

The S-19190 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-19190 Series is suitable for cell balancing and overcharge protection of batteries and capacitors.

**Caution** This product can be used in vehicle equipment and in-vehicle equipment. Before using the product for these purposes, it is imperative to contact our sales representatives.

## ■ Features

- High-accuracy voltage detection circuit
    - Cell balancing detection voltage: 2.0 V to 4.6 V (5 mV step) Accuracy  $\pm 12$  mV ( $2.0 \text{ V} \leq V_{\text{BU}} < 2.4 \text{ V}$ )  
Accuracy  $\pm 0.5\%$  ( $2.4 \text{ V} \leq V_{\text{BU}} \leq 4.6 \text{ V}$ )
    - Cell balancing release voltage: 2.0 V to 4.6 V\*<sup>1</sup> Accuracy  $\pm 24$  mV ( $2.0 \text{ V} \leq V_{\text{BL}} < 2.4 \text{ V}$ )  
Accuracy  $\pm 1.0\%$  ( $2.4 \text{ V} \leq V_{\text{BL}} \leq 4.6 \text{ V}$ )
    - Overcharge detection voltage: 2.0 V to 4.6 V (5 mV step) Accuracy  $\pm 12$  mV ( $2.0 \text{ V} \leq V_{\text{CU}} < 2.4 \text{ V}$ )  
Accuracy  $\pm 0.5\%$  ( $2.4 \text{ V} \leq V_{\text{CU}} \leq 4.6 \text{ V}$ )
    - Overcharge release voltage: 2.0 V to 4.6 V\*<sup>2</sup> Accuracy  $\pm 24$  mV ( $2.0 \text{ V} \leq V_{\text{CL}} < 2.4 \text{ V}$ )  
Accuracy  $\pm 1.0\%$  ( $2.4 \text{ V} \leq V_{\text{CL}} \leq 4.6 \text{ V}$ )
  - Built-in Nch transistor with ON resistance of 5  $\Omega$  typ. between the CB pin and the VSS pin
  - Current consumption: 2.0  $\mu\text{A}$  max. ( $T_a = +25^\circ\text{C}$ )
  - 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:  $T_a = -40^\circ\text{C}$  to  $+105^\circ\text{C}$
  - Lead-free (Sn 100%), halogen-free
  - AEC-Q100 qualified\*<sup>3</sup>
- \*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.)
- \*3. Contact our sales representatives for details.

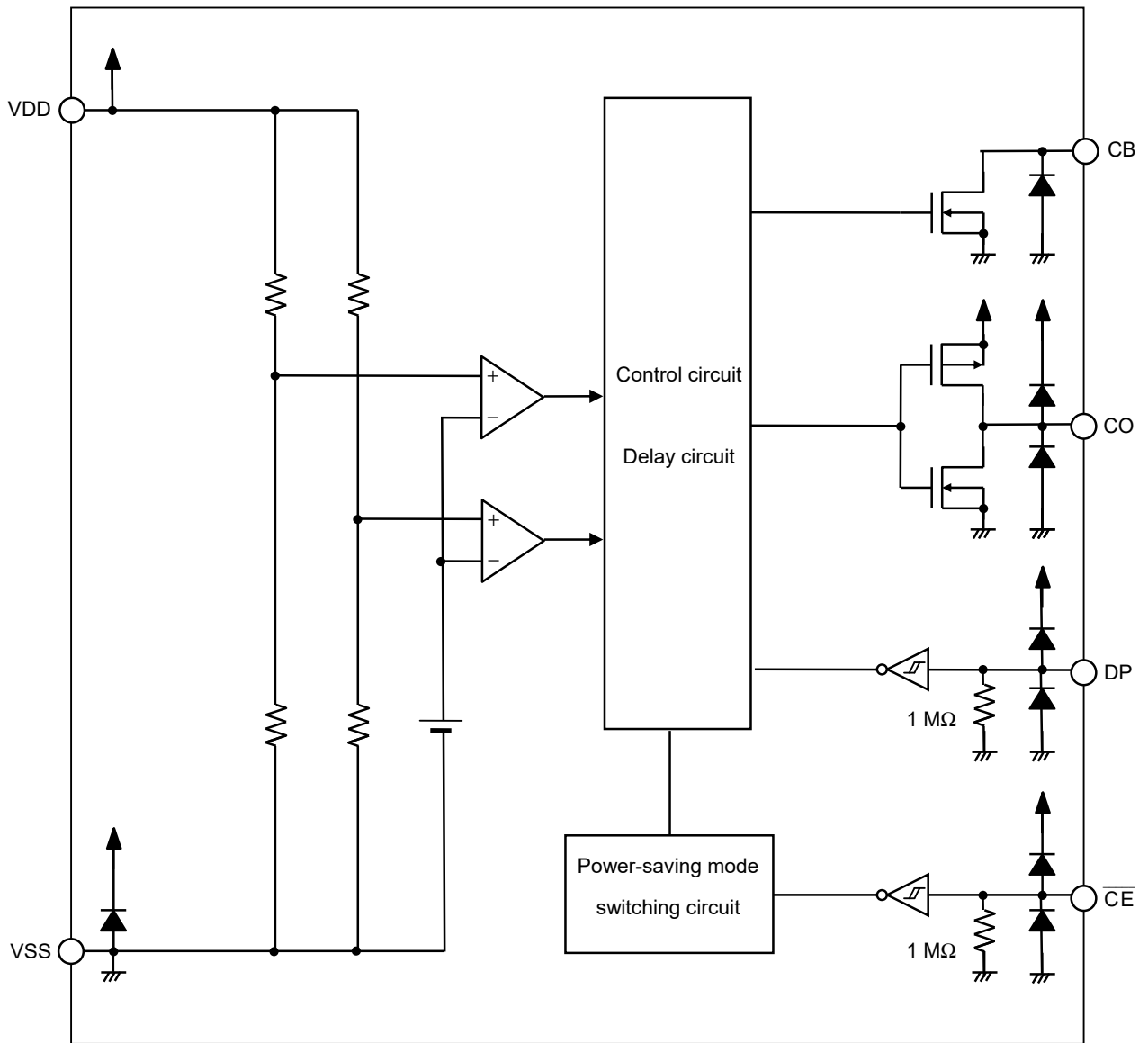
## ■ Applications

- Rechargeable battery module
- Capacitor module

## ■ Package

- SOT-23-6

■ **Block Diagram**



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

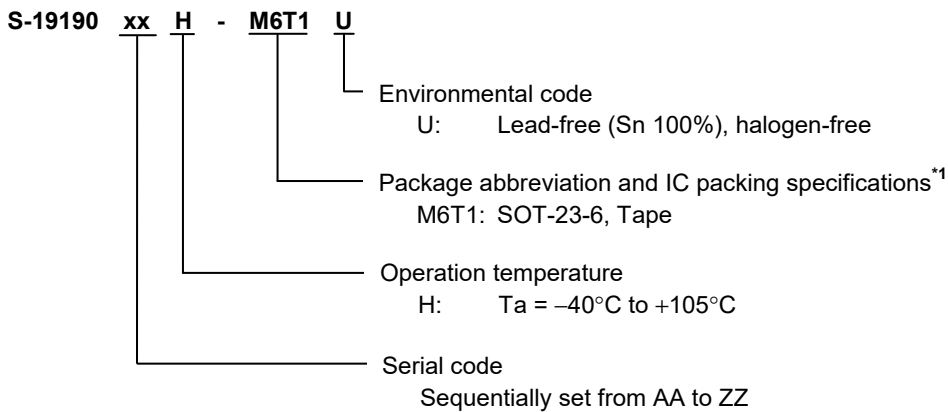
**Figure 1**

**■ AEC-Q100 Qualified**

This IC supports AEC-Q100 for operation temperature grade 2.  
 Contact our sales representatives for details of AEC-Q100 reliability specification.

