board size: 114.3 mm × 76.2 mm × t1.6 mm

(2) Board name: JEDEC STANDARD51-7

**Caution** The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.



**Figure 4 Power Dissipation of Package (When Mounted on Board)**

### ■ Electrical Characteristics

#### 1. Except Detection Delay Time (+25°C)

Table 8

(Ta = +25°C unless otherwise specified)

| Item                                          | Symbol             | Condition                                                         |                                   | Min.                      | Typ.            | Max.                      | Unit | Test Condi-<br>tion | Test<br>Circuit |
|-----------------------------------------------|--------------------|-------------------------------------------------------------------|-----------------------------------|---------------------------|-----------------|---------------------------|------|---------------------|-----------------|
| DETECTION VOLTAGE                             |                    |                                                                   |                                   |                           |                 |                           |      |                     |                 |
| Overcharge detection voltage                  | V <sub>CU</sub>    | 3.60 V to 4.50 V, Adjustable                                      |                                   | V <sub>CU</sub><br>−0.025 | V <sub>CU</sub> | V <sub>CU</sub><br>+0.025 | V    | 1                   | 1               |
|                                               |                    | 3.60 V to 4.50 V, Adjustable,<br>Ta = −5°C to +55°C <sup>*1</sup> |                                   | V <sub>CU</sub><br>−0.03  | V <sub>CU</sub> | V <sub>CU</sub><br>+0.03  | V    | 1                   | 1               |
| Overcharge release voltage                    | V <sub>CL</sub>    | 3.50 V to 4.40 V,<br>Adjustable                                   | V <sub>CL</sub> ≠ V <sub>CU</sub> | V <sub>CL</sub><br>−0.05  | V <sub>CL</sub> | V <sub>CL</sub><br>+0.05  | V    | 1                   | 1               |
|                                               |                    |                                                                   | V <sub>CL</sub> = V <sub>CU</sub> | V <sub>CL</sub><br>−0.05  | V <sub>CL</sub> | V <sub>CL</sub><br>+0.025 | V    | 1                   | 1               |
| Overdischarge detection voltage               | V <sub>DL</sub>    | 2.00 V to 3.00 V, Adjustable                                      |                                   | V <sub>DL</sub><br>−0.05  | V <sub>DL</sub> | V <sub>DL</sub><br>+0.05  | V    | 2                   | 2               |
| Overdischarge release voltage                 | V <sub>DU</sub>    | 2.00 V to 3.40 V,<br>Adjustable                                   | V <sub>DU</sub> ≠ V <sub>DL</sub> | V <sub>DU</sub><br>−0.10  | V <sub>DU</sub> | V <sub>DU</sub><br>+0.10  | V    | 2                   | 2               |
|                                               |                    |                                                                   | V <sub>DU</sub> = V <sub>DL</sub> | V <sub>DU</sub><br>−0.05  | V <sub>DU</sub> | V <sub>DU</sub><br>+0.05  | V    | 2                   | 2               |
| INPUT VOLTAGE                                 |                    |                                                                   |                                   |                           |                 |                           |      |                     |                 |
| Operating voltage between VDD pin and VSS pin | V <sub>DSOP1</sub> | —                                                                 |                                   | 1.5                       | —               | 8                         | V    | —                   | —               |
| INPUT CURRENT                                 |                    |                                                                   |                                   |                           |                 |                           |      |                     |                 |
| Current consumption during operation          | I <sub>OPE</sub>   | V <sub>DD</sub> = 3.5 V, V <sub>VM</sub> = 0 V                    |                                   | 1.0                       | 3.0             | 5.5                       | μA   | 3                   | 2               |
| Current consumption during overdischarge      | I <sub>OPED</sub>  | V <sub>DD</sub> = 1.5 V, V <sub>VM</sub> = 0 V                    |                                   | 0.3                       | 2.0             | 3.5                       | μA   | 3                   | 2               |
| OUTPUT RESISTANCE                             |                    |                                                                   |                                   |                           |                 |                           |      |                     |                 |
| CO pin resistance “H”                         | R <sub>COH</sub>   | —                                                                 |                                   | 2.5                       | 5               | 10                        | kΩ   | 4                   | 3               |
| CO pin resistance “L”                         | R <sub>COL</sub>   | CO pin output logic active “H”                                    |                                   | 2.5                       | 9               | 15                        | kΩ   | 4                   | 3               |
|                                               |                    | CO pin output logic active “L”                                    |                                   | 2.5                       | 5               | 10                        | kΩ   | 4                   | 3               |
| DO pin resistance “H”                         | R <sub>DOH</sub>   | —                                                                 |                                   | 2.5                       | 5               | 10                        | kΩ   | 5                   | 3               |
| DO pin resistance “L”                         | R <sub>DOL</sub>   | —                                                                 |                                   | 2.5                       | 5               | 10                        | kΩ   | 5                   | 3               |

\*1. Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.

**2. Except Detection Delay Time (−40°C to +85°C \*1)**

**Table 9**

(Ta = −40°C to +85°C \*1 unless otherwise specified)

| Item                                          | Symbol             | Condition                                      |                                   | Min.                    | Typ.            | Max.                    | Unit | Test Condition | Test Circuit |
|-----------------------------------------------|--------------------|------------------------------------------------|-----------------------------------|-------------------------|-----------------|-------------------------|------|----------------|--------------|
| DETECTION VOLTAGE                             |                    |                                                |                                   |                         |                 |                         |      |                |              |
| Overcharge detection voltage                  | V <sub>CU</sub>    | 3.60 V to 4.50 V, Adjustable                   |                                   | V <sub>CU</sub> − 0.060 | V <sub>CU</sub> | V <sub>CU</sub> + 0.040 | V    | 1              | 1            |
| Overcharge release voltage                    | V <sub>CL</sub>    | 3.50 V to 4.40 V, Adjustable                   | V <sub>CL</sub> ≠ V <sub>CU</sub> | V <sub>CL</sub> − 0.08  | V <sub>CL</sub> | V <sub>CL</sub> + 0.065 | V    | 1              | 1            |
|                                               |                    |                                                | V <sub>CL</sub> = V <sub>CU</sub> | V <sub>CL</sub> − 0.08  | V <sub>CL</sub> | V <sub>CL</sub> + 0.04  | V    | 1              | 1            |
| Overdischarge detection voltage               | V <sub>DL</sub>    | 2.00 V to 3.00 V, Adjustable                   |                                   | V <sub>DL</sub> − 0.11  | V <sub>DL</sub> | V <sub>DL</sub> + 0.13  | V    | 2              | 2            |
| Overdischarge release voltage                 | V <sub>DU</sub>    | 2.00 V to 3.40 V, Adjustable                   | V <sub>DU</sub> ≠ V <sub>DL</sub> | V <sub>DU</sub> − 0.15  | V <sub>DU</sub> | V <sub>DU</sub> + 0.19  | V    | 2              | 2            |
|                                               |                    |                                                | V <sub>DU</sub> = V <sub>DL</sub> | V <sub>DU</sub> − 0.11  | V <sub>DU</sub> | V <sub>DU</sub> + 0.13  | V    | 2              | 2            |
| INPUT VOLTAGE                                 |                    |                                                |                                   |                         |                 |                         |      |                |              |
| Operating voltage between VDD pin and VSS pin | V <sub>DSOP1</sub> | —                                              |                                   | 1.5                     | —               | 8                       | V    | —              | —            |
| INPUT CURRENT                                 |                    |                                                |                                   |                         |                 |                         |      |                |              |
| Current consumption during operation          | I <sub>OPE</sub>   | V <sub>DD</sub> = 3.5 V, V <sub>VM</sub> = 0 V |                                   | 0.7                     | 3.0             | 6.0                     | μA   | 3              | 2            |
| Current consumption during overdischarge      | I <sub>OPED</sub>  | V <sub>DD</sub> = 1.5 V, V <sub>VM</sub> = 0 V |                                   | 0.2                     | 2.0             | 3.8                     | μA   | 3              | 2            |
| OUTPUT RESISTANCE                             |                    |                                                |                                   |                         |                 |                         |      |                |              |
| CO pin resistance “H”                         | R <sub>COH</sub>   | —                                              |                                   | 1.2                     | 5               | 15                      | kΩ   | 4              | 3            |
| CO pin resistance “L”                         | R <sub>COL</sub>   | CO pin output logic active “H”                 |                                   | 1.2                     | 9               | 27                      | kΩ   | 4              | 3            |
|                                               |                    | CO pin output logic active “L”                 |                                   | 1.2                     | 5               | 15                      | kΩ   | 4              | 3            |
| DO pin resistance “H”                         | R <sub>DOH</sub>   | —                                              |                                   | 1.2                     | 5               | 15                      | kΩ   | 5              | 3            |
| DO pin resistance “L”                         | R <sub>DOL</sub>   | —                                              |                                   | 1.2                     | 5               | 15                      | kΩ   | 5              | 3            |

\*1. Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.

