

The S-8211E Series has the high-accuracy voltage detection circuit and the delay circuit.

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 4.4 V (5 mV step) | Accuracy ± 25 mV (+25°C) Accuracy ± 30 mV (-5°C to +55°C) |
| • Overcharge release voltage | 3.5 V to 4.4 V ^{*1} | Accuracy ± 50 mV |
| • Overdischarge detection voltage | 2.0 V to 3.0 V (10 mV step) | Accuracy ± 50 mV |
| • Overdischarge release voltage | 2.0 V to 3.4 V ^{*2} | Accuracy ± 100 mV |
| (2) Detection delay times are generated by an internal circuit (external capacitors are unnecessary) | | Accuracy $\pm 20\%$ |
| (3) Wide operating temperature range | -40°C to +85°C | |
| (4) Low current consumption | | |
| • Operation mode | 3.0 μ A typ., 5.5 μ A max. (+25°C) | |
| • Overdischarge mode | 2.0 μ A typ., 3.5 μ A max. (+25°C) | |
| (5) Output logic of CO pin is selectable. | Active "H", Active "L" | |
| (6) Lead-free, Sn 100%, halogen-free ^{*3} | | |

*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.

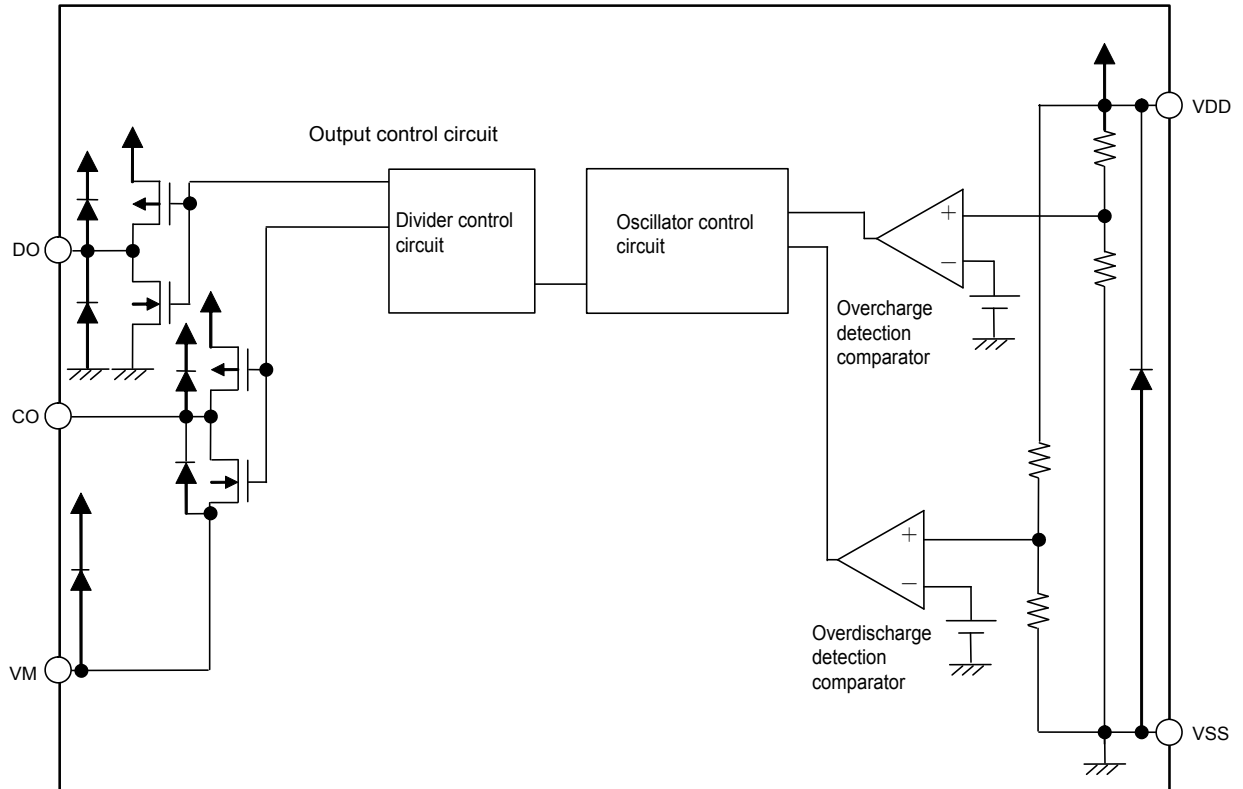
■ Applications

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

■ Packages

- SOT-23-5
- SNT-6A

■ **Block Diagram**



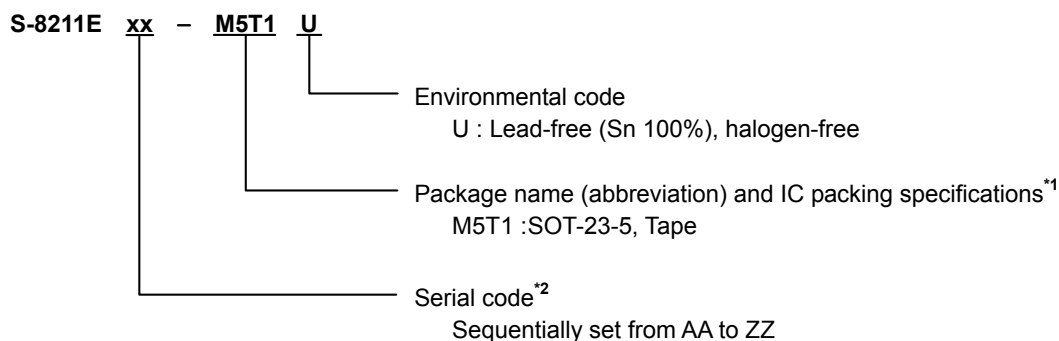
Remark All diodes shown in figure are parasitic diodes.

Figure 1

■ Product Name Structure

1. Product Name

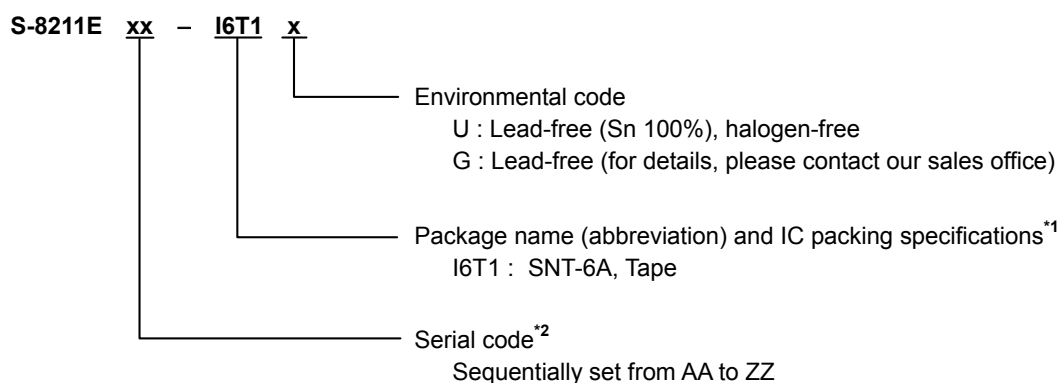
1.1 SOT-23-5



*1. Refer to the tape specifications.

*2. Refer to the "3. Product Name List".

1.2 SNT-6A



*1. Refer to the tape specifications.

*2. Refer to the "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 / Item | Overcharge Detection Voltage [V _{CU}] | Overcharge Release Voltage [V _{CL}] | Overdischarge Detection Voltage [V _{DL}] | Overdischarge Release Voltage [V _{DU}] | Delay Time Combination*1 | 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" |

*1. Refer to the **Table 3** about the details of the delay time combinations (1), (2).

- Remark 1.** Please contact our sales office for the products with detection voltage value other than those specified above.
2. Please select products of environmental code = U for Sn 100%, halogen-free products.

