S-8239B Series

OVERCURRENT MONITORING IC FOR MULTI-SERIAL-CELL PACK

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Rev.1.1_04

The S-8239B Series is an overcurrent monitoring IC for multi-serial-cell pack including high-accuracy voltage detection circuits and delay circuits.
The S-8239B Series is suitable for protection of lithium-ion / lithium polymer rechargeable battery packs from overcurrent.

■ Features

- Built-in high-accuracy voltage detection circuit

Overcurrent 1 detection voltage*1	0.04 V to 0.30 V (10 mV step)	Accuracy ±15 mV
Overcurrent 2 detection voltage	0.1 V to 0.7 V (100 mV step)	Accuracy ±100 mV
Overcurrent 3 detection voltage	1.2 V (Fixed)	Accuracy ±300 mV

- Built-in three-step overcurrent detection circuit: Overcurrent 1, overcurrent 2, overcurrent 3
- Overcurrent 3 detection function is selectable: Available, unavailable
- UVLO (under voltage lock out) function

UVLO detection voltage	2.0 V (Fixed)	Accuracy ±100 mV

- High-withstand voltage: VM pin, DO pin: Absolute maximum rating 28 V
- Delay times are generated only by an internal circuit (External capacitors are unnecessary).
- Low current consumption

During normal operation:	7.0 μA max.
During power-down:	0.1 μA max.

- Output logic: Active "L"
- Wide operation temperature range: Ta = −40°C to +85°C
- Lead-free (Sn 100%), halogen-free

***1.** Overcurrent 1 detection voltage ≤ 0.06 V should be satisfied in the case of overcurrent 2 detection voltage = 0.1 V.
Overcurrent 1 detection voltage ≤ 0.85 × overcurrent 2 detection voltage − 0.05 V should be satisfied in the case of overcurrent 2 detection voltage ≥ 0.2 V.

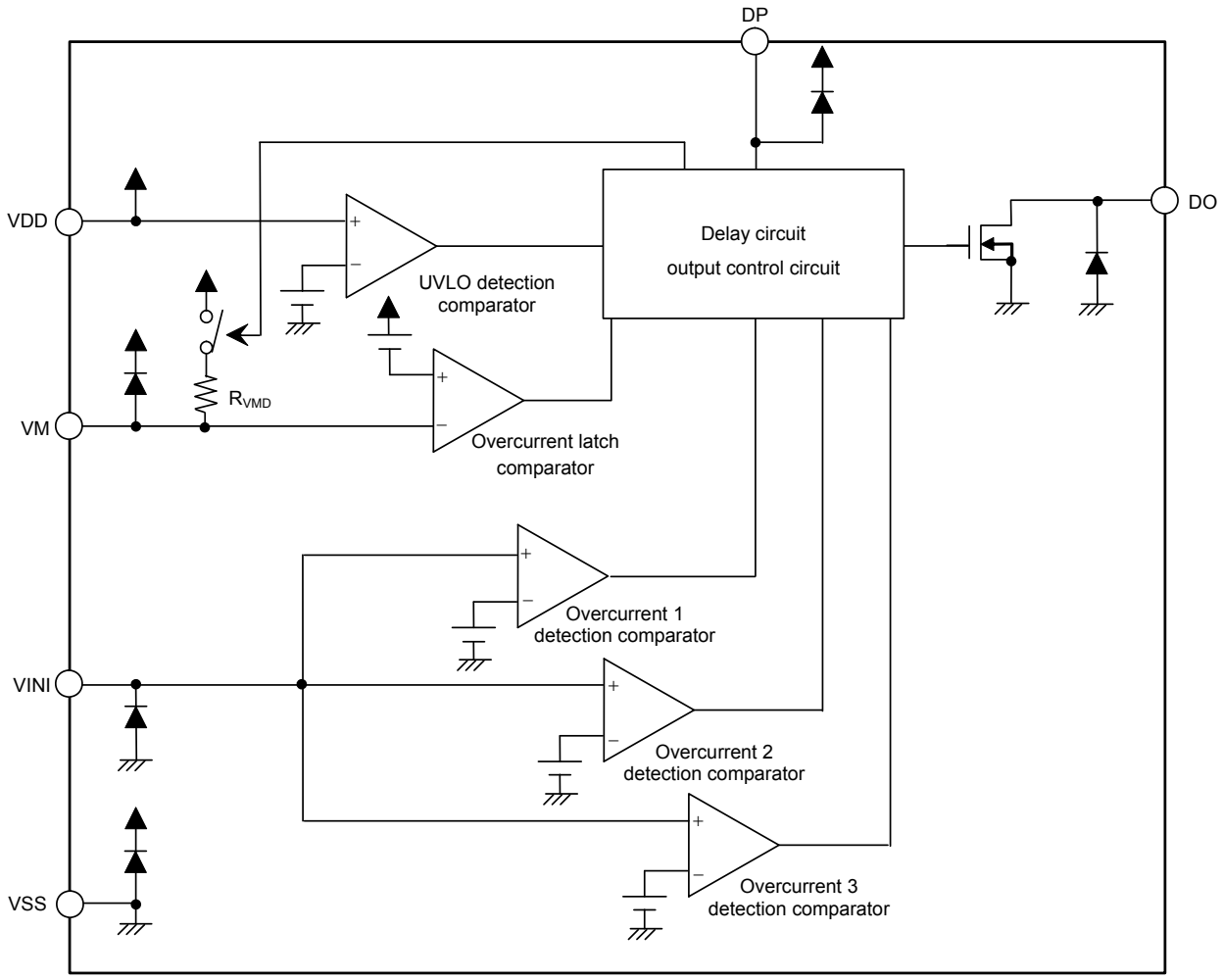
■ Applications

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

■ Package

- SOT-23-6

■ Block Diagram

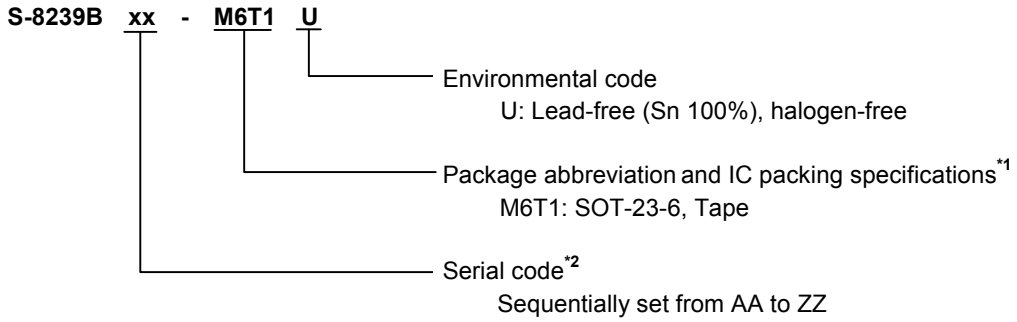


Remark All the diodes shown in the figure are parasitic diodes.

Figure 1

■ Product Name Structure

1. Product name



***1.** Refer to the tape drawing.
***2.** Refer to "**3. Product name list**".

2. 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

Product Name	Overcurrent 1 Detection Voltage [V_{DIOV1}]	Overcurrent 2 Detection Voltage [V_{DIOV2}]	Overcurrent 1 Detection Delay Time [t_{DIOV1}]	Overcurrent 2 Detection Delay Time [t_{DIOV2}]	Overcurrent 3 Detection Function
S-8239BAA-M6T1U	0.20 V	0.4 V	1150 ms	0.56 ms	Unavailable

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

■ Pin Configuration

1. SOT-23-6

Top view

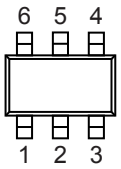


Figure 2

Table 3

Pin No.	Symbol	Description
1	VINI	Voltage detection pin between VINI pin and VSS pin (Overcurrent detection pin)
2	VM	Overcurrent latch pin
3	DO	Connection pin of discharge control FET gate
4	DP*1	Test pin for delay time measurement
5	VDD	Input pin for positive power supply
6	VSS	Input pin for negative power supply

***1.** The DP pin should be open.

***1.** The DP pin should be open.

■ Absolute Maximum Ratings

Table 4

(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} +12	V
VM pin input voltage	V_{VM}	VM	V_{DD} − 28 to V_{DD} + 0.3	V
VINI pin input voltage	V_{VINI}	VINI	V_{SS} − 0.3 to V_{SS} + 12	V
DO pin output voltage	V_{DO}	DO	V_{SS} − 0.3 to V_{SS} + 28	V
Power dissipation	P_D	−	650*1	mW
Operation 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 1. The DP pin should be open.
2. 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.

