

## Automotive NR1700 series

### 200mA 42V Input Adjustable Output LDO Regulator

#### FEATURES

- AEC-Q100 Grade 1
- Operating Temperature Range: -40 °C to 125 °C
- Input Voltage Range (Maximum rating):  
3.5 V to 42.0 V (50.0 V)
- Quiescent Current: Typ. 11.5 μA
- Shutdown Current: Typ. 0.1 μA
- Dropout Voltage: Typ. 0.6 V  
( $I_{OUT} = 200\text{ mA}$ ,  $V_{SET} = 5.0\text{ V}$ )
- Adjustable output voltage range: 1.2 V to 24.0 V
- Feedback Voltage: 1.2 V
- Feedback Voltage Accuracy: -0.5% to +0.7%  
( $T_a = 25\text{ °C}$ )
- Output Current: 200 mA
- Protection Function:  
Thermal Shutdown, Over Current Protection(Fold-back), Short Circuit Current Limit

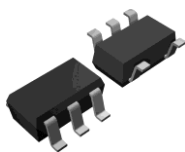
#### GENERAL DESCRIPTION

The NR1700 series is a CMOS-based 42 V, 200 mA low dropout regulator. This device provides outstanding high feedback voltage accuracy as -0.5% to +0.7% and covers adjustable output voltage range from 1.2 V to 24 V with a voltage divider resistor. In addition, this device corresponds to wide capacitance value range of output ceramic capacitor from 0.1 μF to 100 μF to secure stable operation. This product is a highly reliable product that has been tested at high temperatures and for reliability more stringent than consumer products.

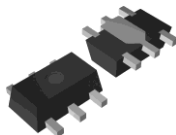
#### Application

- Car accessories such as car audio, car navigation systems, ETC systems, etc.
- Body control applications such as keyless/smart entry systems, power doors/power windows, etc.

#### Packages (unit: mm)

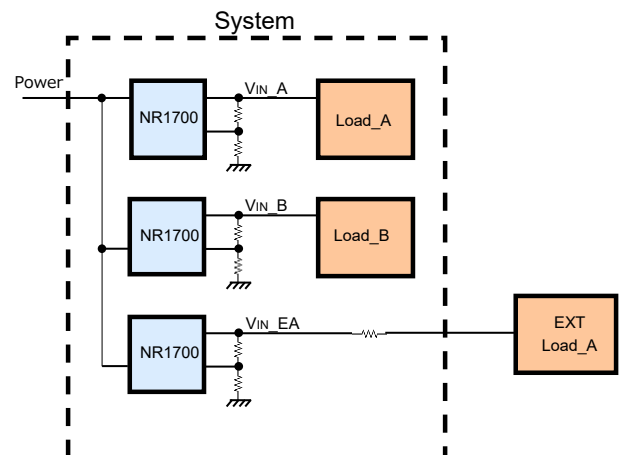


**SOT-23-5-DC**  
2.9 x 2.8 x 1.1



**SOT-89-5-DM**  
4.5 x 4.35 x 1.5

#### Application example



Because of an adjustable output voltage type, this device covers various voltage power rails, and can also compensate for voltage drop caused by longer wiring.

■ PRODUCT NAME INFORMATION

NR1700 aa bbb c dd e

Description of configuration

| composition | Item           | Description  |
|-------------|----------------|--|
| aa          | Package Code   | Indicates the package.<br>DC: SOT-23-5-DC<br>DM: SOT-89-5-DM                         |
| bbb         | Output Voltage | Only "000"   |
| c           | Version        | Only "A"   |
| dd          | Packing        | Insert Direction.<br>Refer to the packing specifications.                            |
| e           | Grade          | Indicating the quality grade.<br>P: Automotive(Chassis, Body control and In-vehicle) |

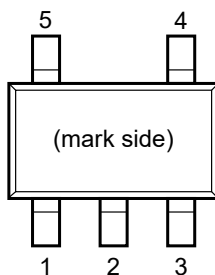
Grade

| e | Applications                         | Operating Temperature Range | Test Temperature |
|---|--------------------------------------|-----------------------------|------------------|
| P | Chassis, Body control and In-vehicle | -40°C to 125°C              | 25°C, 125°C      |

■ ORDER INFORMATION

| PRODUCT NAME    | PACKAGE     | RoHS | HALOGEN-FREE | Plating Composition | WEIGHT (mg) | Quantity per Reel (pcs) |
|-----------------|-------------|------|--------------|---------------------|-------------|-------------------------|
| NR1700DC000AE1P | SOT-23-5-DC | ✓    | ✓            | Sn                  | 14          | 3000                    |
| NR1700DM000AE1P | SOT-89-5-DM | ✓    | ✓            | Sn                  | 55          | 1000                    |

■ PIN DESCRIPTIONS (NR1700DC)

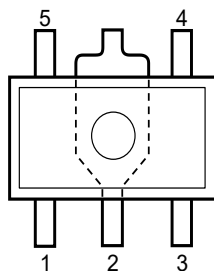


SOT-23-5-DC Pin Configuration

| Pin No. | Pin Name | I/O   | Description  |
|---------|----------|-------|--|
| 1       | VIN      | Power | Power Supply Input Pin<br>Connect the input capacitor ( $C_{IN}$ ) between the VIN pin and GND.  |
| 2       | GND      | -     | Ground Pin   |
| 3       | EN       | I     | Enable Pin (Active-High)<br>Input "Low" to this pin shuts down the IC. Input "High" to this pin enables the IC.<br>This pin is internally pulled-down with constant current. |
| 4       | FB       | I     | Feedback Input Pin<br>Connect external resistors to set output voltage   |
| 5       | VOUT     | O     | Output Pin<br>Connect the output capacitor ( $C_{OUT}$ ) between VOUT pin and GND.   |

Please refer to "[TYPICAL APPLICATION CIRCUIT](#)" or "[THEORY OF OPERATION](#)" for details.

■ PIN DESCRIPTIONS (NR1700DM)



SOT-89-5-DM Pin Configuration

| Pin No. | Pin Name | I/O   | Description  |
|---------|----------|-------|--|
| 1       | EN       | I     | Enable Pin (Active-high)<br>Input "Low" to this pin shuts down the IC. Input "High" to this pin enables the IC.<br>This pin is internally pulled-down with constant current. |
| 2       | GND      | -     | Ground Pin   |
| 3       | VIN      | Power | Power Supply Input Pin<br>Connect the input capacitor ( $C_{IN}$ ) between the VIN pin and GND.  |
| 4       | VOUT     | O     | Output Pin<br>Connect the output capacitor ( $C_{OUT}$ ) between VOUT pin and GND.   |
| 5       | FB       | I     | Feedback Input Pin<br>Connect the external resistors to set output voltage   |

Please refer to "[TYPICAL APPLICATION CIRCUIT](#)" or "[THEORY OF OPERATION](#)" for details.

■ ABSOLUTE MAXIMUM RATINGS

|                              | Symbol    | Ratings                        | Unit |
|------------------------------|-----------|--------------------------------|------|
| Input Voltage                | $V_{IN}$  | -0.3 to 50                     | V    |
| Input Peak Voltage *1        | $V_{IN}$  | 60                             | V    |
| EN pin input Voltage         | $V_{EN}$  | -0.3 to 50                     | V    |
| EN pin Peak Voltage *1       | $V_{EN}$  | 60                             | V    |
| Output Voltage               | $V_{OUT}$ | -0.3 to $V_{IN} + 0.3 \leq 50$ | V    |
| FB pin Voltage               | $V_{FB}$  | -0.3 to 7                      | V    |
| Junction Temperature Range*2 | $T_J$     | -40 to 150                     | °C   |
| Storage Temperature Range    | $T_{stg}$ | -55 to 150                     | °C   |

**ABSOLUTE MAXIMUM RATINGS**

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

\*1 Duration time: within 200 ms

\*2 Calculate the power consumption of the IC from the operating conditions and calculate the junction temperature with the thermal resistance. Please refer to "THERMAL CHARACTERISTICS" below for thermal resistance under our measured substrate conditions.

■ THERMAL CHARACTERISTICS

| Package     | Parameter  | Measurement Result | Unit |
|-------------|--|--------------------|------|
| SOT-23-5-DC | Thermal Resistance ( $\theta_{ja}$ )               | 150                | °C/W |
|             | Thermal Characterization Parameter ( $\psi_{jt}$ ) | 51                 |      |
| SOT-89-5-DM | Thermal Resistance ( $\theta_{ja}$ )               | 38                 |      |
|             | Thermal Characterization Parameter ( $\psi_{jt}$ ) | 13                 |      |

$\theta_{ja}$ : Junction-to-Ambient Thermal Resistance

$\psi_{jt}$ : Junction-to-Top Thermal Characterization Parameter

For more information, click [here](#).

■ ELECTROSTATIC DISCHARGE RATINGS

|     | Conditions             | Protection Voltage |
|-----|------------------------|--------------------|
| HBM | C = 100 pF, R = 1.5 kΩ | ±2000 V            |
| CDM |                        | ±1000 V            |

**ELECTROSTATIC DISCHARGE RATINGS**

The electrostatic discharge test is done based on JESD47.  
 In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins.

■ RECOMMENDED OPERATING CONDITIONS

| Parameter                   | Symbol    | Ratings    | Unit |
|-----------------------------|-----------|------------|------|
| Input Voltage               | $V_{IN}$  | 3.5 to 42  | V    |
| EN Pin Input Voltage        | $V_{EN}$  | 0 to 42    | V    |
| Set Output Voltage          | $V_{SET}$ | 1.2 to 24  | V    |
| Output Current              | $I_{OUT}$ | 0 to 200   | mA   |
| Operating Temperature Range | $T_a$     | -40 to 125 | °C   |

**RECOMMENDED OPERATING CONDITIONS**

All electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

■ ELECTRICAL CHARACTERISTICS

Short-circuit VOUT pin and FB pin ( $V_{SET} = 1.2V$ ) unless otherwise specified.

$V_{IN} = 14 V$ ,  $I_{OUT} = 1 mA$ ,  $C_{IN} = 0.1 \mu F$ ,  $C_{OUT} = 0.1 \mu F$

For items without temperature conditions, TYP values are at  $T_a = 25^\circ C$  and MIN/MAX values are applied to all the temperature range of  $-40^\circ C \leq T_a \leq 125^\circ C$ .

NR1700xx000AExP

| Parameter                                 | Symbol                                  | Conditions  | MIN                               | TYP   | MAX   | Unit       |   |
|---|---|---|-----------------------------------|-------|-------|------------|---|
| FB Voltage                                | $V_{FB}$                                | $V_{IN} = 14 V$   | -                                 | 1.2   | -     | V          |   |
| FB Voltage Accuracy                       |   | $T_a = 25^\circ C$  | $V_{IN} = 14 V$                   | -0.50 | -     | +0.70      | % |
|   |   | $-40^\circ C \leq T_a \leq 125^\circ C$   | $V_{IN} = 14 V$                   | -1.70 | -     | +1.00      | % |
|   |   |   | $V_{IN} = 3.5 V \text{ to } 36 V$ | -3.67 | -     | +3.67      | % |
| FB pin current                            | $I_{FB}$                                | $V_{FB} = 1.2 V$  | -                                 | 0.1   | 0.4   | $\mu A$    |   |
| Quiescent Current*1                       | $I_Q$                                   | $V_{IN} = V_{EN} = 14 V$<br>$I_{OUT} = 0 mA$  | -                                 | 11.5  | 21    | $\mu A$    |   |
| Shutdown Current                          | $I_{SD}$                                | $V_{IN} = 42 V, V_{EN} = 0 V$   | -                                 | 0.1   | 0.9   | $\mu A$    |   |
| Dropout Voltage*2*3                       | $V_{DO}$                                | $I_{OUT} = 200 mA$  | $V_{SET} = 1.2 V$                 | -     | -     | 3.0        | V |
|   |   |   | $V_{SET} = 24 V$                  | -     | 0.5   | 1.0        | V |
| Load Regulation*4                         | $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | $V_{IN} = V_{SET} + 4 V,$<br>$I_{OUT} = 1 mA \text{ to } 200 mA$                        | $V_{SET} = 1.2 V$                 | -0.4  | -     | 2.6        | % |
|   |   |   | $V_{SET} = 24 V$                  | -1.4  | -     | 1.0        | % |
| Line Regulation                           | $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$  | $V_{IN} = 3.5 V \text{ to } 42 V$   | -0.128                            | -     | 0.128 | %/V        |   |
| Ripple Rejection                          | RR                                      | $V_{IN} = V_{SET} + 3 V, \text{ Ripple } 0.2 V_{p-p},$<br>$I_{OUT} = 50 mA, f = 100 Hz$ | -                                 | 55    | -     | dB         |   |
| Output Current Limit                      | $I_{LIM}$                               | $V_{IN} = V_{SET} + 4 V, V_{OUT} = V_{SET} \times 0.90$                                 | 200                               | 350   | -     | mA         |   |
| Short-circuit Current                     | $I_{SC}$                                | $V_{IN} = 3.5 V, V_{OUT} = 0 V$   | 50                                | 85    | 145   | mA         |   |
| EN pin High Input Voltage (enable device) | $V_{ENH}$                               |   | 1.62                              | -     | 42    | V          |   |
| EN pin Low Input Voltage (disable device) | $V_{ENL}$                               |   | 0                                 | -     | 1.0   | V          |   |
| EN pin current                            | $I_{EN}$                                | $V_{IN} = 42 V, V_{EN} = 2 V$   | -                                 | 0.3   | 0.6   | $\mu A$    |   |
| Thermal shutdown detection temperature    | $T_{SDDET}$                             | $T_j = \text{Rising}$   | -                                 | 165   | -     | $^\circ C$ |   |
| Thermal shutdown release temperature      | $T_{SDREL}$                             | $T_j = \text{Falling}$  | -                                 | 140   | -     | $^\circ C$ |   |

All test parameters listed in Electrical Characteristics are tested under the condition of  $T_j \approx T_a = 25^\circ C / 125^\circ C$  except for Ripple Rejection.

\*1 It is the  $V_{IN}$  pin current and is not included the current flowing through external resistors.

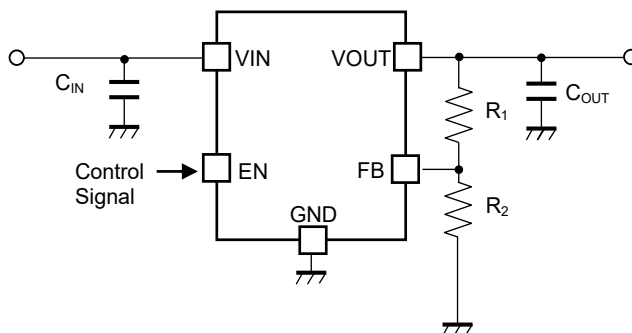
\*2 Input Voltage ( $V_{IN}$ ) should be above 3.5V, and  $V_{SET} + \text{Dropout Voltage}$  or higher.

\*3 Dropout Voltage is specified as the minimum voltage difference between Input Voltage ( $V_{IN}$ ) and Output Voltage ( $V_{OUT}$ ) required to obtain 95% of  $V_{SET}$  at specified load current.

\*4 Load Regulation is the value calculated with  $V_{OUT}(@I_{OUT} = 1 mA) - V_{OUT}(@I_{OUT} = 200 mA)$ .

\*5 Dropout voltage, load regulation, and output current limit are fully tested only at  $T_j \approx T_a = 25^\circ C$ .

■ TYPICAL APPLICATION CIRCUIT



NR1700 TYPICAL APPLICATION CIRCUIT

● EXTERNAL COMPONENTS INFORMATION

**Input Capacitor (C<sub>IN</sub>)**

Connect an input capacitor (C<sub>IN</sub>) of 0.1 μF or more between the VIN pin and the GND pin at the shortest distance. It is recommended to use ceramic capacitors of X7R having small temperature dependence to ESR, ESL, and capacitance. Ceramic capacitors as X7S or X5R could be used depending on the application condition such as temperature condition.