**■ Product Name Structure**

**1. Product name**



\*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 <sub>BU</sub> ]	Cell Balancing Release Voltage [V <sub>BL</sub> ]	Overcharge Detection Voltage [V <sub>CU</sub> ]	Overcharge Release Voltage [V <sub>CL</sub> ]	CO Pin Output Form	CO Pin Output Logic	Combination of Delay Time
S-19190AAH-M6T1U	2.600 V	2.600 V	2.750 V	2.750 V	CMOS output	Active "H"	(1)
S-19190ABH-M6T1U	3.000 V	3.000 V	3.150 V	3.150 V	CMOS output	Active "H"	(1)
S-19190ACH-M6T1U	3.000 V	3.000 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-19190ADH-M6T1U	3.100 V	3.100 V	3.250 V	3.250 V	CMOS output	Active "H"	(1)
S-19190AEH-M6T1U	3.100 V	3.100 V	3.300 V	3.300 V	CMOS output	Active "H"	(1)
S-19190AFH-M6T1U	2.600 V	2.600 V	2.800 V	2.800 V	CMOS output	Active "H"	(1)
S-19190AGH-M6T1U	2.400 V	2.400 V	2.900 V	2.900 V	CMOS output	Active "H"	(1)
S-19190AHH-M6T1U	2.400 V	2.400 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-19190AIH-M6T1U	2.100 V	2.100 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-19190AKH-M6T1U	2.400 V	2.400 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-19190ALH-M6T1U	2.100 V	2.000 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-19190AMH-M6T1U	2.620 V	2.520 V	2.800 V	2.700 V	CMOS output	Active "H"	(1)
S-19190ANH-M6T1U	3.300 V	3.300 V	4.080 V	3.930 V	CMOS output	Active "H"	(1)
S-19190AOH-M6T1U	2.000 V	2.000 V	3.000 V	3.000 V	CMOS output	Active "H"	(1)
S-19190APH-M6T1U	3.700 V	3.700 V	4.500 V	4.500 V	CMOS output	Active "H"	(1)
S-19190AQH-M6T1U	3.800 V	3.800 V	4.080 V	3.930 V	CMOS output	Active "H"	(1)
S-19190ARH-M6T1U	2.800 V	2.800 V	3.150 V	3.150 V	CMOS output	Active "H"	(1)

**Table 2 (2 / 2)**

Product Name	Cell Balancing Detection Voltage [V <sub>BU</sub> ]	Cell Balancing Release Voltage [V <sub>BL</sub> ]	Overcharge Detection Voltage [V <sub>CU</sub> ]	Overcharge Release Voltage [V <sub>CL</sub> ]	CO Pin Output Form	CO Pin Output Logic	Combination of Delay Time
S-19190ASH-M6T1U	2.800 V	2.800 V	3.200 V	3.200 V	CMOS output	Active "H"	(1)
S-19190ATH-M6T1U	2.800 V	2.800 V	3.100 V	3.100 V	CMOS output	Active "H"	(1)
S-19190AUH-M6T1U	2.500 V	2.400 V	3.800 V	3.700 V	CMOS output	Active "H"	(1)
S-19190AVH-M6T1U	2.300 V	2.200 V	3.800 V	3.700 V	CMOS output	Active "H"	(1)
S-19190AWH-M6T1U	2.650 V	2.600 V	2.750 V	2.650 V	Nch open-drain output	Active "L"	(1)
S-19190AXH-M6T1U	2.400 V	2.400 V	2.950 V	2.950 V	CMOS output	Active "H"	(1)
S-19190AYH-M6T1U	4.150 V	4.150 V	4.275 V	4.275 V	CMOS output	Active "H"	(2)
S-19190AZH-M6T1U	2.450 V	2.450 V	2.500 V	2.500 V	CMOS output	Active "H"	(3)
S-19190BCH-M6T1U	4.200 V	4.200 V	4.300 V	4.200 V	CMOS output	Active "L"	(5)
S-19190BDH-M6T1U	2.300 V	2.300 V	2.600 V	2.600 V	CMOS output	Active "H"	(1)
S-19190BEH-M6T1U	4.400 V	4.200 V	4.600 V	4.600 V	CMOS output	Active "H"	(3)
S-19190BFH-M6T1U	3.550 V	3.200 V	4.080 V	3.380 V	CMOS output	Active "L"	(4)
S-19190BGH-M6T1U	2.700 V	2.000 V	4.400 V	3.700 V	CMOS output	Active "H"	(3)
S-19190BHH-M6T1U	3.550 V	3.550 V	3.800 V	3.700 V	CMOS output	Active "L"	(4)
S-19190BIH-M6T1U	2.700 V	2.000 V	4.400 V	4.200 V	CMOS output	Active "H"	(3)
S-19190BJH-M6T1U	2.725 V	2.675 V	2.775 V	2.725 V	CMOS output	Active "L"	(4)
S-19190BKH-M6T1U	2.700 V	2.000 V	4.080 V	3.930 V	CMOS output	Active "H"	(3)
S-19190BLH-M6T1U	4.150 V	3.950 V	4.600 V	3.900 V	CMOS output	Active "L"	(4)
S-19190BMH-M6T1U	3.550 V	3.450 V	4.000 V	3.300 V	CMOS output	Active "L"	(4)
S-19190BNH-M6T1U	2.700 V	2.650 V	3.100 V	2.800 V	CMOS output	Active "H"	(1)

- Remark**
1. 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 <sub>BU</sub> ]	Cell Balancing Release Delay Time [t <sub>BL</sub> ]	Overcharge Detection Delay Time [t <sub>CU</sub> ]	Overcharge Release Delay Time [t <sub>CL</sub> ]
(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	0.5 ms	64 ms	0.5 ms
(4)	128 ms	1.0 ms	1024 ms	2.0 ms
(5)	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 <sub>BU</sub>	64 ms	128 ms*2	256 ms	512 ms	1024 ms	Select a value from the left.
Cell balancing release delay time	t <sub>BL</sub>	0.5 ms		1.0 ms*2		2.0 ms	Select a value from the left.
Overcharge detection delay time*1	t <sub>CU</sub>	64 ms	128 ms*2	256 ms	512 ms	1024 ms	Select a value from the left.
Overcharge release delay time	t <sub>CL</sub>	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

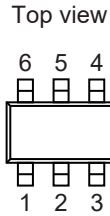


Figure 2

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	$\overline{CE}$	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 <sub>DS</sub>	VDD	V <sub>SS</sub> – 0.3 to V <sub>SS</sub> + 6.0	V
Input pin voltage	V <sub>IN</sub>	$\overline{CE}$ , DP	V <sub>SS</sub> – 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 6.0	V
Output pin voltage	V <sub>OUT</sub>	CO, CB	V <sub>SS</sub> – 0.3 to V <sub>DD</sub> + 0.3 ≤ V <sub>SS</sub> + 6.0	V
Output pin current	I <sub>CB</sub>	CB	100 (–40°C to +105°C)	mA
Operation ambient temperature	T <sub>opr</sub>	–	–40 to +105	°C
Storage temperature	T <sub>stg</sub>	–	–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 <sub>JA</sub>	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 and Table 9, set V2 = V3 = 0 V, and SWn (n = 1 to 4) = OFF.

