VOLTAGE MONITORING IC WITH CELL BALANCING FUNCTION

 Rev.1.5_00

The S-8249 Series is a voltage monitoring IC with a cell balancing function and includes a high-accuracy voltage detection circuit and a delay circuit.
The S-8249 Series is suitable for cell balancing and overcharge protection of batteries and capacitors.

■ Features

- High-accuracy voltage detection circuit

Cell balancing detection voltage:	2.0 V to 4.6 V (5 mV step)	Accuracy ±12 mV (2.0 V ≤ V_{BU} < 2.4 V)
		Accuracy ±0.5% (2.4 V ≤ V_{BU} ≤ 4.6 V)
Cell balancing release voltage:	2.0 V to 4.6 V*1	Accuracy ±24 mV (2.0 V ≤ V_{BL} < 2.4 V)
		Accuracy ±1.0% (2.4 V ≤ V_{BL} ≤ 4.6 V)
Overcharge detection voltage:	2.0 V to 4.6 V (5 mV step)	Accuracy ±12 mV (2.0 V ≤ V_{CU} < 2.4 V)
		Accuracy ±0.5% (2.4 V ≤ V_{CU} ≤ 4.6 V)
Overcharge release voltage:	2.0 V to 4.6 V*2	Accuracy ±24 mV (2.0 V ≤ V_{CL} < 2.4 V)
		Accuracy ±1.0% (2.4 V ≤ V_{CL} ≤ 4.6 V)

- Built-in Nch transistor with ON resistance of 5 Ω typ. between the CB pin and the VSS pin
- Current consumption: 2.0 μA max. (Ta = +25°C)
- Delay times are generated only by an internal circuit (External capacitors are unnecessary).
- CO pin output form and output logic are selectable: CMOS output — Active "H", active "L"; Nch open-drain output — Active "H", active "L"
- Switchable to power-saving mode by using the $\overline{\text{CE}}$ pin
- Operation temperature range: Ta = −40°C to +85°C
- Lead-free (Sn 100%), halogen-free

***1.** Cell balancing release voltage = Cell balancing detection voltage − Cell balancing hysteresis voltage
(Cell balancing hysteresis voltage can be selected as 0 V or from a range of 0.1 V to 0.7 V in 50 mV step.)
***2.** 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 0.7 V in 50 mV step.)

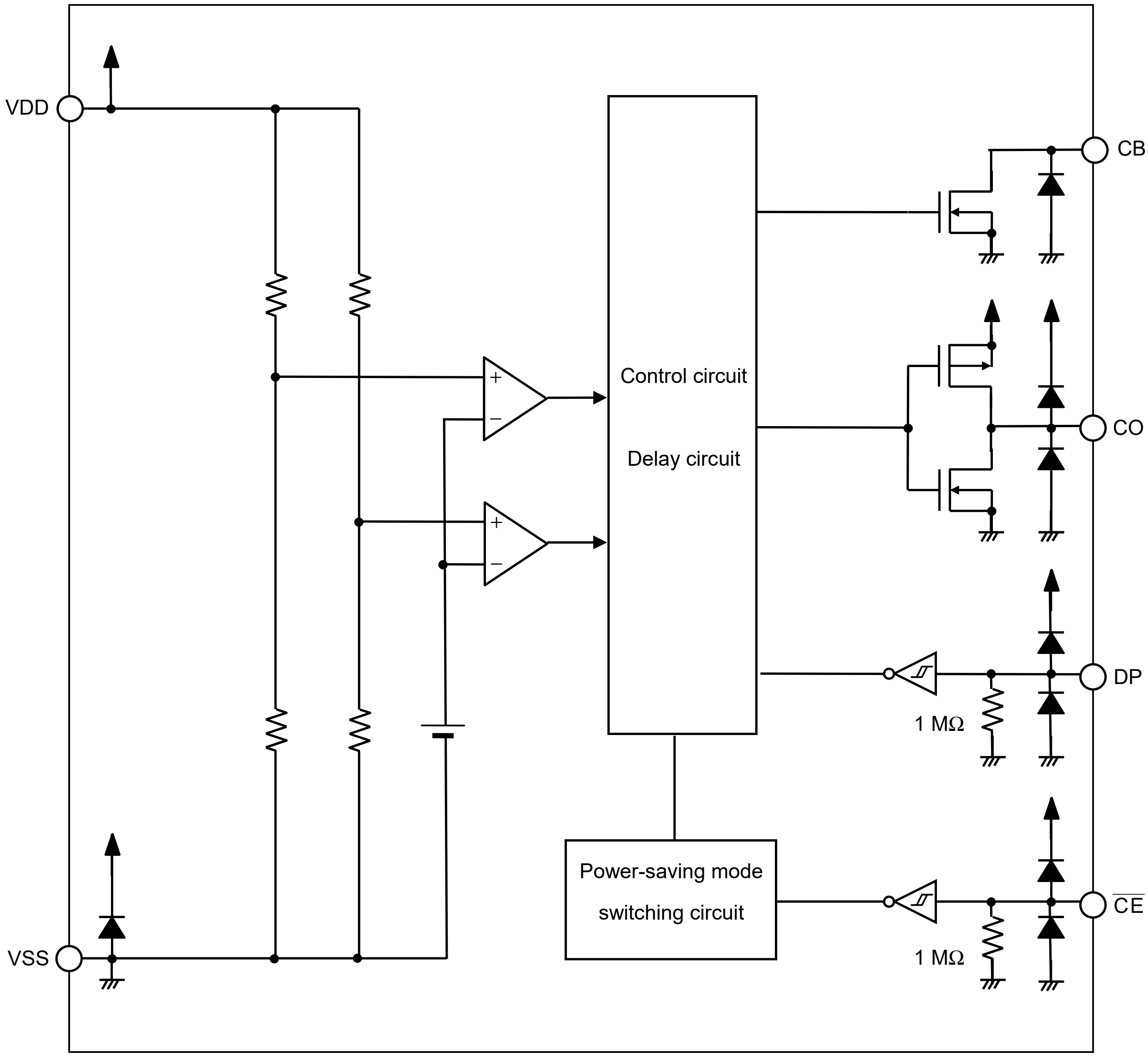
■ Applications

- Rechargeable battery module
- Capacitor module

■ Package

- SOT-23-6

■ Block Diagram



*1. All diodes shown in the figure are parasitic diodes.