**Output Capacitor (C<sub>OUT</sub>)**

Phase compensation is provided to secure stable operation even when the load current is varied. Connect a suitable output capacitor (C<sub>OUT</sub>) between the VOUT pin and the GND pin at the shortest distance. It is recommended to use ceramic capacitors of X7R having small temperature dependence to ESR, ESL, and capacitance. Ceramic capacitors as X7S or X5R could be used depending on the application condition such as temperature condition. Besides, set for the output capacitor to ensure the following effective capacitance in consideration of the dependence of temperature, DC bias, and package size.

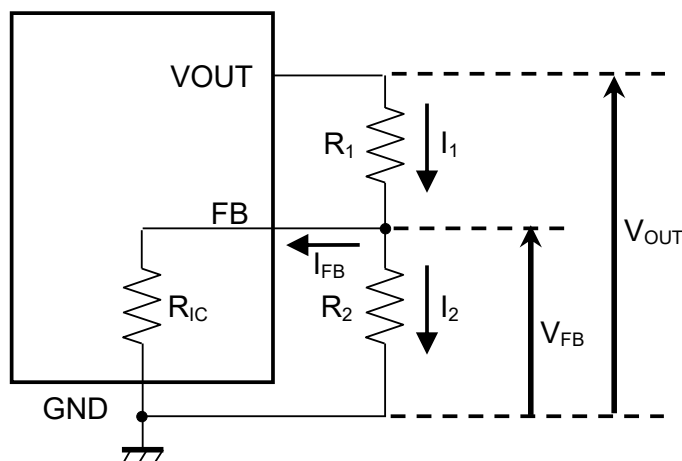
| Set Output Voltage vs. Effective Capacitance |                                     |
|--|-------------------------------------|
| Set Output Voltage (V <sub>SET</sub> )       | Effective Capacitance               |
| 1.2 V ≤ V <sub>SET</sub> < 5 V               | 0.07 μF ≤ C <sub>OUT</sub> ≤ 100 μF |
| 5 V ≤ V <sub>SET</sub> ≤ 12 V                | 0.05 μF ≤ C <sub>OUT</sub> ≤ 100 μF |
| 12 V < V <sub>SET</sub> ≤ 24 V               | 0.03 μF ≤ C <sub>OUT</sub> ≤ 100 μF |

When use capacitors except for ceramic capacitor, choose output capacitors to ensure the above effective capacitance, and ESR (Equivalent Series Resistance) is 100 ohm or lower.

● External Resistors for Adjustable Output Voltage

The NR1700 can be adjusted the output voltage ( $V_{SET}$ ) from 1.2 V to 24 V with a voltage divider resistor ( $R_1, R_2$ ) that is connected to the FB pin as following diagram. Use the formula shown below to calculate output voltage.

$$V_{SET} = V_{FB} \times (R_1 + R_2) / R_2 + V_{FB} \times R_1 / R_{IC} \quad V_{FB} = 1.2 \text{ V (Typ.)} \quad R_{IC} = 12.5 \text{ M}\Omega \text{ (Typ.)}$$



Adjustable Output Voltage R1, R2 connection diagram

Choose a voltage divider resistor ( $R_1, R_2$ ) to refer the below table.

| Adjustable Output Voltage vs. $R_1/R_2$     |  |                           |
|---|--|---------------------------|
| Set Output Voltage ( $V_{SET}$ )            | $R_1$  | $R_2$                     |
| $V_{SET} = 1.2 \text{ V}$                   | 0 (connect the VOUT pin and the FB pin)                            | *1                        |
| $1.2 \text{ V} < V_{SET} \leq 24 \text{ V}$ | $R_2 \times R_{IC} / (R_2 + R_{IC}) \times (V_{SET} / V_{FB} - 1)$ | $\leq 51 \text{ k}\Omega$ |

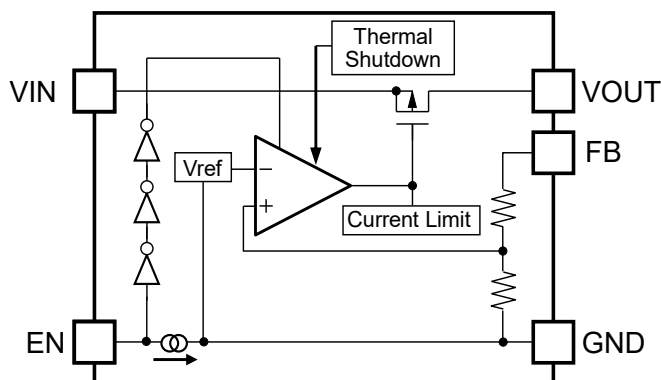
Choose a suitable  $R_2$ , then calculate  $R_1$  to refer the above formula.

An error of the output voltage ( $V_{OUT}$ ) due to the internal resistance ( $R_{IC}$ ) between FB pin and GND pin is calculated by  $V_{FB} \times R_1 / R_{IC}$ . If  $R_1 \ll R_{IC}$  is true, the error can be reduced, however small  $R_1$  value determines a small  $R_2$  value, and invalid current  $I_2 = V_{FB} / R_2$  increases.

Choose  $R_2$  value consider balance between an error due to  $R_{IC}$  and invalid current as well.

\*1 If the load current from NR1700 is below 24  $\mu\text{A}$ , use  $R_2 \leq 51 \text{ k}\Omega$  to prevent rising the output voltage due to leak current.

■ BLOCK DIAGRAM



NR1700 Block Diagram

■ THEORY OF OPERATION

● Enable Function

Forcing above designated "High" voltage to EN pin, the NR1700 becomes active. Forcing below designated "Low" voltage to EN pin shuts down the NR1700.

The EN pin is internally pull-down with Typ. 0.3  $\mu$ A as constant current. When the EN pin is OPEN, the NR1700 is in shutdown state.

If control by the EN pin is not possible or is not required, connect the EN pin to the VIN pin, etc., so that "High" is input to EN pin.

Even if voltage is applied to the EN pin before the VIN pin, the IC will not fail.

● Thermal Shutdown

When the junction temperature exceeds the thermal shutdown detection temperature (Typ. 165  $^{\circ}$ C), this IC cuts off the output transistor and suppresses the self-heating. When the junction temperature falls below the thermal shutdown release temperature (Typ. 140  $^{\circ}$ C), this IC will restart.

■ Cautions for use

● Behavior under minimum operating voltage or lower.

If Output Voltage ( $V_{OUT}$ ) is 2.8V or lower and Input Voltage ( $V_{IN}$ ) is below the recommended operating voltage (Min. 3.5V), the output voltage may exceed the set output voltage. In order to prevent such behavior, control as follows.

- When start-up, either to raise Input Voltage ( $V_{IN}$ ) at a slew rate of 35 V/ms or faster, or to turn the EN pin from "Low" to "High" after Input Voltage ( $V_{IN}$ ) exceeds 3.5V.
- When shutdown, either to be dropped Input Voltage ( $V_{IN}$ ) at a slew rate of -35 V/ms or faster, or to turn the EN pin from "High" to "Low" before Input Voltage ( $V_{IN}$ ) drops below 3.5V.

■ THERMAL CHARACTERISTICS ( SOT-23-5-DC )

Thermal characteristics depend on mounting conditions. The thermal characteristics below are the results of measurements under measurement conditions determined by our company with reference to JEDEC STD. (JESD51).

Measurement Result

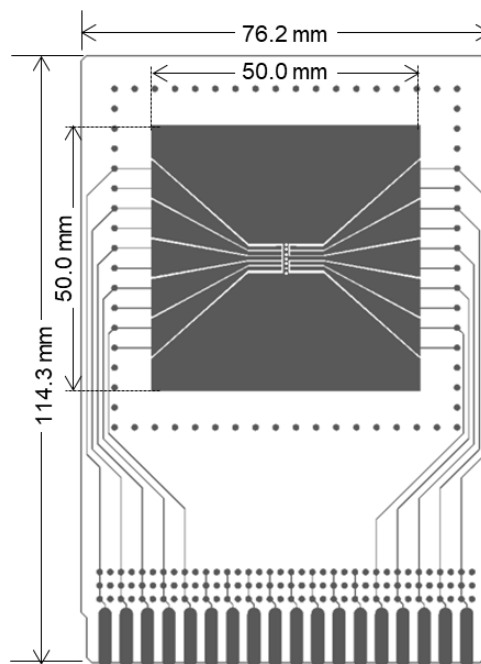
| Item   | Measurement Result |
|--|--------------------|
| Thermal Resistance ( $\theta_{ja}$ )               | 150 °C/W           |
| Thermal Characterization Parameter ( $\psi_{jt}$ ) | 51 °C/W            |

$\theta_{ja}$  : Junction-to-Ambient Thermal Resistance

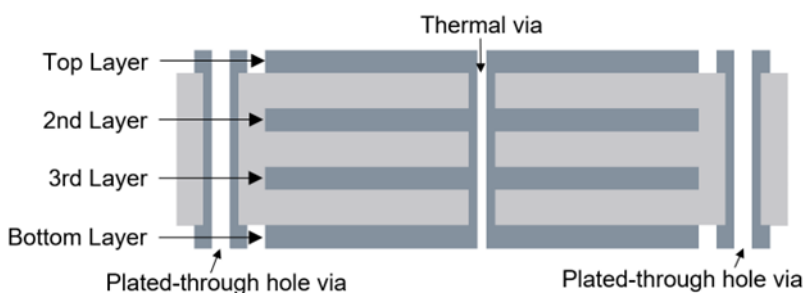
$\psi_{jt}$  : Junction-to-Top Thermal Characterization Parameter

Measurement Conditions

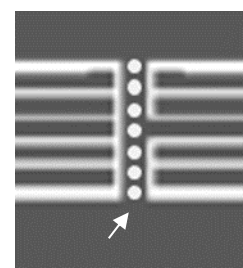
| Item                  | Specification                                       |
|-----------------------|---|
| Measurement Condition | Mounting on Board (Still Air)                       |
| Board material        | FR-4  |
| Board size            | 76.2 mm × 114.3 mm × t 0.8 mm                       |
| Copper foil layer     | 1 50 mm × 50 mm (coverage rate 95%),<br>t 0.040 mm  |
|                       | 2 50 mm × 50 mm (coverage rate 100%),<br>t 0.035 mm |
|                       | 3 50 mm × 50 mm (coverage rate 100%),<br>t 0.035 mm |
|                       | 4 50 mm × 50 mm (coverage rate 100%),<br>t 0.040 mm |
| Thermal via           | $\phi$ 0.3 mm × 7 pcs                               |



Measurement Board Pattern



Cross section view of layers and vias



Enlarged view of IC mounting area

● CALCULATION METHOD OF JUNCTION TEMPERATURE

The junction temperature ( $T_j$ ) can be calculated from the following formula.

$$T_j = T_a + \theta_{ja} \times P$$

$$T_j = T_c(\text{top}) + \psi_{jt} \times P$$

Where:  $T_a$  : Ambient temperature  
 $T_c(\text{top})$  : Package mark side center temperature  
 $P = (V_{IN} - V_{OUT}) \times I_{OUT}$  : Power consumption under user's conditions

■ THERMAL CHARACTERISTICS ( SOT-89-5-DM )

Thermal characteristics depend on mounting conditions. The thermal characteristics below are the results of measurements under conditions determined by our company with reference to JEDEC STD. (JESD51).

Measurement Result

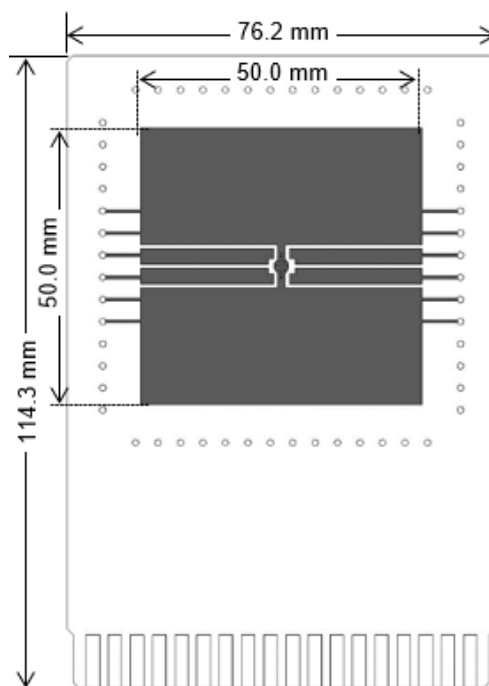
| Item   | Measurement Result |
|--|--------------------|
| Thermal Resistance ( $\theta_{ja}$ )               | 38 °C/W            |
| Thermal Characterization Parameter ( $\psi_{jt}$ ) | 13 °C/W            |

$\theta_{ja}$  : Junction-to-Ambient Thermal Resistance

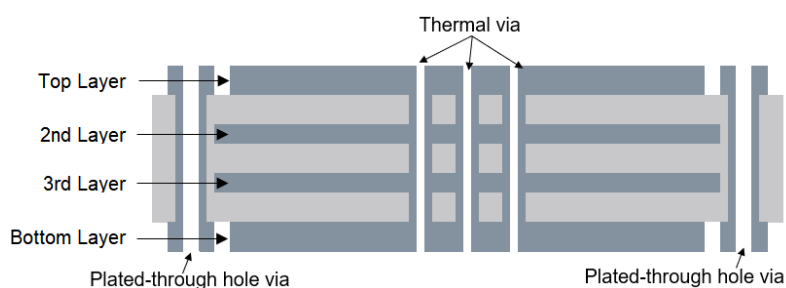
$\psi_{jt}$  : Junction-to-Top Thermal Characterization Parameter

Measurement Conditions

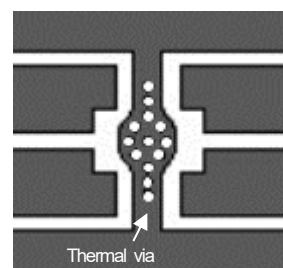
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|                       | 2 50 mm × 50 mm (coverage rate 100%),<br>t 0.035 mm |
|                       | 3 50 mm × 50 mm (coverage rate 100%),<br>t 0.035 mm |
|                       | 4 50 mm × 50 mm (coverage rate 100%),<br>t 0.040 mm |
| Thermal via           | $\phi$ 0.3 mm × 13 pcs                              |



Measurement Board Pattern



Cross section view of layers and vias



Enlarged view of IC mounting area

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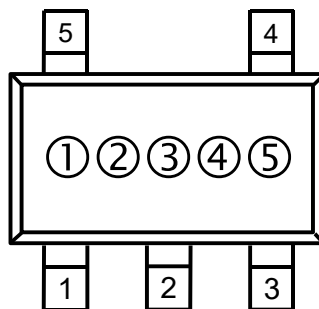
$$T_j = T_c(\text{top}) + \psi_{jt} \times P$$

Where:  $T_a$  : Ambient temperature  
 $T_c(\text{top})$  : Package mark side center temperature  
 $P = (V_{IN} - V_{OUT}) \times I_{OUT}$  : Power consumption under user's conditions

■ NR1700DC MARKING SPECIFICATION

①②③: Product Code (Abbreviation)

④⑤: Lot Number ... Alphanumeric Serial Number.