1. Ta = +25°C

Table 8 (1 / 2)

(Ta = +25°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
<b>Detection voltage</b>							
Cell balancing detection voltage	V <sub>BU</sub>	SW1 = ON	2.0 V ≤ V <sub>BU</sub> < 2.4 V	V <sub>BU</sub> - 0.012	V <sub>BU</sub>	V <sub>BU</sub> + 0.012	V
			2.4 V ≤ V <sub>BU</sub> ≤ 4.6 V	V <sub>BU</sub> × 0.995	V <sub>BU</sub>	V <sub>BU</sub> × 1.005	V
Cell balancing release voltage	V <sub>BL</sub>	SW1 = ON	2.0 V ≤ V <sub>BL</sub> < 2.4 V	V <sub>BL</sub> - 0.024	V <sub>BL</sub>	V <sub>BL</sub> + 0.024	V
			2.4 V ≤ V <sub>BL</sub> ≤ 4.6 V	V <sub>BL</sub> × 0.99	V <sub>BL</sub>	V <sub>BL</sub> × 1.01	V
Overcharge detection voltage	V <sub>CU</sub>	2.0 V ≤ V <sub>CU</sub> < 2.4 V		V <sub>CU</sub> - 0.012	V <sub>CU</sub>	V <sub>CU</sub> + 0.012	V
		2.4 V ≤ V <sub>CU</sub> ≤ 4.6 V		V <sub>CU</sub> × 0.995	V <sub>CU</sub>	V <sub>CU</sub> × 1.005	V
Overcharge release voltage	V <sub>CL</sub>	2.0 V ≤ V <sub>CL</sub> < 2.4 V		V <sub>CL</sub> - 0.024	V <sub>CL</sub>	V <sub>CL</sub> + 0.024	V
		2.4 V ≤ V <sub>CL</sub> ≤ 4.6 V		V <sub>CL</sub> × 0.99	V <sub>CL</sub>	V <sub>CL</sub> × 1.01	V
<b>Input voltage</b>							
Operation voltage between VDD pin and VSS pin	V <sub>DS</sub>	Voltages output from CO pin and CB pin are fixed		1.5	-	5.0	V
CE pin voltage "H"	V <sub>CEH</sub>	-		-	-	V <sub>DD</sub> × 0.9	V
CE pin voltage "L"	V <sub>CEL</sub>	-		V <sub>DD</sub> × 0.1	-	-	V
DP pin voltage "H"	V <sub>DPH</sub>	-		-	-	V <sub>DD</sub> × 0.9	V
DP pin voltage "L"	V <sub>DPL</sub>	-		V <sub>DD</sub> × 0.1	-	-	V
<b>Input current</b>							
Current consumption during operation	I <sub>OPE</sub>	I <sub>VDD</sub> when V1 = V <sub>BL</sub> - 0.1 V		-	1.2	2.0	μA
Current consumption during power-saving	I <sub>PSV</sub>	I <sub>VDD</sub> when V1 = V2 = V <sub>BL</sub> - 0.1 V		-	-	0.1	μA

**Table 8 (2 / 2)**

(Ta = +25°C unless otherwise specified)

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



2. Ta = -40°C to +105°C

**Table 9 (1 / 2)**

(Ta = -40°C to +105°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	
<b>Detection voltage</b>							
Cell balancing detection voltage	V <sub>BU</sub>	SW1 = ON	2.0 V ≤ V <sub>BU</sub> < 2.4 V	V <sub>BU</sub> - 0.040	V <sub>BU</sub>	V <sub>BU</sub> + 0.040	V
			2.4 V ≤ V <sub>BU</sub> ≤ 4.6 V	V <sub>BU</sub> × 0.984	V <sub>BU</sub>	V <sub>BU</sub> × 1.016	V
Cell balancing release voltage	V <sub>BL</sub>	SW1 = ON	2.0 V ≤ V <sub>BL</sub> < 2.4 V	V <sub>BL</sub> - 0.080	V <sub>BL</sub>	V <sub>BL</sub> + 0.080	V
			2.4 V ≤ V <sub>BL</sub> ≤ 4.6 V	V <sub>BL</sub> × 0.968	V <sub>BL</sub>	V <sub>BL</sub> × 1.032	V
Overcharge detection voltage	V <sub>CU</sub>	2.0 V ≤ V <sub>CU</sub> < 2.4 V		V <sub>CU</sub> - 0.040	V <sub>CU</sub>	V <sub>CU</sub> + 0.040	V
		2.4 V ≤ V <sub>CU</sub> ≤ 4.6 V		V <sub>CU</sub> × 0.984	V <sub>CU</sub>	V <sub>CU</sub> × 1.016	V
Overcharge release voltage	V <sub>CL</sub>	2.0 V ≤ V <sub>CL</sub> < 2.4 V		V <sub>CL</sub> - 0.080	V <sub>CL</sub>	V <sub>CL</sub> + 0.080	V
		2.4 V ≤ V <sub>CL</sub> ≤ 4.6 V		V <sub>CL</sub> × 0.968	V <sub>CL</sub>	V <sub>CL</sub> × 1.032	V
<b>Input voltage</b>							
Operation voltage between VDD pin and VSS pin	V <sub>DS</sub>	Voltages output from CO pin and CB pin are fixed		1.5	-	5.0	V
$\overline{\text{CE}}$ pin voltage "H"	V <sub>CEH</sub>	-		-	-	V <sub>DD</sub> × 0.9	V
$\overline{\text{CE}}$ pin voltage "L"	V <sub>CEL</sub>	-		V <sub>DD</sub> × 0.1	-	-	V
DP pin voltage "H"	V <sub>DPH</sub>	-		-	-	V <sub>DD</sub> × 0.9	V
DP pin voltage "L"	V <sub>DPL</sub>	-		V <sub>DD</sub> × 0.1	-	-	V
<b>Input current</b>							
Current consumption during operation	I <sub>OPE</sub>	I <sub>VDD</sub> when V1 = V <sub>BL</sub> - 0.1 V		-	1.2	2.1	μA
Current consumption during power-saving	I <sub>PSV</sub>	I <sub>VDD</sub> when V1 = V2 = V <sub>BL</sub> - 0.1 V		-	-	0.15	μA