### 3. Detection Delay Time

#### 3.1 S-8211EAC, S-8211EAH, S-8211EAI, S-8211EAJ, S-8211EAK, S-8211EAP

Table 10

| Item                                       | Symbol          | Condition | Min. | Typ. | Max. | Unit | Test Condition | Test Circuit |
|--------------------------------------------|-----------------|-----------|------|------|------|------|----------------|--------------|
| <b>DELAY TIME (Ta = +25°C)</b>             |                 |           |      |      |      |      |                |              |
| Overcharge detection delay time            | t <sub>CU</sub> | –         | 0.96 | 1.2  | 1.4  | s    | 6              | 4            |
| Overdischarge detection delay time         | t <sub>DL</sub> | –         | 120  | 150  | 180  | ms   | 6              | 4            |
| <b>DELAY TIME (Ta = –40°C to +85°C) *1</b> |                 |           |      |      |      |      |                |              |
| Overcharge detection delay time            | t <sub>CU</sub> | –         | 0.7  | 1.2  | 2.0  | s    | 6              | 4            |
| Overdischarge detection delay time         | t <sub>DL</sub> | –         | 83   | 150  | 255  | ms   | 6              | 4            |

\*1. Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.

#### 3.2 S-8211EAA, S-8211EAB, S-8211EAD, S-8211EAE, S-8211EAF, S-8211EAG

Table 11

| Item                                       | Symbol          | Condition | Min. | Typ. | Max. | Unit | Test Condition | Test Circuit |
|--------------------------------------------|-----------------|-----------|------|------|------|------|----------------|--------------|
| <b>DELAY TIME (Ta = +25°C)</b>             |                 |           |      |      |      |      |                |              |
| Overcharge detection delay time            | t <sub>CU</sub> | –         | 458  | 573  | 687  | ms   | 6              | 4            |
| Overdischarge detection delay time         | t <sub>DL</sub> | –         | 240  | 300  | 360  | ms   | 6              | 4            |
| <b>DELAY TIME (Ta = –40°C to +85°C) *1</b> |                 |           |      |      |      |      |                |              |
| Overcharge detection delay time            | t <sub>CU</sub> | –         | 334  | 573  | 955  | ms   | 6              | 4            |
| Overdischarge detection delay time         | t <sub>DL</sub> | –         | 166  | 300  | 510  | ms   | 6              | 4            |

\*1. Since products are not screened at high and low temperature, the specification for this temperature range is guaranteed by design, not tested in production.

## ■ Test Circuits

**Caution** Unless otherwise specified, the output voltage levels “H” and “L” at CO pin ( $V_{CO}$ ) are judged by  $V_{VM} + 1.0$  V, and the output voltage levels “H” and “L” at DO pin ( $V_{DO}$ ) are judged by  $V_{SS} + 1.0$  V. Judge the CO pin level with respect to  $V_{VM}$  and the DO pin level with respect to  $V_{SS}$ .

### 1. Overcharge Detection Voltage, Overcharge Release Voltage (Test Condition 1, Test Circuit 1)

#### 1. 1 CO pin output logic = Active “H”

Overcharge detection voltage ( $V_{CU}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{CO}$  goes from “L” to “H” when the voltage  $V_1$  is gradually increased from the starting condition of  $V_1 = 3.5$  V. Overcharge release voltage ( $V_{CL}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{CO}$  goes from “H” to “L” when the voltage  $V_1$  is then gradually decreased. Overcharge hysteresis voltage ( $V_{HC}$ ) is defined as the difference between overcharge detection voltage ( $V_{CU}$ ) and overcharge release voltage ( $V_{CL}$ ).

#### 1. 2 CO pin output logic = Active “L”

Overcharge detection voltage ( $V_{CU}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{CO}$  goes from “H” to “L” when the voltage  $V_1$  is gradually increased from the starting condition of  $V_1 = 3.5$  V. Overcharge release voltage ( $V_{CL}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{CO}$  goes from “L” to “H” when the voltage  $V_1$  is then gradually decreased. Overcharge hysteresis voltage ( $V_{HC}$ ) is defined as the difference between overcharge detection voltage ( $V_{CU}$ ) and overcharge release voltage ( $V_{CL}$ ).

### 2. Overdischarge Detection Voltage, Overdischarge Release Voltage (Test Condition 2, Test Circuit 2)

Overdischarge detection voltage ( $V_{DL}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{DO}$  goes from “H” to “L” when the voltage  $V_1$  is gradually decreased from the starting condition of  $V_1 = 3.5$  V,  $V_2 = 0$  V. Overdischarge release voltage ( $V_{DU}$ ) is defined as the voltage between the VDD pin and VSS pin at which  $V_{DO}$  goes from “L” to “H” when the voltage  $V_1$  is then gradually increased. Overdischarge hysteresis voltage ( $V_{HD}$ ) is defined as the difference between overdischarge release voltage ( $V_{DU}$ ) and overdischarge detection voltage ( $V_{DL}$ ).

### 3. Current Consumption during Operation (Test Condition 3, Test Circuit 2)

The current consumption during operation ( $I_{OPE}$ ) is the current that flows through the VDD pin ( $I_{DD}$ ) under the set conditions of  $V_1 = 3.5$  V and  $V_2 = 0$  V (normal status).

### 4. Current Consumption during Overdischarge (Test Condition 3, Test Circuit 2)

The current consumption during overdischarge ( $I_{OPED}$ ) is the current that flows through the VDD pin ( $I_{DD}$ ) under the set conditions of  $V_1 = 1.5$  V,  $V_2 = 0$  V (overdischarge status).

**5. CO Pin Resistance “H”****(Test Condition 4, Test Circuit 3)****5.1 CO pin output logic = Active “H”**

The CO pin resistance “H” ( $R_{COH}$ ) is the resistance at the CO pin under the set conditions of  $V_1 = 4.5\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_3 = 4.0\text{ V}$ .

**5.2 CO pin output logic = Active “L”**

The CO pin resistance “H” ( $R_{COH}$ ) is the resistance at the CO pin under the set conditions of  $V_1 = 3.5\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_3 = 3.0\text{ V}$ .

**6. CO Pin Resistance “L”****(Test Condition 4, Test Circuit 3)****6.1 CO pin output logic = Active “H”**

The CO pin resistance “L” ( $R_{COL}$ ) is the resistance at the CO pin under the set conditions of  $V_1 = 3.5\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_3 = 0.5\text{ V}$ .

**6.2 CO pin output logic = Active “L”**

The CO pin resistance “L” ( $R_{COL}$ ) is the resistance at the CO pin under the set conditions of  $V_1 = 4.5\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_3 = 0.5\text{ V}$ .

**7. DO Pin Resistance “H”****(Test Condition 5, Test Circuit 3)**

The DO pin “H” resistance ( $R_{DOH}$ ) is the resistance at the DO pin under the set conditions of  $V_1 = 3.5\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_4 = 3.0\text{ V}$ .

**8. DO Pin Resistance “L”****(Test Condition 5, Test Circuit 3)**

The DO pin “L” resistance ( $R_{DOL}$ ) is the resistance at the DO pin under the set conditions of  $V_1 = 1.8\text{ V}$ ,  $V_2 = 0\text{ V}$ ,  $V_4 = 0.5\text{ V}$ .

**9. Overcharge Detection Delay Time****(Test Condition 6, Test Circuit 4)****9.1 CO pin output logic = Active “H”**

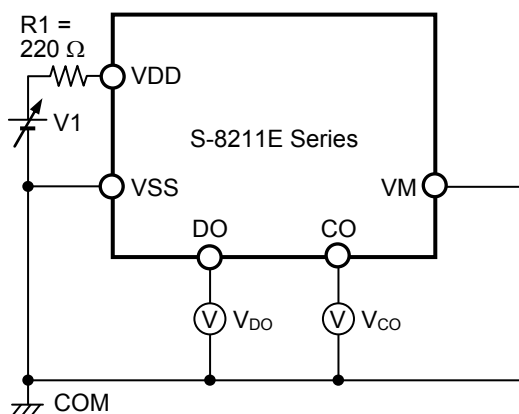
The overcharge detection delay time ( $t_{CU}$ ) is the time needed for  $V_{CO}$  to change from “L” to “H” just after the voltage  $V_1$  momentarily increases (within  $10\text{ }\mu\text{s}$ ) from overcharge detection voltage ( $V_{CU}$ )  $-0.2\text{ V}$  to overcharge detection voltage ( $V_{CU}$ )  $+0.2\text{ V}$  under the set conditions of  $V_2 = 0\text{ V}$ .