Figure 1

■ Product Name Structure

1. Product name

S-8249A xx - M6T1 U

- U — Environmental code
  U: Lead-free (Sn 100%), halogen-free
- M6T1 — Package abbreviation and IC packing specifications*1
  M6T1: SOT-23-6, Tape
- xx — Serial code
  Sequentially set from AA to ZZ

***1.** Refer to the tape drawing.

2. Package

Table 1 Package Drawing Codes

Package Name	Dimension	Tape	Reel
SOT-23-6	MP006-A-P-SD	MP006-A-C-SD	MP006-A-R-SD

3. Product name list

Table 2 (2 / 1)

Product Name	Cell Balancing Detection Voltage [V_{BU}]	Cell Balancing Release Voltage [V_{BL}]	Overcharge Detection Voltage [V_{CU}]	Overcharge Release Voltage [V_{CL}]	CO Pin Output Form	CO Pin Output Logic	Combination of Delay Time
S-8249AAA-M6T1U	2.600 V	2.600 V	2.750 V	2.750 V	CMOS output	Active "H"	(1)
S-8249AAB-M6T1U	3.000 V	3.000 V	3.150 V	3.150 V	CMOS output	Active "H"	(1)
S-8249AAC-M6T1U	3.000 V	3.000 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-8249AAD-M6T1U	3.100 V	3.100 V	3.250 V	3.250 V	CMOS output	Active "H"	(1)
S-8249AAE-M6T1U	3.100 V	3.100 V	3.300 V	3.300 V	CMOS output	Active "H"	(1)
S-8249AAF-M6T1U	2.600 V	2.600 V	2.800 V	2.800 V	CMOS output	Active "H"	(1)
S-8249AAG-M6T1U	2.400 V	2.400 V	2.900 V	2.900 V	CMOS output	Active "H"	(1)
S-8249AAH-M6T1U	2.400 V	2.400 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-8249AAI-M6T1U	2.100 V	2.100 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-8249AAK-M6T1U	2.400 V	2.400 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-8249AAL-M6T1U	2.100 V	2.000 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-8249AAM-M6T1U	2.620 V	2.520 V	2.800 V	2.700 V	CMOS output	Active "H"	(1)
S-8249AAN-M6T1U	3.300 V	3.300 V	4.080 V	3.930 V	CMOS output	Active "H"	(1)
S-8249AAO-M6T1U	2.000 V	2.000 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-8249AAP-M6T1U	3.700 V	3.700 V	4.500 V	4.500 V	CMOS output	Active "H"	(1)
S-8249AAQ-M6T1U	3.800 V	3.800 V	4.080 V	3.930 V	CMOS output	Active "H"	(1)
S-8249AAR-M6T1U	2.800 V	2.800 V	3.150 V	3.150 V	CMOS output	Active "H"	(1)
S-8249AAS-M6T1U	2.800 V	2.800 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-8249AAT-M6T1U	2.800 V	2.800 V	3.100 V	3.100 V	CMOS output	Active "H"	(1)
S-8249AAU-M6T1U	2.500 V	2.400 V	3.800 V	3.700 V	CMOS output	Active "H"	(1)
S-8249AAV-M6T1U	2.300 V	2.200 V	3.800 V	3.700 V	CMOS output	Active "H"	(1)
S-8249AAW-M6T1U	2.650 V	2.600 V	2.750 V	2.650 V	Nch open-drain output	Active "L"	(1)
S-8249AAY-M6T1U	4.150 V	4.150 V	4.275 V	4.275 V	CMOS output	Active "H"	(2)

Table 2 (2 / 2)

Product Name	Cell Balancing Detection Voltage [V_{BU}]	Cell Balancing Release Voltage [V_{BL}]	Overcharge Detection Voltage [V_{CU}]	Overcharge Release Voltage [V_{CL}]	CO Pin Output Form	CO Pin Output Logic	Combination of Delay Time
S-8249ABA-M6T1U	3.650 V	3.550 V	3.800 V	3.500 V	CMOS output	Active "L"	(3)
S-8249ABB-M6T1U	4.350 V	4.350 V	4.425 V	4.325 V	CMOS output	Active "L"	(3)
S-8249ABC-M6T1U	4.200 V	4.200 V	4.300 V	4.200 V	CMOS output	Active "L"	(4)

Remark1. Please contact our sales representatives for products other than the above.
2. Set V_{CU} > V_{BU}.
3. Refer to **Table 3** for details about combinations of delay times.

Table 3

Combination of Delay Time	Cell Balancing Detection Delay Time [t_{BU}]	Cell Balancing Release Delay Time [t_{BL}]	Overcharge Detection Delay Time [t_{CU}]	Overcharge Release Delay Time [t_{CL}]
(1)	128 ms	1.0 ms	128 ms	1.0 ms
(2)	128 ms	1.0 ms	1024 ms	1.0 ms
(3)	64 ms	2.0 ms	256 ms	2.0 ms
(4)	64 ms	2.0 ms	256 ms	1.0 ms

Remark The delay times can be changed within the ranges listed above. For details, please contact our sales representatives.

Table 4

Delay Time	Symbol	Selection Range					Remark
Cell balancing detection delay time*1	t_{BU}	64 ms	128 ms*2	256 ms	512 ms	1024 ms	Select a value from the left.
Cell balancing release delay time	t_{BL}	0.5 ms		1.0 ms*2		2.0 ms	Select a value from the left.
Overcharge detection delay time*1	t_{CU}	64 ms	128 ms*2	256 ms	512 ms	1024 ms	Select a value from the left.
Overcharge release delay time	t_{CL}	0.5 ms		1.0 ms*2		2.0 ms	Select a value from the left.

***1.** Set $t_{CU} \geq t_{BU}$.
***2.** The value is the delay time of the standard products.

■ Pin Configuration

1. SOT-23-6

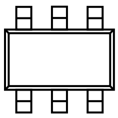


Figure 2

Table 5

Pin No.	Symbol	Description
1	CO	Output pin for overcharge signal
2	VSS	Input pin for negative power supply
3	DP	Test mode switching pin "H": Test mode (used to shorten the delay time) "L": Normal operation mode
4	$\overline{\text{CE}}$	Power-saving mode switching pin "H": Power-saving mode "L": Normal operation mode
5	VDD	Input pin for positive power supply
6	CB	Output pin for cell balancing signal (Nch open-drain output)

■ Absolute Maximum Ratings

Table 6

(Ta = +25°C unless otherwise specified)

Item	Symbol	Applied Pin	Absolute Maximum Rating	Unit
Input voltage between VDD pin and VSS pin	V_{DS}	VDD	V_{SS} − 0.3 to V_{SS} + 6.0	V
Input pin voltage	V_{IN}	$\overline{CE}$, DP	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 6.0	V
Output pin voltage	V_{OUT}	CO, CB	V_{SS} − 0.3 to V_{DD} + 0.3 ≤ V_{SS} + 6.0	V
Output pin current	I_{CB}	CB	100 (−40°C to +85°C)	mA
Operation ambient temperature	T_{opr}	−	−40 to +85	°C
Storage temperature	T_{stg}	−	−55 to +125	°C

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.

■ Thermal Resistance Value

Table 7

Item	Symbol	Condition		Min.	Typ.	Max.	Unit
Junction-to-ambient thermal resistance*1	θ_{JA}	SOT-23-6	Board A	−	159	−	°C/W
			Board B	−	124	−	°C/W
			Board C	−	−	−	°C/W
			Board D	−	−	−	°C/W
			Board E	−	−	−	°C/W

***1.** Test environment: compliance with JEDEC STANDARD JESD51-2A

Remark Refer to "**■ Power Dissipation**" and "**Test Board**" for details.

■ Electrical Characteristics

For details about the test circuits and testing method, refer to "**■ Test Circuit**".

Caution Unless otherwise specified in Table 8, set V2 = V3 = 0 V, and SWn (n = 1 to 4) = OFF.