3.2 SNT-6A

Table 2

| Product Name / Item | Overcharge Detection Voltage [V _{CU}] | Overcharge Release Voltage [V _{CL}] | Overdischarge Detection Voltage [V _{DL}] | Overdischarge Release Voltage [V _{DU}] | Delay Time Combination*1 | CO Pin Output Form |
|---------------------|---|---|--|--|--------------------------|------------------------|
| S-8211EAA-I6T1x | 4.220 V | 4.220 V | 2.00 V | 2.00 V | (2) | CMOS output active "L" |
| S-8211EAB-I6T1x | 4.270 V | 4.270 V | 2.00 V | 2.00 V | (2) | CMOS output active "L" |
| S-8211EAD-I6T1x | 4.220 V | 4.220 V | 2.50 V | 2.50 V | (2) | CMOS output active "L" |
| S-8211EAE-I6T1x | 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" |

*1. Refer to the **Table 3** about the details of the delay time combinations (1), (2).

- Remark 1.** Please contact our sales office for the products with detection voltage value other than those specified above.
2. x: G or U
3. Please select products of environmental code = U for Sn 100%, halogen-free products.

Table 3

| Delay Time Combination | Overcharge Detection Delay Time [t _{CU}] | Overdischarge Detection Delay Time [t _{DL}] |
|------------------------|--|---|
| (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 _{CU} | 143 ms | 573 ms | 1.2 s | Select a value from the left. |
| Overdischarge detection delay time | t _{DL} | 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

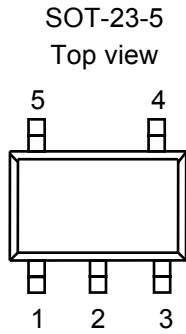


Figure 2

Table 5

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

2. SNT-6A

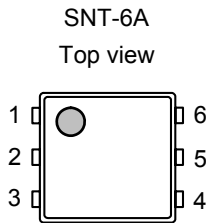


Figure 3

Table 6

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

*1. The NC pin is electrically open.
The NC pin can be connected to VDD or VSS.

■ **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 | - | 600 ^{*1} | mW |
| | SNT-6A | | 400 ^{*1} | 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.

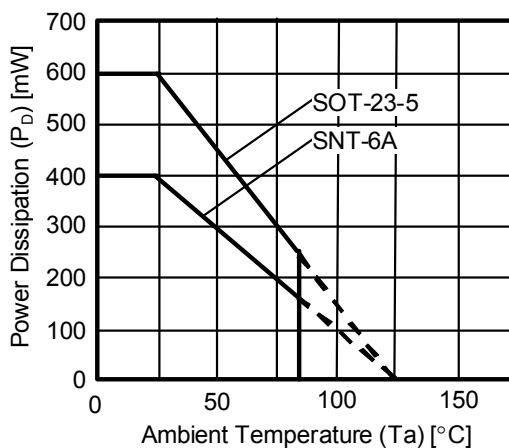


Figure 4 Power Dissipation of Package (When Mounted on Board)

BATTERY PROTECTION IC FOR 1-CELL PACK S-8211E Series

Rev.2.1_01

■ 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 Condition | Test Circuit | |
|---|--------------------|---|-----------------------------------|--------------------------|---------------------------|---------------------------|----------------|--------------|---|
| DETECTION VOLTAGE | | | | | | | | | |
| Overcharge detection voltage | V _{CU} | 3.60 V to 4.40 V, Adjustable | V _{CU} -0.025 | V _{CU} | V _{CU} +0.025 | V | 1 | 1 | |
| | | 3.60 V to 4.40 V, Adjustable, Ta = -5°C to +55°C*1 | V _{CU} -0.03 | V _{CU} | V _{CU} +0.03 | V | 1 | 1 | |
| Overcharge release voltage | V _{CL} | 3.50 V to 4.40 V, Adjustable | V _{CL} ≠ V _{CU} | V _{CL} -0.05 | V _{CL} | V _{CL} +0.05 | V | 1 | 1 |
| | | | V _{CL} = V _{CU} | V _{CL} -0.05 | V _{CL} | V _{CL} +0.025 | V | 1 | 1 |
| Overdischarge detection voltage | V _{DL} | 2.00 V to 3.00 V, Adjustable | V _{DL} -0.05 | V _{DL} | V _{DL} +0.05 | V | 2 | 2 | |
| Overdischarge release voltage | V _{DU} | 2.00 V to 3.40 V, Adjustable | V _{DU} ≠ V _{DL} | V _{DU} -0.10 | V _{DU} | V _{DU} +0.10 | V | 2 | 2 |
| | | | V _{DU} = V _{DL} | V _{DU} -0.05 | V _{DU} | V _{DU} +0.05 | V | 2 | 2 |
| INPUT VOLTAGE | | | | | | | | | |
| Operating voltage between VDD pin and VSS pin | V _{DSOP1} | – | 1.5 | – | 8 | V | – | – | |
| INPUT CURRENT | | | | | | | | | |
| Current consumption during operation | I _{OPE} | V _{DD} = 3.5 V, V _{VM} = 0 V | 1.0 | 3.0 | 5.5 | μA | 3 | 2 | |
| Current consumption during overdischarge | I _{OPED} | V _{DD} = 1.5 V, V _{VM} = 0 V | 0.3 | 2.0 | 3.5 | μA | 3 | 2 | |
| OUTPUT RESISTANCE | | | | | | | | | |
| CO pin resistance "H" | R _{COH} | – | 2.5 | 5 | 10 | kΩ | 4 | 3 | |
| CO pin resistance "L" | R _{COL} | 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 _{DOH} | – | 2.5 | 5 | 10 | kΩ | 5 | 3 | |
| DO pin resistance "L" | R _{DOL} | – | 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 _{CU} | 3.60 V to 4.40 V, Adjustable | V _{CU} − 0.060 | V _{CU} | V _{CU} + 0.040 | V | 1 | 1 |
| Overcharge release voltage | V _{CL} | 3.50 V to 4.40 V, Adjustable | V _{CL} ≠ V _{CU} | V _{CL} − 0.08 | V _{CL} + 0.065 | V | 1 | 1 |
| | | | V _{CL} = V _{CU} | V _{CL} − 0.08 | V _{CL} + 0.04 | V | 1 | 1 |
| Overdischarge detection voltage | V _{DL} | 2.00 V to 3.00 V, Adjustable | V _{DL} − 0.11 | V _{DL} | V _{DL} + 0.13 | V | 2 | 2 |
| Overdischarge release voltage | V _{DU} | 2.00 V to 3.40 V, Adjustable | V _{DU} ≠ V _{DL} | V _{DU} − 0.15 | V _{DU} + 0.19 | V | 2 | 2 |
| | | | V _{DU} = V _{DL} | V _{DU} − 0.11 | V _{DU} + 0.13 | V | 2 | 2 |
| INPUT VOLTAGE | | | | | | | | |
| Operating voltage between VDD pin and VSS pin | V _{DSOP1} | − | 1.5 | − | 8 | V | − | − |
| INPUT CURRENT | | | | | | | | |
| Current consumption during operation | I _{OPe} | V _{DD} = 3.5 V, V _{VM} = 0 V | 0.7 | 3.0 | 6.0 | μA | 3 | 2 |
| Current consumption during overdischarge | I _{OPeD} | V _{DD} = 1.5 V, V _{VM} = 0 V | 0.2 | 2.0 | 3.8 | μA | 3 | 2 |
| OUTPUT RESISTANCE | | | | | | | | |
| CO pin resistance "H" | R _{COH} | − | 1.2 | 5 | 15 | kΩ | 4 | 3 |
| CO pin resistance "L" | R _{COL} | 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 _{DOH} | − | 1.2 | 5 | 15 | kΩ | 5 | 3 |
| DO pin resistance "L" | R _{DOL} | − | 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

Table 10

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Test Condition | Test Circuit |
|--|-----------------|-----------|------|------|------|------|----------------|--------------|
| DELAY TIME (Ta = +25°C) | | | | | | | | |
| Overcharge detection delay time | t _{CU} | – | 0.96 | 1.2 | 1.4 | s | 6 | 4 |
| Overdischarge detection delay time | t _{DL} | – | 120 | 150 | 180 | ms | 6 | 4 |
| DELAY TIME (Ta = –40°C to +85°C) *1 | | | | | | | | |
| Overcharge detection delay time | t _{CU} | – | 0.7 | 1.2 | 2.0 | s | 6 | 4 |
| Overdischarge detection delay time | t _{DL} | – | 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 |
|--|-----------------|-----------|------|------|------|------|----------------|--------------|
| DELAY TIME (Ta = +25°C) | | | | | | | | |
| Overcharge detection delay time | t _{CU} | – | 458 | 573 | 687 | ms | 6 | 4 |
| Overdischarge detection delay time | t _{DL} | – | 240 | 300 | 360 | ms | 6 | 4 |
| DELAY TIME (Ta = –40°C to +85°C) *1 | | | | | | | | |
| Overcharge detection delay time | t _{CU} | – | 334 | 573 | 955 | ms | 6 | 4 |
| Overdischarge detection delay time | t _{DL} | – | 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. Operating Current Consumption (Test Condition 3, Test Circuit 2)

The operating current consumption (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. Overdischarge Current Consumption (Test Condition 3, Test Circuit 2)

The overdischarge current consumption (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 $V1 = 4.5\text{ V}$, $V2 = 0\text{ V}$, $V3 = 4.0\text{ V}$.