SOT-23-5-DC Marking

Marking List

|                     |     |
|---------------------|-----|
| <b>Product Code</b> | ①②③ |
| NR1700DC000A        | 1AA |

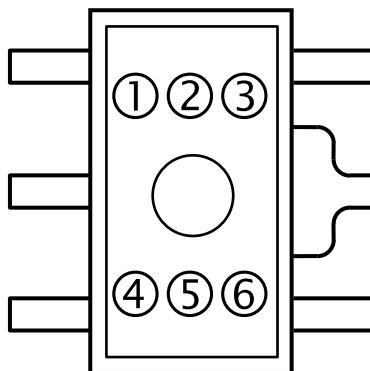
**NOTICE**

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

■ NR1700DM MARKING SPECIFICATION

①②③④: Product Code (Abbreviation)

⑤⑥: Lot Number ... Alphanumeric Serial Number.



SOT-89-5-DM Marking

Marking List

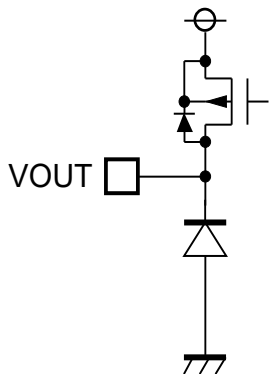
|              |      |
|--------------|------|
| Product Code | ①②③④ |
| NR1700DM000A | 109A |

NOTICE

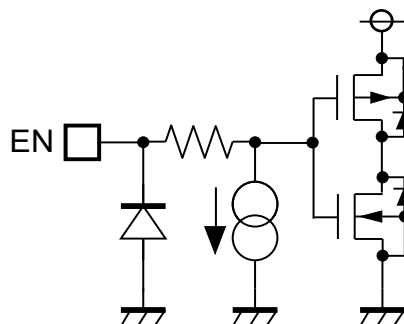
There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

■ Application Note

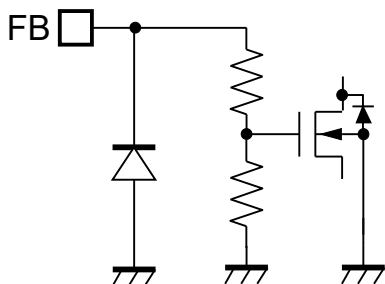
● Internal Equivalent Circuit Diagram of Pin



VOUT pin

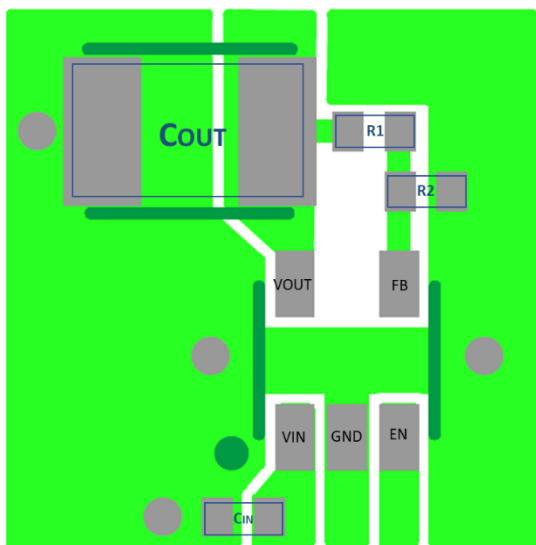


EN pin

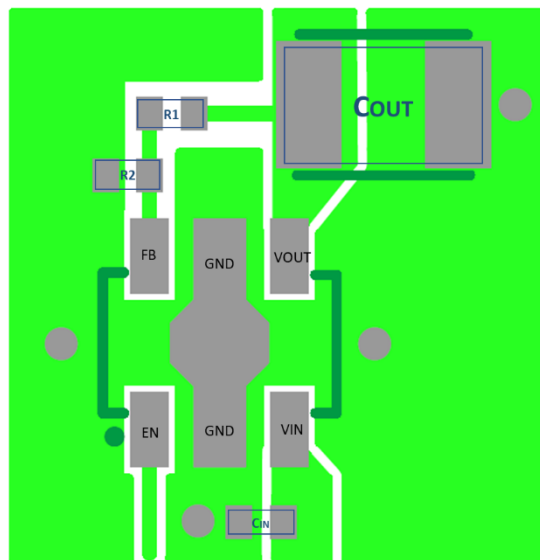


FB pin

● Evaluation Board / PCB Layout Pattern Example



NR1700DC



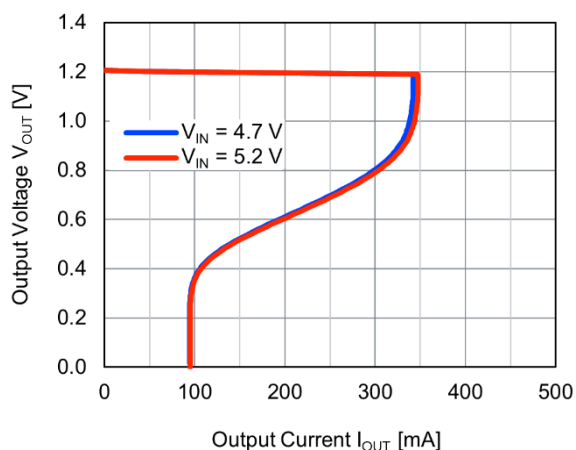
NR1700DM

■ TYPICAL CHARACTERISTICS

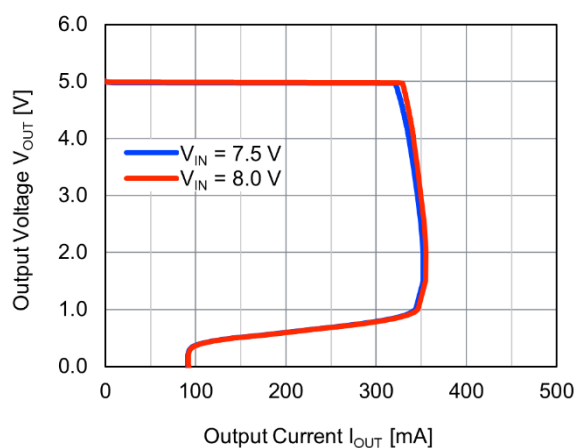
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.  
 Ta = 25 °C, CIN = 1 μF, CBIAS = 1 μF, COUT = 10 μF unless otherwise noted.

1) Output Voltage vs Output Current (Current Limit)

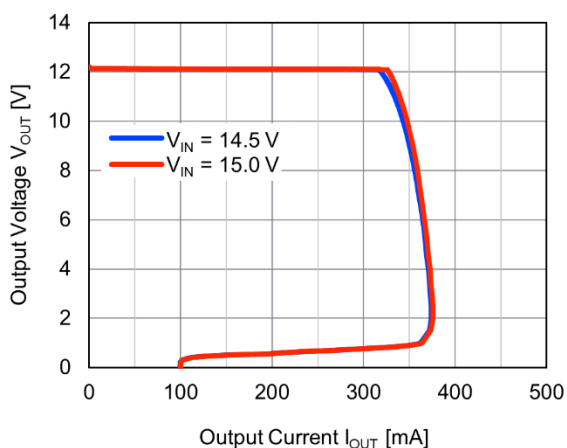
VSET = 1.2 V



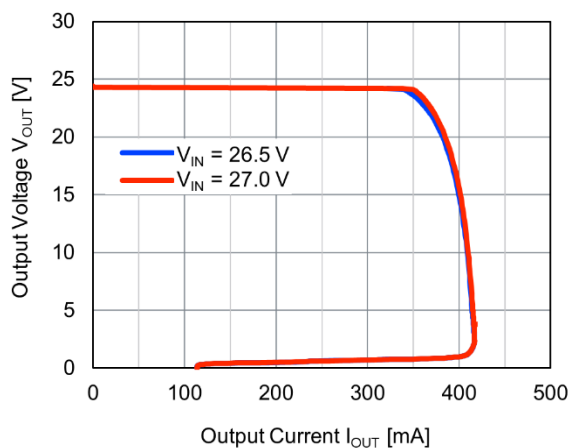
VSET = 5 V



VSET = 12 V

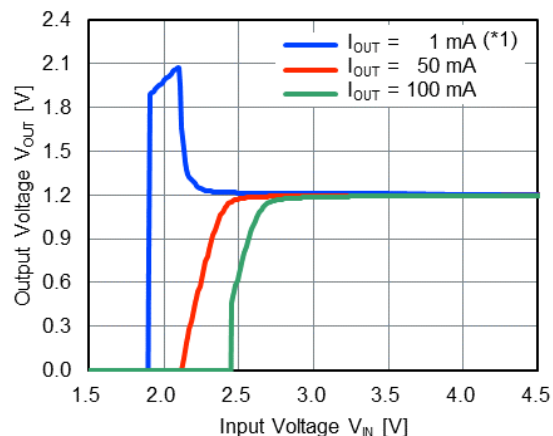


VSET = 24 V

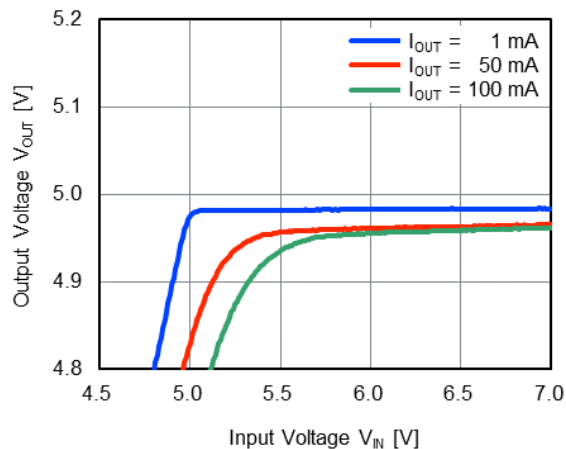
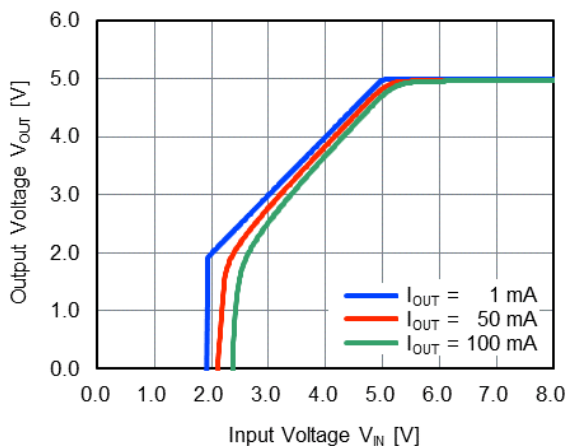


2) Output Voltage vs Input Voltage

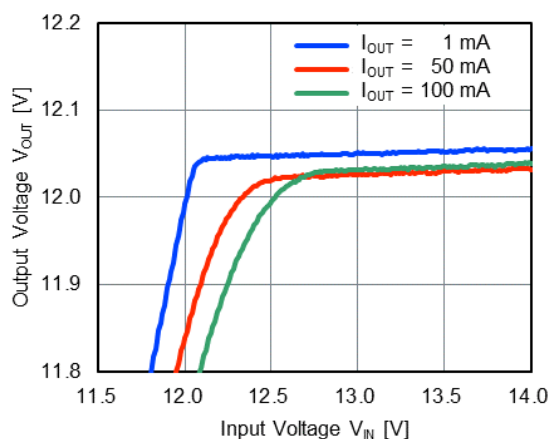
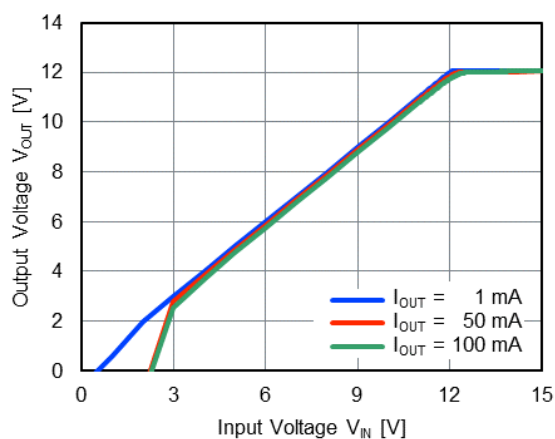
VSET = 1.2 V



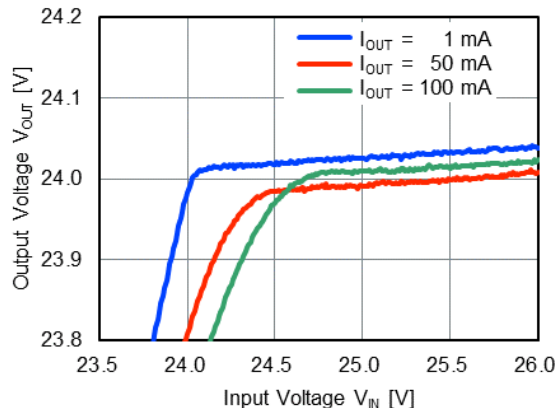
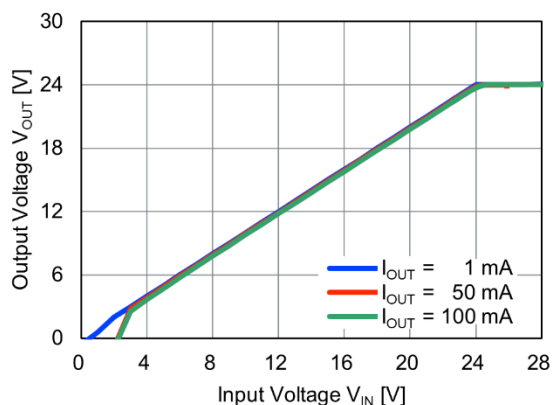
$V_{SET} = 5V$



$V_{SET} = 12V$



$V_{SET} = 24V$

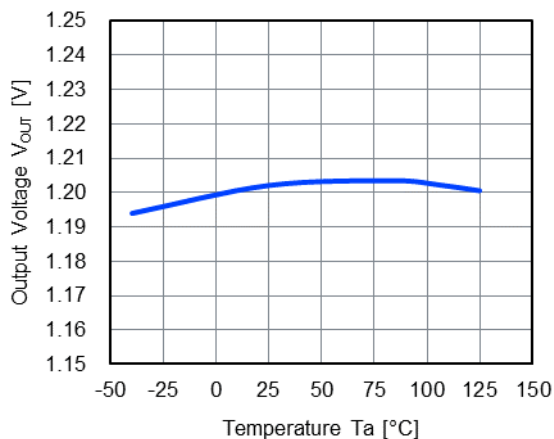


\*1 Though there is a condition of  $V_{OUT} > V_{SET}$  when  $V_{IN} < 3.5V$ , regulation is not guaranteed due to below the recommended operating condition. For more information, see "Cautions for Use".