Table 8 (1 / 2)

(Ta = +25°C unless otherwise specified)

Item	Symbol	Condition		Min.	Typ.	Max.	Unit
Detection voltage							
Cell balancing detection voltage	V_{BU}	SW1 = ON	$2.0\ V \le V_{BU} < 2.4\ V$	V_{BU} − 0.012	V_{BU}	V_{BU} + 0.012	V
			$2.4\ V \le V_{BU} \le 4.6\ V$	V_{BU} × 0.995	V_{BU}	V_{BU} × 1.005	V
Cell balancing release voltage	V_{BL}	SW1 = ON	$2.0\ V \le V_{BL} < 2.4\ V$	V_{BL} − 0.024	V_{BL}	V_{BL} + 0.024	V
			$2.4\ V \le V_{BL} \le 4.6\ V$	V_{BL} × 0.99	V_{BL}	V_{BL} × 1.01	V
Overcharge detection voltage	V_{CU}	$2.0\ V \le V_{CU} < 2.4\ V$		V_{CU} − 0.012	V_{CU}	V_{CU} + 0.012	V
		$2.4\ V \le V_{CU} \le 4.6\ V$		V_{CU} × 0.995	V_{CU}	V_{CU} × 1.005	V
Overcharge release voltage	V_{CL}	$2.0\ V \le V_{CL} < 2.4\ V$		V_{CL} − 0.024	V_{CL}	V_{CL} + 0.024	V
		$2.4\ V \le V_{CL} \le 4.6\ V$		V_{CL} × 0.99	V_{CL}	V_{CL} × 1.01	V
Temperature coefficient							
Detection voltage temperature coefficient 1*1	$\frac{\Delta V_{BU}}{\Delta Ta \bullet V_{BU}}$	Ta = −40°C to +85°C*3		−	100	350	ppm/°C
Detection voltage temperature coefficient 2*2	$\frac{\Delta V_{CU}}{\Delta Ta \bullet V_{CU}}$	Ta = −40°C to +85°C*3		−	100	350	ppm/°C
Input voltage							
Operation voltage between VDD pin and VSS pin	V_{DS}	Voltages output from CO pin and CB pin are fixed		1.5	−	5.0	V
$\overline{CE}$ pin voltage "H"	$V_{\overline{CE}H}$	−		−	−	V_{DD} × 0.9	V
$\overline{CE}$ pin voltage "L"	$V_{\overline{CE}L}$	−		V_{DD} × 0.1	−	−	V
DP pin voltage "H"	V_{DPH}	−		−	−	V_{DD} × 0.9	V
DP pin voltage "L"	V_{DPL}	−		V_{DD} × 0.1	−	−	V
Input current							
Current consumption during operation	I_{OPE}	I_{VDD} when $V1 = V_{BL} - 0.1\ V$		−	1.2	2.0	μA
Current consumption during power-saving	I_{PSV}	I_{VDD} when $V1 = V2 = V_{BL} - 0.1\ V$		−	−	0.1	μA

***1.** A change in the temperature of the detection voltage [mV/°C] is calculated by using the following equation.

$$\frac{\Delta V_{BU}}{\Delta Ta}\ [mV/°C] = V_{BU}\ [V] \times \frac{\Delta V_{BU}}{\Delta Ta \bullet V_{BU}}\ [ppm/°C] \div 1000$$

***2.** A change in the temperature of the detection voltage [mV/°C] is calculated by using the following equation.

$$\frac{\Delta V_{CU}}{\Delta Ta}\ [mV/°C] = V_{CU}\ [V] \times \frac{\Delta V_{CU}}{\Delta Ta \bullet V_{CU}}\ [ppm/°C] \div 1000$$

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

Remark 1. $\frac{\Delta V_{BU}}{\Delta Ta}, \frac{\Delta V_{CU}}{\Delta Ta}$: Change in temperature of detection voltage

2. V_{BU}, V_{CU}: Set detection voltage

3. $\frac{\Delta V_{BU}}{\Delta Ta \bullet V_{BU}}, \frac{\Delta V_{CU}}{\Delta Ta \bullet V_{CU}}$: Detection voltage temperature coefficient

Table 8 (2 / 2)

(Ta = +25°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Delay time						
Cell balancing detection delay time	t_{BU}	–	$t_{BU} \times 0.8$	t_{BU}	$t_{BU} \times 1.2$	ms
Cell balancing release delay time	t_{BL}	–	$t_{BL} \times 0.8$	t_{BL}	$t_{BL} \times 1.2$	ms
Overcharge detection delay time	t_{CU}	–	$t_{CU} \times 0.8$	t_{CU}	$t_{CU} \times 1.2$	ms
Overcharge release delay time	t_{CL}	–	$t_{CL} \times 0.8$	t_{CL}	$t_{CL} \times 1.2$	ms
Output current						
CB pin output current						
CB pin sink current	I_{CBS}	V1 = V_{BU} + 0.1 V, SW2 = ON, V4 = 0.5 V	30	–	–	mA
CB pin leakage current	I_{CBL}	V1 = V_{BL} – 0.1 V, SW2 = ON, V4 = 6.0 V	–	–	0.1	μA
CO pin output current (output form: CMOS output, output logic: active "H")						
CO pin sink current	I_{COL}	V1 = V_{CL} – 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	–	–	mA
CO pin source current	I_{COH}	V1 = V_{CU} + 0.1 V, SW4 = ON, V5 = V1 – 0.5 V	1.0	–	–	mA
CO pin output current (output form: CMOS output, output logic: active "L")						
CO pin sink current	I_{COL}	V1 = V_{CU} + 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	–	–	mA
CO pin source current	I_{COH}	V1 = V_{CL} – 0.1 V, SW4 = ON, V5 = V1 – 0.5 V	1.0	–	–	mA
CO pin output current (output form: Nch open-drain output, output logic: active "H")						
CO pin sink current	I_{COL}	V1 = V_{CL} – 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	–	–	mA
CO pin leakage current	I_{COHL}	V1 = V_{CU} + 0.1 V, SW4 = ON, V5 = 6.0 V	–	–	0.1	μA
CO pin output current (output form: Nch open-drain output, output logic: active "L")						
CO pin sink current	I_{COL}	V1 = V_{CU} + 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	–	–	mA
CO pin leakage current	I_{COHL}	V1 = V_{CL} – 0.1 V, SW4 = ON, V5 = 6.0 V	–	–	0.1	μA

■ Test Circuit

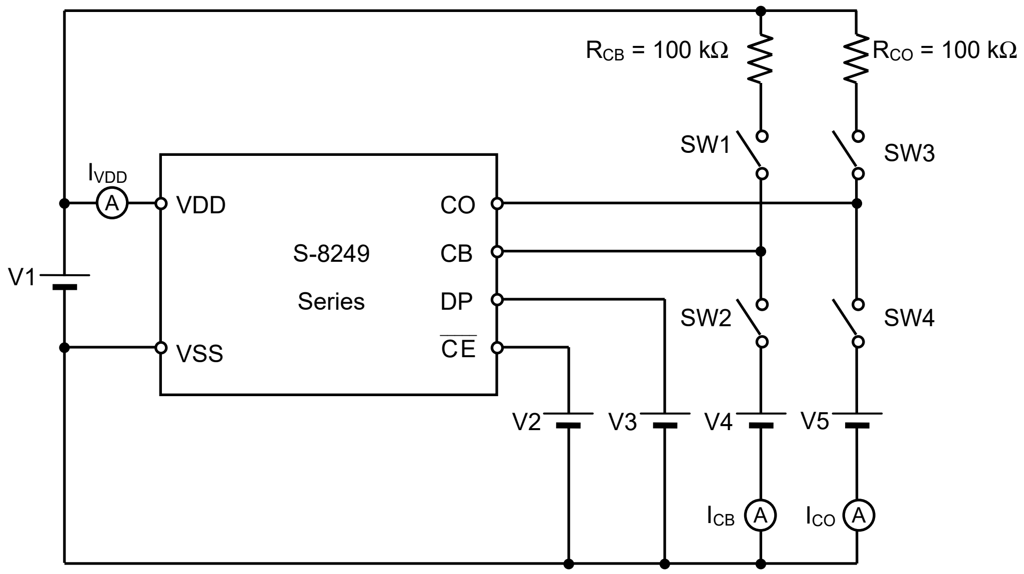


Figure 3

Caution Unless otherwise specified in Table 8, set V2 = V3 = 0 V, and SWn (n = 1 to 4) = OFF.