**9.2 CO pin output logic = Active “L”**

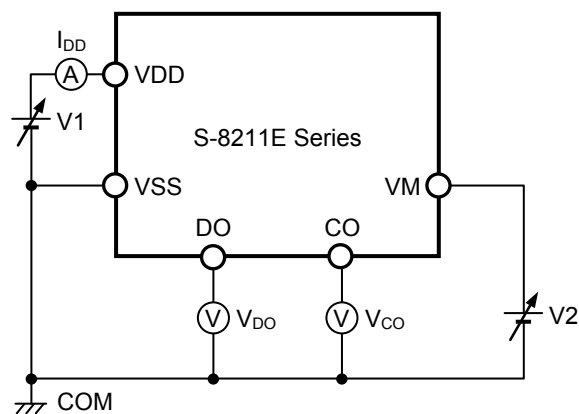
The overcharge detection delay time ( $t_{CU}$ ) is the time needed for  $V_{CO}$  to change from “H” to “L” just after the voltage  $V_1$  momentarily increases (within  $10\text{ }\mu\text{s}$ ) from overcharge detection voltage ( $V_{CU}$ )  $-0.2\text{ V}$  to overcharge detection voltage ( $V_{CU}$ )  $+0.2\text{ V}$  under the set conditions of  $V_2 = 0\text{ V}$ .

**10. Overdischarge Detection Delay Time****(Test Condition 6, Test Circuit 4)**

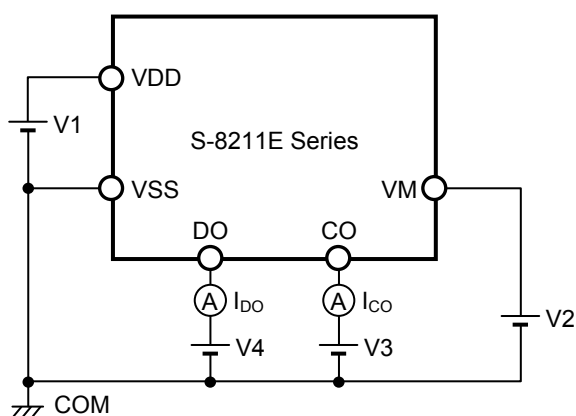
The overdischarge detection delay time ( $t_{DL}$ ) is the time needed for  $V_{DO}$  to change from “H” to “L” just after the voltage  $V_1$  momentarily decreases (within  $10\text{ }\mu\text{s}$ ) from overdischarge detection voltage ( $V_{DL}$ )  $+0.2\text{ V}$  to overdischarge detection voltage ( $V_{DL}$ )  $-0.2\text{ V}$  under the set condition of  $V_2 = 0\text{ V}$ .



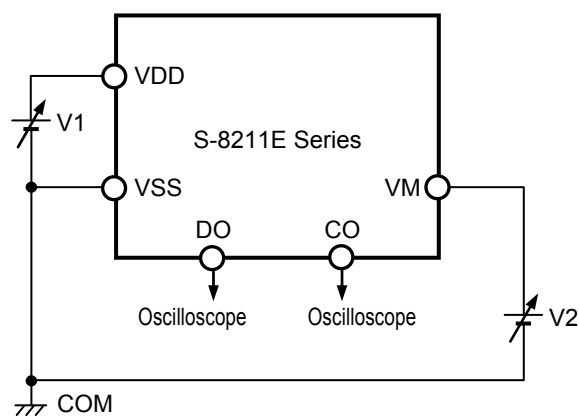
**Figure 5 Test Circuit 1**



**Figure 6 Test Circuit 2**



**Figure 7 Test Circuit 3**



**Figure 8 Test Circuit 4**

## ■ Operation

**Remark** Refer to the “■ Battery Protection IC Connection Example”.

### 1. Normal Status

The S-8211E Series monitors the voltage of the battery connected between the VDD and VSS pins.

In case of overdischarge detection voltage ( $V_{DL}$ )  $\leq$  battery voltage  $\leq$  overcharge detection voltage ( $V_{CU}$ ), the output levels of CO and DO pins are as follows. This is the normal status.

**Table 12**

| CO Pin Output Logic | CO Pin   | DO Pin   |
|---------------------|----------|----------|
| Active “H”          | $V_{VM}$ | $V_{DD}$ |
| Active “L”          | $V_{DD}$ | $V_{DD}$ |

### 2. Overcharge Status

When the battery voltage in the normal status exceeds the overcharge detection voltage ( $V_{CU}$ ) during charge, and this status is held for the overcharge detection delay time ( $t_{CU}$ ) or more, the output levels of CO and DO pins are as follows. This is the overcharge status.

This overcharge status is released when the battery voltage decreases to the overcharge release voltage ( $V_{CL}$ ) or less.

**Table 13**

| CO Pin Output Logic | CO Pin   | DO Pin   |
|---------------------|----------|----------|
| Active “H”          | $V_{DD}$ | $V_{DD}$ |
| Active “L”          | $V_{VM}$ | $V_{DD}$ |

### 3. Overdischarge Status

When the battery voltage in the normal status decreases than the overcharge detection voltage ( $V_{DL}$ ) during discharge, and this status is held for the overdischarge detection delay time ( $t_{DL}$ ) or more, the output levels of CO and DO pins are as follows. This is the overdischarge status.

This overdischarge status is released when the battery voltage increases to the overdischarge release voltage ( $V_{DU}$ ) or more.

**Table 14**

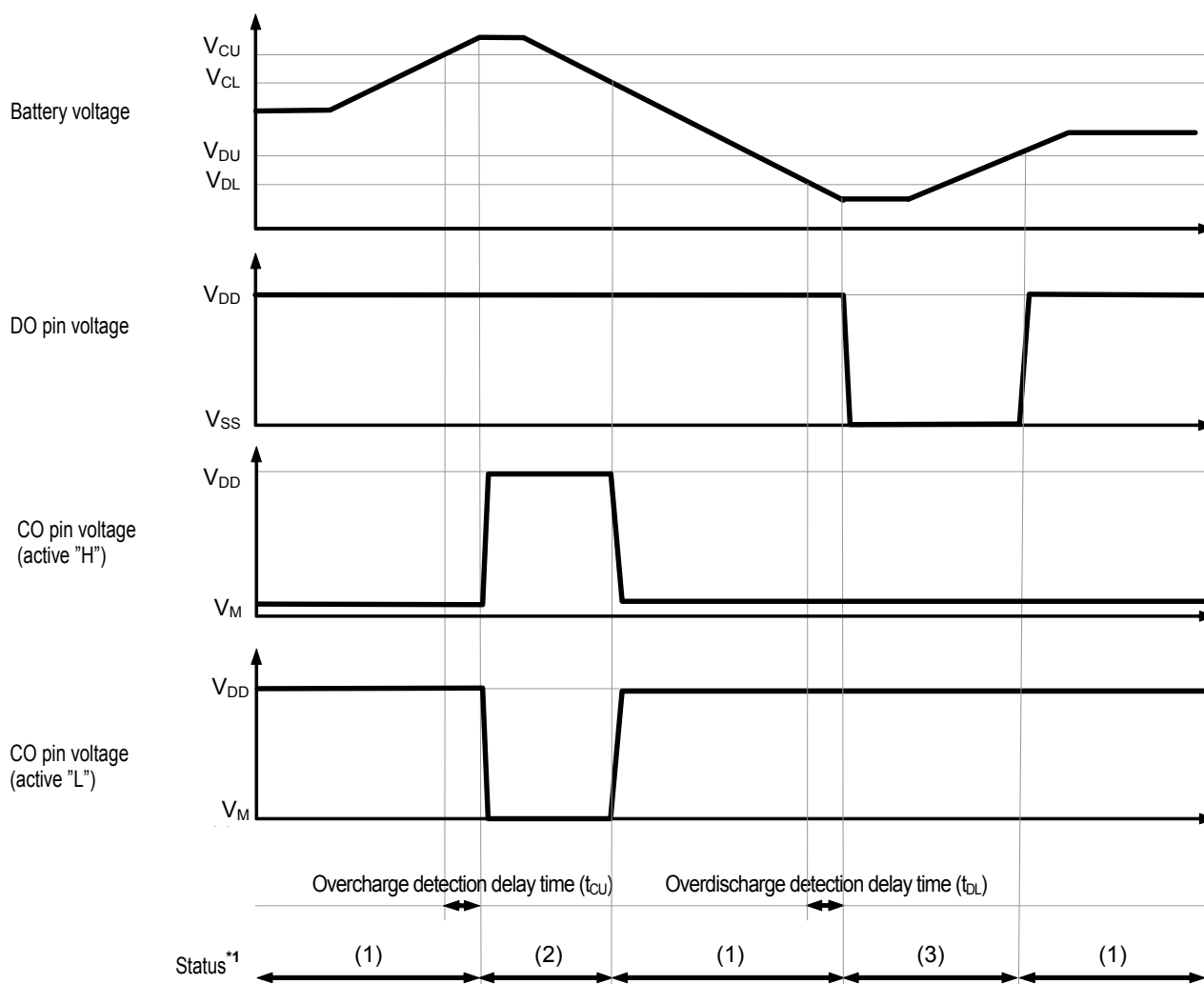
| CO Pin Output Logic | CO Pin   | DO Pin   |
|---------------------|----------|----------|
| Active “H”          | $V_{VM}$ | $V_{SS}$ |
| Active “L”          | $V_{DD}$ | $V_{SS}$ |

### 4. Delay Circuit

The detection delay times are determined by dividing a clock of approximately 3.5 kHz by the counter.