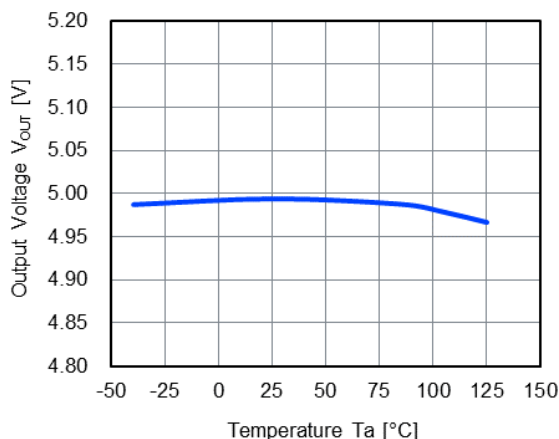
3) Output Voltage vs Temperature

$V_{IN} = 14\text{ V}$  ( $V_{SET} < 24\text{ V}$ ) or  $V_{IN} = 26\text{ V}$  ( $V_{SET} = 24\text{ V}$ ),  $I_{OUT} = 1\text{ mA}$

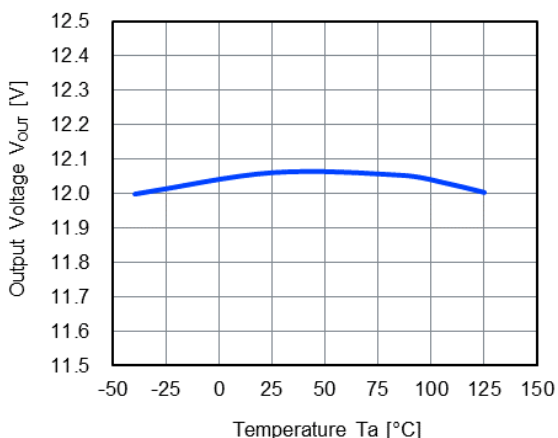
$V_{SET} = 1.2\text{ V}$



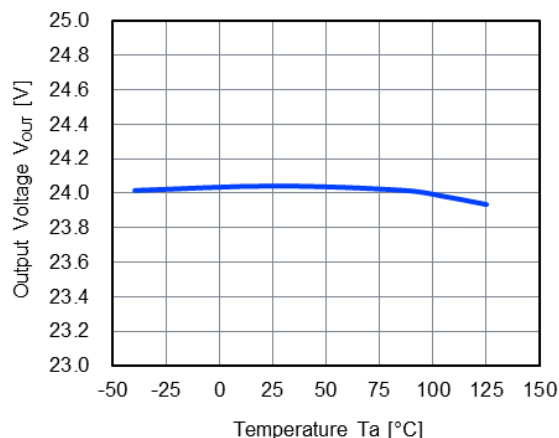
$V_{SET} = 5.0\text{ V}$



$V_{SET} = 12\text{ V}$



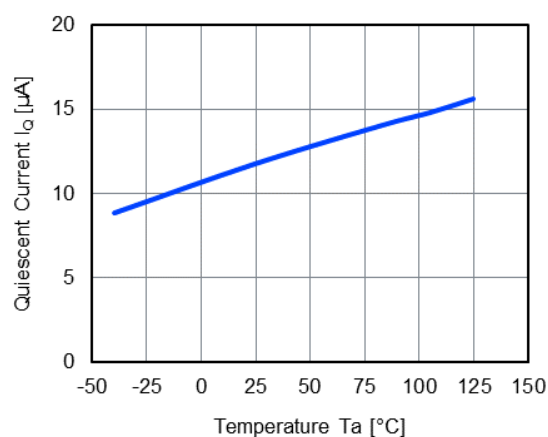
$V_{SET} = 24\text{ V}$



4) Quiescent Current<sup>2</sup> vs Temperature

$C_{IN} = \text{none}$ ,  $V_{IN} = 14\text{ V}$ ,  $I_{OUT} = 0\text{ mA}$

$V_{SET} = 1.2\text{ V}$

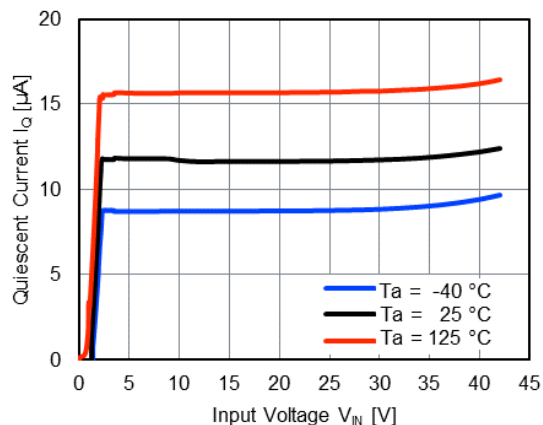


<sup>2</sup> Not include current flow into external resistors.

5) Quiescent Current<sup>\*3</sup> vs Input Voltage

$C_{IN}$  = none,  $I_{OUT}$  = 0 mA

$V_{SET}$  = 1.2 V

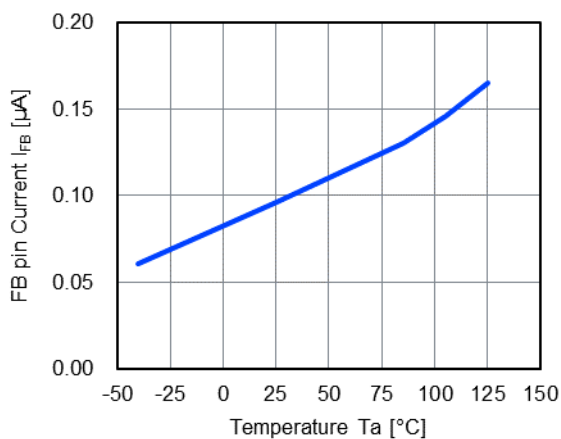


<sup>\*3</sup> Not include current flow into external resistors.

6) FB pin Current vs Temperature

$V_{IN}$  = 14 V,  $V_{EN}$  = 0 V,  $V_{FB}$  = 1.2 V,  $V_{OUT}$  = 0 V

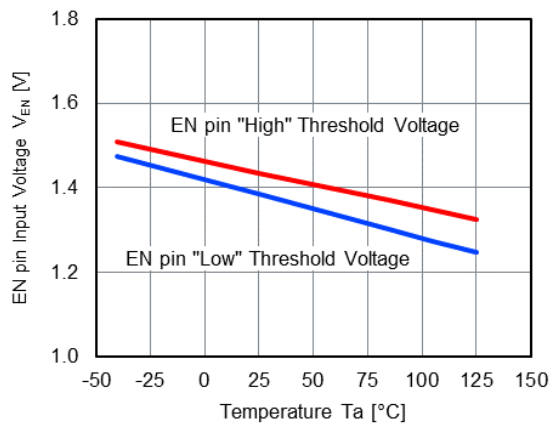
$V_{SET}$  = 1.2 V



7) EN pin input "High / Low" Voltages vs Temperature

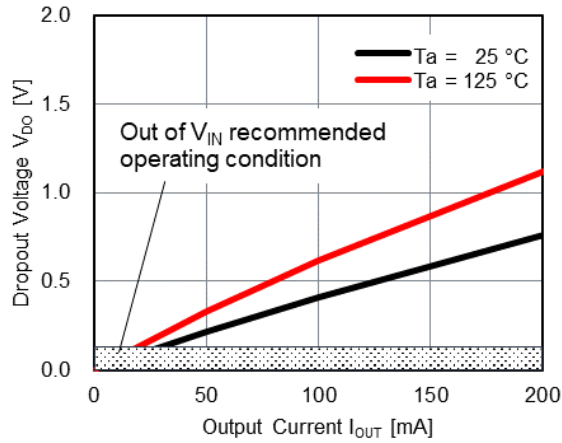
$V_{IN}$  = 3.5 V

$V_{SET}$  = 1.2 V

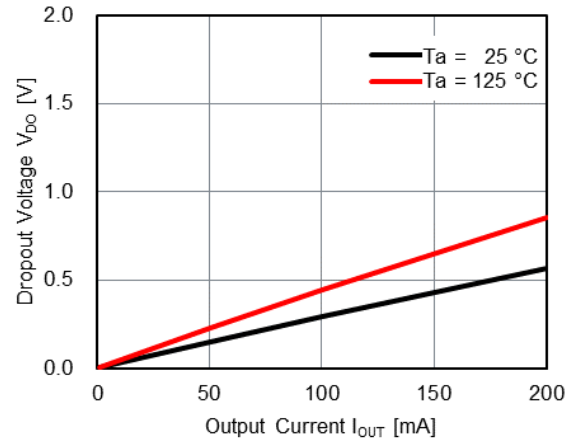


8) Dropout Voltage vs Output Current

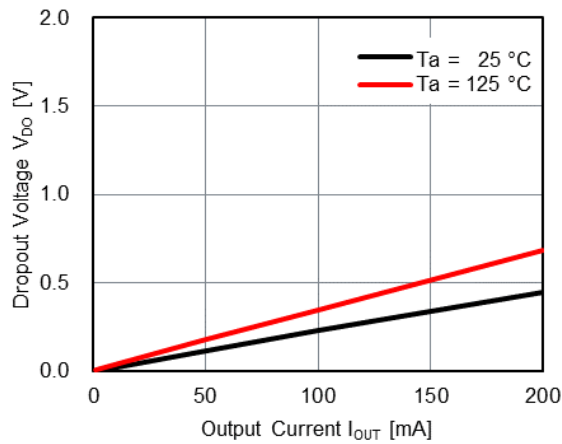
$V_{SET} = 3.3\text{ V}$



$V_{SET} = 5\text{ V}$

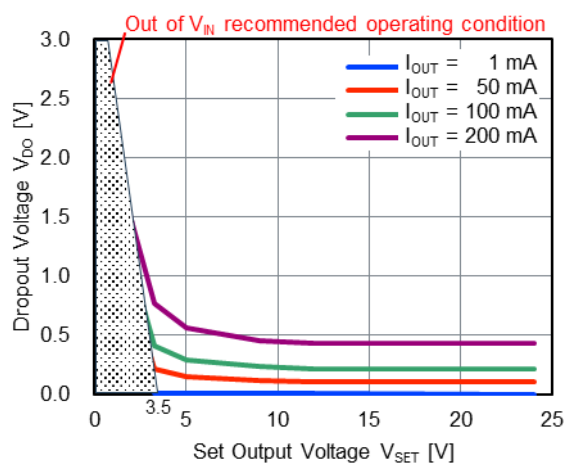


$V_{SET} = 9\text{ V}$

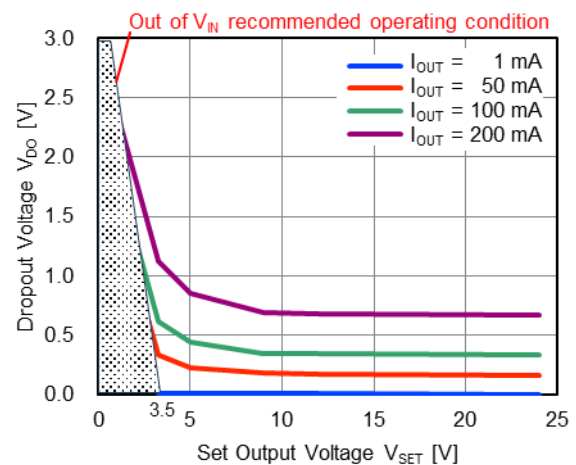


9) Dropout Voltage vs Set Output Voltage

$T_a = 25\text{ }^\circ\text{C}$



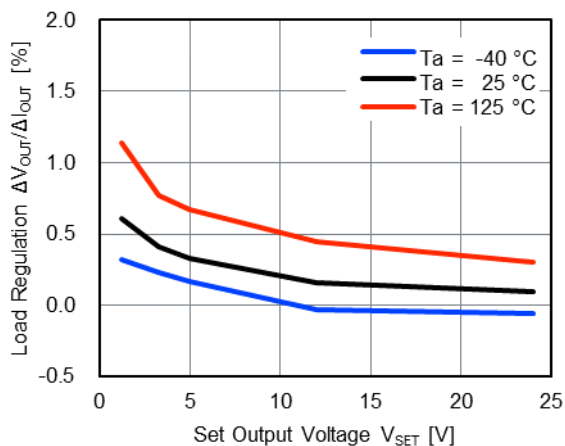
$T_a = 125\text{ }^\circ\text{C}$



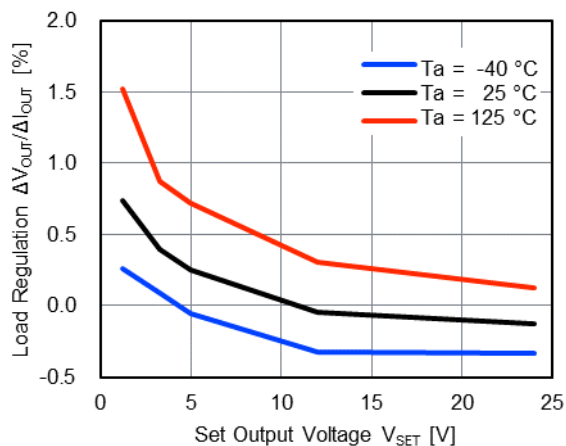
10) Load Regulation vs Set Output Voltage

$V_{IN} = V_{SET} + 4\text{ V}$

$I_{OUT} = 1\text{ mA to }100\text{ mA}$



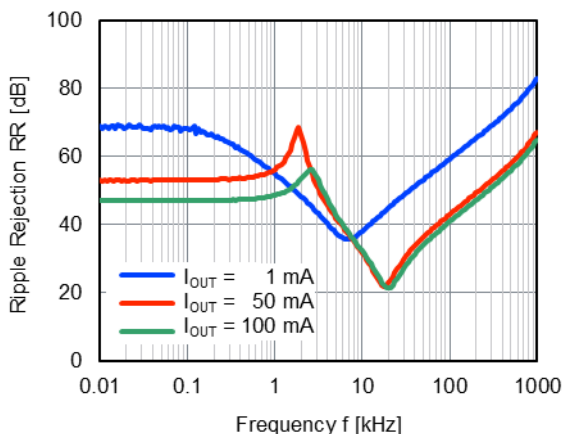
$I_{OUT} = 1\text{ mA to }200\text{ mA}$



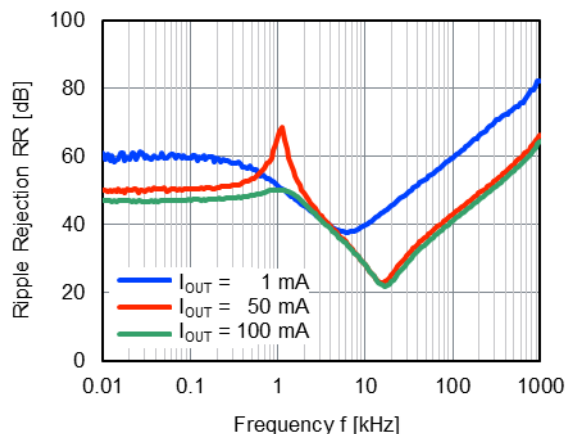
11) Ripple Rejection vs Frequency

$C_{IN} = \text{none}$ ,  $V_{IN} = V_{SET} + 3\text{ V}$ , Ripple  $0.2\text{ V}_{P-P}$