1. $\overline{CE}$ pin voltage "H"

$\overline{CE}$ pin voltage "H" ($V_{\overline{CE}H}$) is defined as the voltage at which I_{VDD} is changed from I_{OPE} to I_{PSV} when V2 is increased from 0 V after setting V1 = V_{BL} − 0.1 V.

2. $\overline{CE}$ pin voltage "L"

$\overline{CE}$ pin voltage "L" ($V_{\overline{CE}L}$) is defined as the voltage at which I_{VDD} is changed from I_{PSV} to I_{OPE} when V2 is decreased from V_{BL} − 0.1 V after setting V1 = V2 = V_{BL} − 0.1 V.

3. DP pin voltage "H"*1

DP pin voltage "H" (V_{DPH}) is defined as the voltage at which the test mode is switched when V3 is increased from 0 V after setting V1 = V_{BL} − 0.1 V.

4. DP pin voltage "L" *1

DP pin voltage "L" (V_{DPL}) is defined as the voltage at which the normal operation mode is switched when V3 is decreased from V_{BL} − 0.1 V after setting V1 = V3 = V_{BL} − 0.1 V.

5. Cell balancing detection delay time

Cell balancing detection delay time (t_{BU}) is defined as the time from when SW1 is set to ON and V1 is set to V_{BU} − 0.1 V to when the CB pin output is inverted after setting V1 to V_{BU} + 0.1 V.

6. Cell balancing release delay time

Cell balancing release delay time (t_{BL}) is defined as the time from when SW1 is set to ON and V1 is set to V_{BL} + 0.1 V to when the CB pin output is inverted after setting V1 to V_{BL} − 0.1 V.

7. Overcharge detection delay time

Overcharge detection delay time (t_{CU}) is defined as the time from when SW1 is set to ON and V1 is set to V_{CU} − 0.1 V to when the CO pin output is inverted after setting V1 to V_{CU} + 0.1 V.

8. Overcharge release delay time

Overcharge release delay time (t_{CL}) is defined as the time from when SW1 is set to ON and V1 is set to V_{CL} + 0.1 V to when the CO pin output is inverted after setting V1 to V_{CL} − 0.1 V.

***1.** For details about switching to the test mode by using the DP pin, refer to "**5. DP pin**" in "**■ Operation**".

■ Standard Circuit

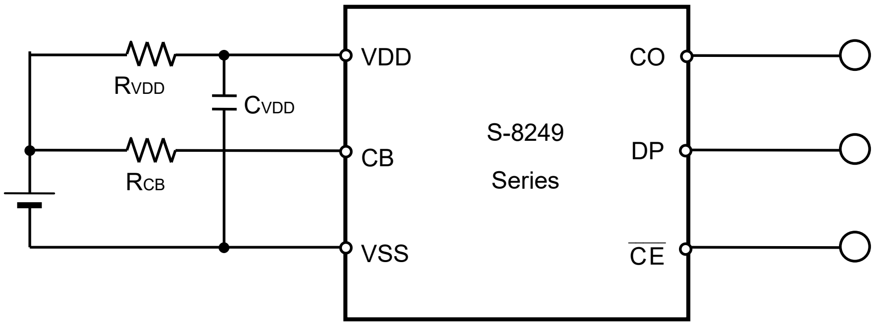


Figure 4

Table 9 Constants for External Components

Symbol	Part	Purpose	Min.	Typ.	Max.	Remark
R_{VDD}	Resistor	ESD protection, for power fluctuation control	150 Ω	330 Ω	1.0 kΩ	Resistance should be as small as possible to avoid worsening the overcharge detection accuracy due to current consumption.*1
C_{VDD}	Capacitor	For power fluctuation control	0.068 μF	0.1 μF	1.0 μF	Connect a capacitor of 0.068 μF or more between VDD pin and VSS pin.*1
R_{CB}	Resistor	For setting the cell balancing current value	–	–	–	Set the required cell balancing current value depending on "**2. Cell balancing status**" in "**■ Operation**".*2

***1.** When connecting a resistor less than 150 Ω to R_{VDD} or a capacitor less than 0.068 μF to C_{VDD}, the S-8249 Series may malfunction when power is largely fluctuated.

***2.** Set the cell balancing current value so that R_{CB} does not exceed the power dissipation.

Cautions 1. The constants may be changed without notice.

2. It has not been confirmed whether the operation is normal or not in circuits other than the connection example. In addition, the connection example and the constants do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constants.

■ Operation

Remark Refer to "**■ Standard Circuit**".

1. Normal status

In the S-8249 Series, if the voltage between the VDD pin and the VSS pin (V_{DS}) has not reached the cell balancing detection voltage (V_{BU}), the CB pin output is in the high-impedance status. The CO pin output status varies according to the output form and output logic selected, as shown in **Table 10**. This is the normal status.

Table 10

CO Pin Output Form and Output Logic	CB Pin Output	CO Pin Output
CMOS output, active "H"	"H"	"L"
CMOS output, active "L"	"H"	"H"
Nch open-drain output, active "H"	"H"	"L"
Nch open-drain output, active "L"	"H"	"H"

2. Cell balancing status

In the S-8249 Series, if V_{DS} is V_{BU} or higher and this status continues for the cell balancing detection delay time (t_{BU}) or longer, the CB pin output becomes "L". This is the cell balancing status.

The cell balancing status is released when V_{DS} drops to the cell balancing release voltage (V_{BL}) or lower and this status continues for the cell balancing release delay time (t_{BL}) or longer.

The S-8249 Series includes an Nch transistor with ON resistance of 5 Ω typ. (R_{CBON}) between the CB pin and the VSS pin, thus causing the cell balancing current (I_{CB}) to flow in cell balancing status, and the cell balancing operation to start.

By connecting a resistor (R_{CB}) to the CB pin, I_{CB} in cell balancing status can be calculated by using the following equation.

$$I_{CB} = V_{BU} / (R_{CBON} + R_{CB})$$

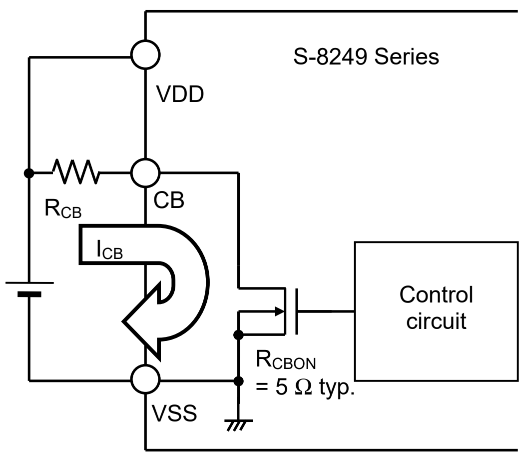


Figure 5

3. Overcharge status

In the S-8249 Series, if V_{DS} is the overcharge detection voltage (V_{CU}) or higher and this status continues for the overcharge detection delay time (t_{CU}) or longer, the CO pin output is inverted. The CO pin output status varies according to the output form and output logic selected, as shown in **Table 11**. This is the overcharge status. In the overcharge status, the CB pin output becomes "L".