**Table 9 (2 / 2)**

(Ta = -40°C to +105°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
<b>Delay time</b>						
Cell balancing detection delay time	t <sub>BU</sub>	-	t <sub>BU</sub> × 0.5	t <sub>BU</sub>	t <sub>BU</sub> × 1.5	ms
Cell balancing release delay time	t <sub>BL</sub>	-	t <sub>BL</sub> × 0.5	t <sub>BL</sub>	t <sub>BL</sub> × 1.5	ms
Overcharge detection delay time	t <sub>CU</sub>	-	t <sub>CU</sub> × 0.5	t <sub>CU</sub>	t <sub>CU</sub> × 1.5	ms
Overcharge release delay time	t <sub>CL</sub>	-	t <sub>CL</sub> × 0.5	t <sub>CL</sub>	t <sub>CL</sub> × 1.5	ms
<b>Output current</b>						
<b>CB pin output current</b>						
CB pin sink current	I <sub>CBS</sub>	V1 = V <sub>BU</sub> + 0.1 V, SW2 = ON, V4 = 0.5 V	30	-	-	mA
CB pin leakage current	I <sub>CBL</sub>	V1 = V <sub>BL</sub> - 0.1 V, SW2 = ON, V4 = 6.0 V	-	-	0.15	μA
<b>CO pin output current (output form: CMOS output, output logic: active "H")</b>						
CO pin sink current	I <sub>COL</sub>	V1 = V <sub>CL</sub> - 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	-	-	mA
CO pin source current	I <sub>COH</sub>	V1 = V <sub>CU</sub> + 0.1 V, SW4 = ON, V5 = V1 - 0.5 V	1.0	-	-	mA
<b>CO pin output current (output form: CMOS output, output logic: active "L")</b>						
CO pin sink current	I <sub>COL</sub>	V1 = V <sub>CU</sub> + 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	-	-	mA
CO pin source current	I <sub>COH</sub>	V1 = V <sub>CL</sub> - 0.1 V, SW4 = ON, V5 = V1 - 0.5 V	1.0	-	-	mA
<b>CO pin output current (output form: Nch open-drain output, output logic: active "H")</b>						
CO pin sink current	I <sub>COL</sub>	V1 = V <sub>CL</sub> - 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	-	-	mA
CO pin leakage current	I <sub>COHL</sub>	V1 = V <sub>CU</sub> + 0.1 V, SW4 = ON, V5 = 6.0 V	-	-	0.15	μA
<b>CO pin output current (output form: Nch open-drain output, output logic: active "L")</b>						
CO pin sink current	I <sub>COL</sub>	V1 = V <sub>CU</sub> + 0.1 V, SW4 = ON, V5 = 0.5 V	5.0	-	-	mA
CO pin leakage current	I <sub>COHL</sub>	V1 = V <sub>CL</sub> - 0.1 V, SW4 = ON, V5 = 6.0 V	-	-	0.15	μA

■ Test Circuit

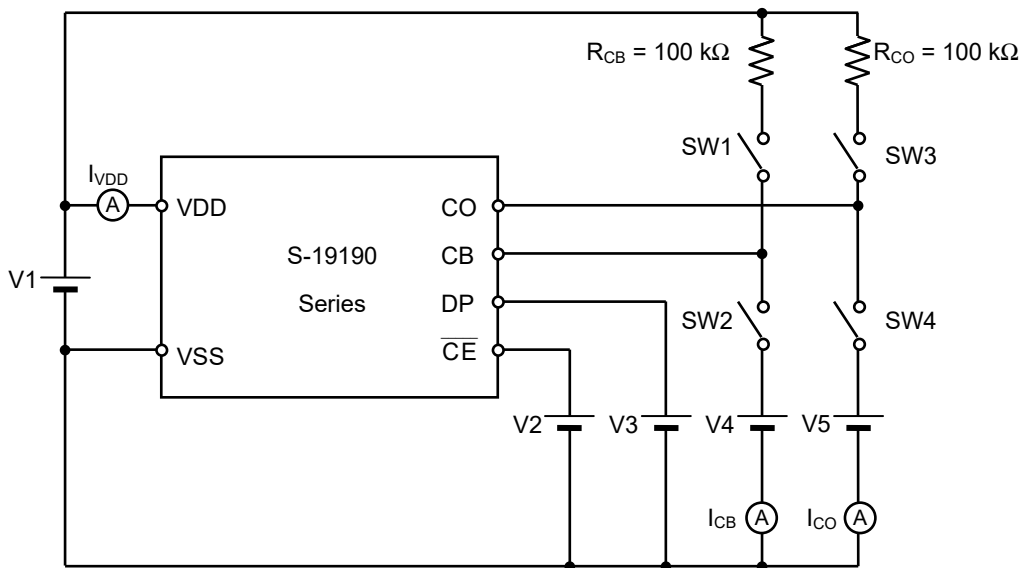


Figure 3

**Caution** Unless otherwise specified in Table 8, set  $V2 = V3 = 0\text{ V}$ , and  $SW_n$  ( $n = 1$  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  $V1 = V_{BL} - 0.1\text{ V}$ .

**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  $V_{BL} - 0.1\text{ V}$  after setting  $V1 = V2 = V_{BL} - 0.1\text{ V}$ .

**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  $V1 = V_{BL} - 0.1\text{ V}$ .

**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  $V_{BL} - 0.1\text{ V}$  after setting  $V1 = V3 = V_{BL} - 0.1\text{ V}$ .

**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  $V_{BU} - 0.1\text{ V}$  to when the CB pin output is inverted after setting  $V1$  to  $V_{BU} + 0.1\text{ V}$ .

**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  $V_{BL} + 0.1\text{ V}$  to when the CB pin output is inverted after setting  $V1$  to  $V_{BL} - 0.1\text{ V}$ .

**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  $V_{CU} - 0.1\text{ V}$  to when the CO pin output is inverted after setting  $V1$  to  $V_{CU} + 0.1\text{ V}$ .

**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  $V_{CL} + 0.1\text{ V}$  to when the CO pin output is inverted after setting  $V1$  to  $V_{CL} - 0.1\text{ V}$ .

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

■ **Standard Circuit**

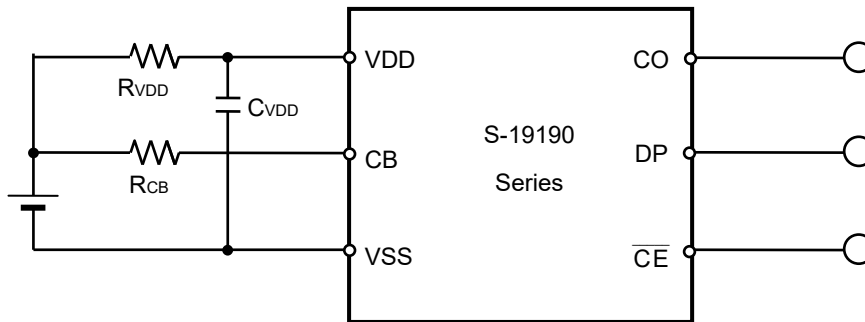


Figure 4

Table 10 Constants for External Components

Symbol	Part	Purpose	Min.	Typ.	Max.	Remark
R <sub>VDD</sub>	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 <sub>VDD</sub>	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 <sub>CB</sub>	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<sub>VDD</sub> or a capacitor less than 0.068 μF to C<sub>VDD</sub>, the S-19190 Series may malfunction when power is largely fluctuated.