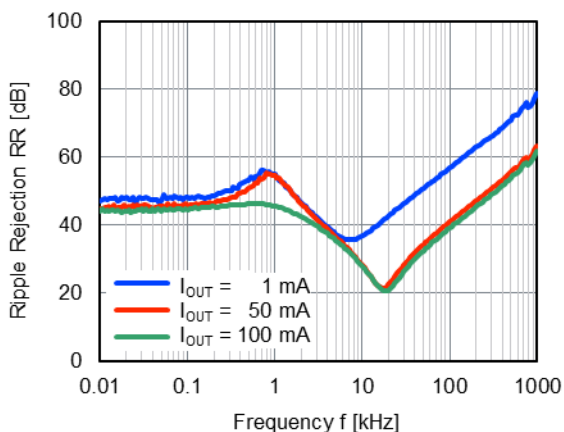
$V_{SET} = 1.2\text{ V}$



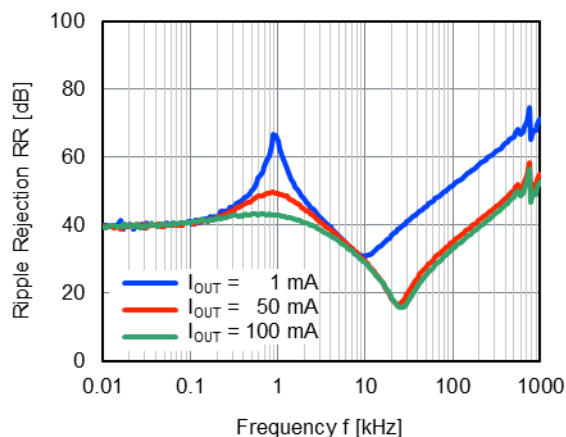
$V_{SET} = 5\text{ V}$



$V_{SET} = 12\text{ V}$



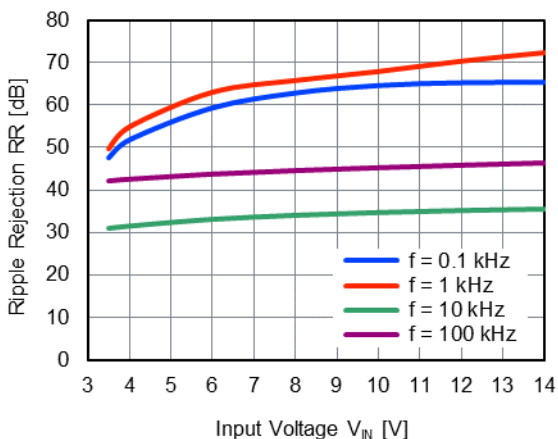
$V_{SET} = 24\text{ V}$



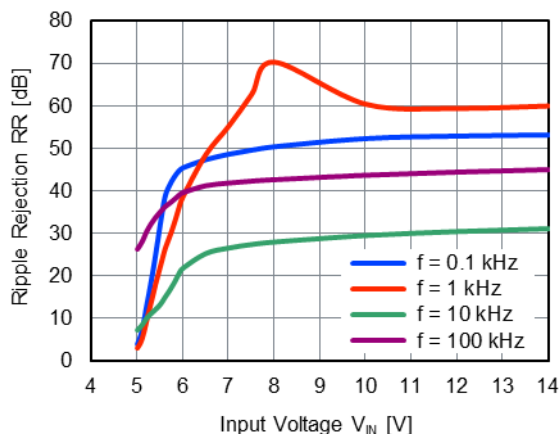
12) Ripple Rejection vs Input Voltage

$C_{IN}$  = none, Ripple 0.2 V<sub>P-P</sub>,  $I_{OUT}$  = 50 mA

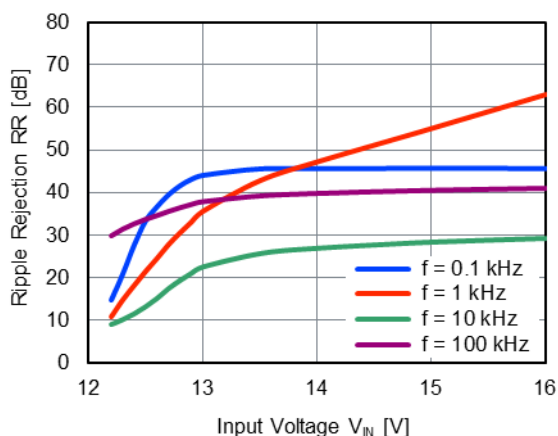
$V_{SET}$  = 1.2 V



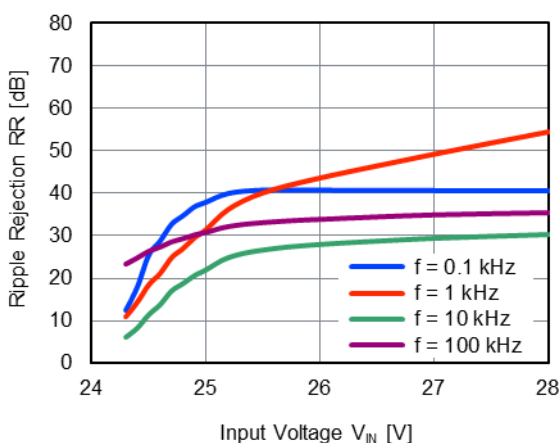
$V_{SET}$  = 5 V



$V_{SET}$  = 12 V



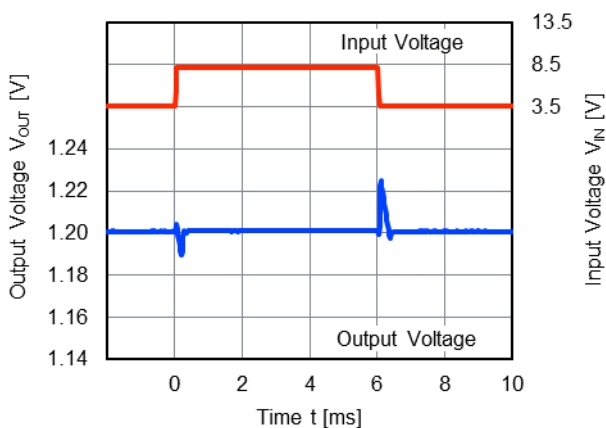
$V_{SET}$  = 24 V



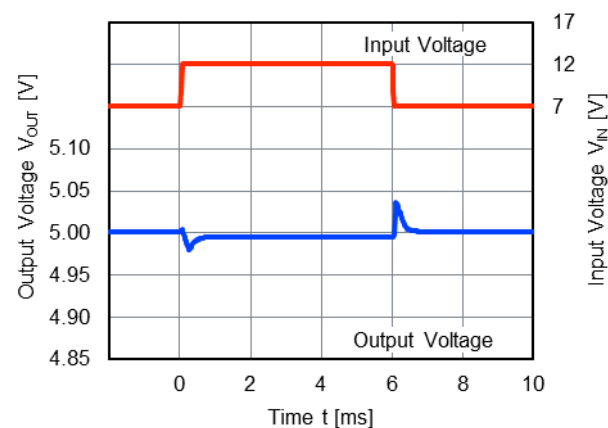
13) Line Transient Response

$C_{IN}$  = none,  $t_R = t_F = 5 \mu s$ ,  $I_{OUT} = 1 mA$

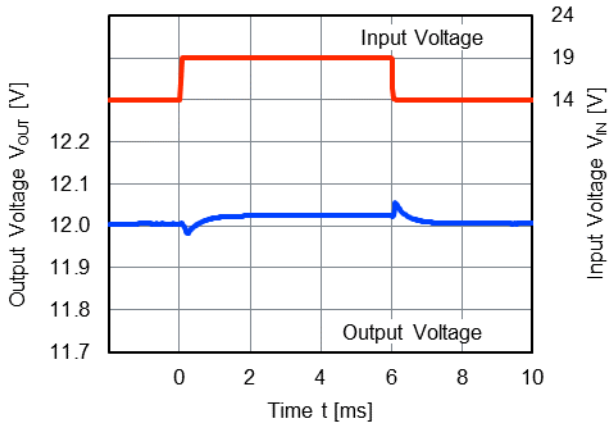
$V_{SET}$  = 1.2 V



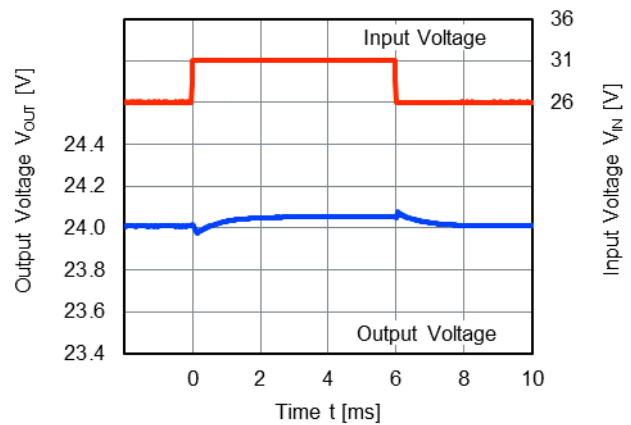
$V_{SET}$  = 5 V



$V_{SET} = 12\text{ V}$



$V_{SET} = 24\text{ V}$

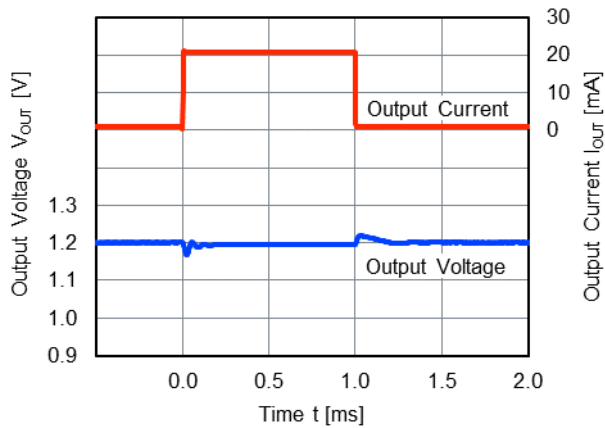


14) Load Transient Response

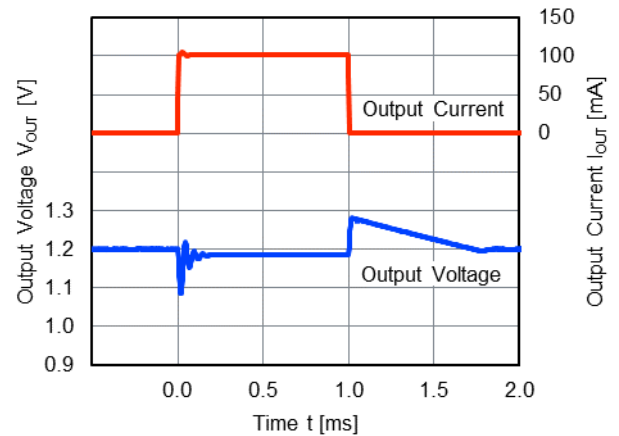
$t_R = t_F = 0.5\ \mu\text{s}$ ,  $V_{IN} = V_{SET} + 2\text{ V}$  (Min. 3.5 V)

$V_{SET} = 1.2\text{ V}$

$I_{OUT} = 1\text{ mA} \leftrightarrow 20\text{ mA}$

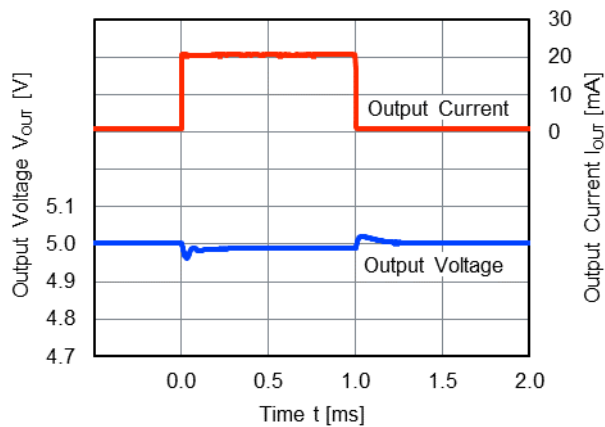


$I_{OUT} = 1\text{ mA} \leftrightarrow 100\text{ mA}$

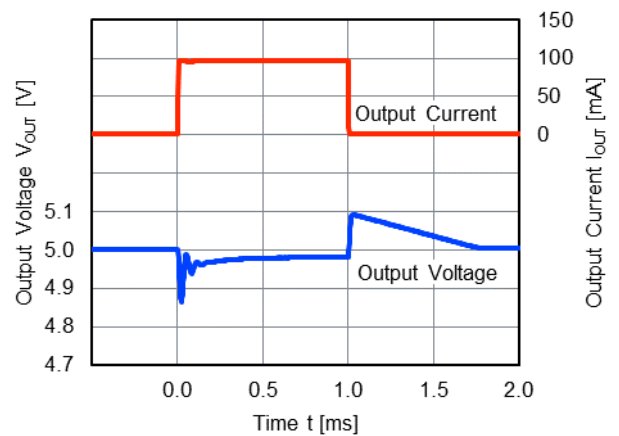


$V_{SET} = 5\text{ V}$

$I_{OUT} = 1\text{ mA} \leftrightarrow 20\text{ mA}$

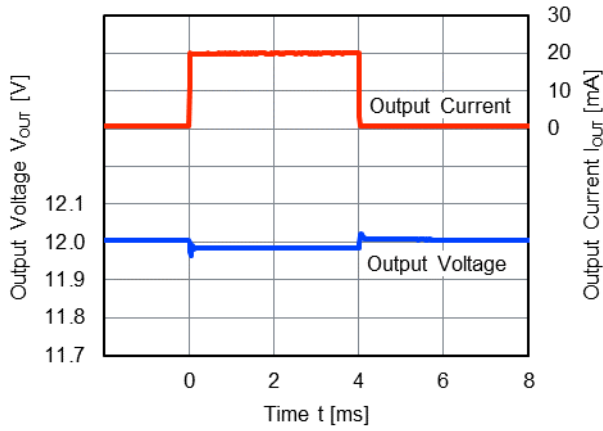


$I_{OUT} = 1\text{ mA} \leftrightarrow 100\text{ mA}$

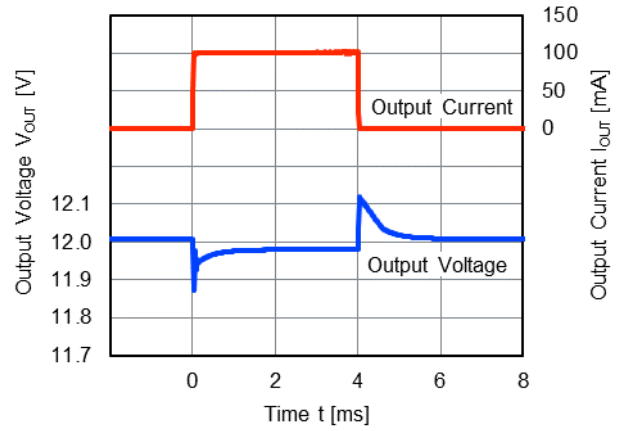


$V_{SET} = 12\text{ V}$

$I_{OUT} = 1\text{ mA} \leftrightarrow 20\text{ mA}$

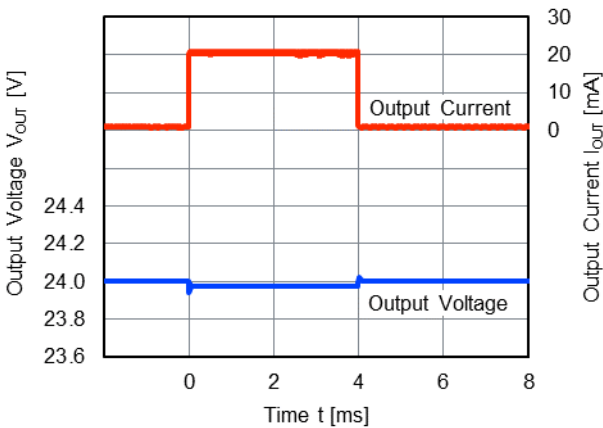


$I_{OUT} = 1\text{ mA} \leftrightarrow 100\text{ mA}$

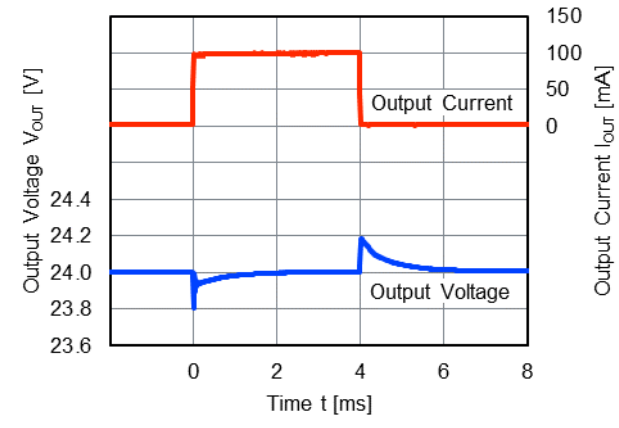


$V_{SET} = 24\text{ V}$

$I_{OUT} = 1\text{ mA} \leftrightarrow 20\text{ mA}$



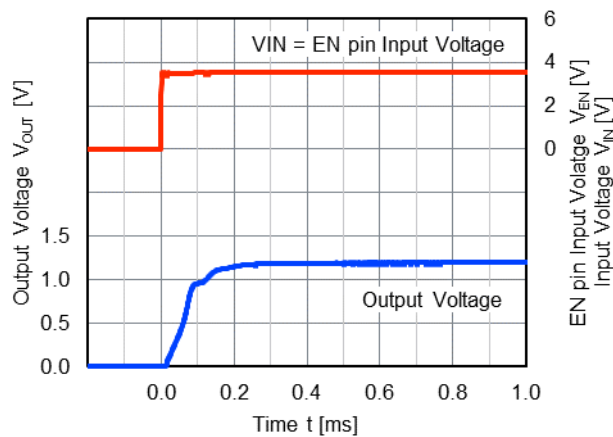
$I_{OUT} = 1\text{ mA} \leftrightarrow 100\text{ mA}$