Table 11

CO Pin Output Form and Output Logic	CB Pin Output	CO Pin Output
CMOS output, active "H"	"L"	"H"
CMOS output, active "L"	"L"	"L"
Nch open-drain output, active "H"	"L"	"H"
Nch open-drain output, active "L"	"L"	"L"

The overcharge status is released when V_{DS} drops to the overcharge release voltage (V_{CL}) or lower and this status continues for the overcharge release delay time (t_{CL}) or longer.

4. $\overline{\text{CE}}$ pin

The S-8249 Series has the $\overline{\text{CE}}$ pin (Power-saving mode switching pin). The S-8249 Series is set to the power-saving mode by inputting a voltage of $V_{\overline{CE}H}$ or higher to the $\overline{\text{CE}}$ pin.

Table 12

$\overline{\text{CE}}$ Pin	Status
Open ($V_{\overline{CE}} = V_{SS}$)	Normal operation mode
"H" ($V_{\overline{CE}} \geq V_{\overline{CE}H}$)	Power-saving mode
"L" ($V_{\overline{CE}} \leq V_{\overline{CE}L}$)	Normal operation mode

In the power-saving mode, the current consumption is decreased to current consumption during power-saving (I_{PSV}). Also, in the power-saving mode, almost all operations are stopped, and the CB pin or the CO pin output in power-saving mode is the same as that in the normal status.

The $\overline{\text{CE}}$ pin is pulled down to V_{SS} by the internal resistor. When in a mode other than power-saving mode, leave the $\overline{\text{CE}}$ pin open or short it with V_{SS}.

5. DP pin

The S-8249 Series has the DP pin (Test mode switching pin). The S-8249 Series is set to test mode (used to shorten the delay time) by inputting a voltage of V_{DPH} or higher to the DP pin.

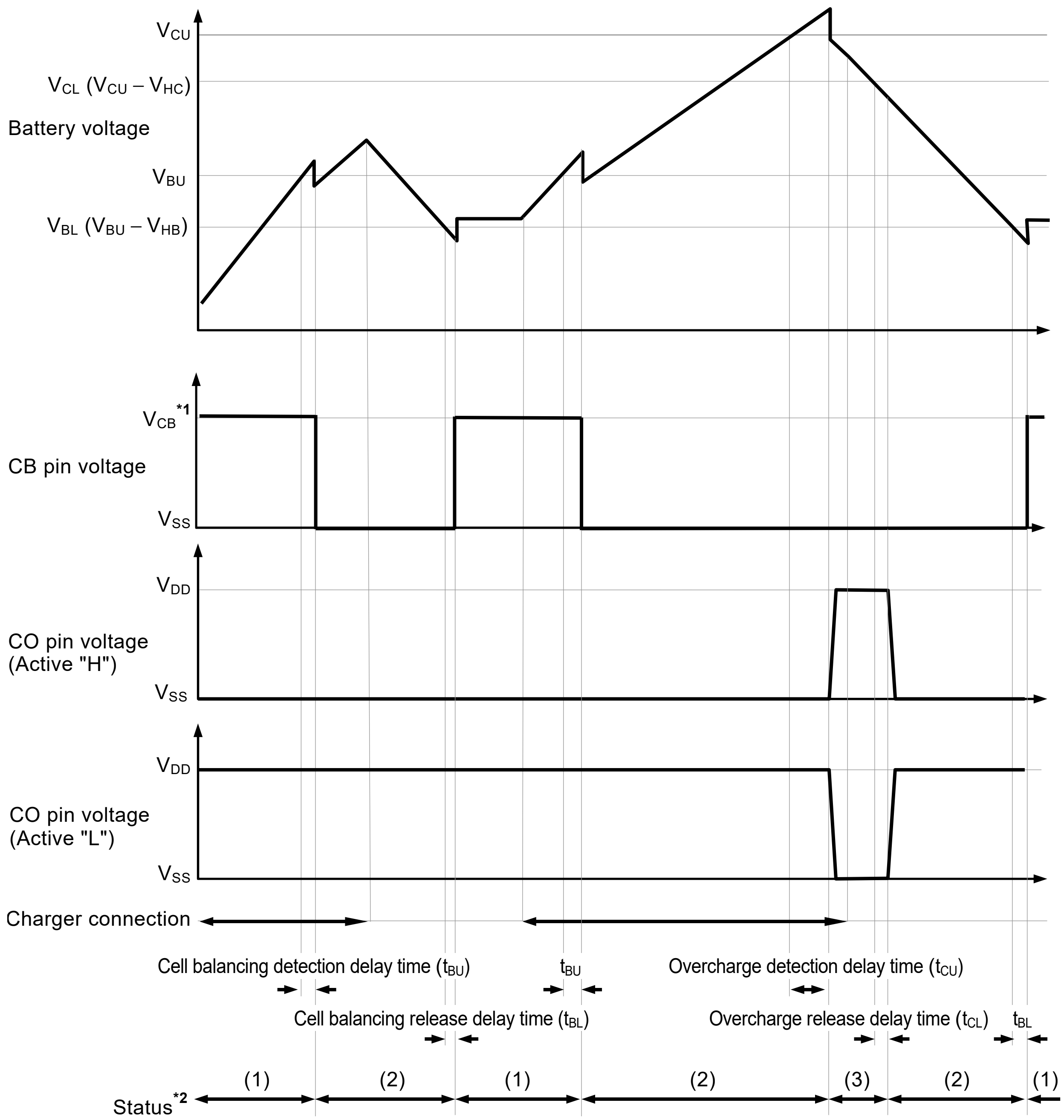
Table 13

DP Pin	Status
Open (V_{DP} = V_{SS})	Normal operation mode
"H" (V_{DP} ≥ V_{DPH})	Test mode
"L" (V_{DP} ≤ V_{DPL})	Normal operation mode

In test mode, the cell balancing detection delay time (t_{BU}) and overcharge detection delay time (t_{CU}) are shortened to 1/64 of the delay time in the normal operation mode.

The DP pin is pulled down to V_{SS} by the internal resistor. When in a mode other than test mode, leave the DP pin open or short it with V_{SS}.

■ Timing Chart



***1.** The CB pin is pulled up by the external resistor.
***2.** (1): Normal status
(2): Cell balancing status
(3): Overcharge status

Remark The charger is assumed to charge with a constant current.