\*2. Set the cell balancing current value so that R<sub>CB</sub> does not exceed the power dissipation.

**Caution 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-19190 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 11**. This is the normal status.

**Table 11**

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

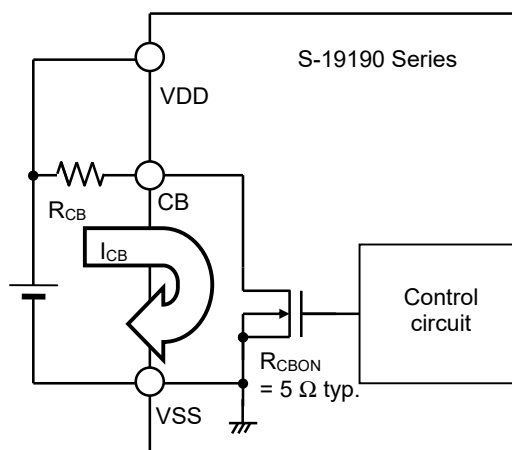
In the S-19190 Series, if  $V_{DS}$  is  $V_{BU}$  or higher and this status continues for the cell balancing detection delay time ( $t_{BU}$ ) or longer, the CB pin output becomes "L". This is the cell balancing status.

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-19190 Series includes an Nch transistor with ON resistance of  $5\ \Omega$  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-19190 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 12**. This is the overcharge status. In the overcharge status, the CB pin output becomes "L".

**Table 12**

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. $\overline{CE}$ pin

The S-19190 Series has the  $\overline{CE}$  pin (Power-saving mode switching pin). The S-19190 Series is set to the power-saving mode by inputting a voltage of  $V_{\overline{CEH}}$  or higher to the  $\overline{CE}$  pin.

**Table 13**

$\overline{CE}$ Pin	Status
Open ( $V_{\overline{CE}} = V_{SS}$ )	Normal operation mode
"H" ( $V_{\overline{CE}} \geq V_{\overline{CEH}}$ )	Power-saving mode
"L" ( $V_{\overline{CE}} \leq V_{\overline{CEL}}$ )	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 is the same as in the normal status.

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

### 5. DP pin

The S-19190 Series has the DP pin (Test mode switching pin). The S-19190 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.

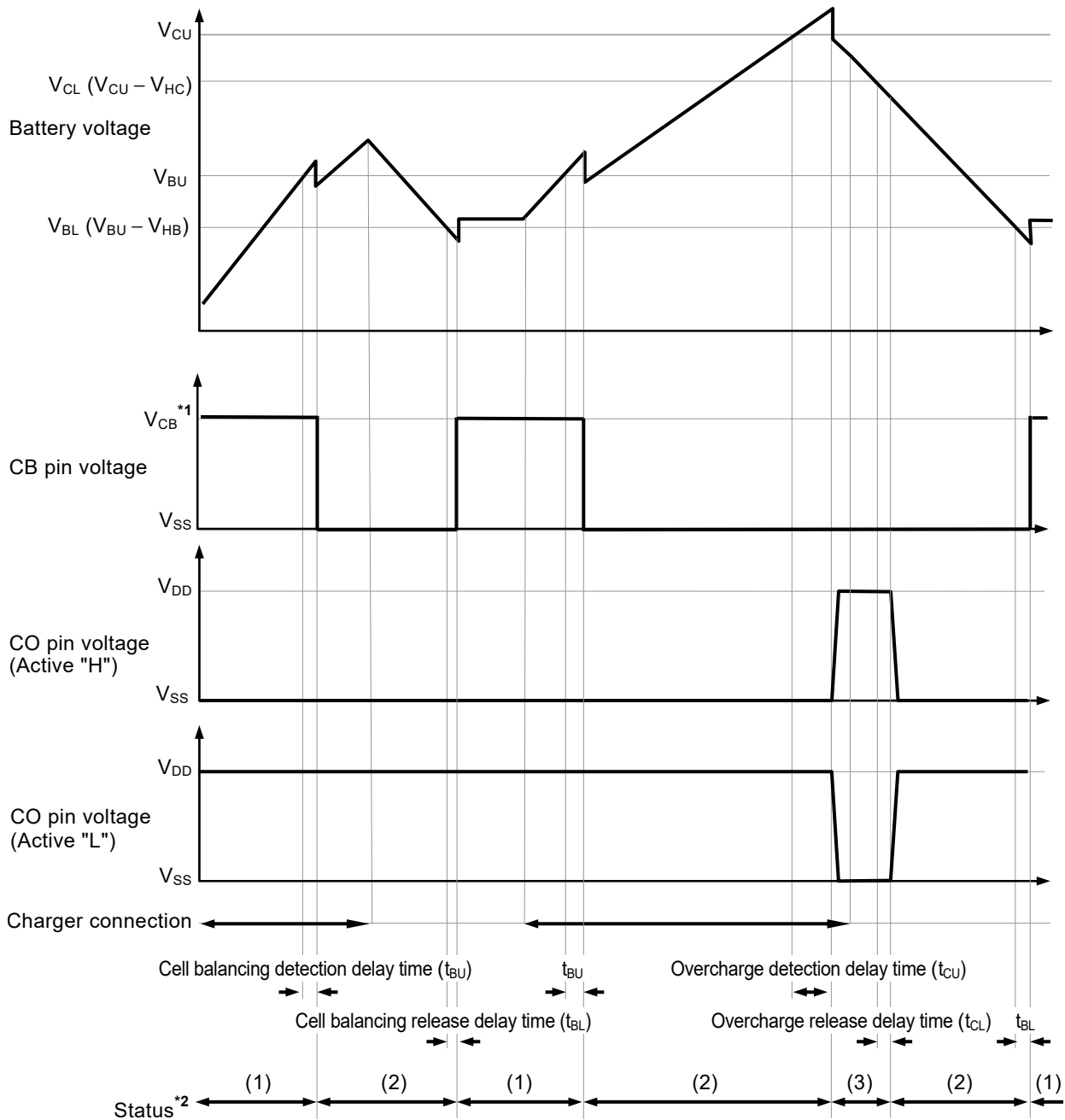
**Table 14**

DP Pin	Status
Open ( $V_{DP} = V_{SS}$ )	Normal operation mode
"H" ( $V_{DP} \geq V_{DPH}$ )	Test mode
"L" ( $V_{DP} \leq V_{DPL}$ )	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**