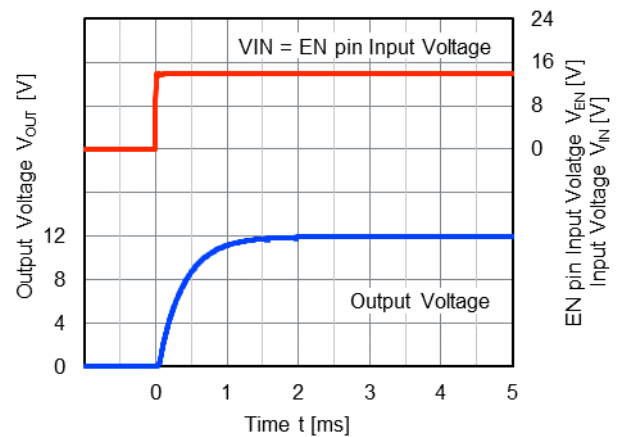
15) Turn on Speed with  $V_{IN} = EN$  Pin

$V_{IN} = V_{EN} = 0\text{ V}$  to  $V_{SET} + 2\text{ V}$  (Min. 3.5V),  $I_{OUT} = 0\text{ mA}$

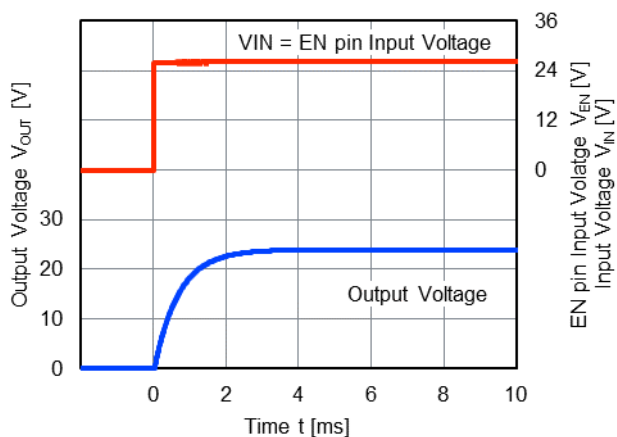
$V_{SET} = 1.2\text{ V}$



$V_{SET} = 12\text{ V}$



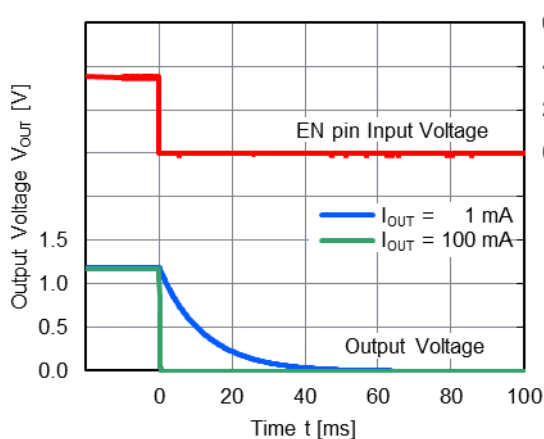
$V_{SET} = 24\text{ V}$



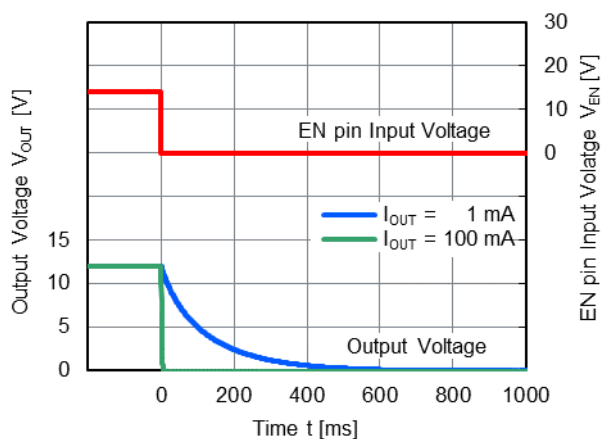
16) Turn off Speed with EN Pin

$V_{IN} = V_{SET} + 2\text{ V}$  (Min. 3.5 V)

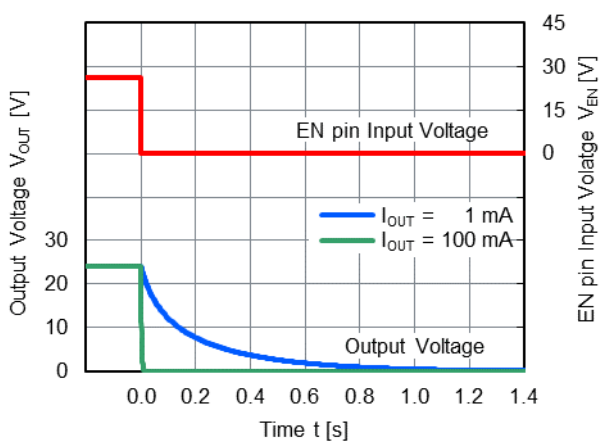
$V_{SET} = 1.2\text{ V}$



$V_{SET} = 12\text{ V}$



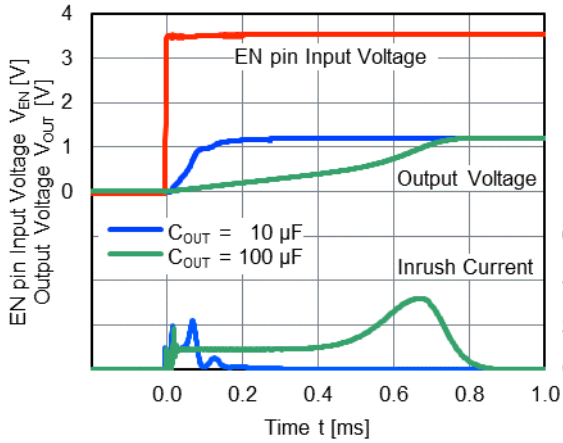
$V_{SET} = 24\text{ V}$



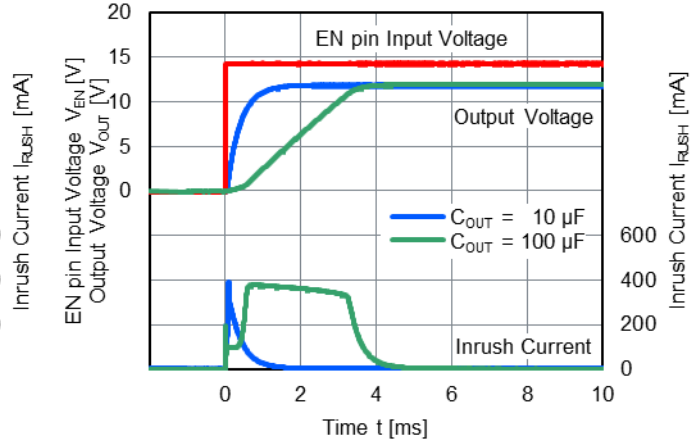
17) Inrush Current

$V_{IN} = V_{SET} + 2V$  (Min. 3.5V),  $I_{OUT} = 1mA$

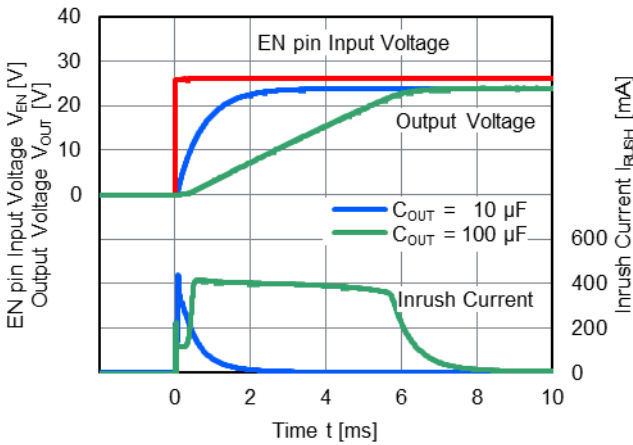
$V_{SET} = 1.2V$



$V_{SET} = 12V$



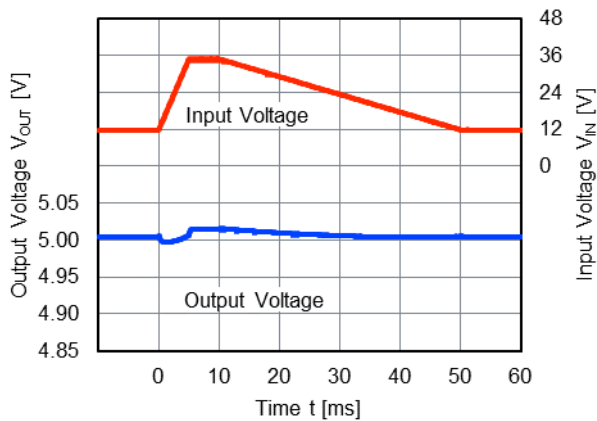
$V_{SET} = 24V$



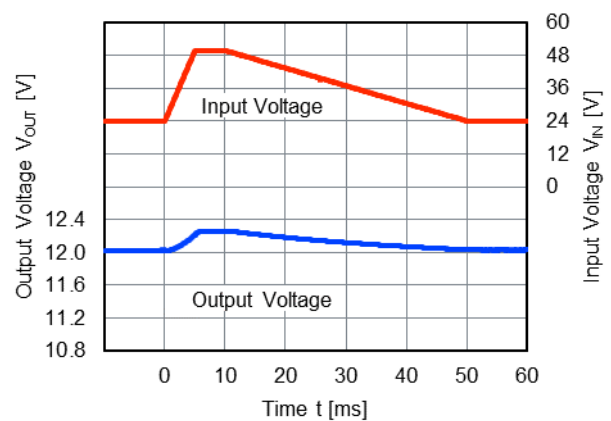
18) Load Dump

$I_{OUT} = 1mA$

$V_{SET} = 5V$



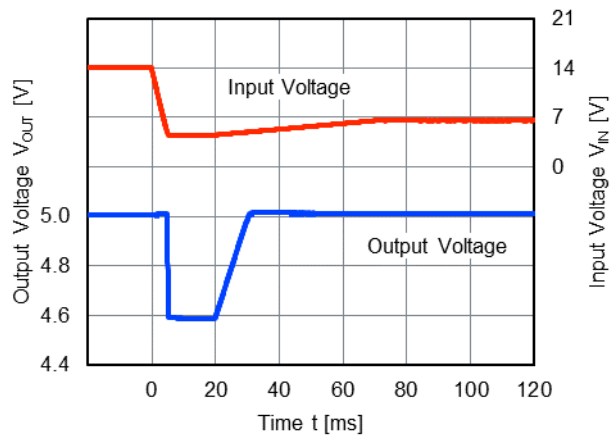
$V_{SET} = 12V$



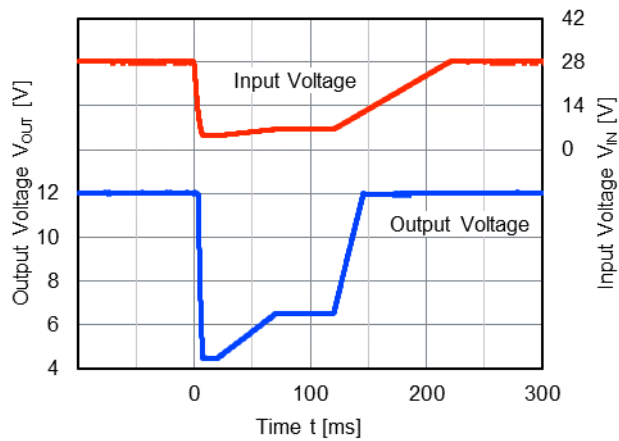
19) Cranking

$I_{OUT} = 1\text{ mA}$

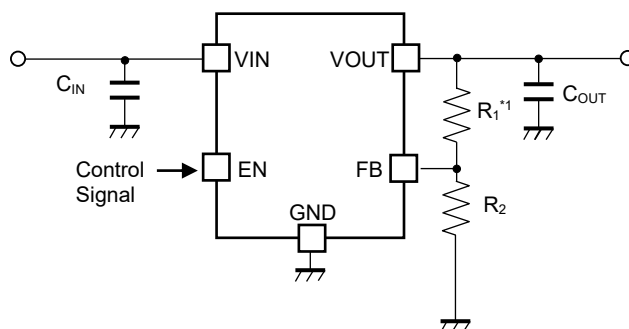
$V_{SET} = 5\text{ V}$



$V_{SET} = 12\text{ V}$



■ TEST CIRCUIT



NR1700 Test Circuit

【Components List for Our Evaluation】

External Capacitors

| Symbol           | Capacitance | Parts Number       |
|------------------|-------------|--------------------|
| C <sub>IN</sub>  | 0.1 μF      | CGA2B3X7R1H104K    |
| C <sub>OUT</sub> | 10 μF       | CGA6P3X7S1H106K    |
|                  | 100 μF      | EKY-500ELL101MHB5D |

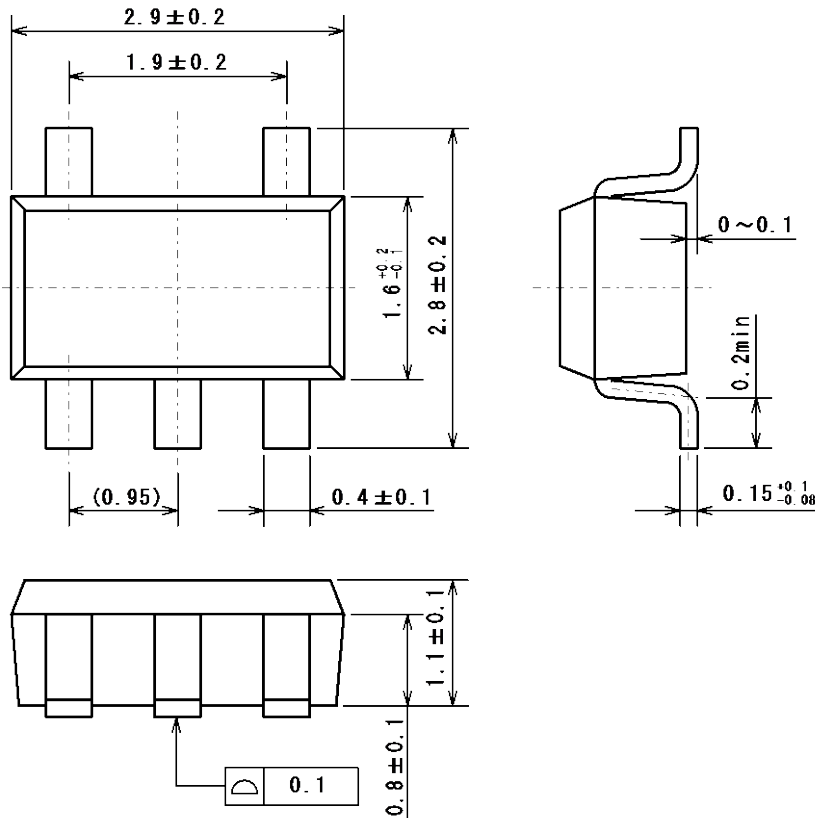
External Resistors

| Symbol            | Set Output Voltage (V <sub>SET</sub> )          | Resistance     |
|-------------------|---|----------------|
| R <sub>1</sub> *1 | V <sub>SET</sub> = 3.3 V                        | 6.8 kΩ + 82 kΩ |
|                   | V <sub>SET</sub> = 5.0 V                        | 51 kΩ+ 110 kΩ  |
|                   | V <sub>SET</sub> = 9.0 V                        | 300 Ω+ 330 kΩ  |
|                   | V <sub>SET</sub> = 12 V                         | 4.7 kΩ+ 453 kΩ |
|                   | V <sub>SET</sub> = 24 V                         | 220 kΩ+ 750 kΩ |
| R <sub>2</sub>    | V <sub>SET</sub> = 1.2, 3.3, 5.0, 9.0, 12, 24 V | 51 kΩ          |

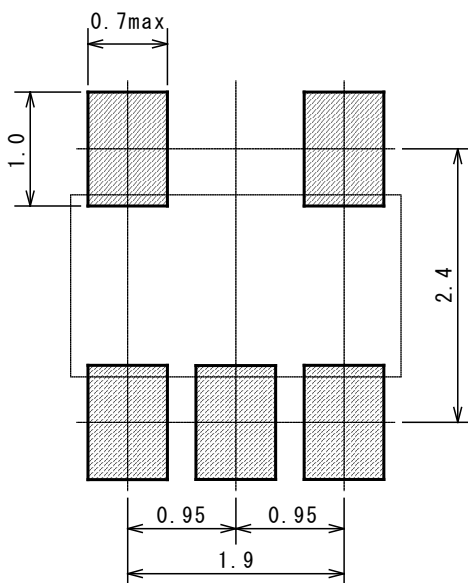
\*1 Two resistors are connected in series.