Figure 6

■ Precautions

- The application conditions for the input voltage, output voltage, and load current should not exceed the power dissipation.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
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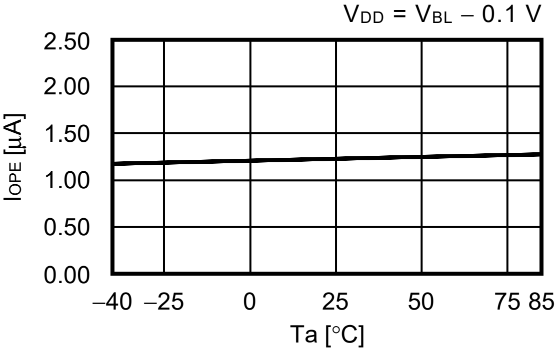
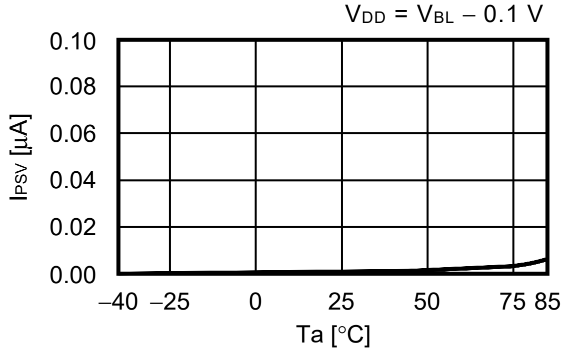
■ Characteristics (Typical Data)