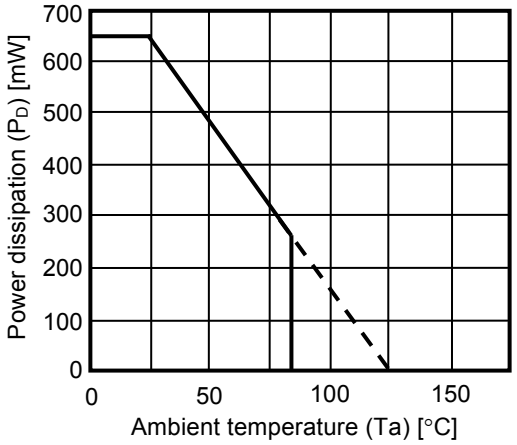


Figure 3 Power Dissipation of Package (When Mounted on Board)

■ Electrical Characteristics

1. Ta = +25°C

Table 5

(Ta = +25°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Condition	Test Circuit
Detection Voltage								
Overcurrent 1 detection voltage	V_{DIOV1}	–	V_{DIOV1} – 0.015	V_{DIOV1}	V_{DIOV1} + 0.015	V	1	1
Overcurrent 2 detection voltage*1	V_{DIOV2}	–	V_{DIOV2} – 0.100	V_{DIOV2}	V_{DIOV2} + 0.100	V	1	1
Overcurrent 3 detection voltage	V_{DIOV3}	Overcurrent 3 detection function "available"	0.90	1.20	1.50	V	1	1
UVLO detection voltage	V_{UVLO}	–	1.90	2.00	2.10	V	1	1
Release Voltage								
Overcurrent release voltage	V_{RIOV}	V_{DD} criteria, V_{DD} = 3.5 V	0.7	1.2	1.5	V	1	1
Input Voltage, Operation Voltage								
Operation voltage between VDD pin and VSS pin	V_{DSOP}	Output logic is determined*2	1.5	–	8	V	–	–
Current Consumption								
Current consumption during normal operation	I_{OPE}	V_{DD} = 3.5 V, V_{VM} = 0 V	1.0	3.5	7.0	μA	2	2
Current consumption during power-down	I_{PDN}	V_{DD} = V_{VM} = 1.5 V	–	–	0.1	μA	2	2
Internal Resistance								
Internal resistance between VM pin and VDD pin	R_{VMD}	V_{DD} = 1.8 V, V_{VM} = 0 V	100	300	900	kΩ	3	3
Output Resistance								
DO pin resistance "L"	R_{DOL}	V_{DD} = V_{VINI} = 3.5 V, V_{DO} = 0.5 V	2.5	5	10	kΩ	4	4
Delay Time								
Overcurrent 1 detection delay time	t_{DIOV1}	–	t_{DIOV1} × 0.6	t_{DIOV1}	t_{DIOV1} × 1.4	ms	5	5
Overcurrent 2 detection delay time	t_{DIOV2}	–	t_{DIOV2} × 0.6	t_{DIOV2}	t_{DIOV2} × 1.4	ms	5	5
Overcurrent 3 detection delay time	t_{DIOV3}	Overcurrent 3 detection function "available"	168	280	392	μs	5	5
UVLO detection delay time	t_{UVLO}	–	2.94	4.90	6.86	s	5	5

***1.** Even if overcurrent 1 detection voltage and overcurrent 2 detection voltage are in the same range, V_{DIOV1} is lower than V_{DIOV2}.

***2.** It indicates that DO pin output logic is determined.

2. Ta = –40°C to +85°C[*1]

Table 6

(Ta = –40°C to +85°C[*1] unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Condition	Test Circuit
Detection Voltage								
Overcurrent 1 detection voltage	V_{DIOV1}	–	V_{DIOV1} – 0.021	V_{DIOV1}	V_{DIOV1} + 0.021	V	1	1
Overcurrent 2 detection voltage[*2]	V_{DIOV2}	–	V_{DIOV2} – 0.130	V_{DIOV2}	V_{DIOV2} + 0.130	V	1	1
Overcurrent 3 detection voltage	V_{DIOV3}	Overcurrent 3 detection function "available"	0.70	1.20	1.70	V	1	1
UVLO detection voltage	V_{UVLO}	–	1.85	2.00	2.15	V	1	1
Release Voltage								
Overcurrent release voltage	V_{RIOV}	V_{DD} criteria, V_{DD} = 3.5 V	0.5	1.2	1.7	V	1	1
Input Voltage, Operation Voltage								
Operation voltage between VDD pin and VSS pin	V_{DSOP}	Output logic is determined[*3]	1.5	–	8	V	–	–
Current Consumption								
Current consumption during normal operation	I_{OPE}	V_{DD} = 3.5 V, V_{VM} = 0 V	0.7	3.5	8.0	μA	2	2
Current consumption during power-down	I_{PDN}	V_{DD} = V_{VM} = 1.5 V	–	–	0.15	μA	2	2
Internal Resistance								
Internal resistance between VM pin and VDD pin	R_{VMD}	V_{DD} =1.8 V, V_{VM} = 0 V	78	300	1310	kΩ	3	3
Output Resistance								
DO pin resistance "L"	R_{DOL}	V_{DD} = V_{VINI} = 3.5 V, V_{DO} = 0.5 V	1.2	5	15	kΩ	4	4
Delay Time								
Overcurrent 1 detection delay time	t_{DIOV1}	–	t_{DIOV1} × 0.2	t_{DIOV1}	t_{DIOV1} × 1.8	ms	5	5
Overcurrent 2 detection delay time	t_{DIOV2}	–	t_{DIOV2} × 0.2	t_{DIOV2}	t_{DIOV2} × 1.8	ms	5	5
Overcurrent 3 detection delay time	t_{DIOV3}	Overcurrent 3 detection function "available"	56	280	504	μs	5	5
UVLO detection delay time	t_{UVLO}	–	0.98	4.90	8.82	s	5	5

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

***2.** Even if overcurrent 1 detection voltage and overcurrent 2 detection voltage are in the same range, V_{DIOV1} is lower than V_{DIOV2}.

***3.** It indicates that DO pin output logic is determined.

■ Test Circuits

Caution Unless otherwise specified, the output voltage levels "H" and "L" at the DO pin (V_{DO}) are judged by the threshold voltage (1.0 V) of the N-channel FET. Judge the DO pin level with respect to V_{SS}.

1. Overcurrent 1 detection voltage, overcurrent 2 detection voltage, overcurrent release voltage, UVLO detection voltage (Test condition 1, test circuit 1)

The overcurrent 1 detection voltage (V_{DIOV1}) is defined as the voltage V2 whose delay time for changing V_{DO} from "H" to "L" lies between the minimum and the maximum value of the overcurrent 1 detection delay time after the voltage V2 is increased instantaneously (within 10 μs) from the set conditions of V1 = V3 = 3.5 V, V2 = 0 V.
The overcurrent 2 detection voltage (V_{DIOV2}) is defined as the voltage V2 whose delay time for changing V_{DO} from "H" to "L" lies between the minimum and the maximum value of the overcurrent 2 detection delay time after the voltage V2 is increased instantaneously (within 10 μs) from the set conditions of V1 = V3 = 3.5 V, V2 = 0 V.
The overcurrent release voltage (V_{RIOV}) is defined as the voltage V3 at which V_{DO} goes from "L" to "H" after decreasing V2 to 0 V and the voltage V3 is increased gradually from the set conditions of V1 = V2 = 3.5 V, V3 = 0 V.
The UVLO detection voltage (V_{UVLO}) is defined as the voltage V1 at which V_{DO} goes from "H" to "L" after the voltages V1 and V3 are decreased gradually from the set conditions of V1 = V3 = 3.5 V, V2 = 0 V.

2. Overcurrent 3 detection voltage (Overcurrent 3 detection function "available") (Test condition 1, test circuit 1)

The overcurrent 3 detection voltage (V_{DIOV3}) is defined as the voltage V2 whose delay time for changing V_{DO} from "H" to "L" lies between the minimum and the maximum value of the overcurrent 3 detection delay time after the voltage V2 is increased instantaneously (within 10 μs) from the set conditions of V1 = V3 = 3.5 V, V2 = 0 V.