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 $V1 = 3.5\text{ V}$, $V2 = 0\text{ V}$, $V3 = 3.0\text{ V}$.

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 $V1 = 3.5\text{ V}$, $V2 = 0\text{ V}$, $V3 = 0.5\text{ V}$.

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 $V1 = 4.5\text{ V}$, $V2 = 0\text{ V}$, $V3 = 0.5\text{ V}$.

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 $V1 = 3.5\text{ V}$, $V2 = 0\text{ V}$, $V4 = 3.0\text{ V}$.

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 $V1 = 1.8\text{ V}$, $V2 = 0\text{ V}$, $V4 = 0.5\text{ V}$.

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 $V1$ momentarily increases (within $10\text{ }\mu\text{s}$) from overcharge detection voltage (V_{CU}) -0.2 V to overcharge detection voltage (V_{CU}) $+0.2\text{ V}$ under the set conditions of $V2 = 0\text{ V}$.

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 $V1$ momentarily increases (within $10\text{ }\mu\text{s}$) from overcharge detection voltage (V_{CU}) -0.2 V to overcharge detection voltage (V_{CU}) $+0.2\text{ V}$ under the set conditions of $V2 = 0\text{ V}$.

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 $V1$ 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 V under the set condition of $V2 = 0\text{ V}$.

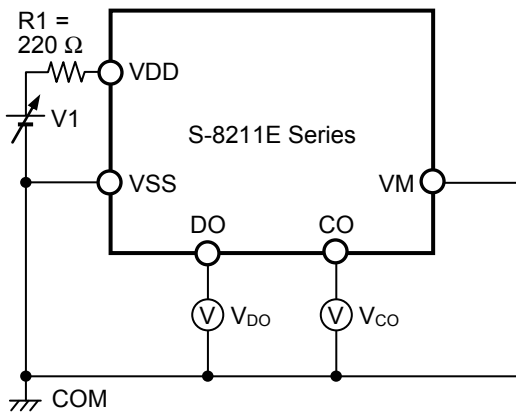


Figure 5 Test Circuit 1

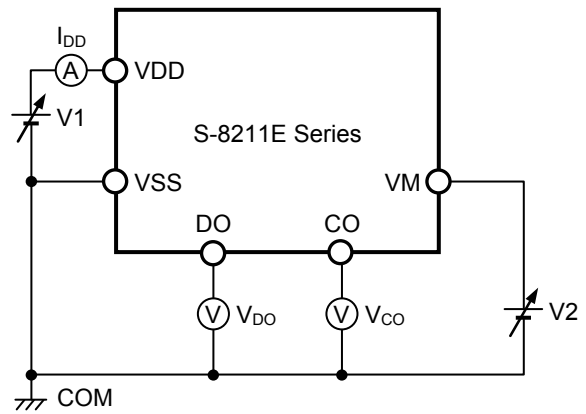


Figure 6 Test Circuit 2

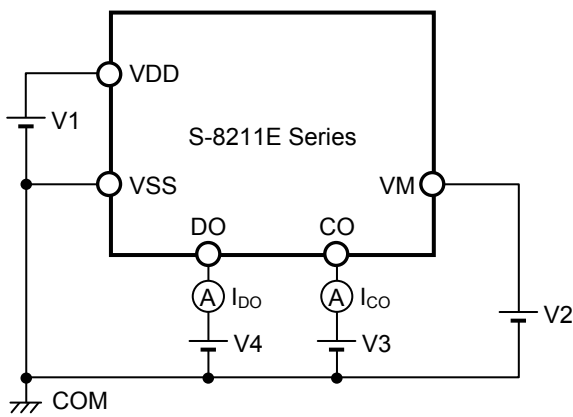


Figure 7 Test Circuit 3

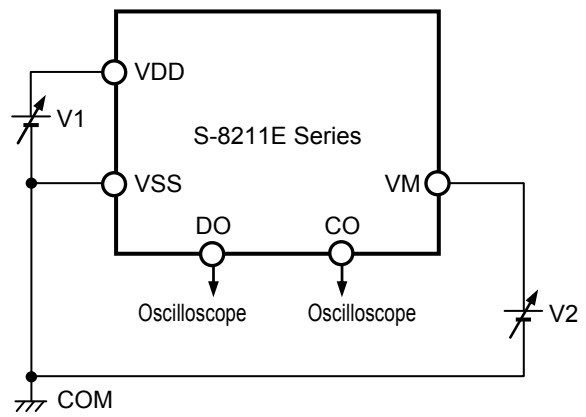


Figure 8 Test Circuit 4

■ **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

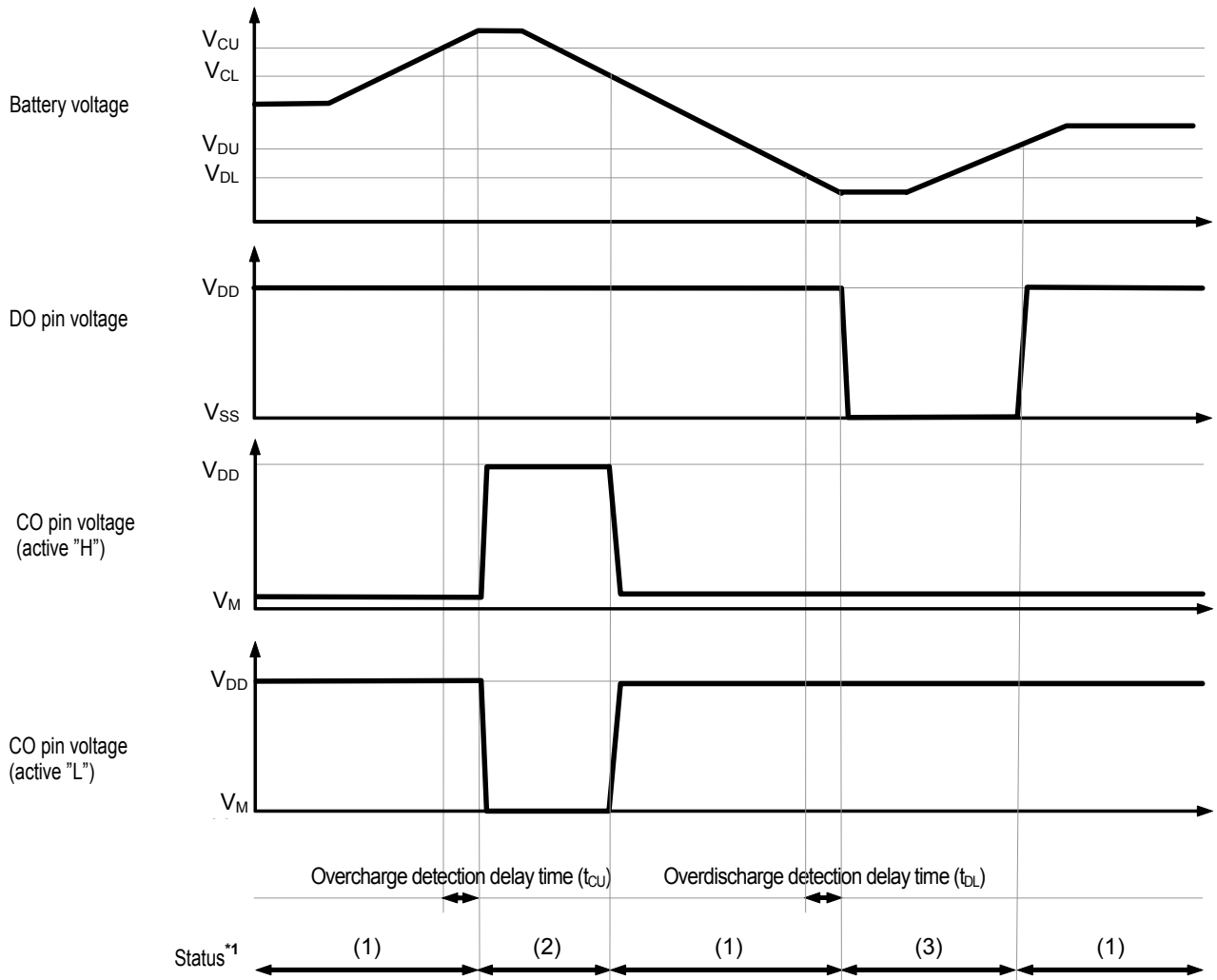
| CO Pin Output Logic | CO Pin | DO Pin |
|---------------------|----------|----------|
| Active “H” | V_{VM} | V_{SS} |
| Active “L” | V_{DD} | V_{SS} |