## ■ Timing Chart

### 1. Overcharge Detection, Overdischarge Detection



- \*1. (1) : Normal status  
 (2) : Overcharge status  
 (3) : Overdischarge status

Figure 9

### ■ Battery Protection IC Connection Example

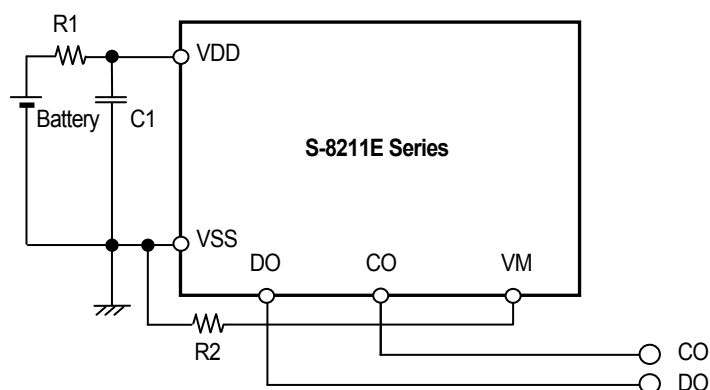


Figure 10

Table 15 Constants for External Components

| Symbol           | Part      | Purpose                                  | Min.                | Typ.              | Max.              | Remark                                                                                                                                  |
|------------------|-----------|------------------------------------------|---------------------|-------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| R1               | Resistor  | ESD protection,<br>For power fluctuation | 100 $\Omega$        | 220 $\Omega$      | 330 $\Omega$      | Resistance should be as small as possible to avoid lowering the overcharge detection accuracy due to current consumption. <sup>*1</sup> |
| C1               | Capacitor | For power fluctuation                    | 0.022 $\mu\text{F}$ | 0.1 $\mu\text{F}$ | 1.0 $\mu\text{F}$ | Connect a capacitor of 0.022 $\mu\text{F}$ or higher between VDD pin and VSS pin. <sup>*2</sup>                                         |
| R2 <sup>*3</sup> | Resistor  | ESD protection                           | 300 $\Omega$        | 1 k $\Omega$      | 4 k $\Omega$      | -                                                                                                                                       |

<sup>\*1</sup>. Insert a resistor of 100  $\Omega$  or higher as R1 for ESD protection.

<sup>\*2</sup>. If a capacitor of less than 0.022  $\mu\text{F}$  is connected to C1, DO pin may oscillate. Be sure to connect a capacitor of 0.022  $\mu\text{F}$  or higher to C1.

<sup>\*3</sup>. Be sure to using R2, connect the VM pin with the VSS pin.

- Caution**
1. The above constants may be changed without notice.
  2. It has not been confirmed whether the operation is normal or not in circuits other than the above example of connection. In addition, the example of connection shown above and the constant do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.