3. Current consumption during normal operation, current consumption during power-down (Test condition 2, test circuit 2)

The current consumption during normal operation (I_{OPE}) is the current that flows through the VDD pin (I_{DD}) under the set conditions of V1 = 3.5 V, V2 = 0 V.
The current consumption during power-down (I_{PDN}) is I_{DD} under the set conditions of V1 = V2 = 1.5 V.

4. Internal resistance between VM pin and VDD pin (Test condition 3, test circuit 3)

The internal resistance between the VM pin and the VDD pin (R_{VMD}) is the resistance between the VM pin and the VDD pin under the set conditions of V1 = 1.8 V, V2 = V3 = 0 V.

5. DO pin resistance "L" (Test condition 4, test circuit 4)

The DO pin resistance "L" (R_{DOL}) is the DO pin resistance under the set conditions of V1 = V2 = 3.5 V, V3 = 0.5 V.

6. Overcurrent 1 detection delay time (Test condition 5, test circuit 5)

6. 1 V_{DIOV2} = 0.1 V

The overcurrent 1 detection delay time (t_{DIOV1}) is the time period from when the voltage V2 exceeds V_{DIOV1} to when V_{DO} goes to "L", after V2 is increased to 0.08 V instantaneously (within 10 μs) under the set conditions of V1 = 3.5 V, V2 = 0 V.

6. 2 $V_{DIOV2} \geq$ 0.2 V

The overcurrent 1 detection delay time (t_{DIOV1}) is the time period from when the voltage V2 exceeds V_{DIOV1} to when V_{DO} goes to "L", after V2 is increased to V_{DIOV1} max. + 0.01 V instantaneously (within 10 μs) under the set conditions of V1 = 3.5 V, V2 = 0 V.

7. Overcurrent 2 detection delay time, UVLO detection delay time (Test condition 5, test circuit 5)

The overcurrent 2 detection delay time (t_{DIOV2}) is the time period from when the voltage V2 exceeds V_{DIOV2} to when V_{DO} goes to "L", after V2 is increased to 0.9 V instantaneously (within 10 μs) under the set conditions of V1 = 3.5 V, V2 = 0 V.

The UVLO detection delay time (t_{UVLO}) is the time period from when the voltage V1 falls below V_{UVLO} to when V_{DO} goes to "L", after V1 is decreased to 1.8 V instantaneously (within 10 μs) under the set conditions of V1 = 3.5 V, V2 = 0 V.

8. Overcurrent 3 detection delay time (Overcurrent 3 detection function "available") (Test condition 5, test circuit 5)

The overcurrent 3 detection delay time (t_{DIOV3}) is the time period from when the voltage V2 exceeds V_{DIOV3} to when V_{DO} goes to "L", after V2 is increased to 1.6 V instantaneously (within 10 μs) under the set conditions of V1 = 3.5 V, V2 = 0 V.

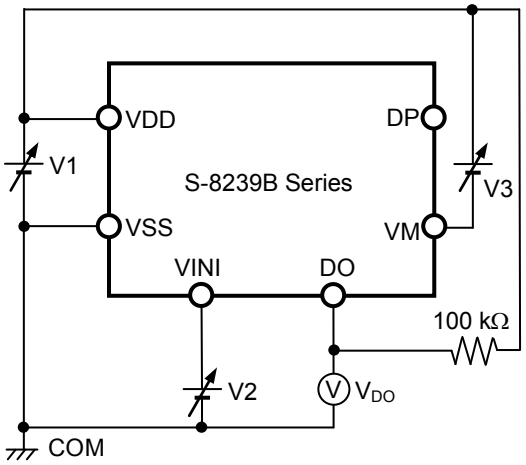


Figure 4 Test Circuit 1

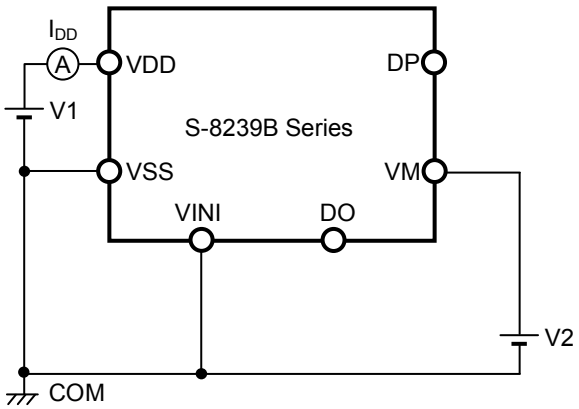


Figure 5 Test Circuit 2

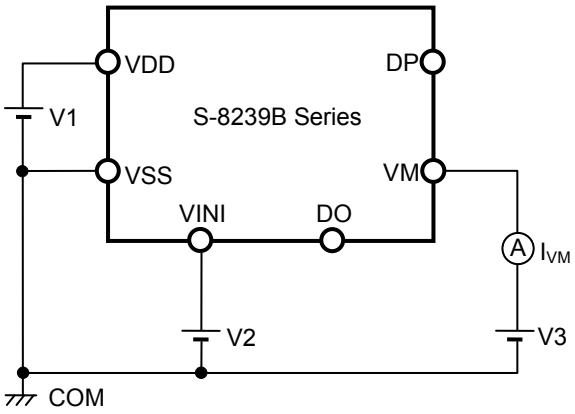


Figure 6 Test Circuit 3

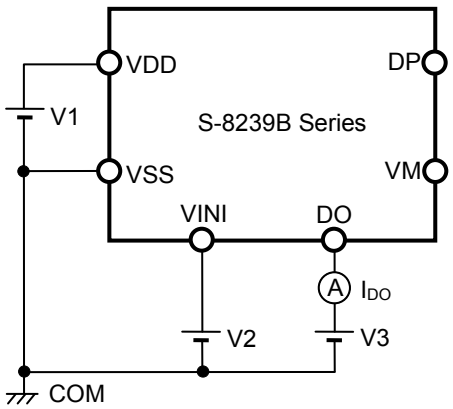


Figure 7 Test Circuit 4

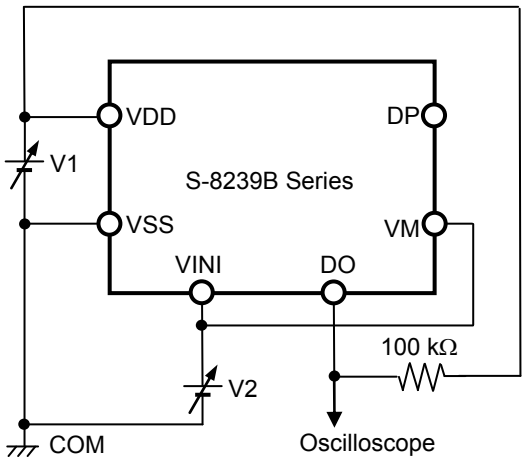


Figure 8 Test Circuit 5

■ Operation

1. Normal status

The S-8239B Series monitors the voltage between the VINI pin and the VSS pin to control discharging. When the VINI pin voltage is equal to or lower than the overcurrent 1 detection voltage (V_{DIOV1}), the DO pin becomes "High-Z". This status is called the normal status.

Caution When a battery is connected for the first time, the S-8239B Series may not be in the normal status. In this case, short the VM pin and VSS pin or connect the charger. The S-8239B Series then becomes the normal status.

2. Overcurrent status (Overcurrent 1, overcurrent 2, overcurrent 3)

When a battery is in the normal status, if the VINI pin voltage is equal to or higher than the overcurrent detection voltage because the discharge current is equal to or higher than the specified value and the status continues for the overcurrent detection delay time or longer, the DO pin becomes V_{SS} potential. This status is called the overcurrent status. The overcurrent status is retained when the voltage between the VDD pin and the VM pin is equal to or lower than the overcurrent release voltage (V_{RIOV}).
In the overcurrent status, the VM pin and the VDD pin are shorted by the internal resistance between the VM pin and the VDD pin (R_{VMD}) in the S-8239B Series.
After that, the overcurrent status is released if the voltage between the VDD pin and the VM pin becomes equal to or higher than V_{RIOV} by connecting a charger.

3. UVLO status

The S-8239B Series includes a UVLO (under voltage lock out) function to prevent the IC malfunction due to the decrease of the battery voltage when detecting the overcurrent. When the battery voltage in the normal status is equal to or lower than the UVLO detection voltage (V_{UVLO}) and the status continues for the UVLO detection delay time (t_{UVLO}) or longer, the DO pin becomes V_{SS} potential. This status is called the UVLO status.
In the UVLO status, the VM pin and the VDD pin are shorted by R_{VMD} between the VM pin and the VDD pin in the S-8239B Series.
After that, the UVLO status is released if the battery voltage becomes equal to or higher than V_{UVLO}.