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**

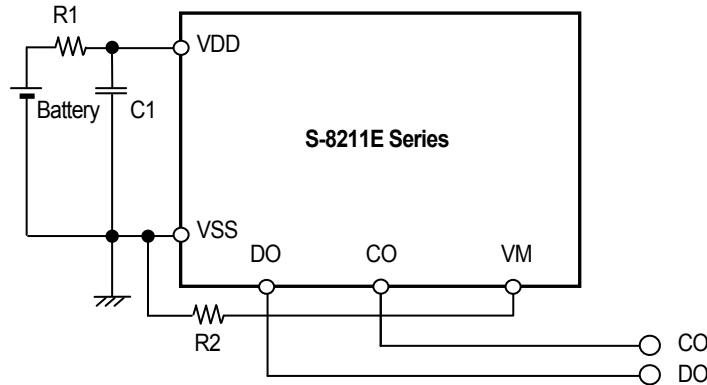


Figure 10

Table 15 Constants for External Components

| Symbol | Part | Purpose | Typ. | Min. | Max. | Remark |
|------------------|-----------|--|--------|----------|--------|---|
| R1 | Resistor | ESD protection, For power fluctuation | 220 Ω | 100 Ω | 330 Ω | Resistance should be as small as possible to avoid lowering the overcharge detection accuracy due to current consumption. ^{*1} |
| C1 | Capacitor | For power fluctuation | 0.1 μF | 0.022 μF | 1.0 μF | Connect a capacitor of 0.022 μF or higher between VDD pin and VSS pin. ^{*2} |
| R2 ^{*3} | Resistor | ESD protection | 1 kΩ | 300 Ω | 4 kΩ | - |

^{*1}. Insert a resistor of 100 Ω or higher as R1 for ESD protection.

^{*2}. If a capacitor of less than 0.022 μF is connected to C1, DO pin may oscillate. Be sure to connect a capacitor of 0.022 μF or higher to C1.