## ■ Application Circuit Examples

### 1. Protection circuits series multi-cells

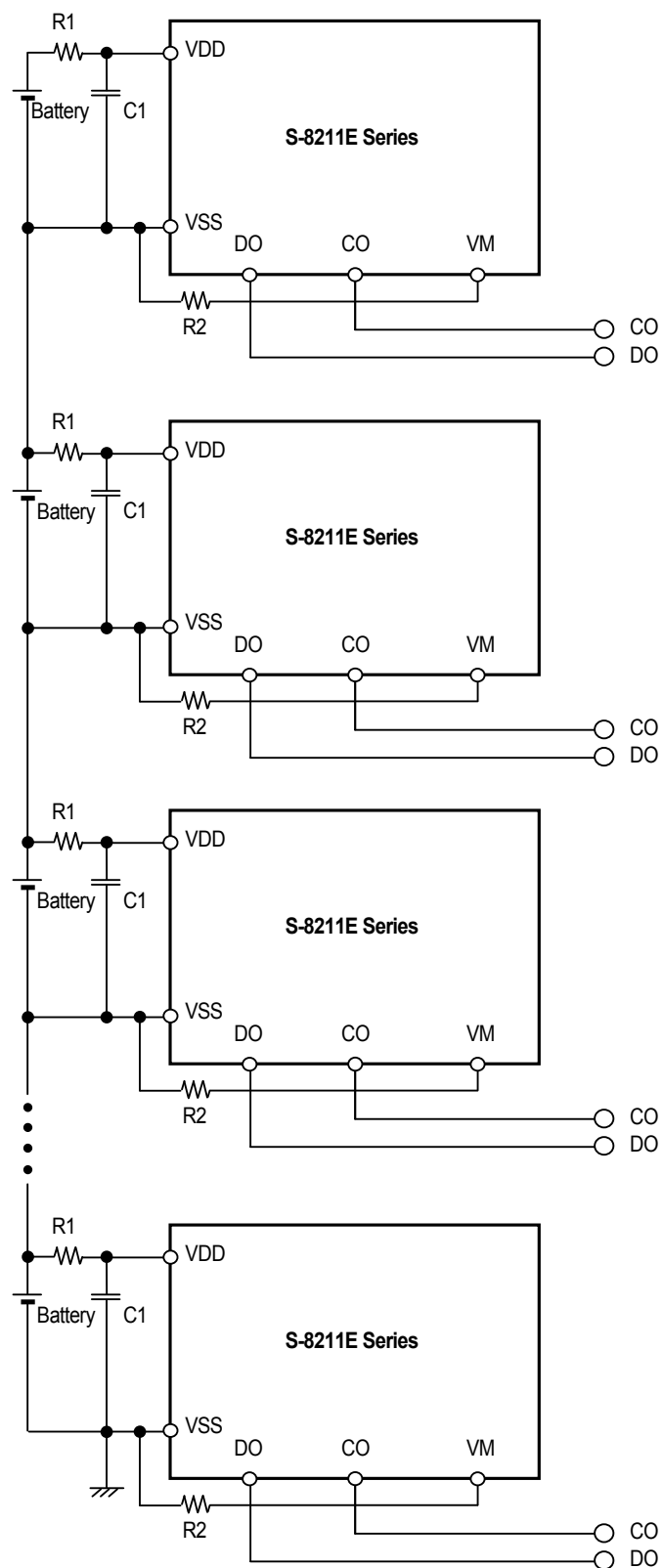


Figure 11

### 2. Charge cell-balance detection circuit

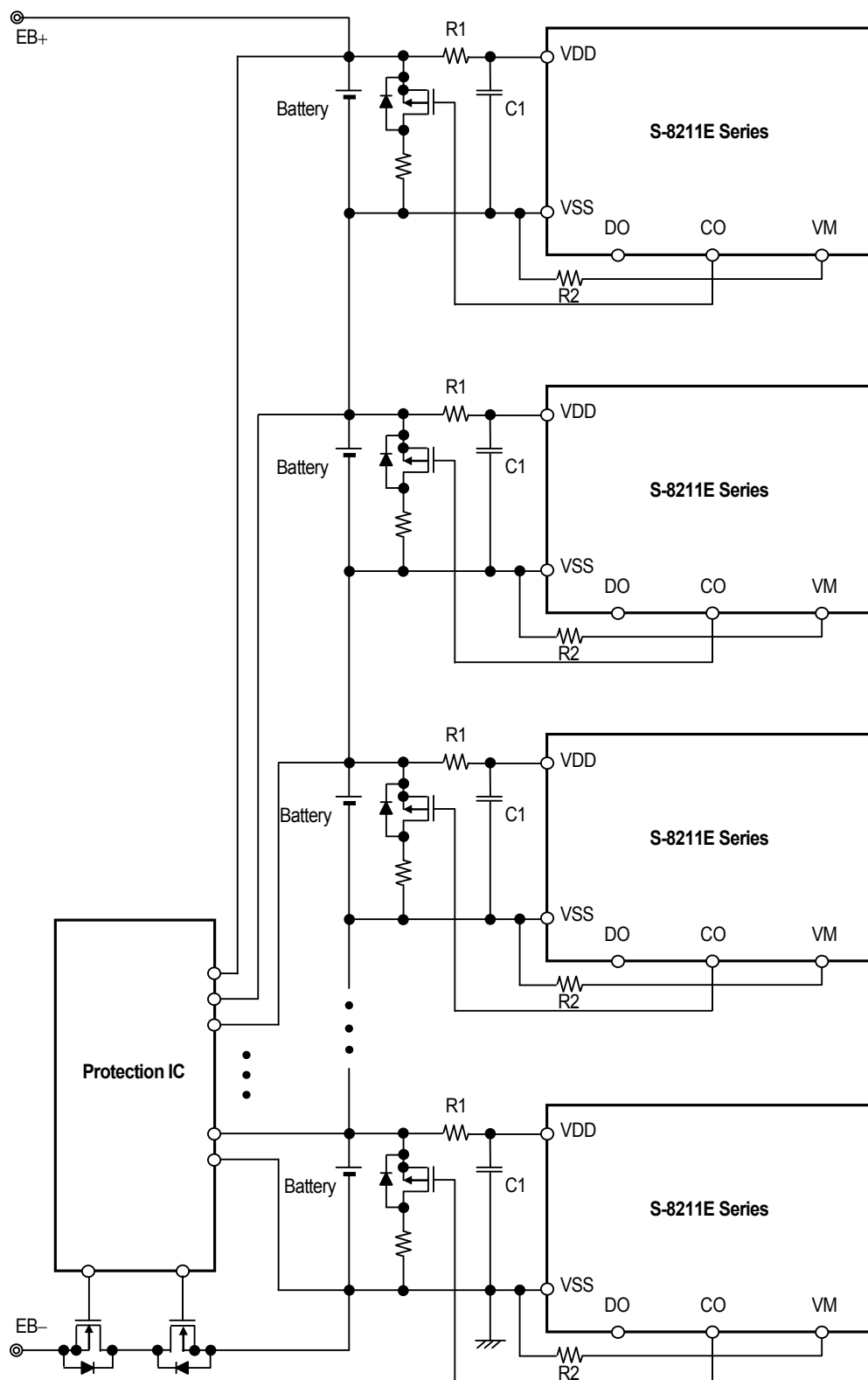


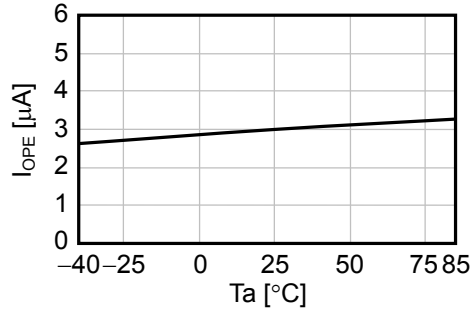
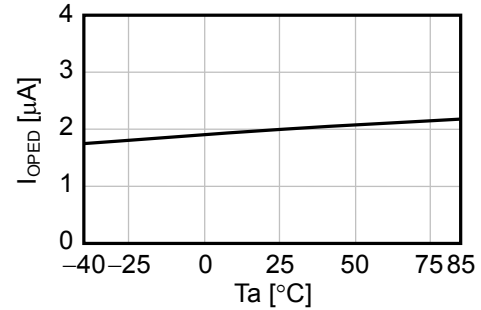
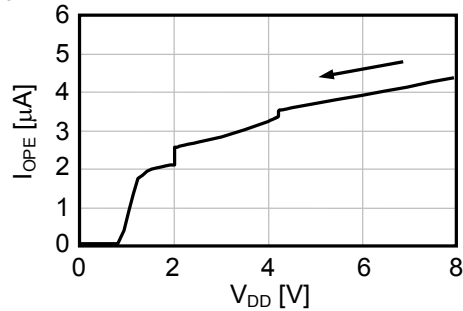
Figure 12

■ **Precautions**

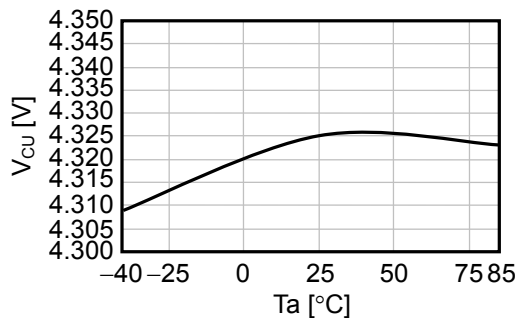
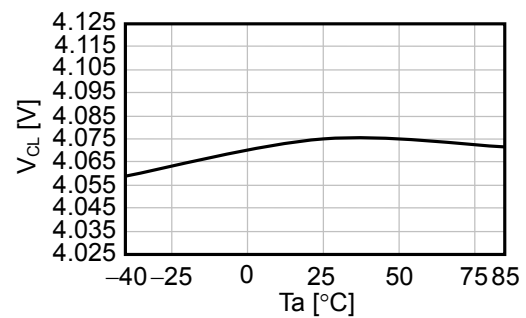
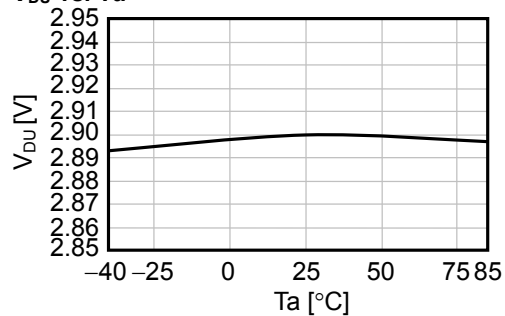
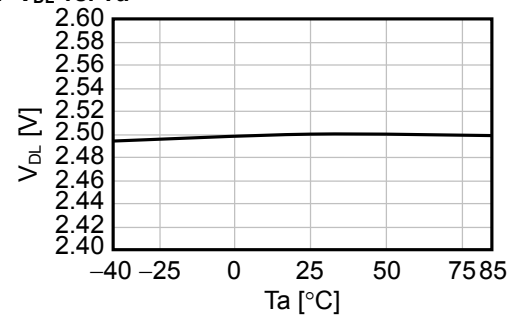
- The application conditions for the input voltage, output voltage, and load current should not exceed the package power dissipation.
- Be sure to using R2, connect the VM pin with the VSS pin.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- ABLIC Inc. claims no responsibility for any and all disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

## ■ Characteristics (Typical Data)

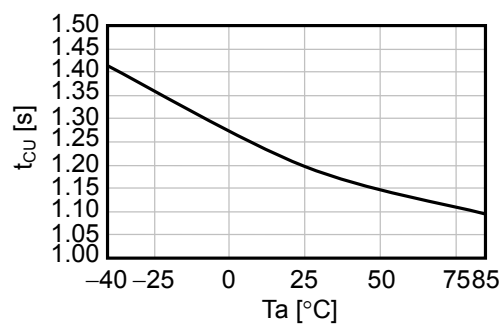
### 1. Current Consumption

1.1  $I_{OPE}$  vs.  $T_a$ 1.2  $I_{OPED}$  vs.  $T_a$ 1.3  $I_{OPE}$  vs.  $V_{DD}$ 

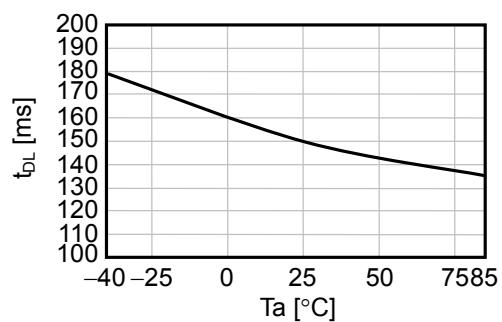
### 2. Overcharge Detection / Release Voltage, Overdischarge Detection / Release Voltage, Overcurrent Detection Voltage, and Delay Time

2.1  $V_{CU}$  vs.  $T_a$ 2.2  $V_{CL}$  vs.  $T_a$ 2.3  $V_{DU}$  vs.  $T_a$ 2.4  $V_{DL}$  vs.  $T_a$ 