4. Power-down status

In the UVLO status, the current consumption is decreased to the current consumption during power-down (I_{PDN}) if the voltage between the VDD pin and the VM pin becomes equal to or lower than 0.7 V typ. in the S-8239B Series. This status is called the power-down status.
Moreover, if the voltage between the VDD pin and the VM pin becomes equal to or lower than 0.7 V typ. and the status continues for t_{UVLO} or longer in the normal status, the DO pin becomes V_{SS} potential and the S-8239B Series becomes power-down status.
After that, the power-down status is released if the voltage between the VDD pin and the VM pin is equal to or higher than 0.7 V typ. by connecting a charger.

5. Delay circuit

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

Remark The overcurrent 2 detection delay time (t_{DIOV2}) starts when the overcurrent 1 detection voltage (V_{DIOV1}) is detected. When the overcurrent 2 detection voltage (V_{DIOV2}) is detected over t_{DIOV2} after the detection of V_{DIOV1}, the S-8239B Series becomes the overcurrent status within t_{DIOV2} from the time of detecting V_{DIOV2}.

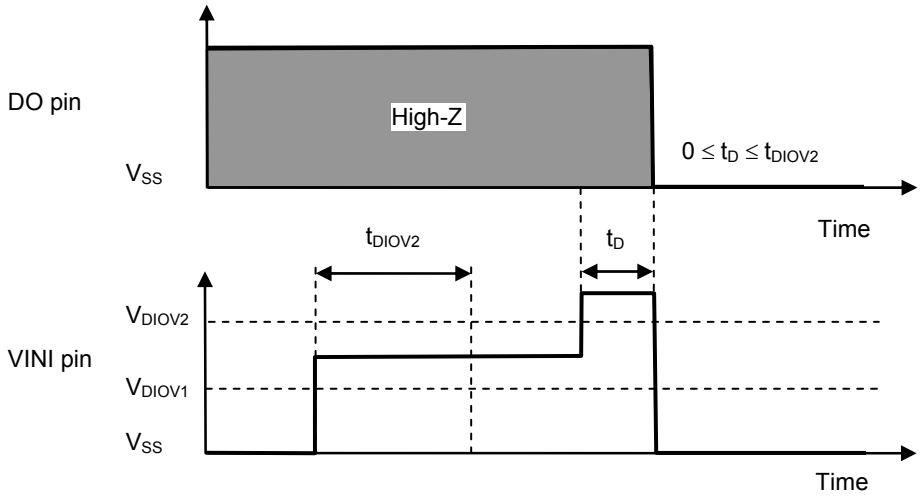


Figure 9

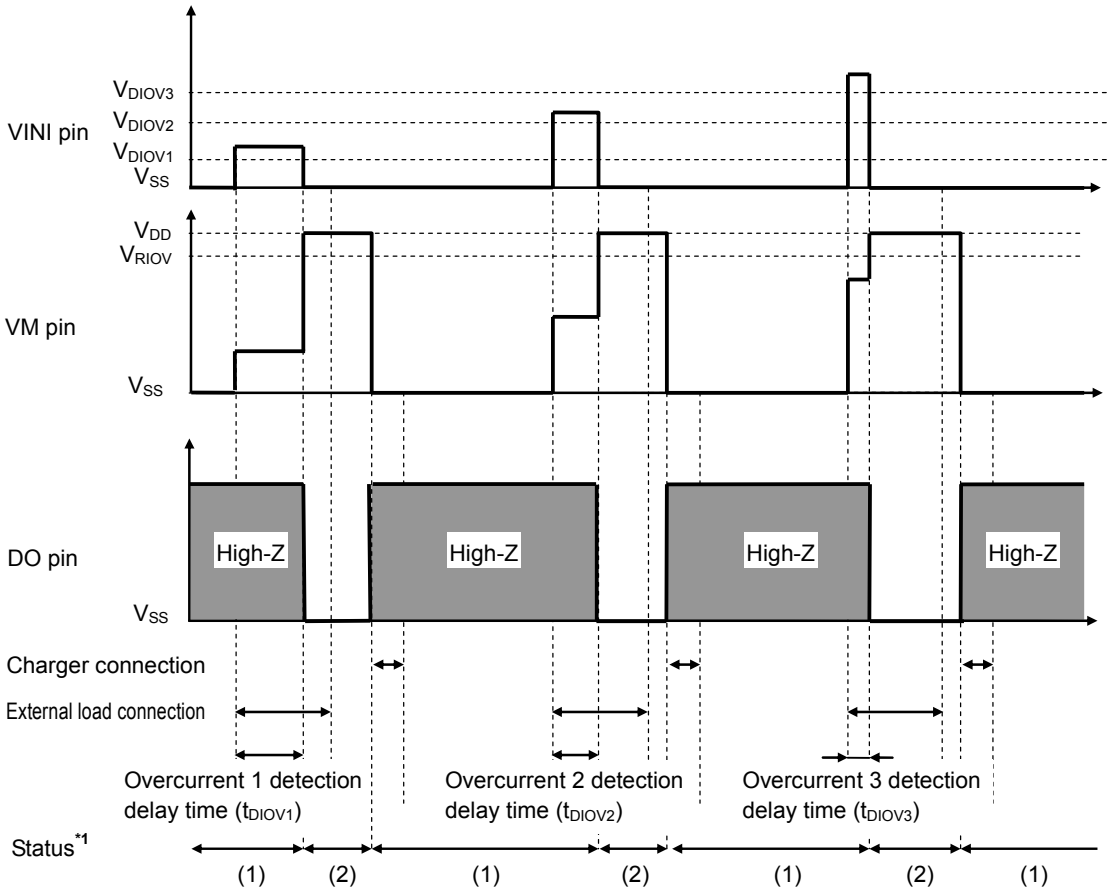
6. DP pin

The DP pin is a test pin for delay time measurement and it should be open in the actual application.
If a capacitor whose capacitance is 1000 pF or more or a resistor whose resistance is 1 MΩ or less is connected to this pin, error may occur in the delay times or in the detection voltages.

■ Timing Charts

1. Overcurrent detection

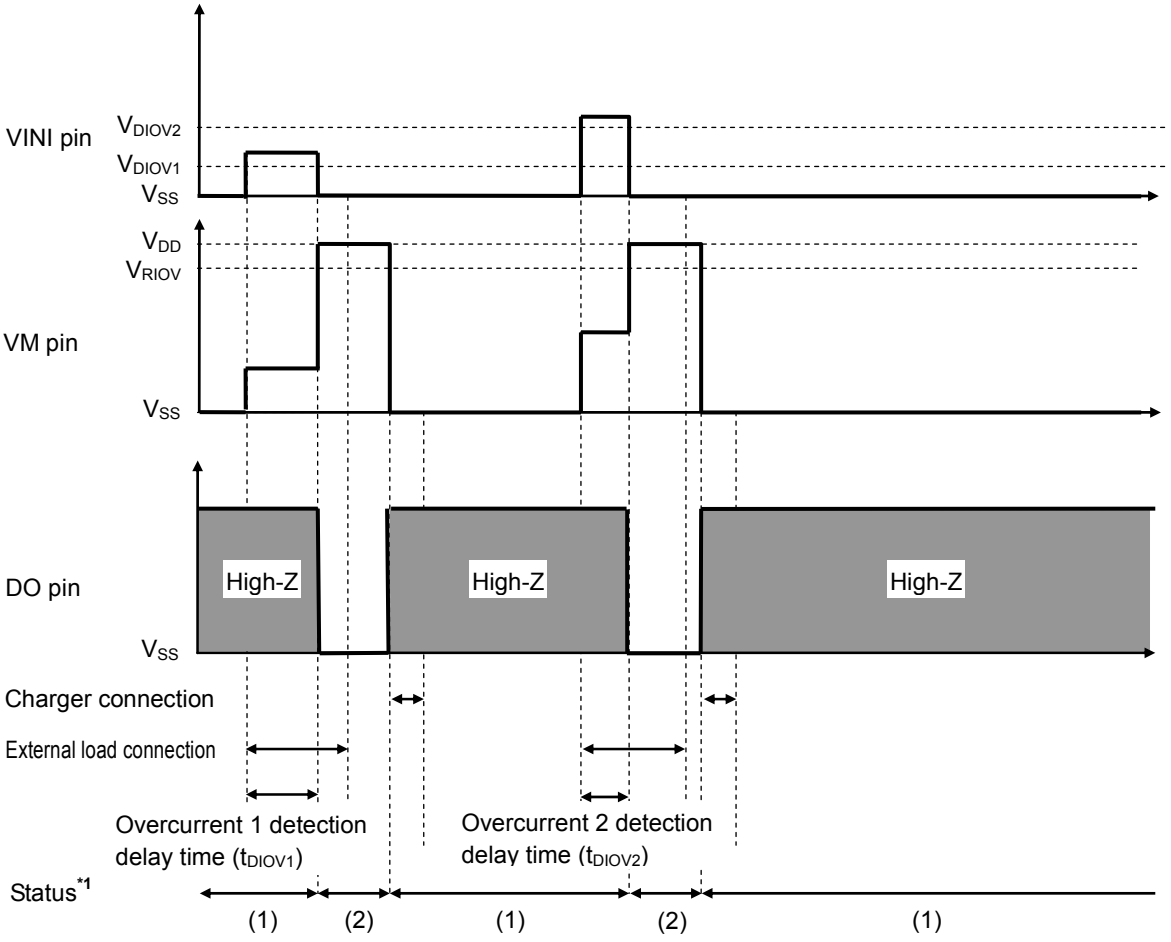
1. 1 Overcurrent 3 detection function "available"