^{*3}. 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

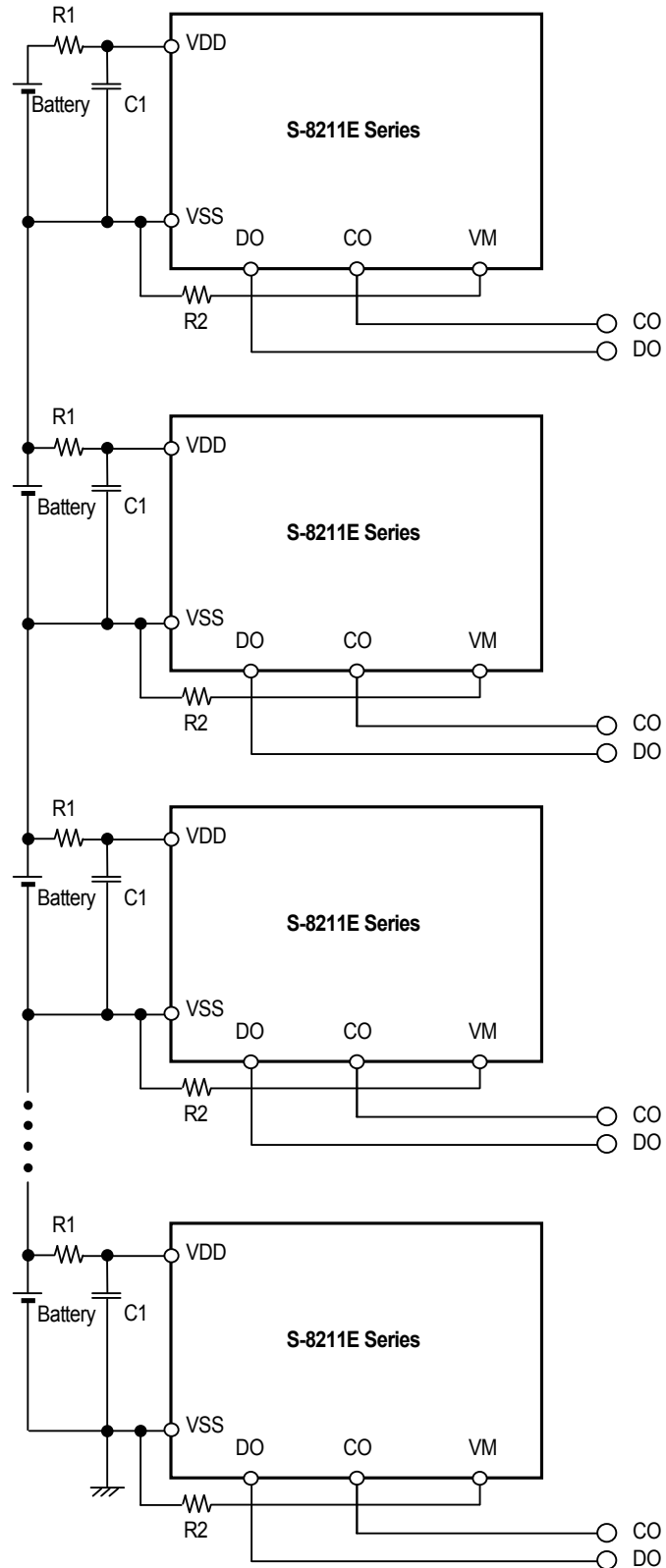


Figure 11

2. Charge cell-balance detection circuit

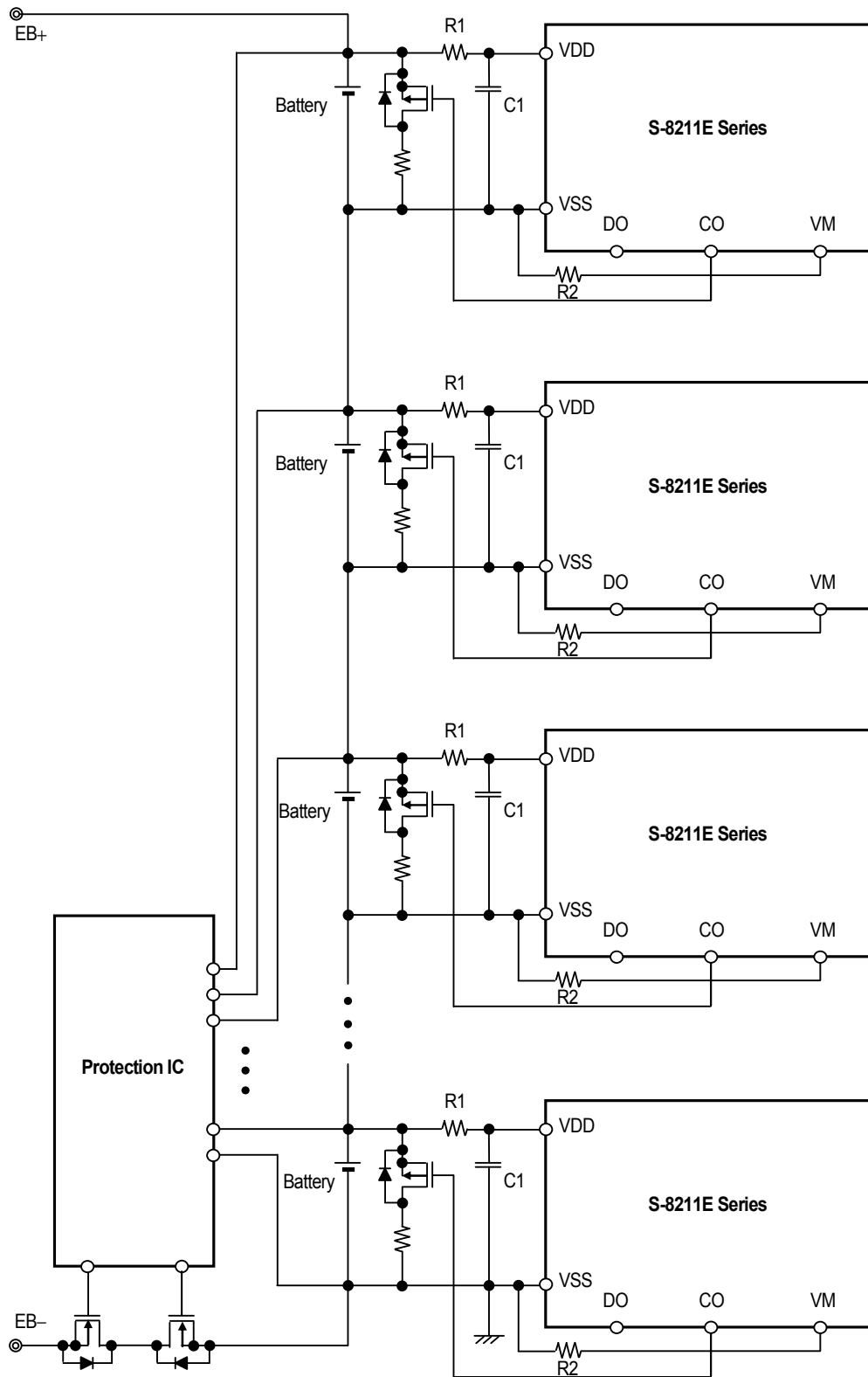


Figure 12

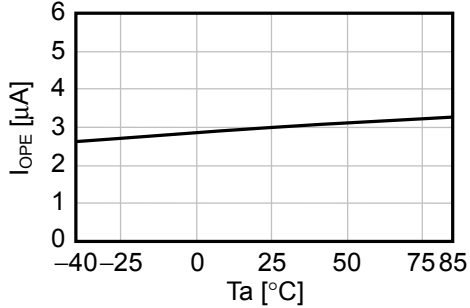
■ **Precautions**

- 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.
- SII 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.

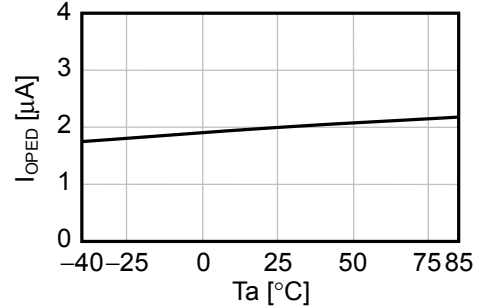
■ Characteristics (Typical Data)

1. Current Consumption

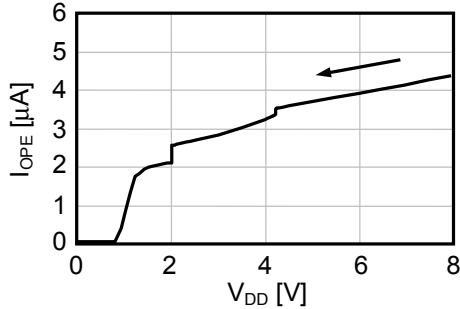
1.1 I_{OPE} vs. T_a



1.2 I_{OPED} vs. T_a

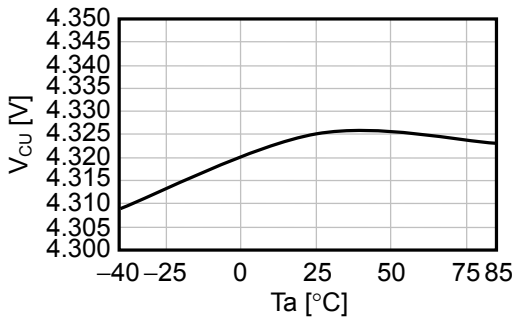


1.3 I_{OPE} vs. V_{DD}

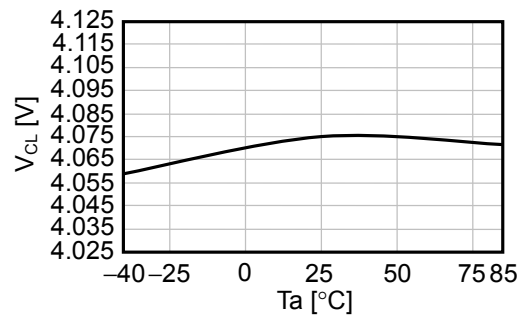


2. Overcharge Detection / Release Voltage, Overdischarge Detection / Release Voltage, Overcurrent Detection Voltage, and Delay Time