**2. 5  $t_{CU}$  vs.  $T_a$**

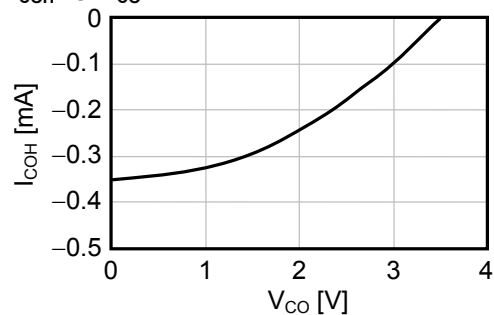


**2. 6  $t_{DL}$  vs.  $T_a$**

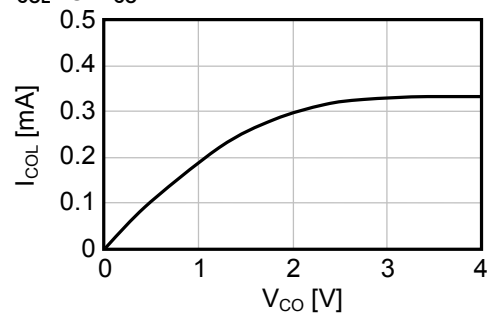


### 3. CO pin / DO pin

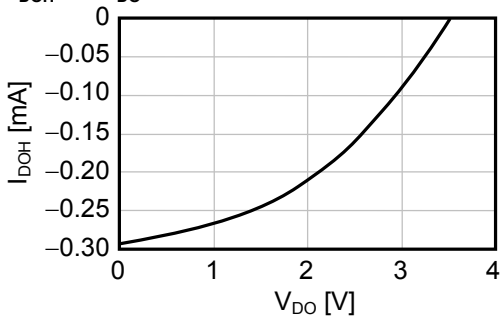
**3. 1  $I_{COH}$  vs.  $V_{CO}$**



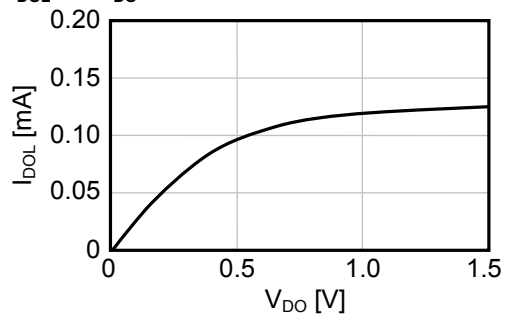
**3. 2  $I_{COL}$  vs.  $V_{CO}$**



**3. 3  $I_{DOH}$  vs.  $V_{DO}$**

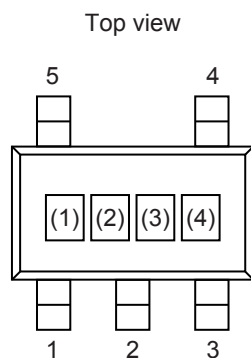


**3. 4  $I_{DOL}$  vs.  $V_{DO}$**



## ■ Marking Specifications

### 1. SOT-23-5

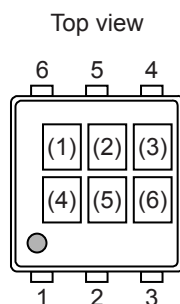


(1) to (3): Product Code (refer to **Product Name vs. Product Code**)  
(4) : Lot number

#### Product Name vs. Product Code

| Product Name    | Product Code |     |     |
|-----------------|--------------|-----|-----|
|                 | (1)          | (2) | (3) |
| S-8211EAC-M5T1U | R            | 3   | C   |
| S-8211EAF-M5T1U | R            | 3   | F   |
| S-8211EAG-M5T1U | R            | 3   | G   |
| S-8211EAJ-M5T1U | R            | 3   | J   |
| S-8211EAK-M5T1U | R            | 3   | K   |

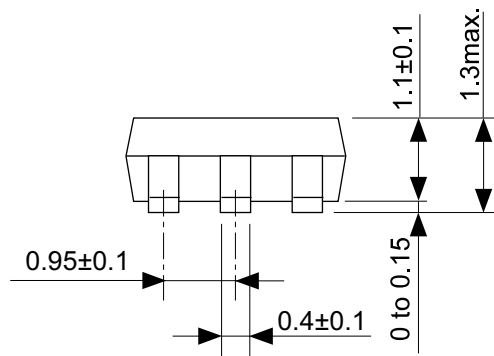
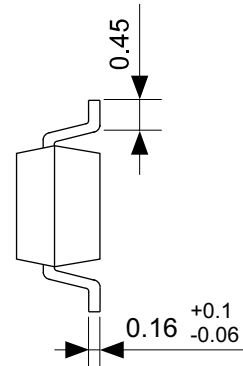
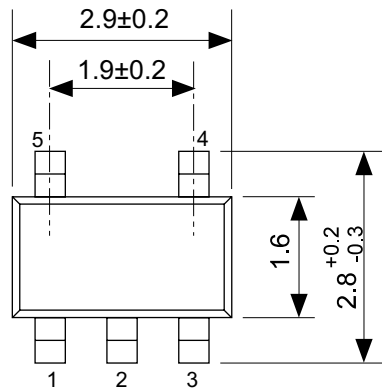
### 2. SNT-6A



(1) to (3): Product Code (refer to **Product Name vs. Product Code**)  
(4) to (6): Lot number

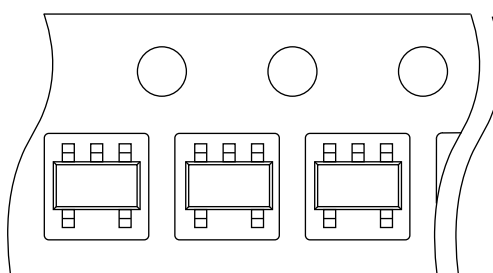
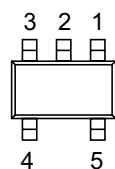
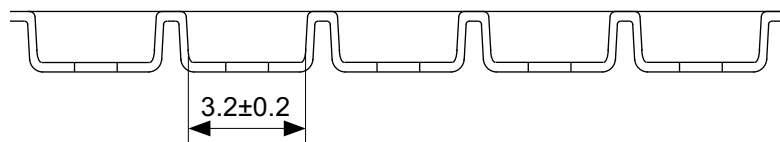
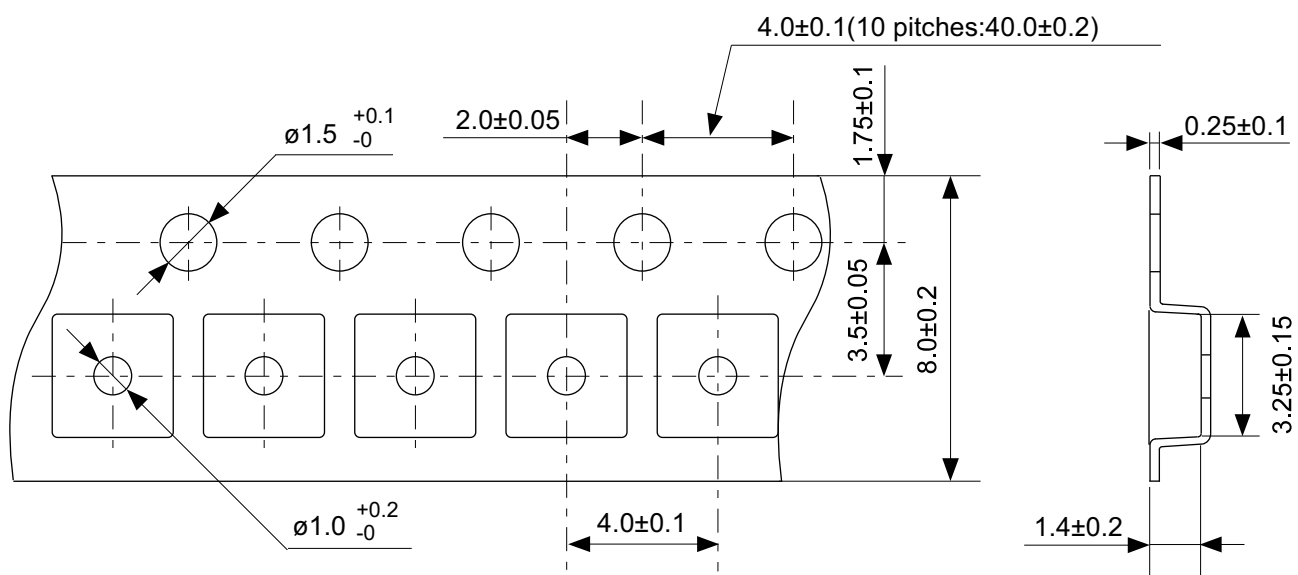
#### Product Name vs. Product Code

| Product Name    | Product Code |     |     |
|-----------------|--------------|-----|-----|
|                 | (1)          | (2) | (3) |
| S-8211EAA-I6T1U | R            | 3   | A   |
| S-8211EAB-I6T1U | R            | 3   | B   |
| S-8211EAD-I6T1U | R            | 3   | D   |
| S-8211EAE-I6T1U | R            | 3   | E   |
| S-8211EAH-I6T1U | R            | 3   | H   |
| S-8211EAI-I6T1U | R            | 3   | I   |
| S-8211EAP-I6T1U | R            | 3   | P   |