***1.** (1): Normal status
(2): Overcurrent status

Figure 10

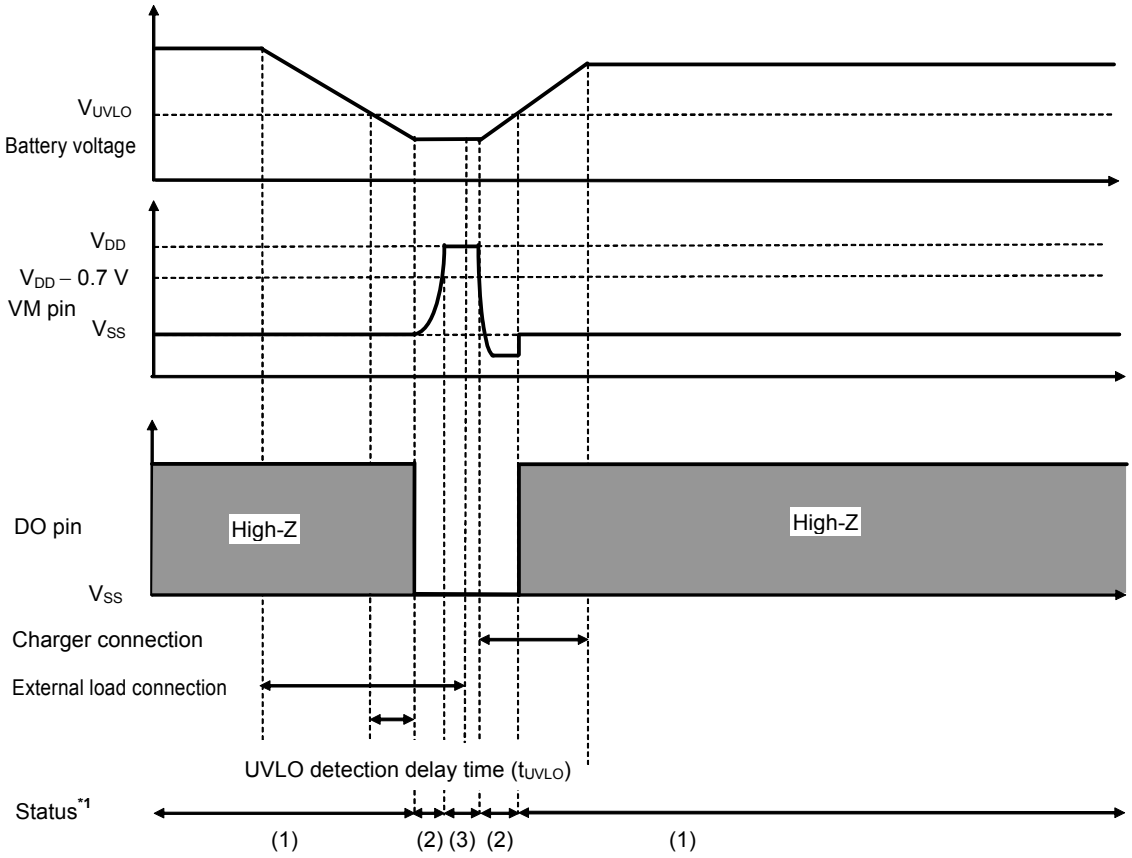
1. 2 Overcurrent 3 detection function "unavailable"



***1.** (1): Normal status
(2): Overcurrent status

Figure 11

2. UVLO detecion



***1.** (1): Normal status
(2): UVLO status
(3): Power-down status

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

Figure 12

■ 5-serial-cell Protection Circuit Example

Figure 13 shows the 5-serial-cell protection circuit example used by the S-8239B Series and the S-8225A Series. Contact our sales office when using the circuit other than the following protection circuit example.

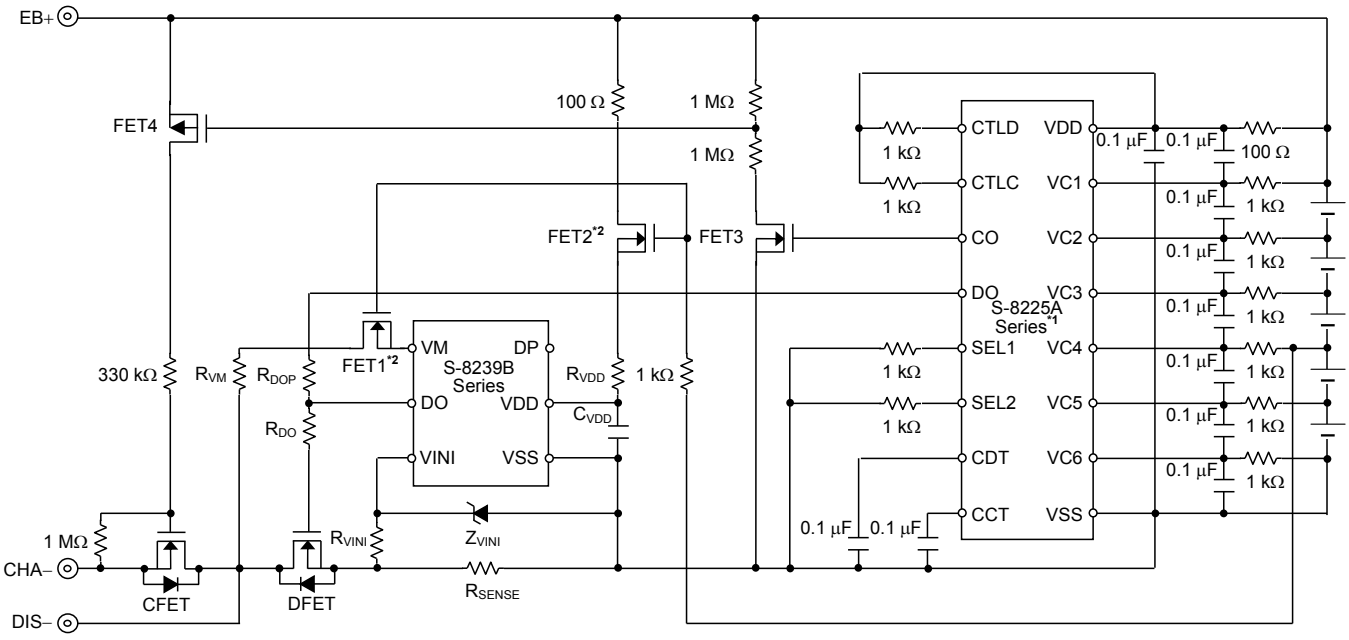


Figure 13

Table 7 Constants for External Components

Symbol	Min.	Typ.	Max.	Unit
R_{VDD}	300	470	1000	Ω
R_{VINI}	1	–	–	kΩ
R_{SENSE}	0	–	–	mΩ
R_{VM}	1	5.1	51	kΩ
R_{DO}*3	–	5.1	–	kΩ
R_{DOP}	330	510	2000	kΩ
C_{VDD}	0.022	0.1	1	μF

***1.** Refer to the data sheet of the S-8225A Series for the recommended value for external components of the S-8225A Series.
***2.** Use the products with the same model number for FET1 and FET2.
***3.** Set up the optimal constant according to the FET in use.