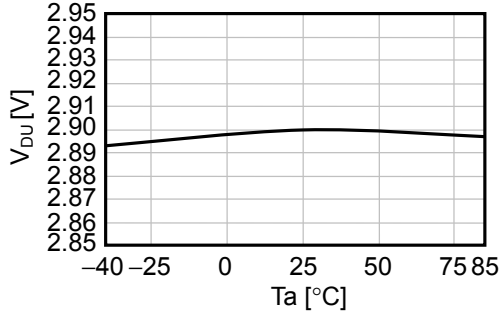
2.1 V_{CU} vs. T_a



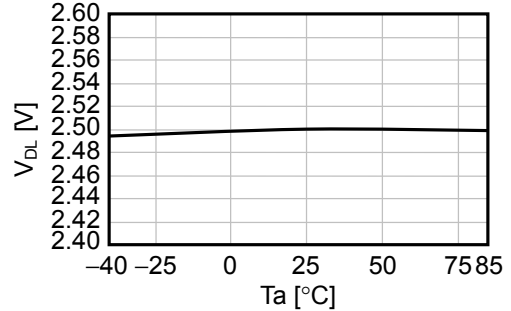
2.2 V_{CL} vs. T_a



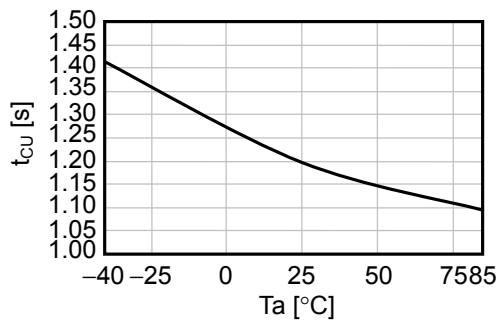
2.3 V_{DU} vs. T_a



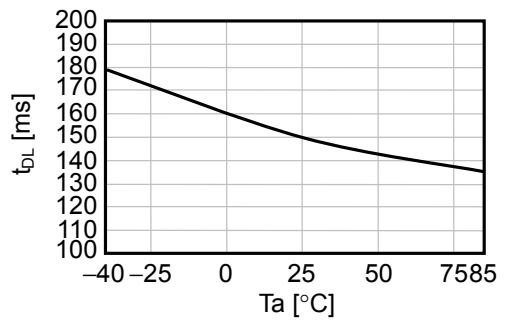
2.4 V_{DL} vs. T_a



2. 5 t_{CU} vs. T_a

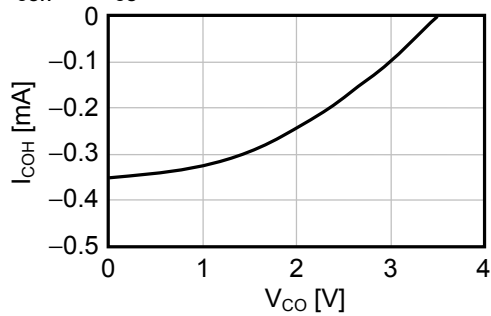


2. 6 t_{DL} vs. T_a

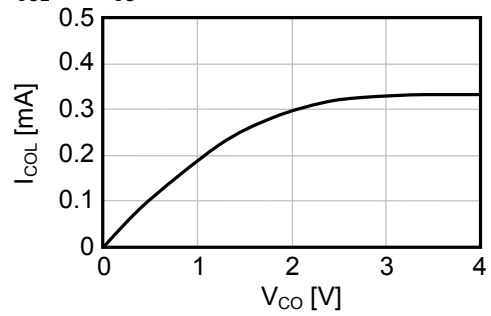


3. CO pin / DO pin

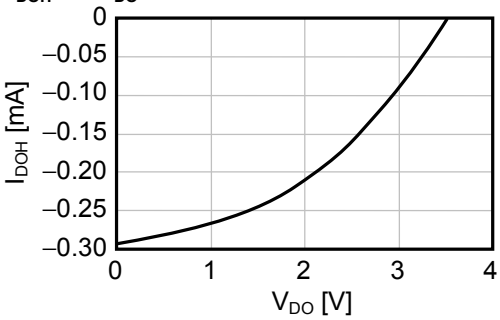
3. 1 I_{COH} vs. V_{CO}



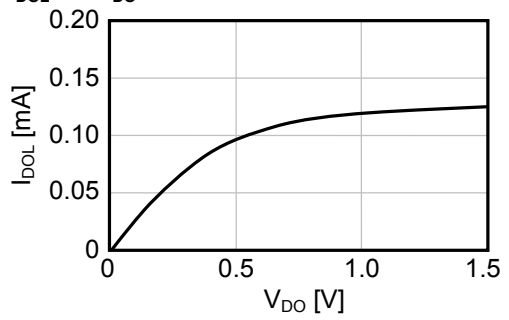
3. 2 I_{COL} vs. V_{CO}



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

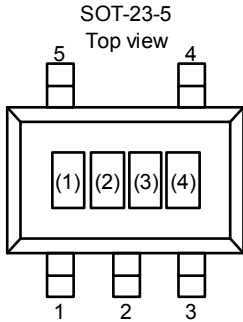


3. 4 I_{DOL} vs. V_{DO}



■ **Marking Specifications**

1. SOT-23-5



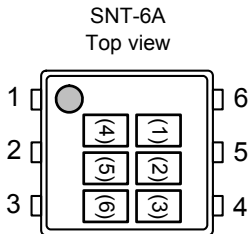
(1) to (3): Product Code (refer to **Product Name vs. Product Code**)
(4) : Lot number

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 |

- Remark 1.** Please contact our sales office for the products other than those specified above.
2. Please select products of environmental code = U for Sn 100%, halogen-free products.

2. SNT-6A

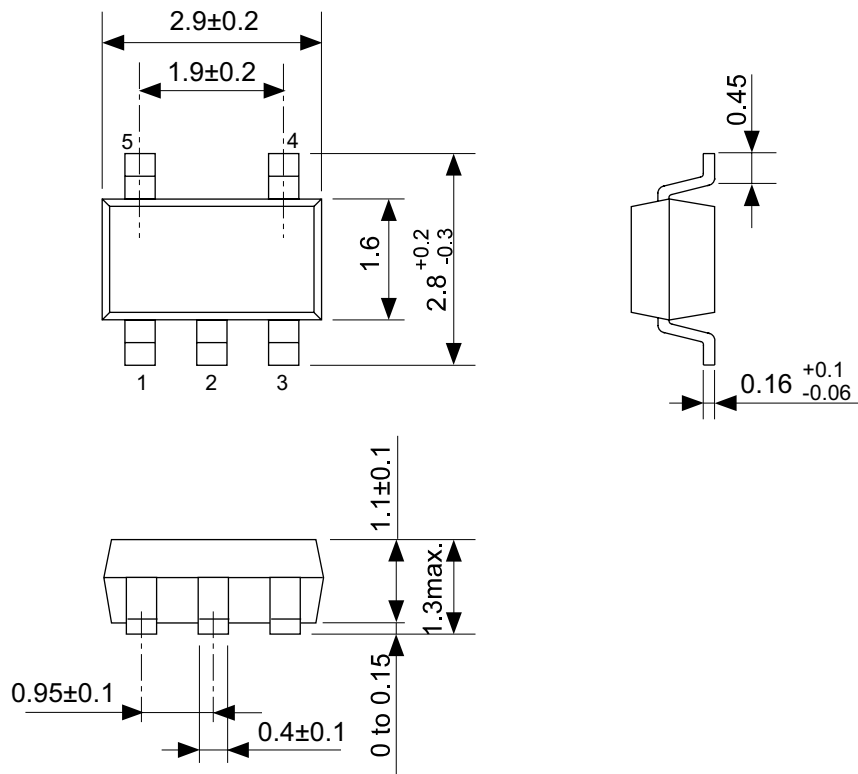


(1) to (3): Product Code (refer to **Product Name vs. Product Code**)
(4) to (6): Lot number

Product Name vs. Product Code

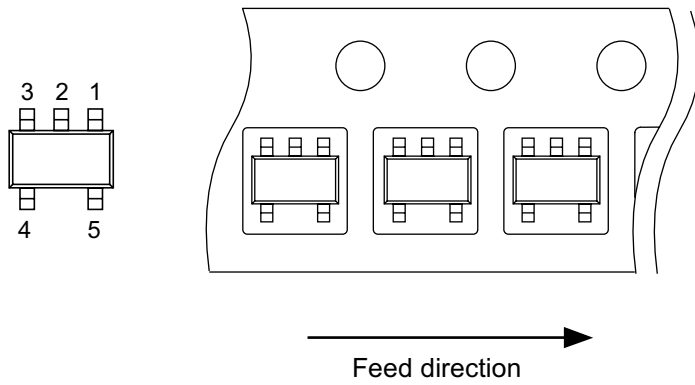
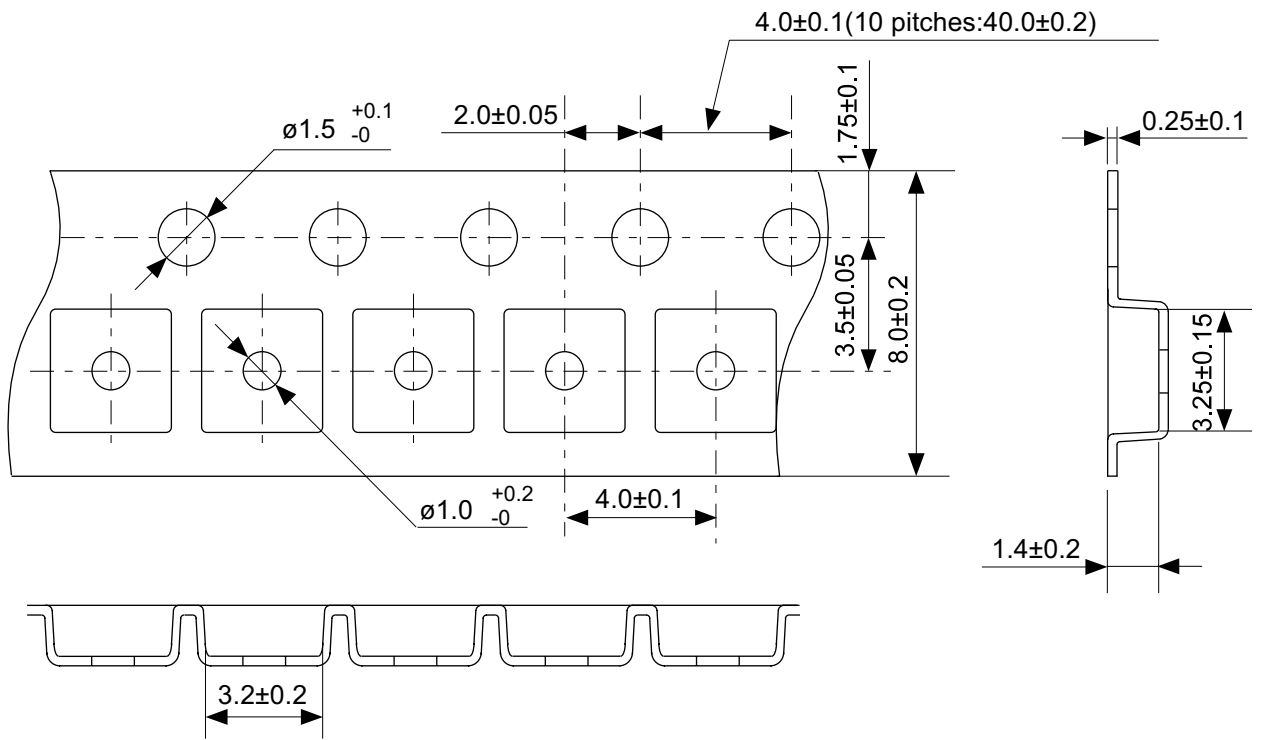
| Product Name | Product Code | | |
|-----------------|--------------|-----|-----|
| | (1) | (2) | (3) |
| S-8211EAA-I6T1x | R | 3 | A |
| S-8211EAB-I6T1x | R | 3 | B |
| S-8211EAD-I6T1x | R | 3 | D |
| S-8211EAE-I6T1x | R | 3 | E |
| S-8211EAH-I6T1U | R | 3 | H |
| S-8211EAI-I6T1U | R | 3 | I |

- Remark 1.** Please contact our sales office for the products other than those specified above.
2. x: G or U
3. Please select products of environmental code = U for Sn 100%, halogen-free products.