■ PACKAGE DIMENSIONS

UNIT: mm



■ EXAMPLE OF SOLDER PADS DIMENSIONS



# Nisshinbo Micro Devices Inc.

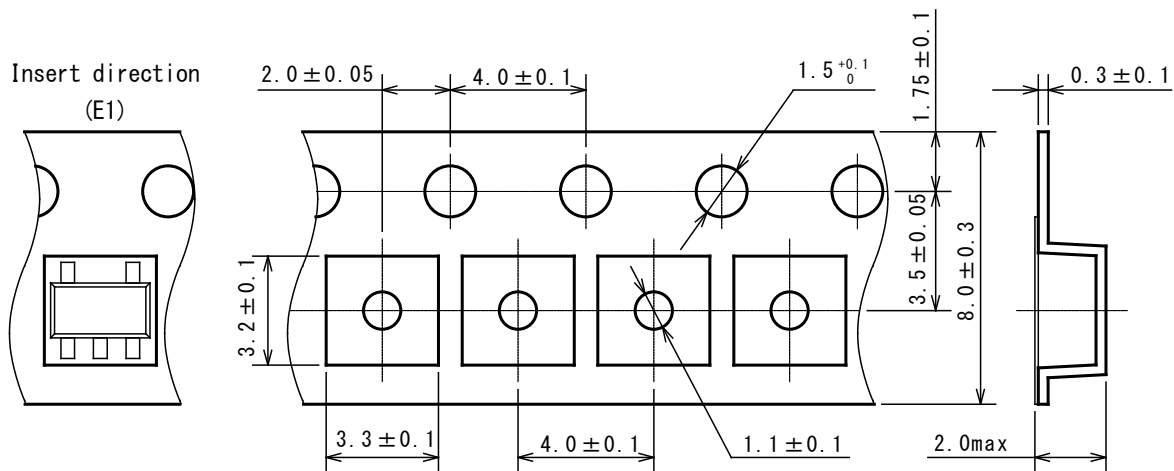
SOT-23-5-DC

PI-SOT-23-5-DC-01-E-A

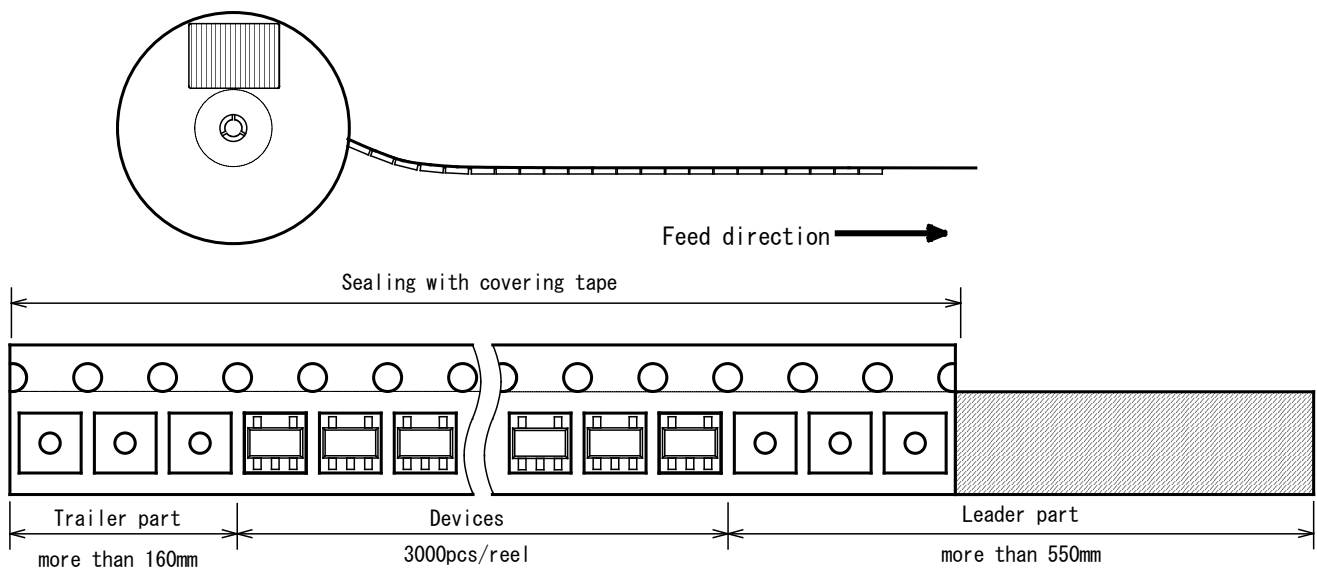
■ PACKING SPEC

UNIT: mm

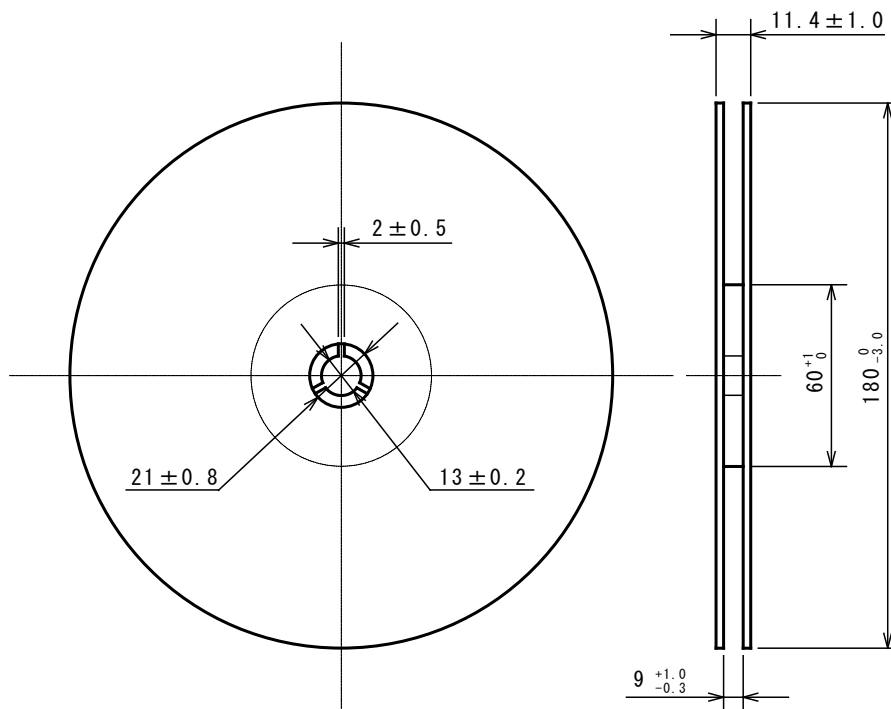
(1) Taping dimensions / Insert direction



(2) Taping state



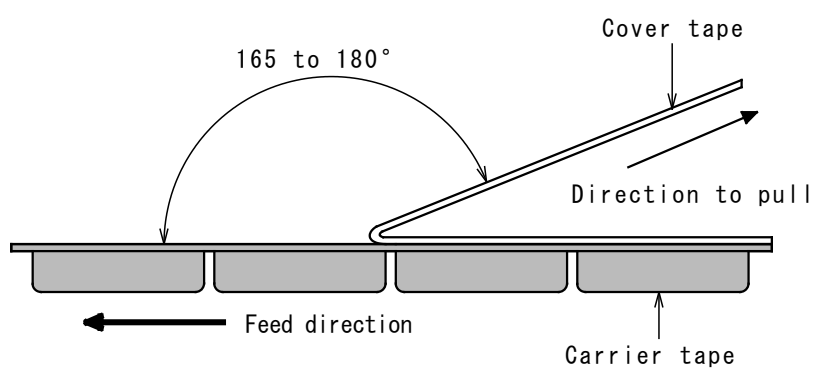
(3) Reel dimensions



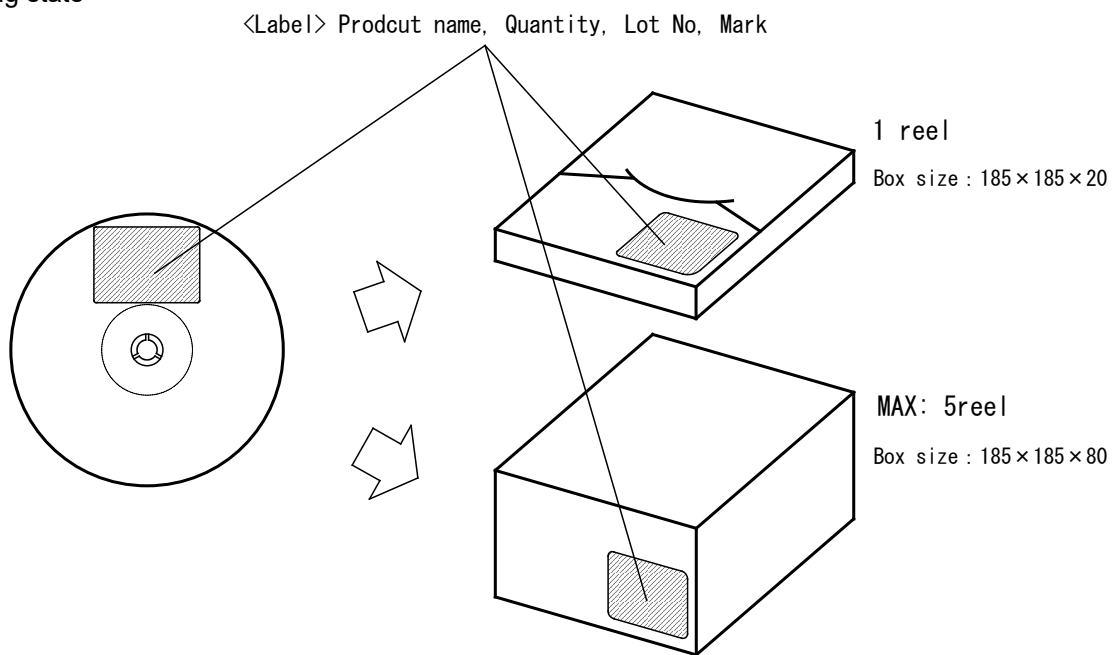
(4) Peeling strength

Peeling strength of cover tape

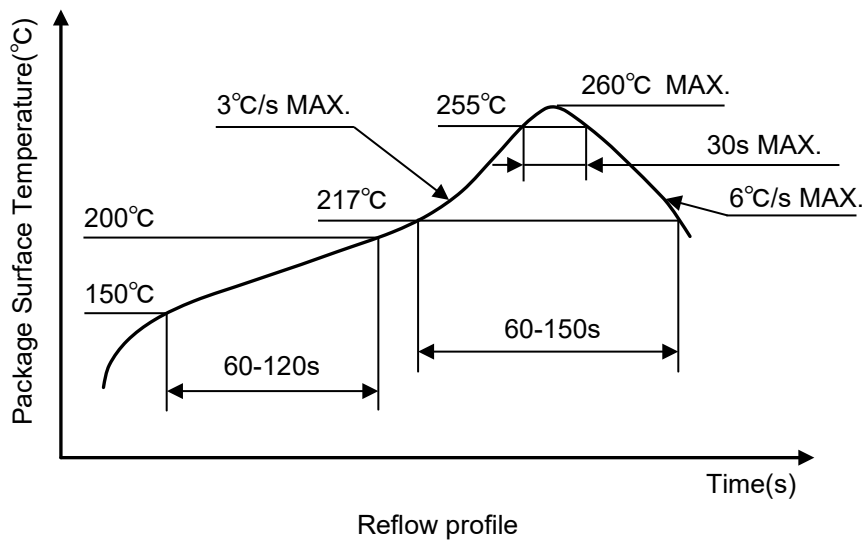
- Peeling angle 165 to 180° degrees to the taped surface.
- Peeling speed 300mm/min
- Peeling strength 0.1 to 1.0N



(5) Packing state



■ HEAT-RESISTANCE PROFILES



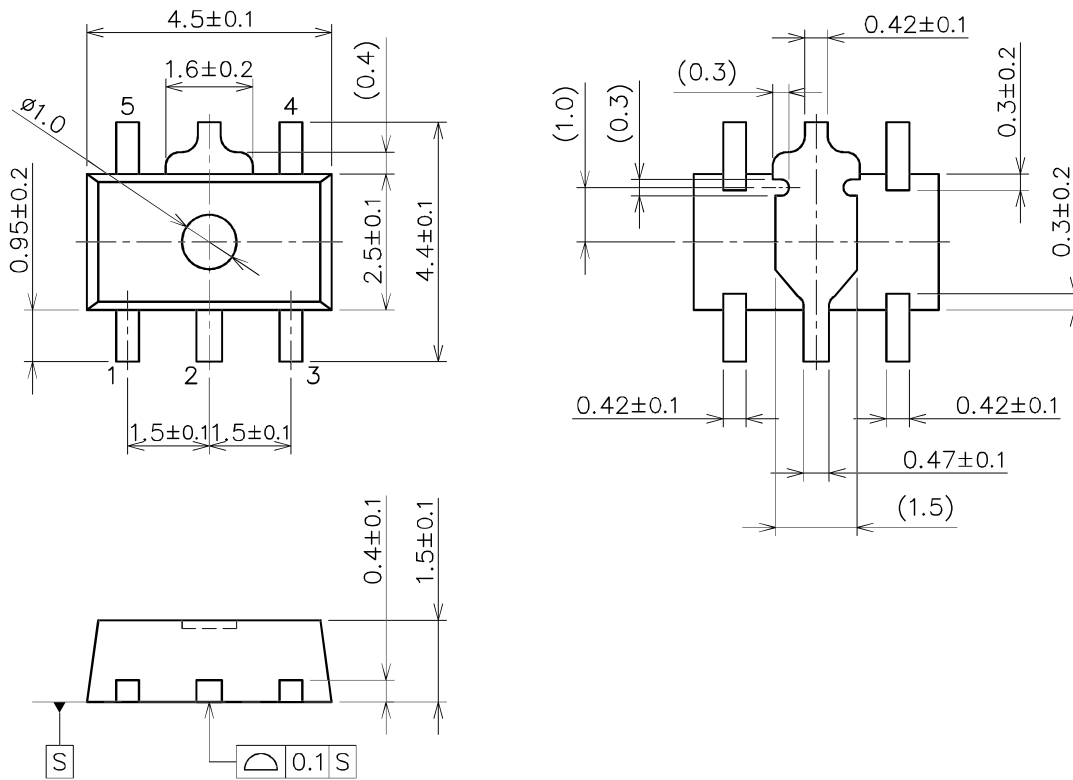
# Nisshinbo Micro Devices Inc.