Caution 1. The above constants may be changed without notice.
2. The example of connection shown above and the constants do not guarantee proper operation. Perform thorough evaluation using the actual application to set the constant.
3. The DP pin should be open.

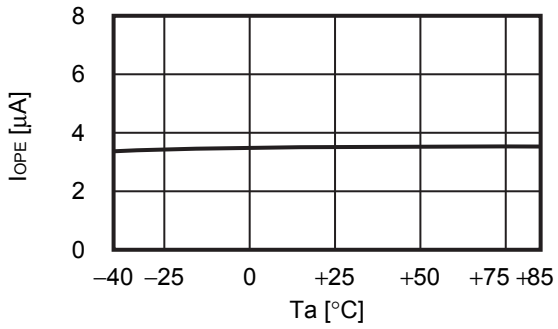
■ Precautions

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

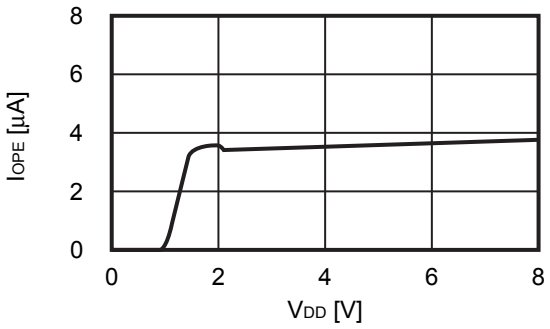
■ Characteristics (Typical Data)