1. Current consumption

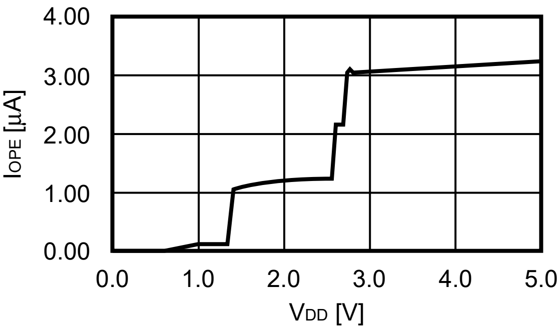
1. 1 I_{OPE} vs. Ta



1. 2 I_{PSV} vs. Ta

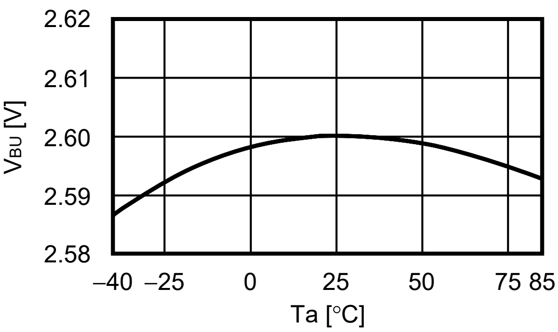


1. 3 I_{OPE} vs. V_{DD}

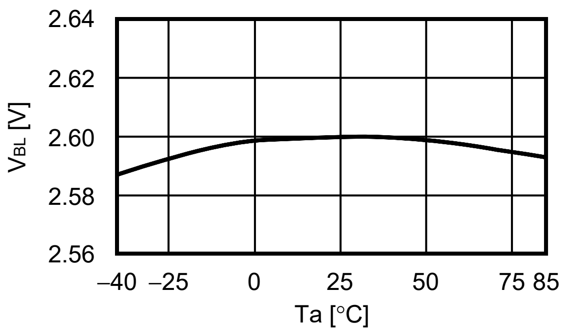


2. Cell balancing detection / release voltage, overcharge detection / release voltage and delay times

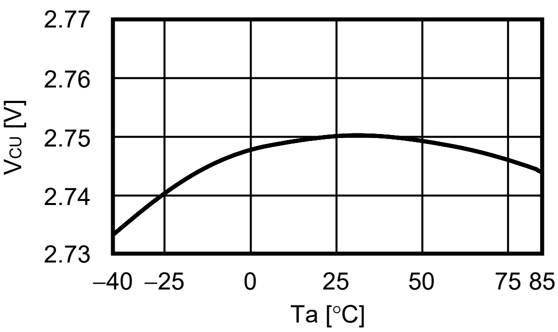
2. 1 V_{BU} vs. Ta



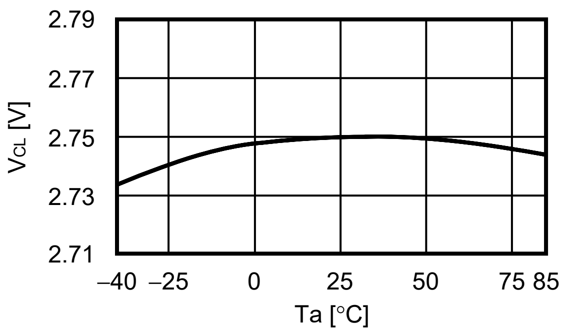
2. 2 V_{BL} vs. Ta



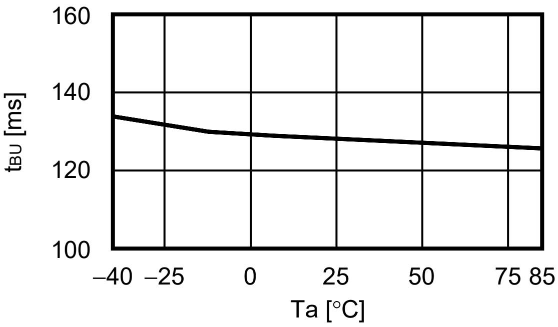
2. 3 V_{CU} vs. Ta



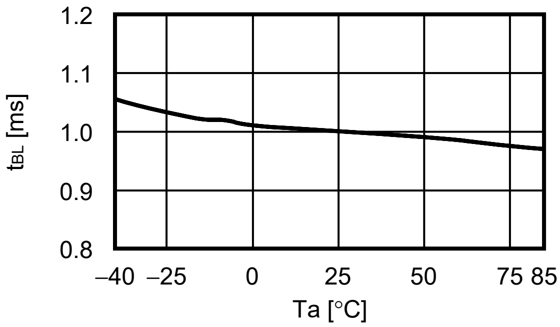
2. 4 V_{CL} vs. Ta



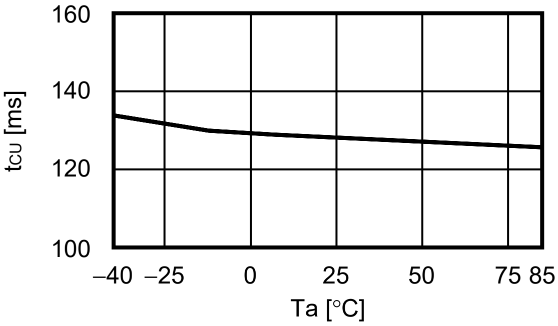
2. 5 t_{BU} vs. Ta



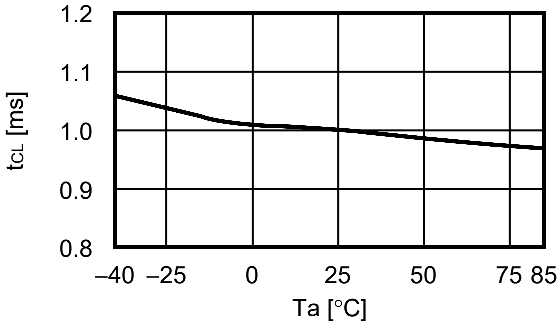
2. 6 t_{BL} vs. Ta



2. 7 t_{CU} vs. Ta

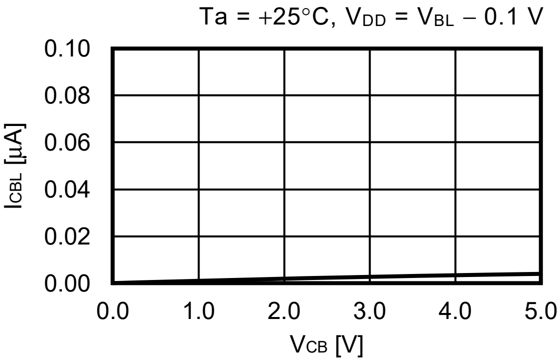


2. 8 t_{CL} vs. Ta

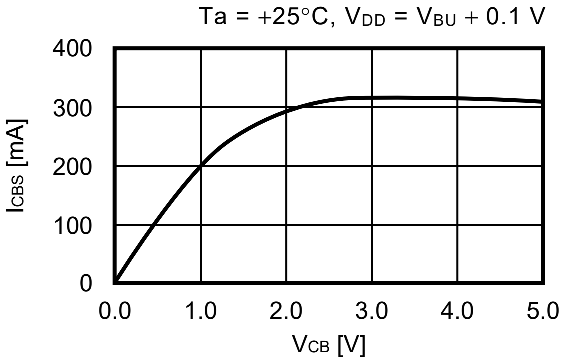


3. Output current

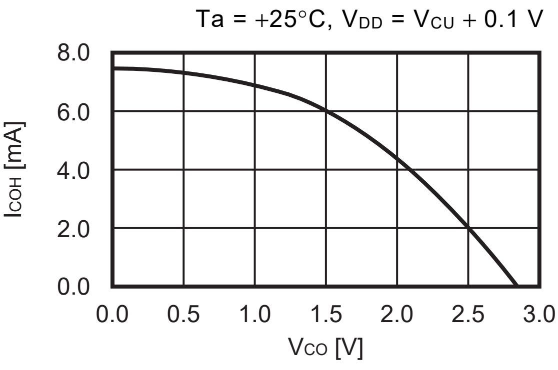
3. 1 I_{CBL} vs. V_{CB}



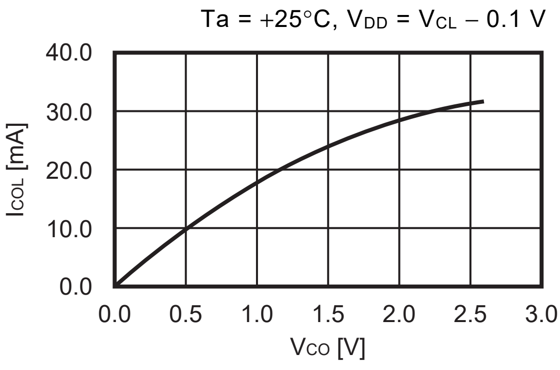
3. 2 I_{CBS} vs. V_{CB}



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

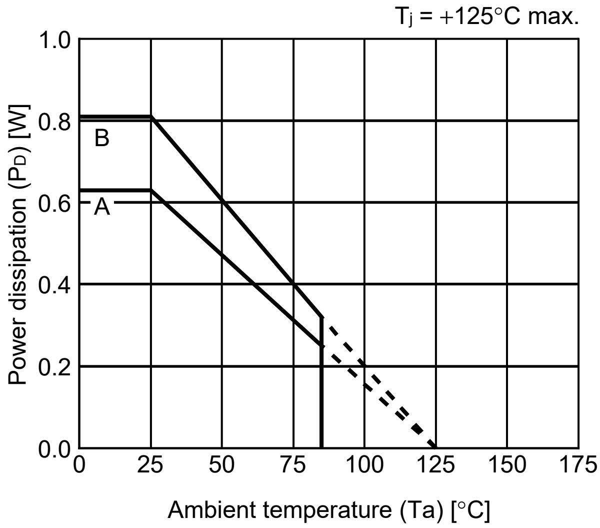


3. 4 I_{COL} vs. V_{CO}



■ Power Dissipation

SOT-23-6

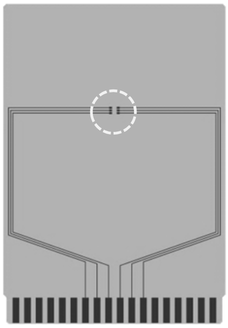


Board	Power Dissipation (P_D)
A	0.63 W
B	0.81 W
C	–
D	–
E	–

SOT-23-3/3S/5/6 Test Board

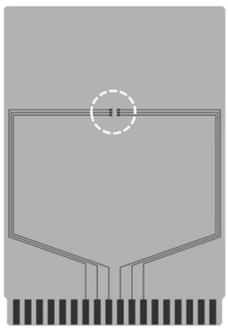
IC Mount Area

(1) Board A



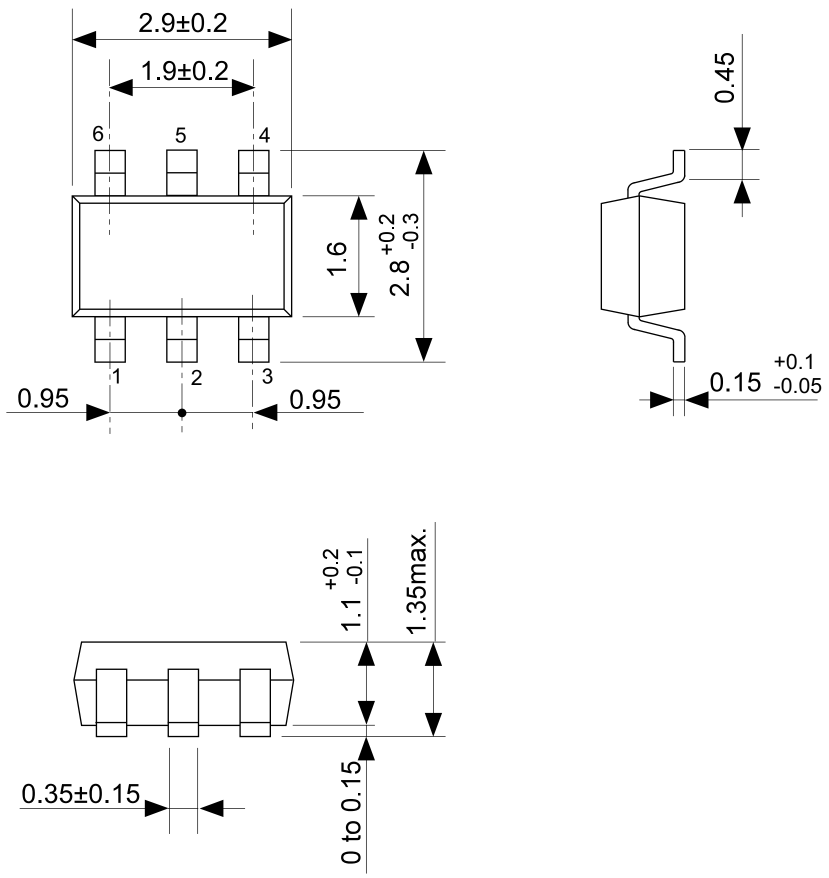
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