No. MP005-A-P-SD-1.3

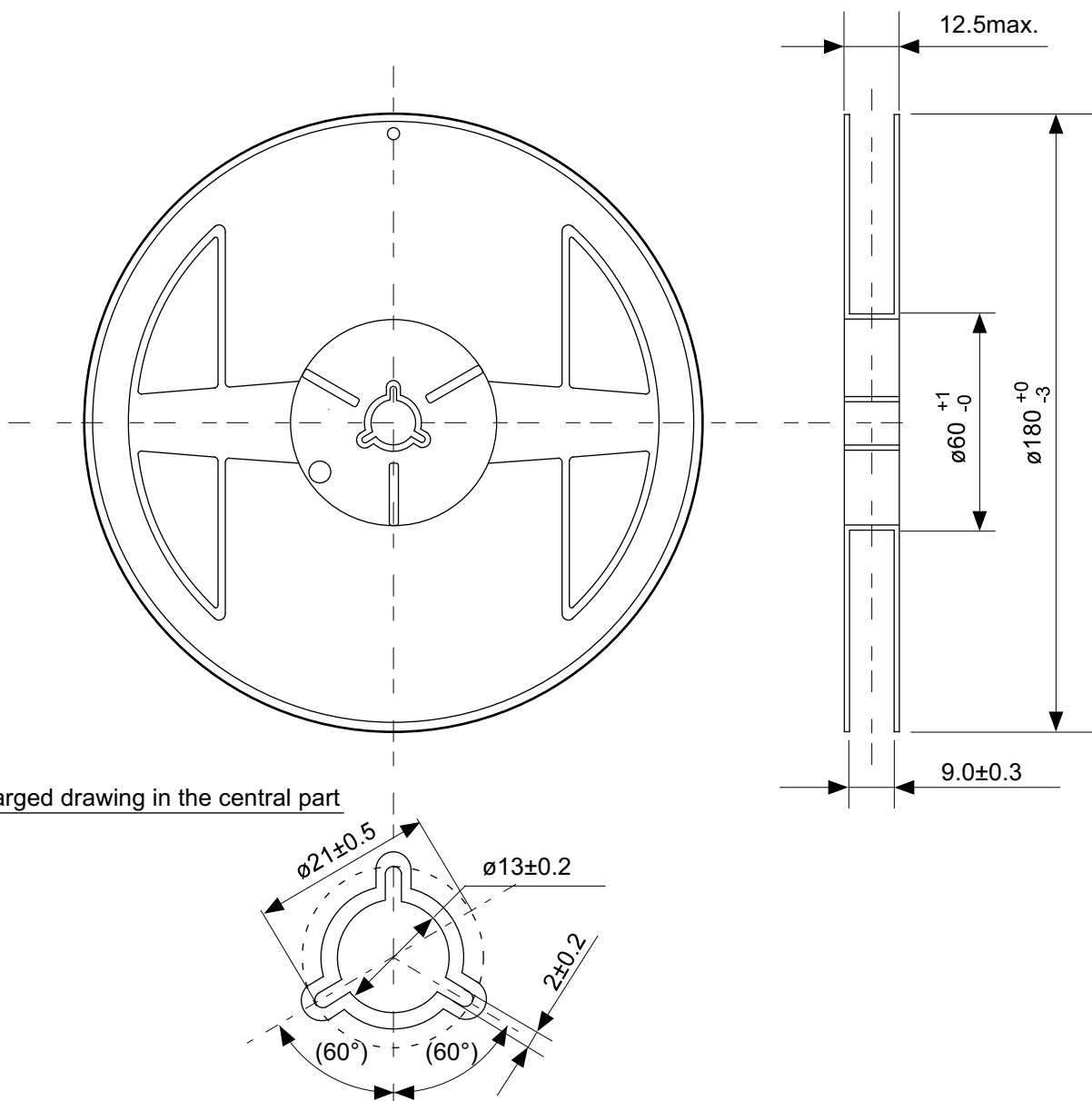
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| ANGLE      |  |
| UNIT       | mm                                                                                    |
|            |                                                                                       |
| ABLIC Inc. |                                                                                       |



Feed direction

No. MP005-A-C-SD-2.1

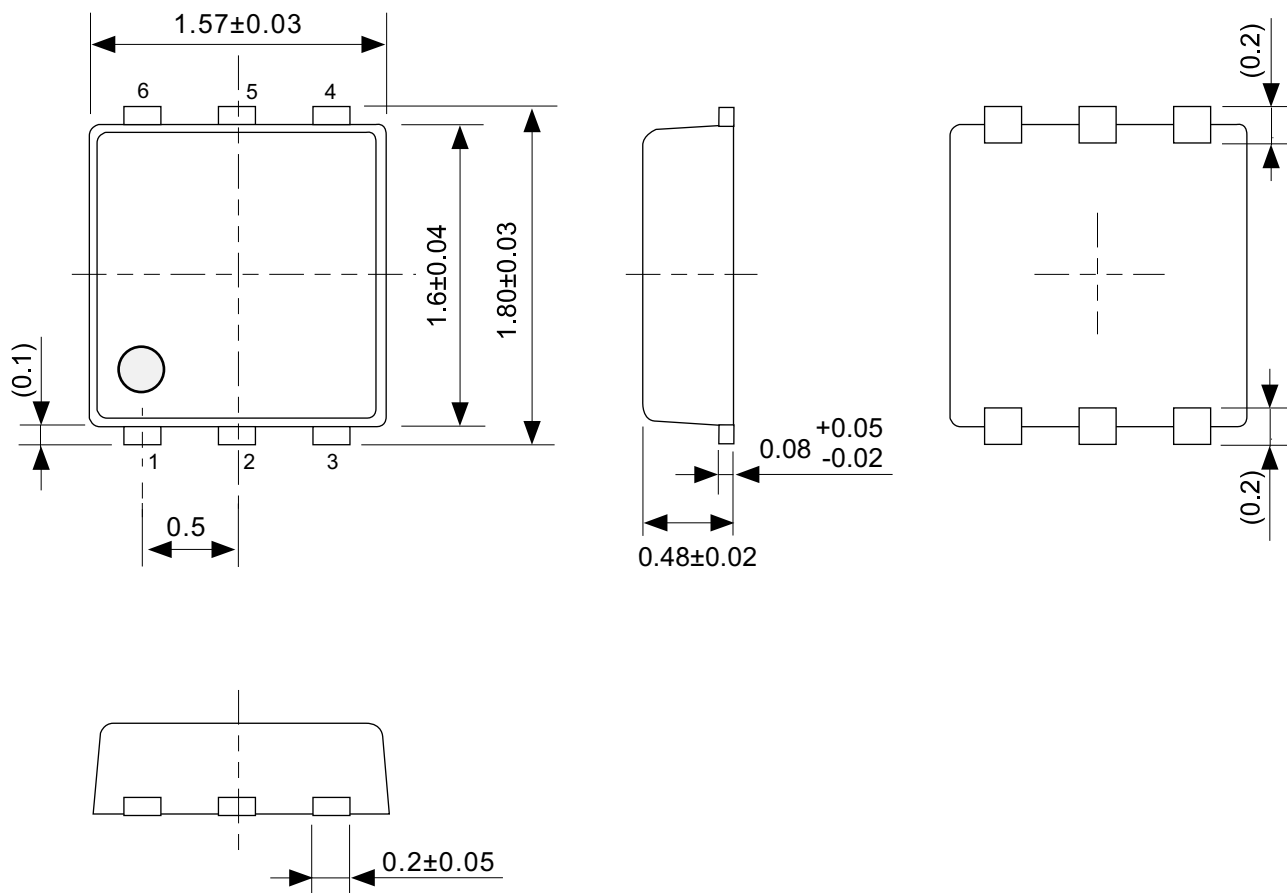
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| No.        | MP005-A-C-SD-2.1      |
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|            |                       |
| ABLIC Inc. |                       |



Enlarged drawing in the central part

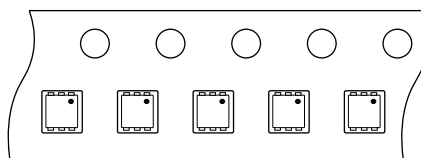
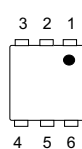
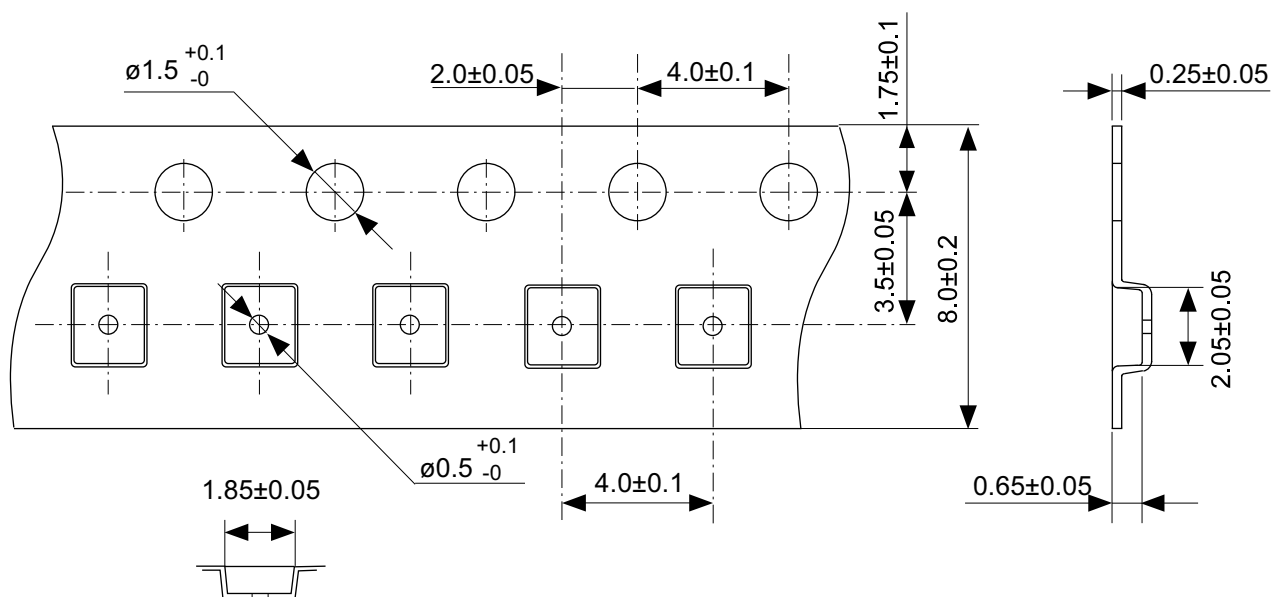
No. MP005-A-R-SD-1.1