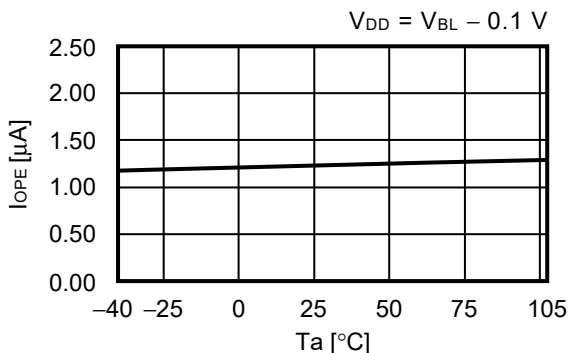
■ **Precautions**

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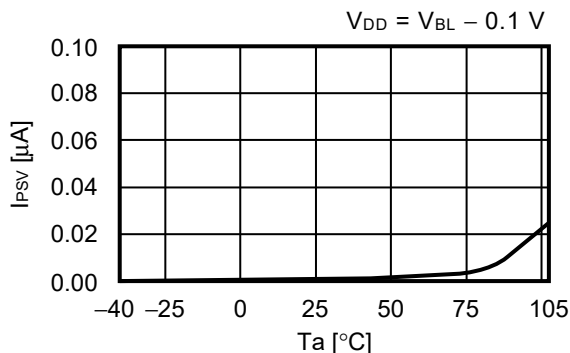
■ **Characteristics (Typical Data)**