No. SOT23x-A-Board-SD-2.0



No. MP006-A-P-SD-2.1

TITLE	SOT236-A-PKG Dimensions
No.	MP006-A-P-SD-2.1
ANGLE	
UNIT	mm

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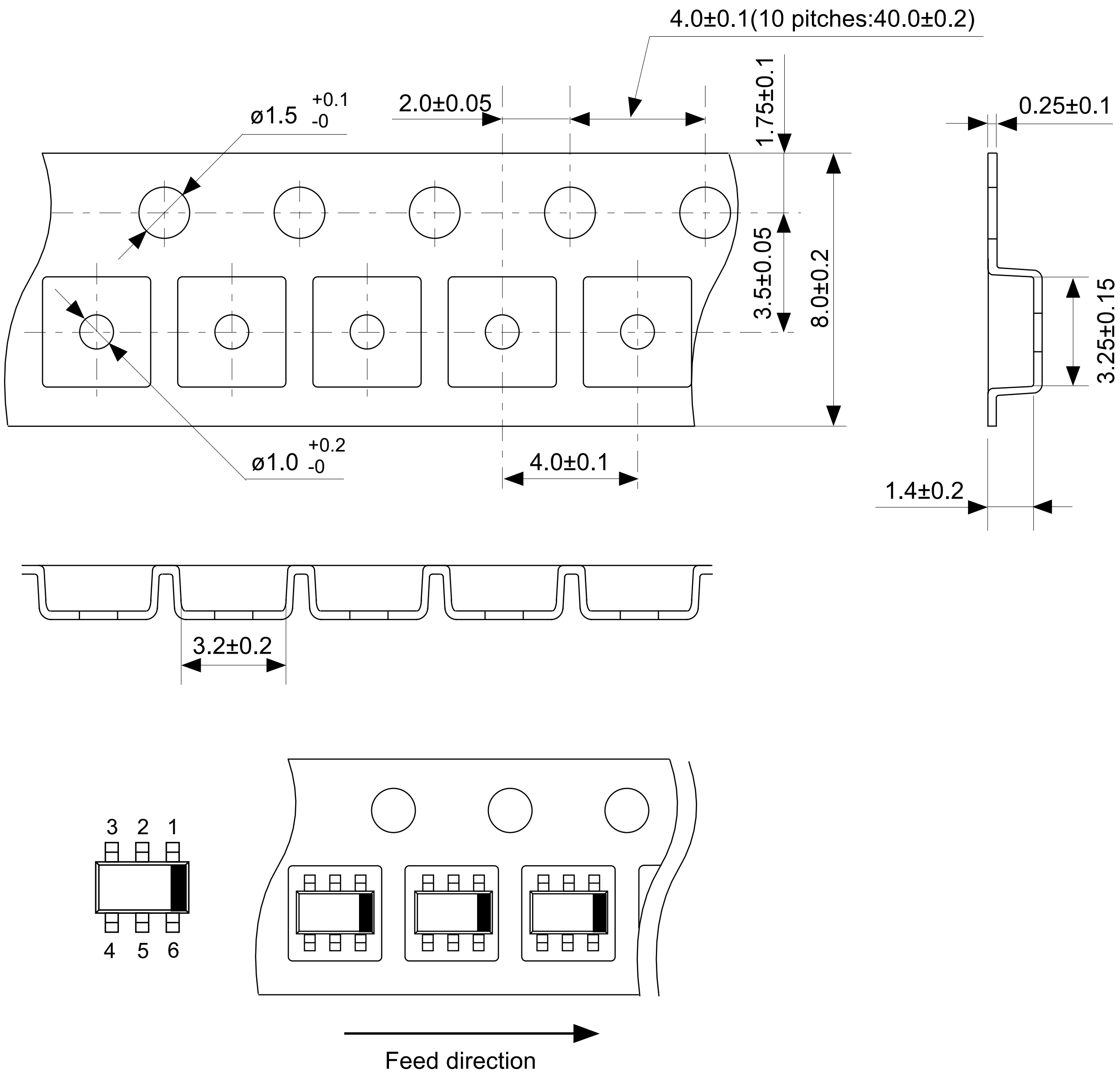
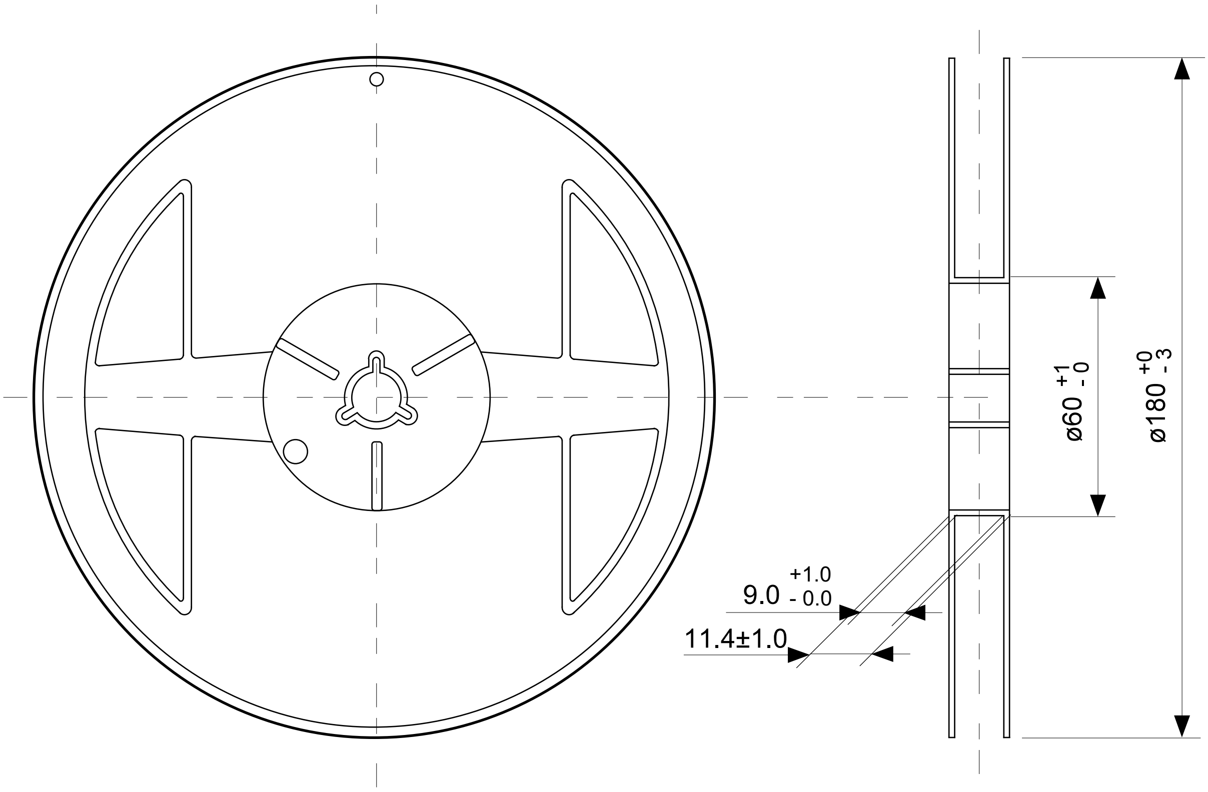


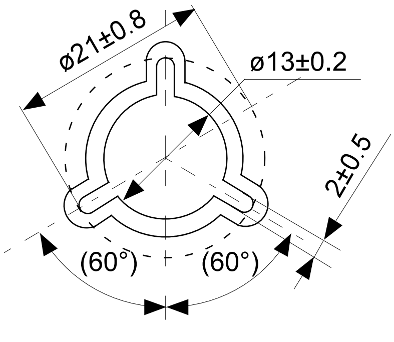
No. MP006-A-C-SD-3.1

TITLE	SOT236-A-Carrier Tape
No.	MP006-A-C-SD-3.1
ANGLE	
UNIT	mm

ABLIC Inc.



Enlarged drawing in the central part



No. MP006-A-R-SD-3.0

TITLE	SOT236-A-Reel		
No.	MP006-A-R-SD-3.0		
ANGLE		QTY	3,000
UNIT	mm		

ABLIC Inc.

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