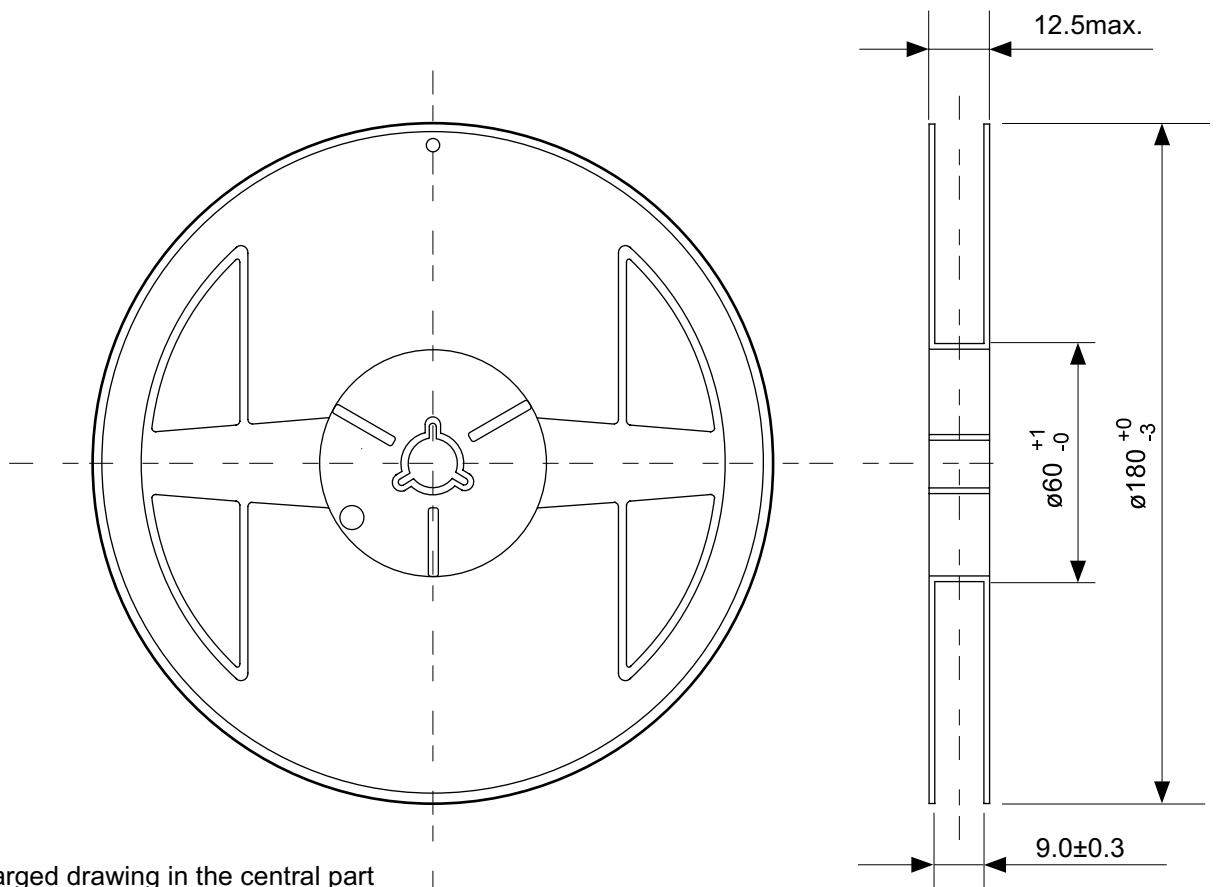
No. MP005-A-P-SD-1.2

| | |
|------------------------|-------------------------|
| TITLE | SOT235-A-PKG Dimensions |
| No. | MP005-A-P-SD-1.2 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

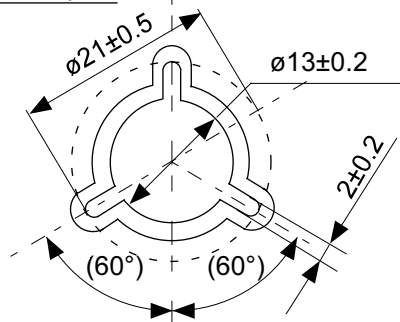


No. MP005-A-C-SD-2.1

| | |
|------------------------|-----------------------|
| TITLE | SOT235-A-Carrier Tape |
| No. | MP005-A-C-SD-2.1 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

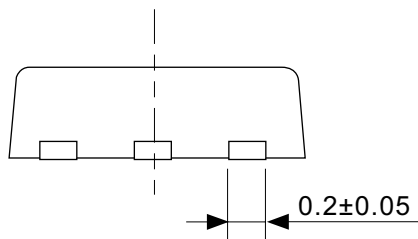
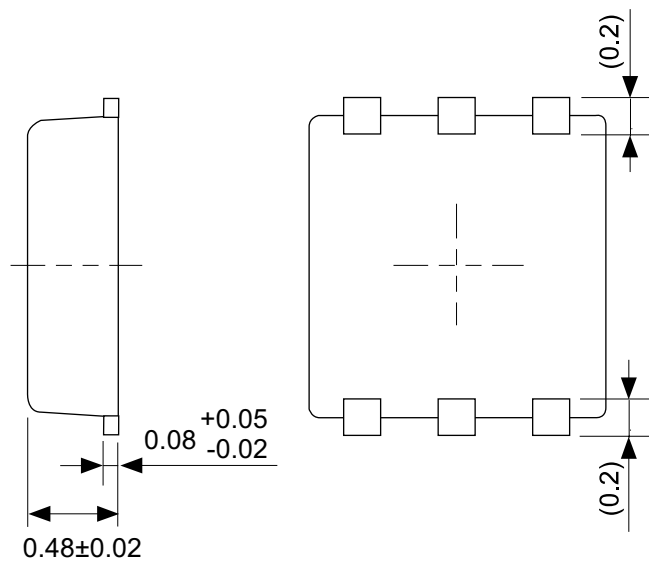
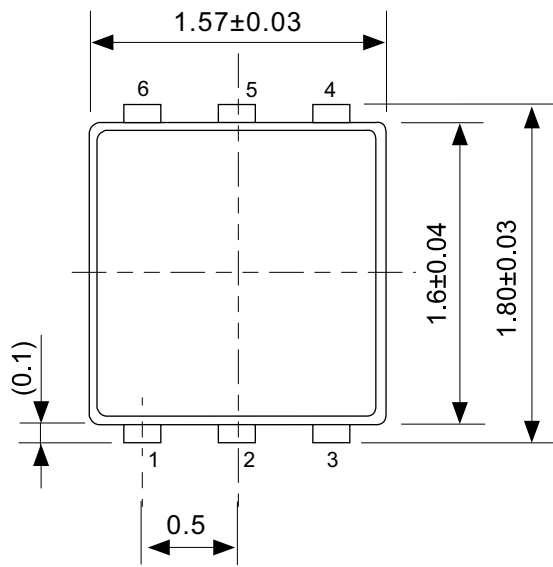