**1. Current consumption**

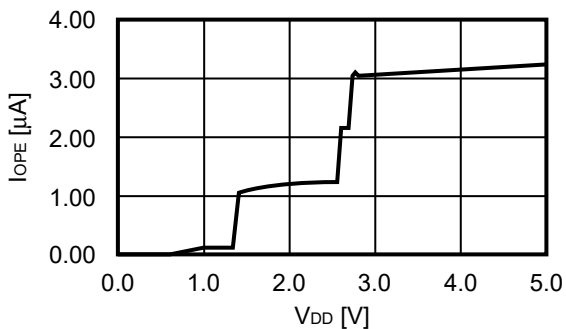
**1.1 I<sub>OPe</sub> vs. Ta**



**1.2 I<sub>PSV</sub> vs. Ta**

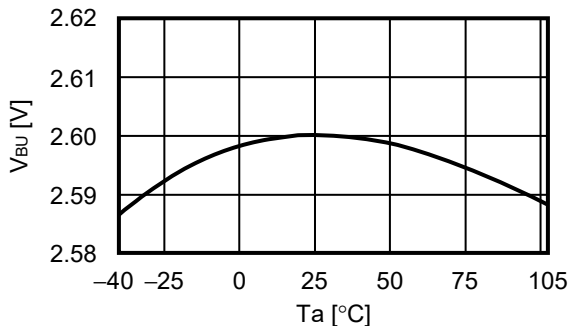


**1.3 I<sub>OPe</sub> vs. V<sub>DD</sub>**

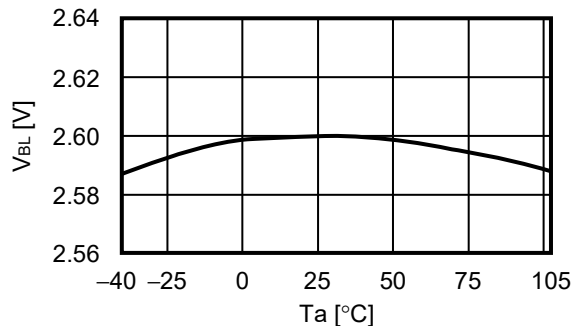


**2. Cell balancing detection / release voltage, overcharge detection / release voltage and delay times**

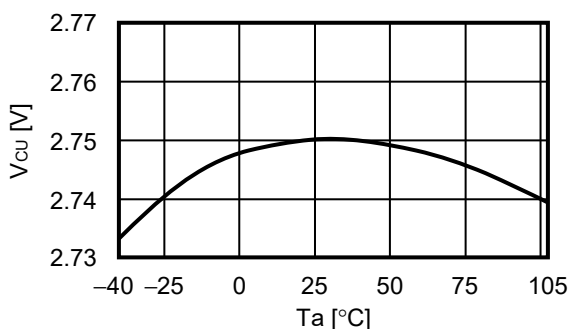
**2.1 V<sub>BU</sub> vs. Ta**



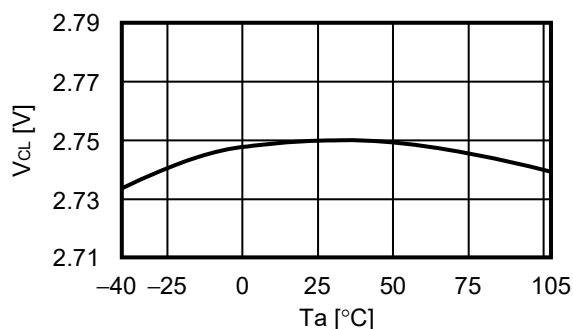
**2.2 V<sub>BL</sub> vs. Ta**



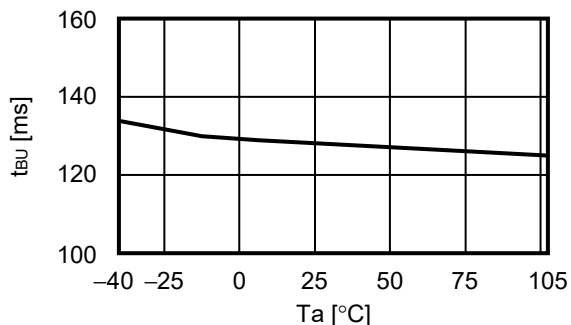
**2.3 V<sub>CU</sub> vs. Ta**



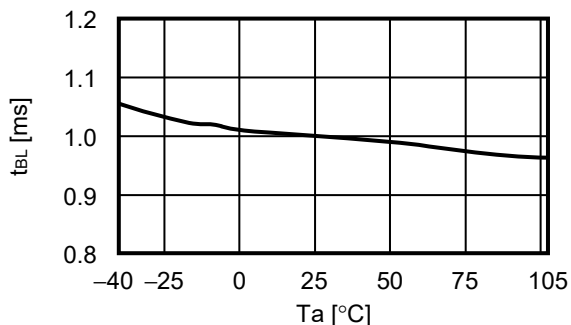
**2.4 V<sub>CL</sub> vs. Ta**



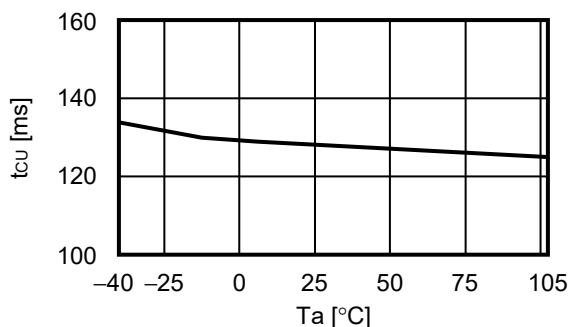
**2.5  $t_{BU}$  vs.  $T_a$**



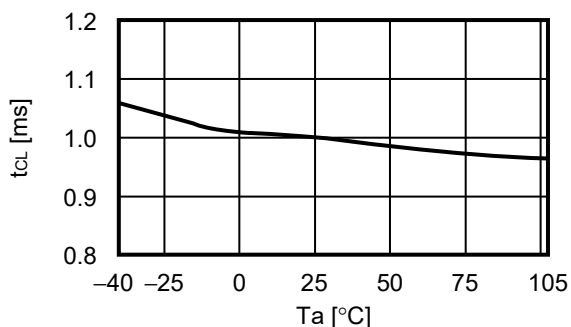
**2.6  $t_{BL}$  vs.  $T_a$**



**2.7  $t_{CU}$  vs.  $T_a$**

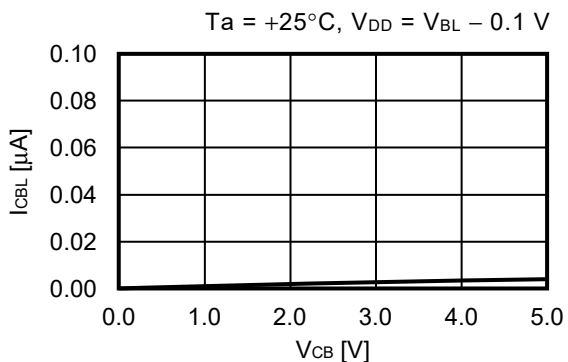


**2.8  $t_{CL}$  vs.  $T_a$**

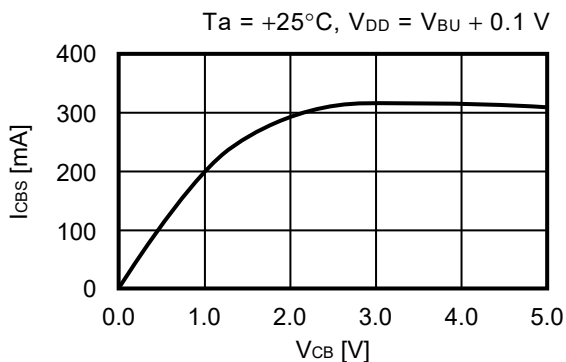


**3. Output current**

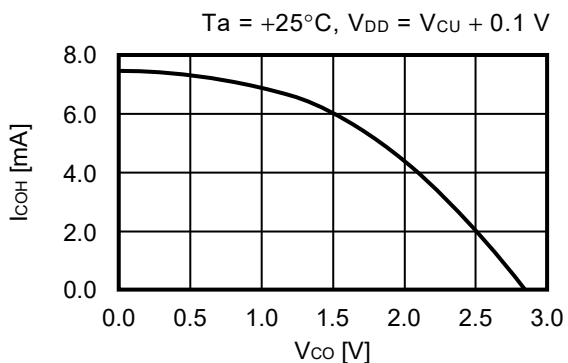
**3.1  $I_{CBL}$  vs.  $V_{CB}$**



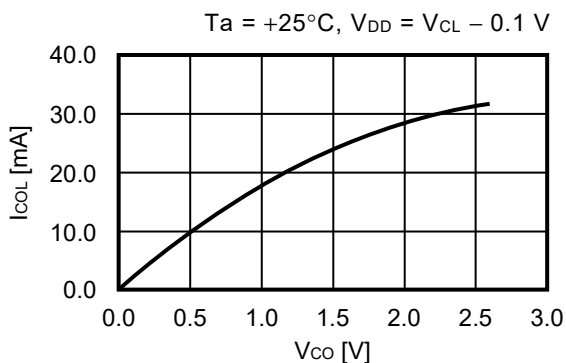
**3.2  $I_{CBS}$  vs.  $V_{CB}$**



**3.3  $I_{COH}$  vs.  $V_{CO}$**

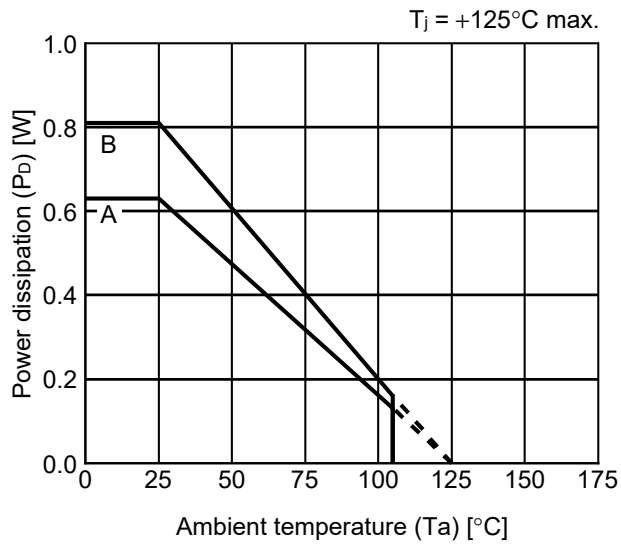


**3.4  $I_{COL}$  vs.  $V_{CO}$**



■ **Power Dissipation**

SOT-23-6



Board	Power Dissipation (P <sub>D</sub> )
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



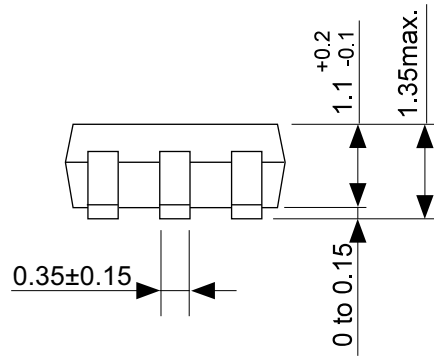
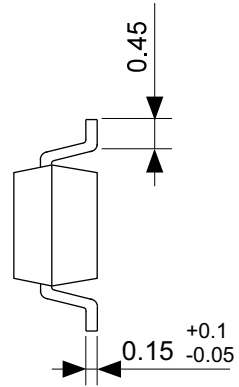
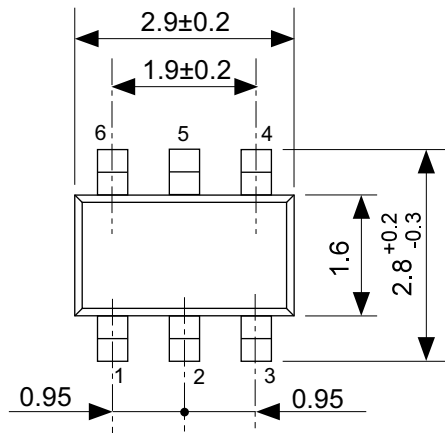
Item	Specification	
Size [mm]	114.3 x 76.2 x t1.6	
Material	FR-4	
Number of copper foil layer	2	
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via	-	