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| No.        | MP005-A-R-SD-1.1 |      |       |
| ANGLE      |                  | QTY. | 3,000 |
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|            |                  |      |       |
| ABLIC Inc. |                  |      |       |



No. PG006-A-P-SD-2.1

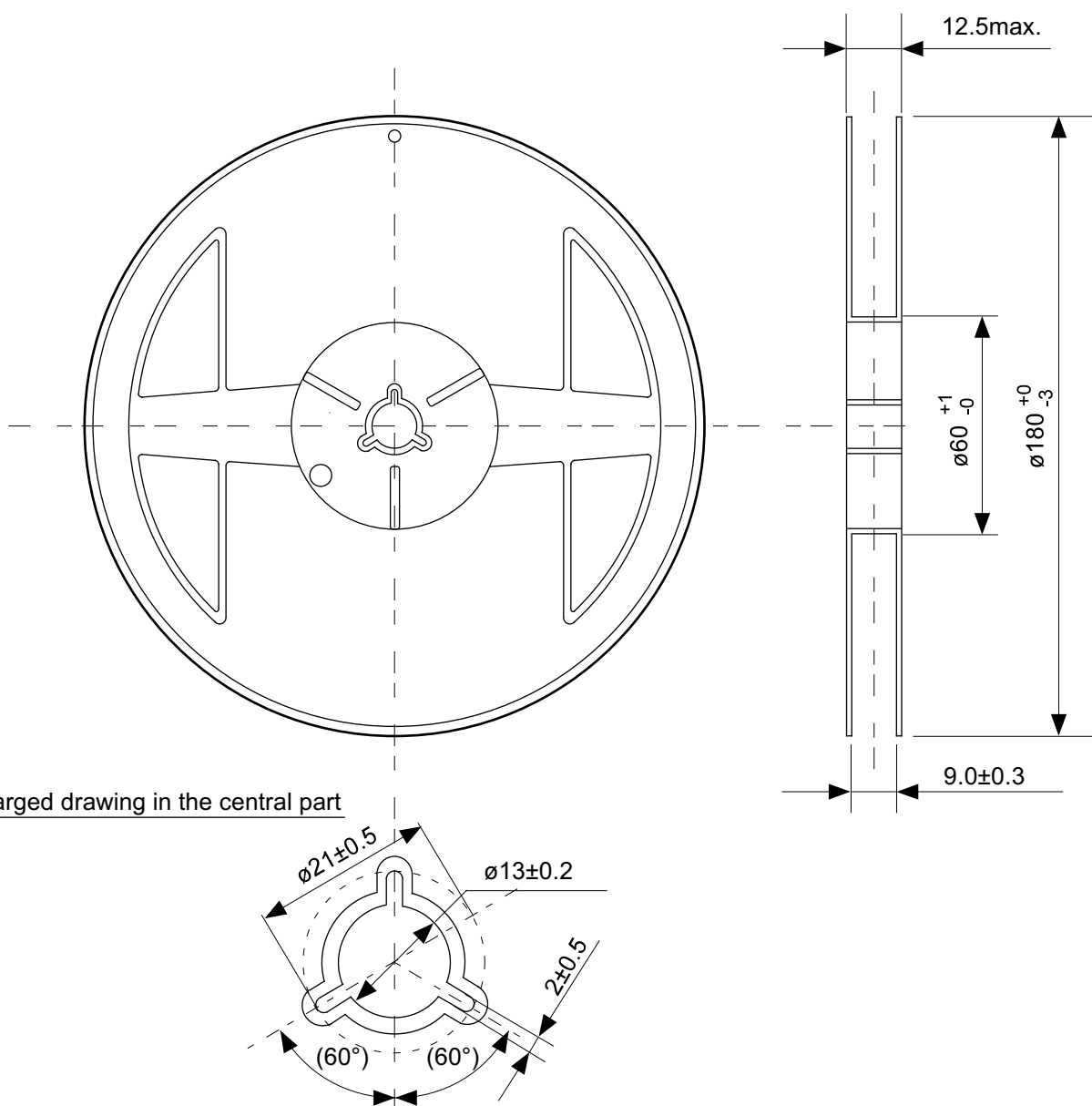
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| ABLIC Inc. |                                                                                       |



Feed direction

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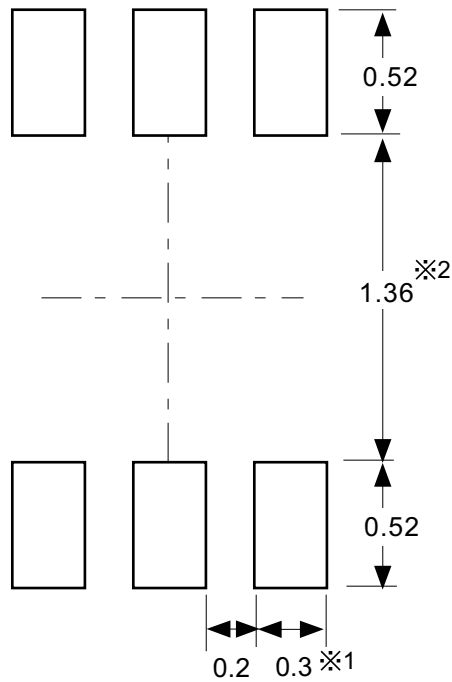
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| UNIT       | mm                    |
|            |                       |
| ABLIC Inc. |                       |



Enlarged drawing in the central part

No. PG006-A-R-SD-1.0

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|------------|------------------|------|-------|
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| ANGLE      |                  | QTY. | 5,000 |
| UNIT       | mm               |      |       |
|            |                  |      |       |
| ABLIC Inc. |                  |      |       |



※1. ランドパターンの幅に注意してください (0.25 mm min. / 0.30 mm typ.).

※2. パッケージ中央にランドパターンを広げないでください (1.30 mm ~ 1.40 mm)。

- 注意
1. パッケージのモールド樹脂下にシルク印刷やハンダ印刷などしないでください。
  2. パッケージ下の配線上のソルダーレジストなどの厚みをランドパターン表面から0.03 mm以下にしてください。
  3. マスク開口サイズと開口位置はランドパターンと合わせてください。
  4. 詳細は“SNTパッケージ活用の手引き”を参照してください。

※1. Pay attention to the land pattern width (0.25 mm min. / 0.30 mm typ.).

※2. Do not widen the land pattern to the center of the package ( 1.30 mm ~ 1.40 mm ).

- Caution**
1. Do not do silkscreen printing and solder printing under the mold resin of the package.
  2. The thickness of the solder resist on the wire pattern under the package should be 0.03 mm or less from the land pattern surface.
  3. Match the mask aperture size and aperture position with the land pattern.
  4. Refer to "SNT Package User's Guide" for details.

※1. 请注意焊盘模式的宽度 (0.25 mm min. / 0.30 mm typ.)。

※2. 请勿向封装中间扩展焊盘模式 (1.30 mm ~ 1.40 mm)。

- 注意
1. 请勿在树脂型封装的下面印刷丝网、焊锡。
  2. 在封装下、布线上的阻焊膜厚度 (从焊盘模式表面起) 请控制在 0.03 mm 以下。
  3. 钢网的开口尺寸和开口位置请与焊盘模式对齐。
  4. 详细内容请参阅 "SNT 封装的应用指南"。

No. PG006-A-L-SD-4.1

|            |                                  |
|------------|----------------------------------|
| TITLE      | SNT-6A-A<br>-Land Recommendation |
| No.        | PG006-A-L-SD-4.1                 |
| ANGLE      |                                  |
| UNIT       | mm                               |
|            |                                  |
| ABLIC Inc. |                                  |

## Disclaimers (Handling Precautions)

1. All the information described herein (product data, specifications, figures, tables, programs, algorithms and application circuit examples, etc.) is current as of publishing date of this document and is subject to change without notice.
2. The circuit examples and the usages described herein are for reference only, and do not guarantee the success of any specific mass-production design.  
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5. Before using the products, confirm their applications, and the laws and regulations of the region or country where they are used and verify suitability, safety and other factors for the intended use.
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