SOT-89-5-DM

PI-SOT-89-5-DM-E-A

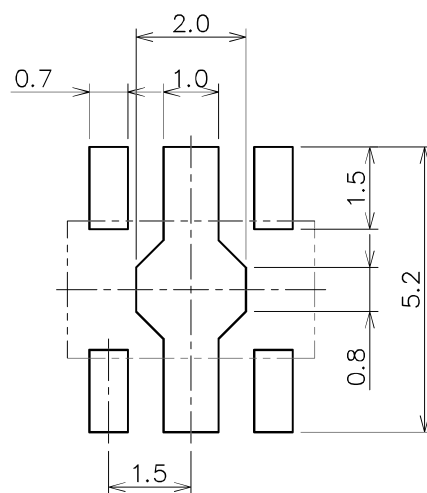
## ■ PACKAGE DIMENSIONS

UNIT: mm



## ■ EXAMPLE OF SOLDER PADS DIMENSIONS

UNIT: mm



Nisshinbo Micro Devices Inc.

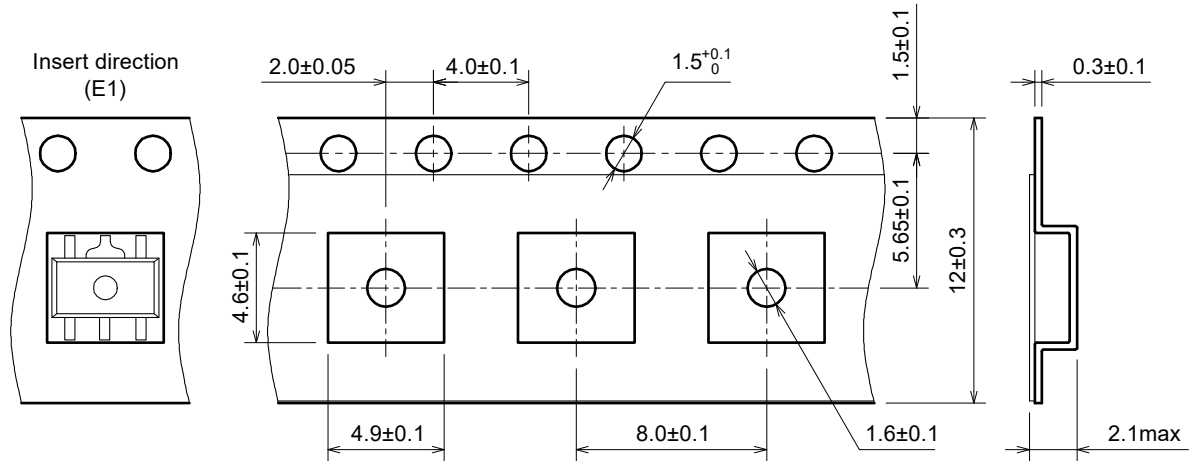
SOT-89-5-DM

PI-SOT-89-5-DM-E-A

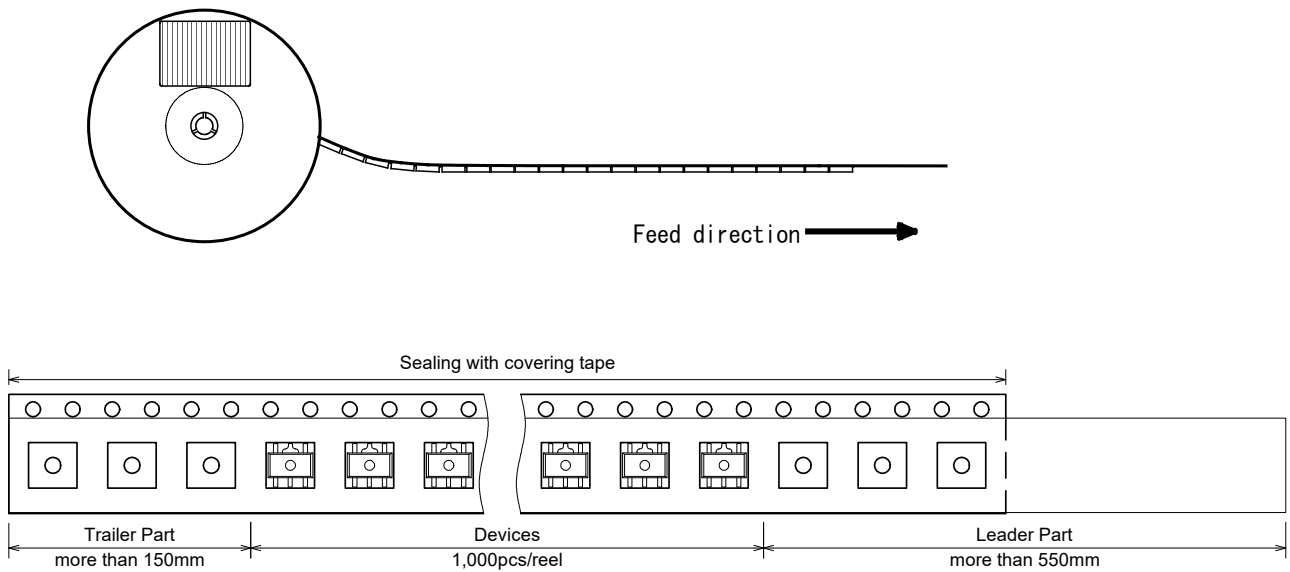
■ PACKING SPEC

UNIT: mm

(1) Taping dimensions / Insert direction



(2) Taping state

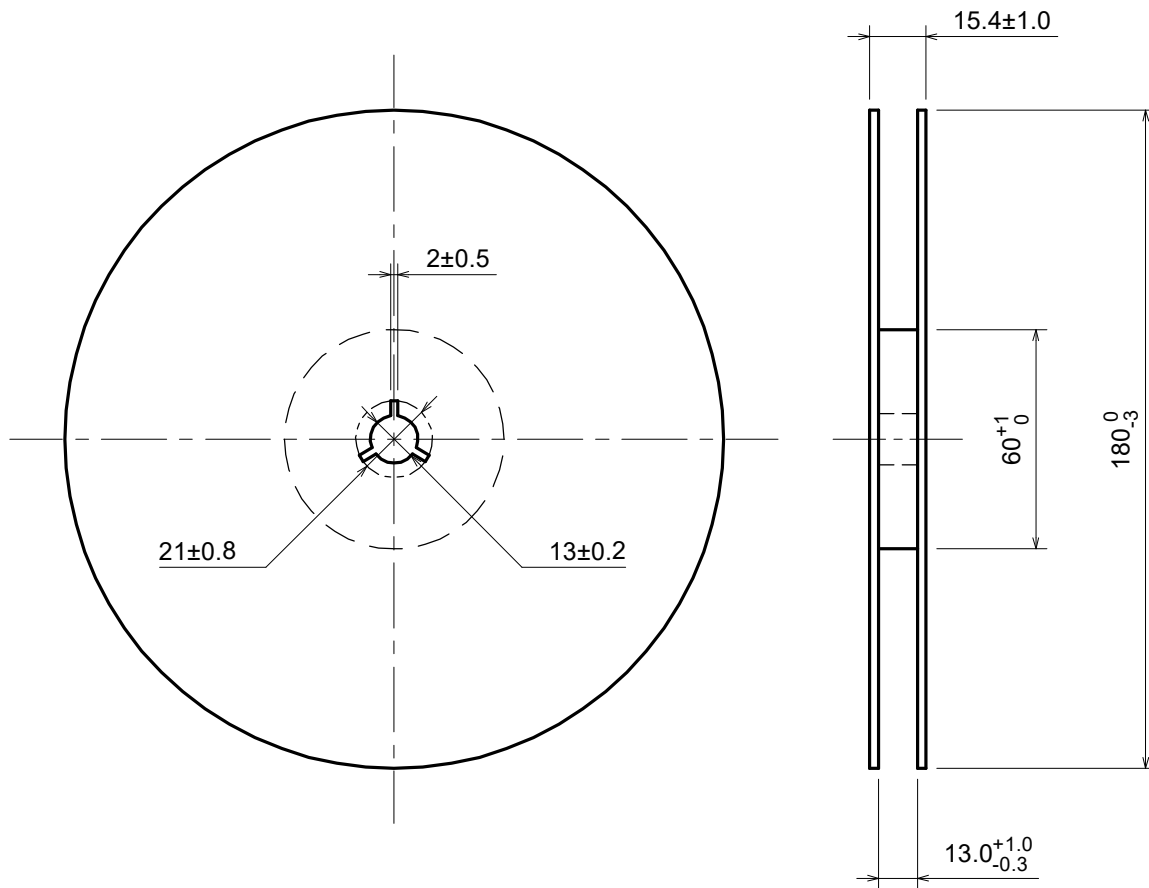


Nisshinbo Micro Devices Inc.

SOT-89-5-DM

PI-SOT-89-5-DM-E-A

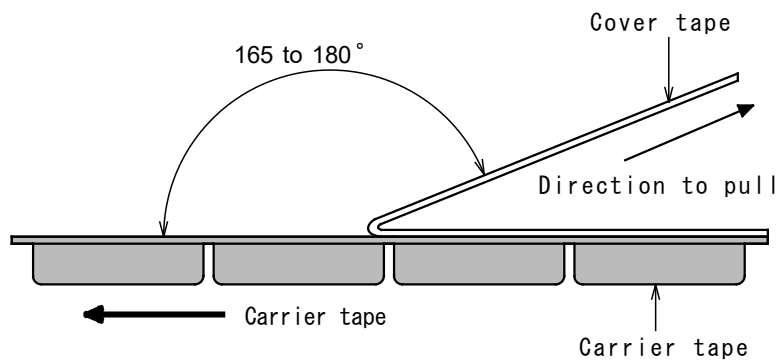
(3) Reel dimensions



(4) Peeling strength

Peeling strength of cover tape

- Peeling angle 165 to 180° degrees to the taped surface.
- Peeling speed 300mm/min
- Peeling strength 0.1 to 1.3N

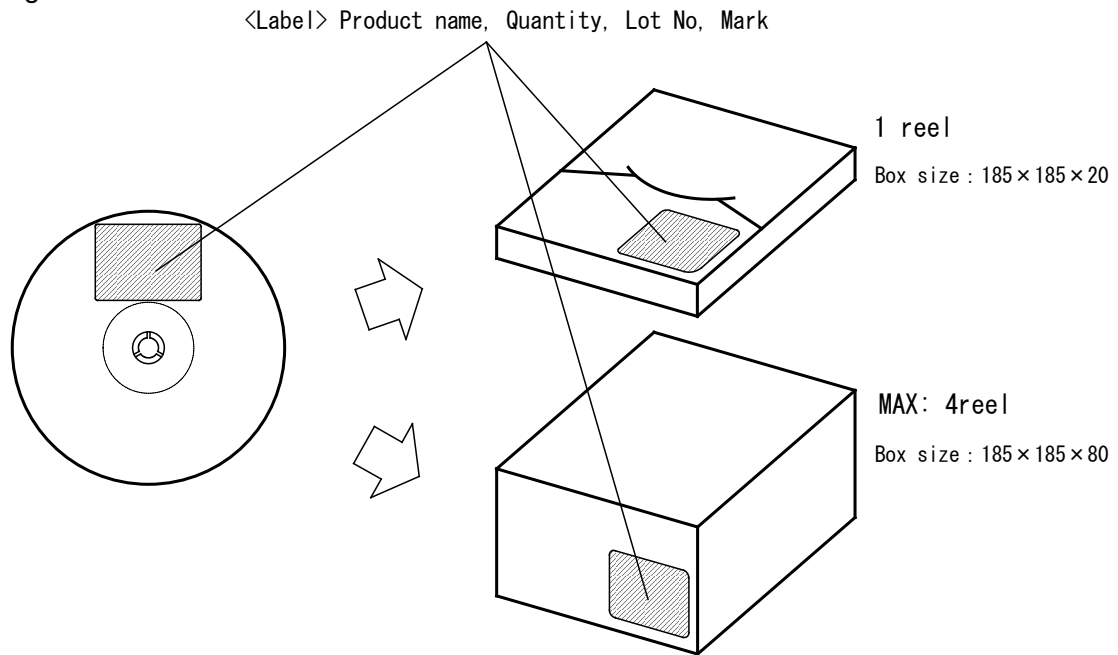


Nisshinbo Micro Devices Inc.

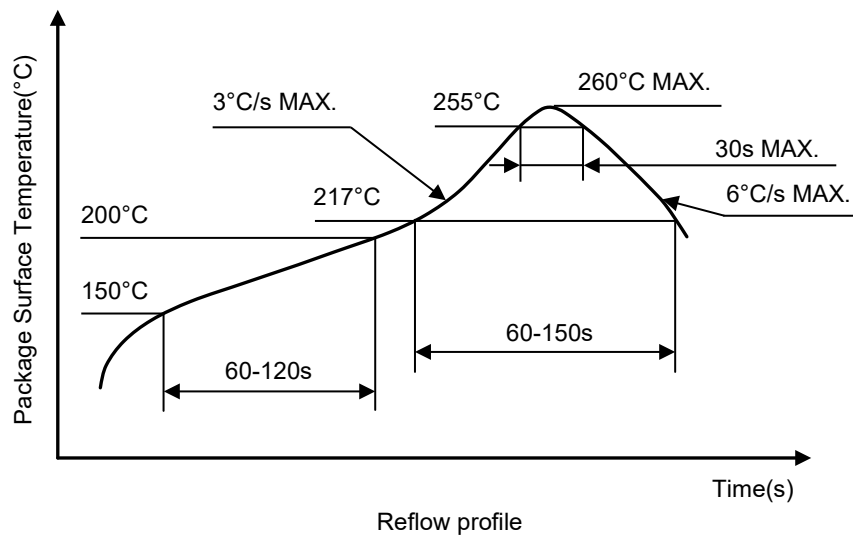
SOT-89-5-DM

PI-SOT-89-5-DM-E-A

(5) Packing state



■ HEAT-RESISTANCE PROFILES



## Revision History

| Date             | Revision | Changes  |
|------------------|----------|--|
| July 22, 2024    | Ver. 1.0 | Initial release  |
| January 07, 2025 | Ver.1.1  | <ul style="list-style-type: none"><li>•Changed the minimum specifications of the "FB Voltage Accuracy" and "Line Regulation" .<br/>FB Voltage Accuracy (@-40°C≤j≤125°C,VIN=3.5V to 26V):<br/>-2.50% → -3.67%</li><li>Line Regulation:<br/>-0.074%/V → -0.128%/V</li><li>•Deleted the VIN condition in 12) Ripple Rejection vs Input Voltage of "TYPICAL CHARACTERISTICS" .</li></ul> |

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  - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
  - Life Maintenance Medical Equipment
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  - Various Safety Devices
  - Traffic control system
  - Combustion equipment

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Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
  - 8-3. Remedies after Quality Warranty Period
 

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
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