Enlarged drawing in the central part



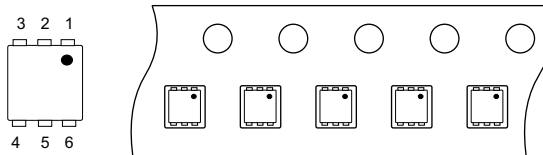
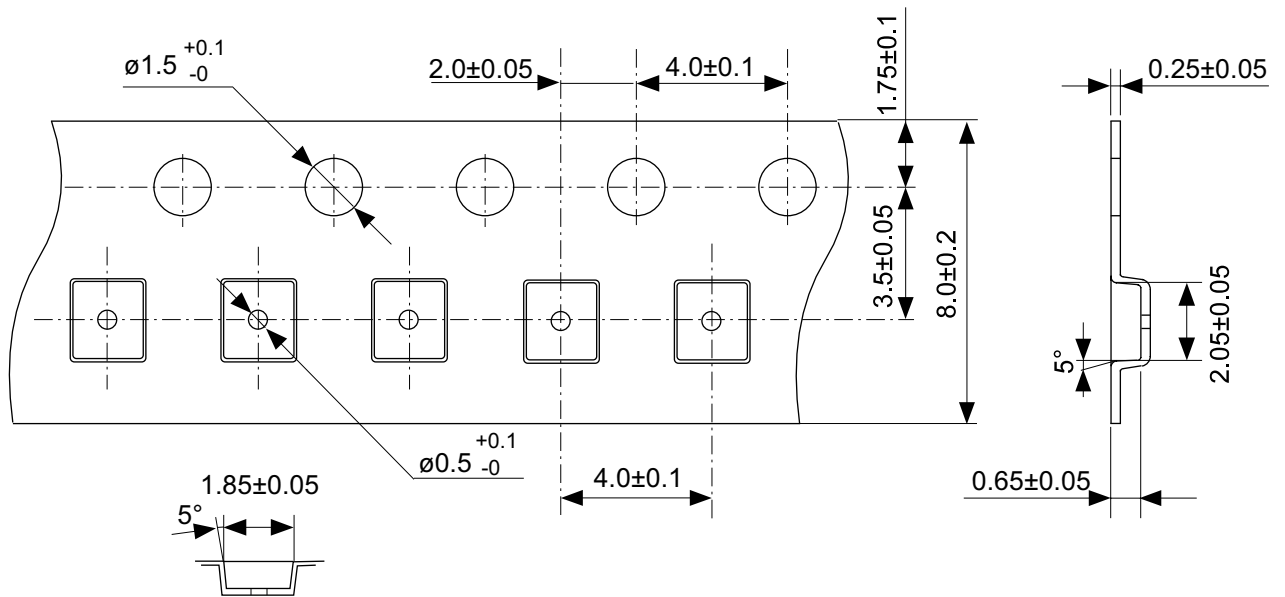
No. MP005-A-R-SD-1.1

| | | | |
|------------------------|------------------|------|-------|
| TITLE | SOT235-A-Reel | | |
| No. | MP005-A-R-SD-1.1 | | |
| SCALE | | QTY. | 3,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



No. PG006-A-P-SD-2.0

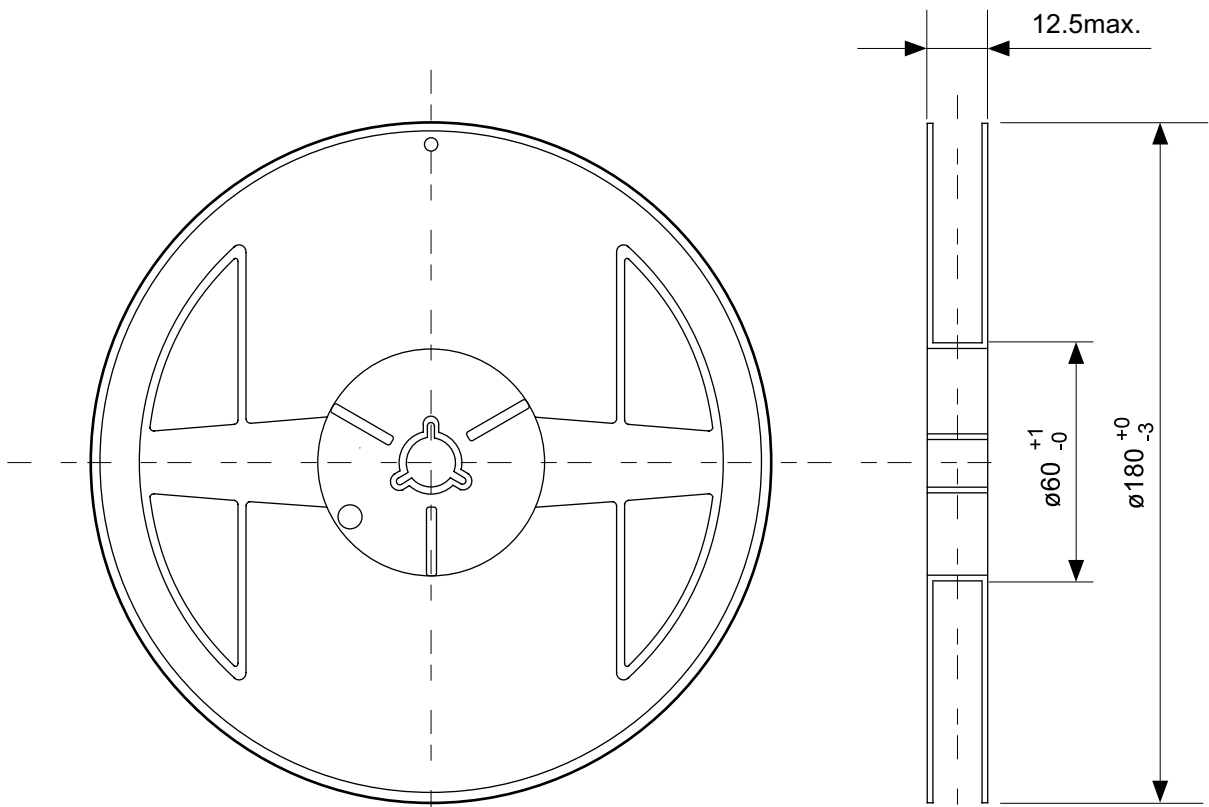
| | |
|------------------------|-------------------------|
| TITLE | SNT-6A-A-PKG Dimensions |
| No. | PG006-A-P-SD-2.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |



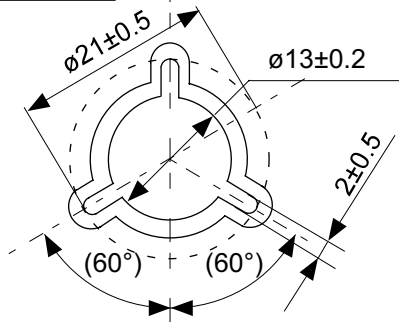
Feed direction →

No. PG006-A-C-SD-1.0

| | |
|------------------------|-----------------------|
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| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

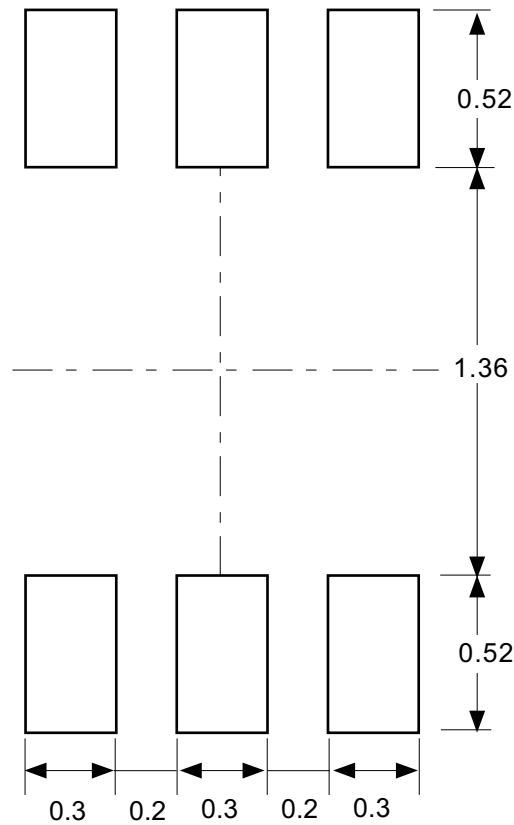


Enlarged drawing in the central part



No. PG006-A-R-SD-1.0

| | | | |
|------------------------|------------------|------|-------|
| TITLE | SNT-6A-A-Reel | | |
| No. | PG006-A-R-SD-1.0 | | |
| SCALE | | QTY. | 5,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



Caution Making the wire pattern under the package is possible. However, note that the package may be upraised due to the thickness made by the silk screen printing and of a solder resist on the pattern because this package does not have the standoff.

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No. PG006-A-L-SD-3.0

| | |
|------------------------|------------------------------|
| TITLE | SNT-6A-A-Land Recommendation |
| No. | PG006-A-L-SD-3.0 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |



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