1. Current consumption

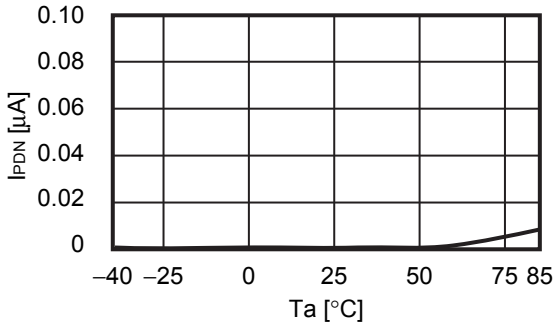
1. 1 I_{OPE} vs. Ta



1. 2 I_{OPE} vs. V_{DD}

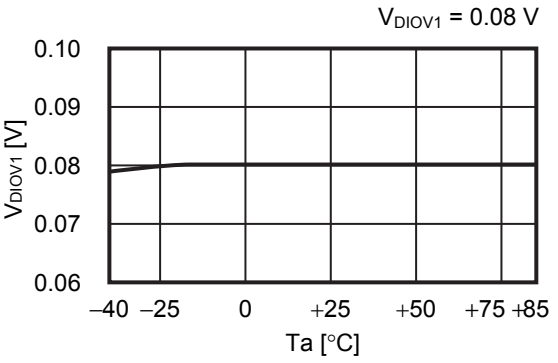


1. 3 I_{PDN} vs. Ta

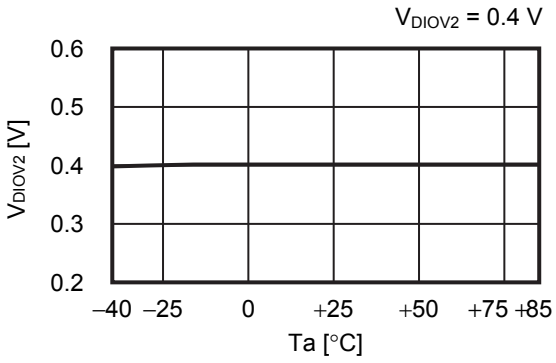


2. Overcurrent detection / release voltage, UVLO function and delay times

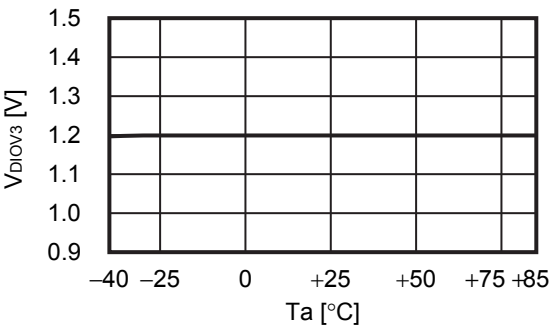
2. 1 V_{DIOV1} vs. Ta



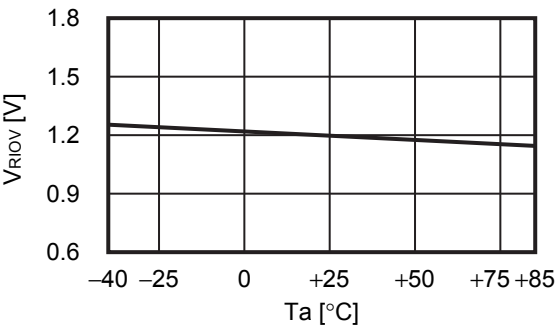
2. 2 V_{DIOV2} vs. Ta



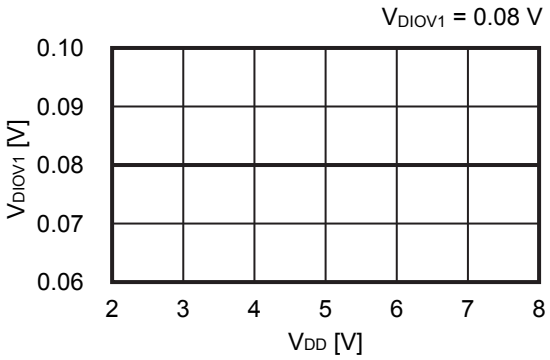
2. 3 V_{DIOV3} vs. Ta



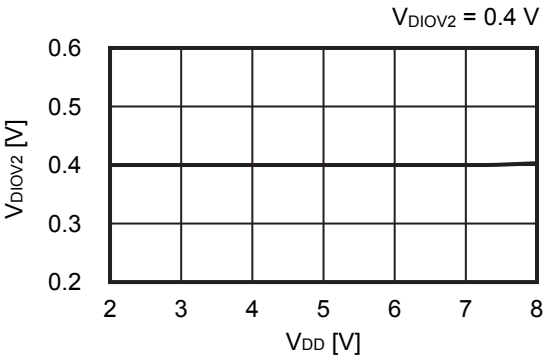
2. 4 V_{RIOV} vs. Ta



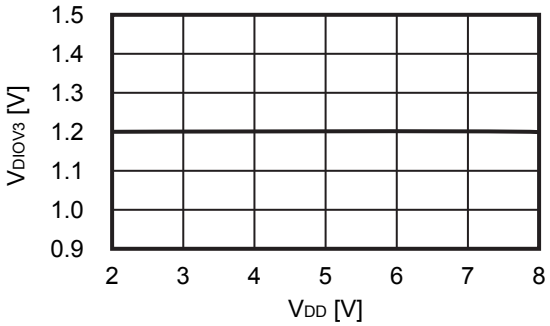
2. 5 V_{DIOV1} vs. V_{DD}



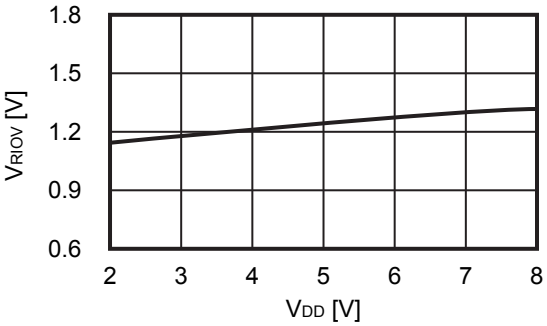
2. 6 V_{DIOV2} vs. V_{DD}



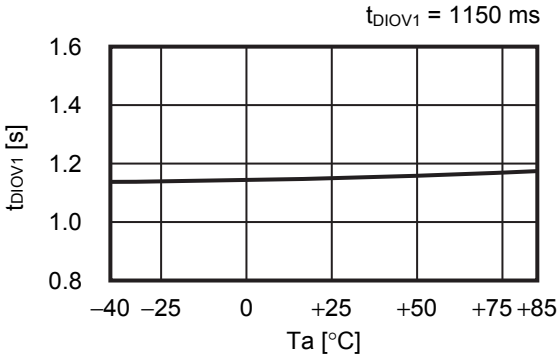
2. 7 V_{DIOV3} vs. V_{DD}



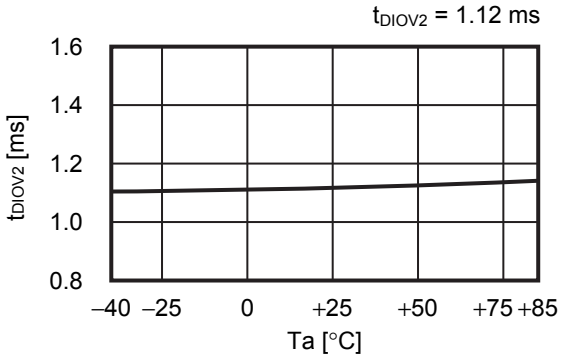
2. 8 V_{RIOV} vs. V_{DD}



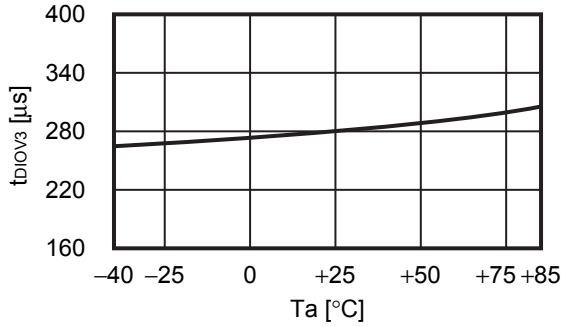
2. 9 t_{DIOV1} vs. Ta



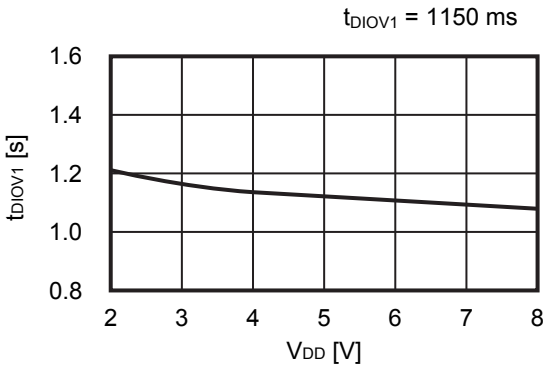
2. 10 t_{DIOV2} vs. Ta



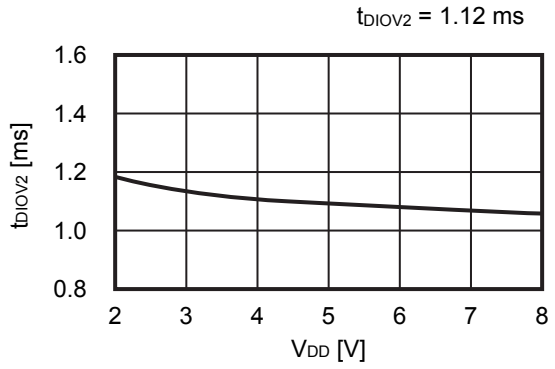
2. 11 t_{DIOV3} vs. Ta



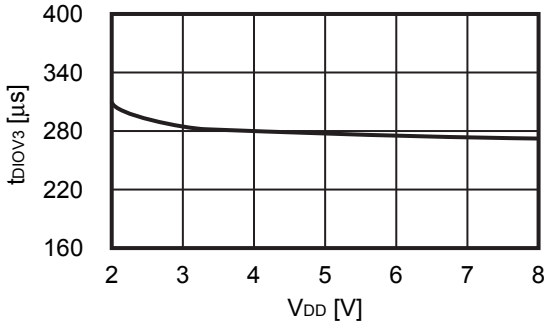
2. 12 t_{DIOV1} vs. V_{DD}



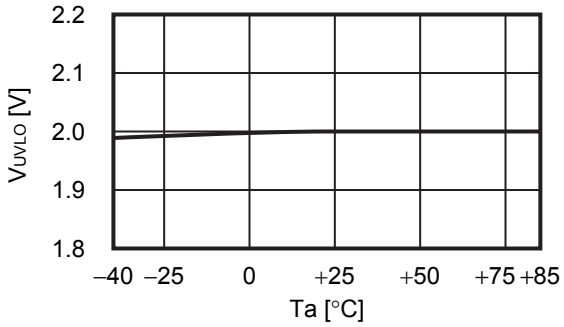
2. 13 t_{DIOV2} vs. V_{DD}



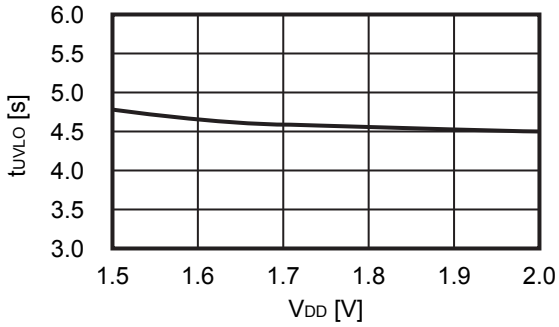
2. 14 t_{DIOV3} vs. V_{DD}



2. 15 V_{UVLO} vs. Ta

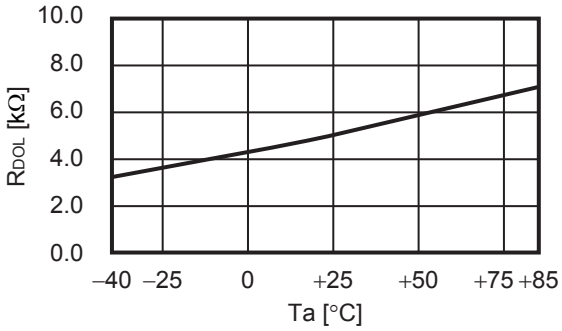


2. 16 t_{UVLO} vs. V_{DD}



3. Output Resistance

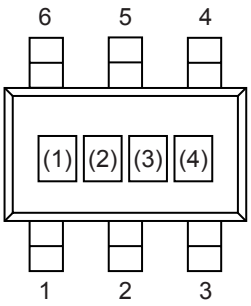
3. 1 R_{DOL} vs. Ta



■ Marking Specification

1. SOT-23-6

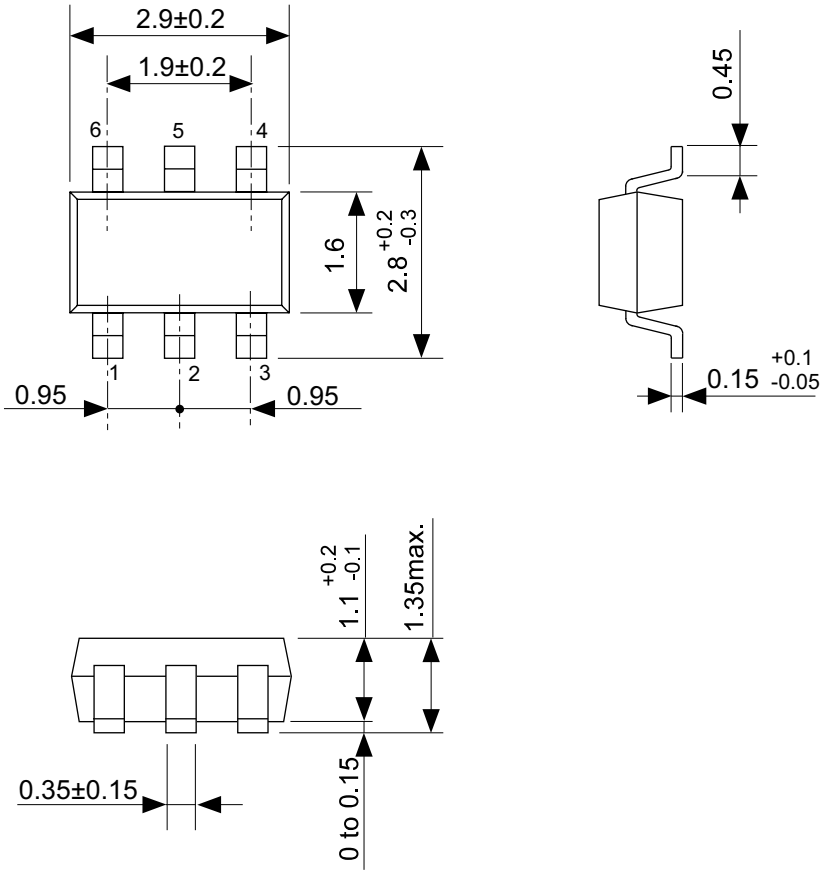
Top view



(1) to (3): Product code (Refer to **Product name vs. Product code**)
(4): Lot number