(2) Board B



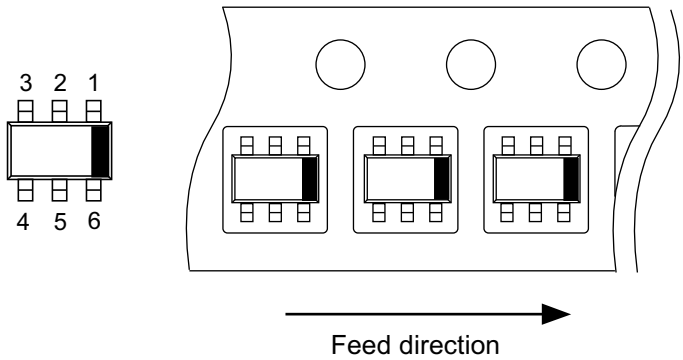
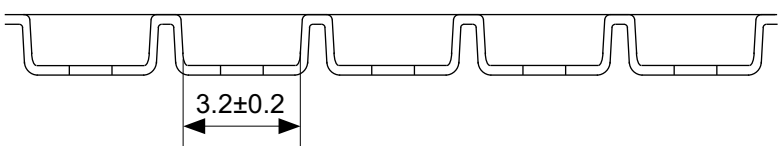
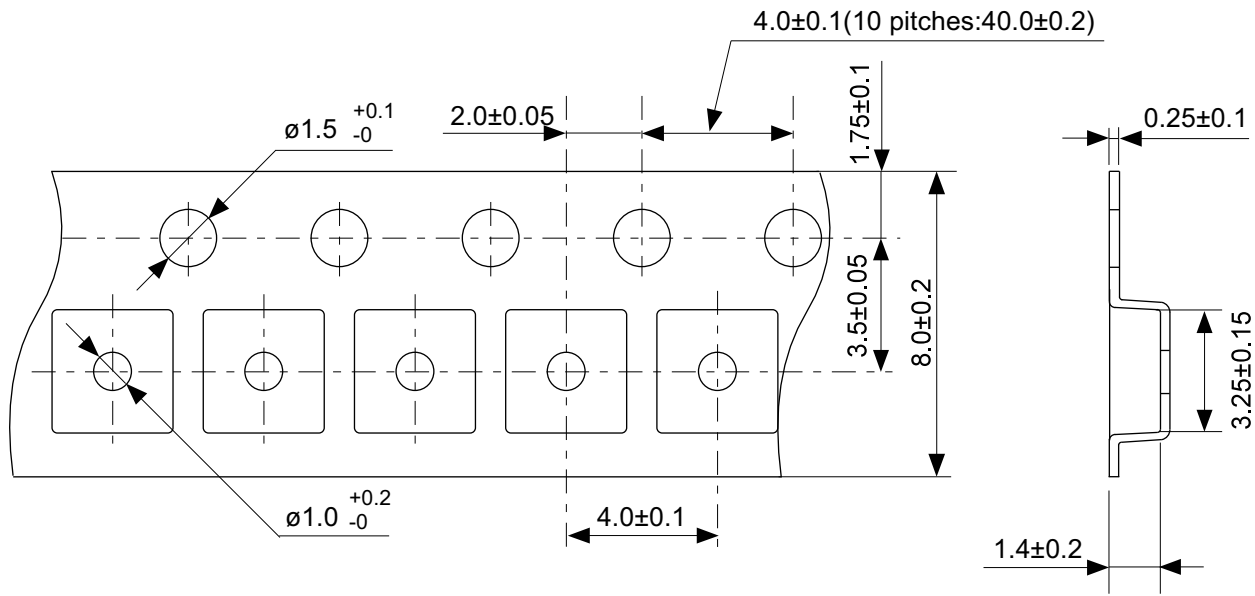
Item	Specification	
Size [mm]	114.3 x 76.2 x t1.6	
Material	FR-4	
Number of copper foil layer	4	
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via	-	

No. SOT23x-A-Board-SD-2.0



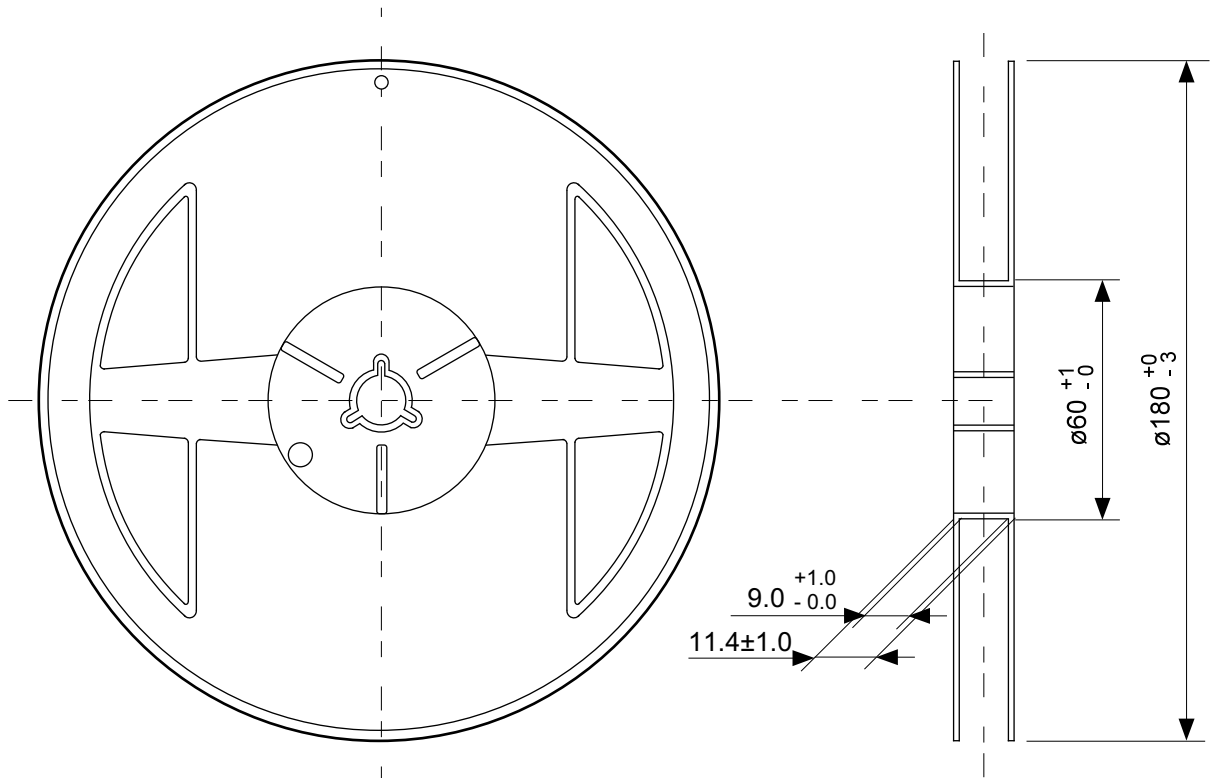
No. MP006-A-P-SD-2.1

TITLE	SOT236-A-PKG Dimensions
No.	MP006-A-P-SD-2.1
ANGLE	
UNIT	mm
<b>ABLIC Inc.</b>	

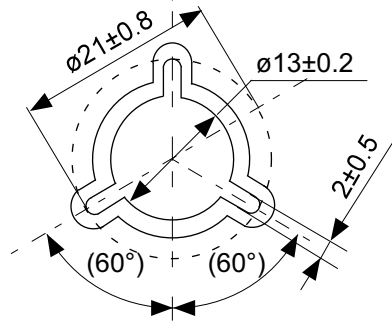


No. MP006-A-C-SD-3.1

TITLE	SOT236-A-Carrier Tape
No.	MP006-A-C-SD-3.1
ANGLE	
UNIT	mm
<b>ABLIC Inc.</b>	



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		
<b>ABLIC Inc.</b>			



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2.4-2019.07