Product name vs. Product code

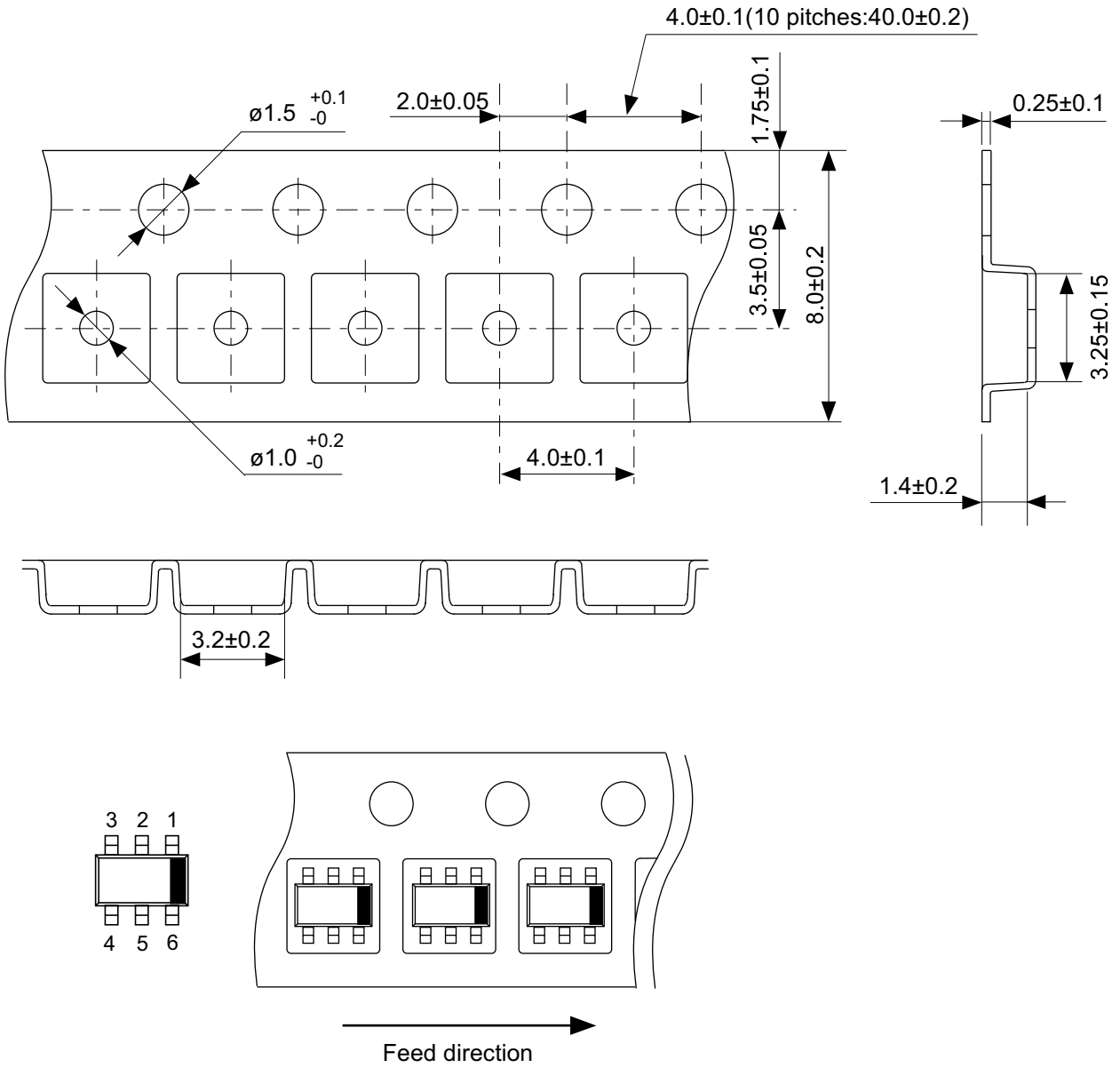
Product Name	Product Code		
	(1)	(2)	(3)
S-8239BAA-M6T1U	3	L	A



No. MP006-A-P-SD-2.1

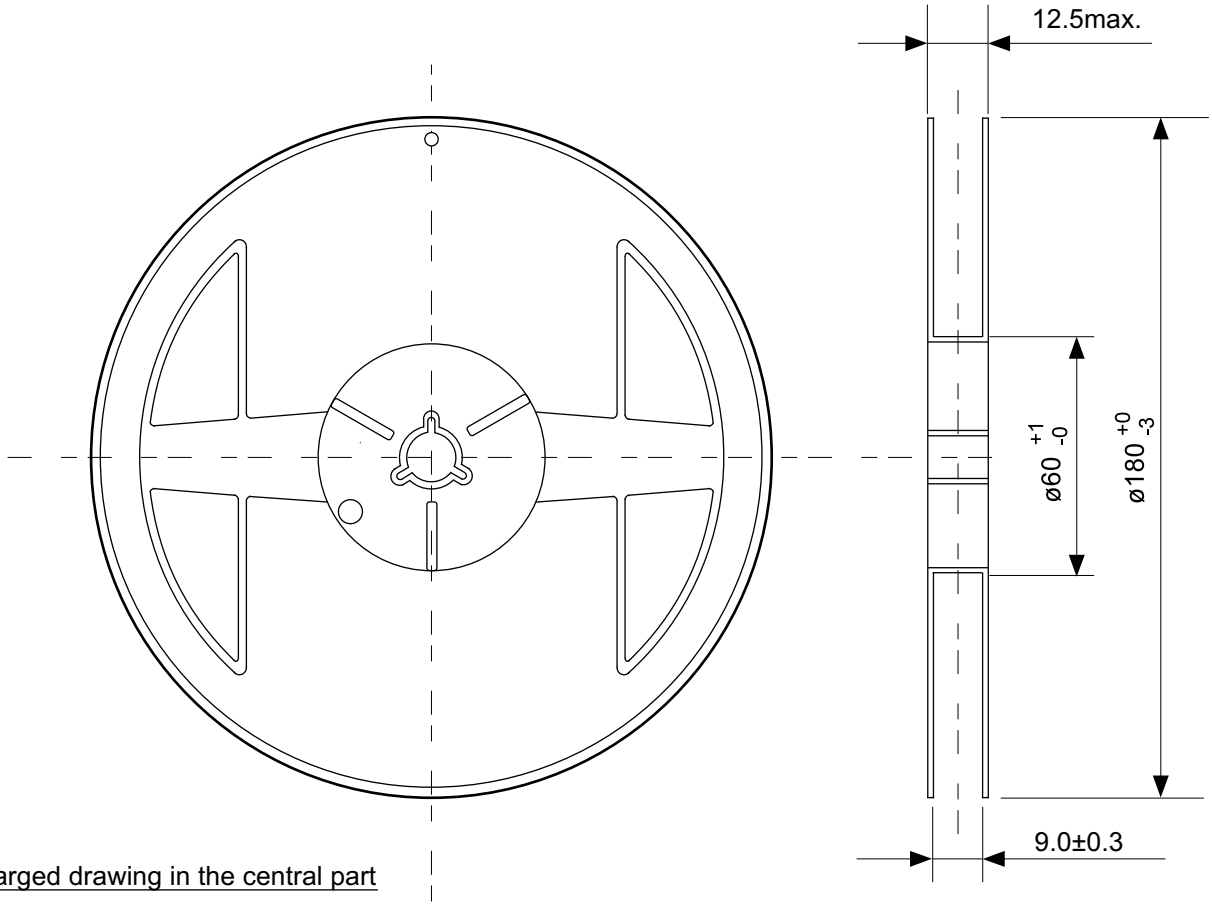
TITLE	SOT236-A-PKG Dimensions
No.	MP006-A-P-SD-2.1
ANGLE	
UNIT	mm

ABLIC Inc.

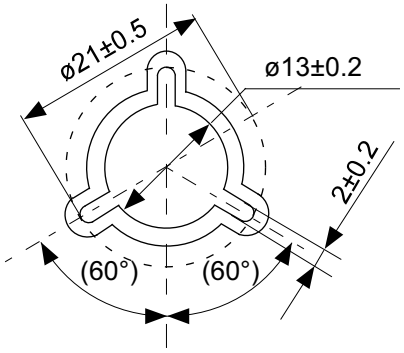


No. MP006-A-C-SD-3.1

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-2.1

TITLE	SOT236-A-Reel		
No.	MP006-A-R-SD-2.1		
ANGLE		QTY	3,000
UNIT	mm		
ABLIC Inc.			

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2.2-2018.06