# Automotive NR1640
## 200mA Ultra-low Noise Voltage Regulator

## KEY SPECIFICATIONS

- AEC-Q100 grade 1 Under Evaluation
- Input Voltage Range (Maximum Rating)：
  2.7 V to 5.5 V (6.5 V)
- Operating Temperature Range： −40°C to 125°C
- Output Voltage Range： 2.5 V to 4.8 V
- Output Current： 200 mA
- Quiescent Current： Typ.350 µA
- Output Noise Voltage： Typ.6 µVrms ($I_{OUT}$ = 100 mA)
- Ripple Rejection： Typ.80 dB (f = 1 kHz)
  Typ.80 dB (f = 100 kHz)
- Dropout Voltage： Typ.0.13 V
  ($I_{OUT}$ = 200 mA, $V_{SET}$ = 3.3 V)
- Thermal Shutdown Function： Typ.165°C
- Slope of Output Voltage at Start-up：
  55 / 110 / 220 / 440 µs/V
  Selectable from 4 types
- Auto-discharge Function：Selectable by product name

## APPLICATIONS

- In-vehicle camera system
- High accuracy sensing systems

## OVERVIEW

The NR1640 is an ultra-low noise, high PSRR voltage regulator featuring 200 mA output current and 5.5 V maximum input voltage.

With noise characteristics of 6 µVrms and high ripple rejection of 80 dB or more @100 kHz, high quality power can be supplied, ideal for high precision sensing systems where noise is an issue.

The slope of output voltage at startup can be selected from 4 types.

These options will meet the demand of suppression of inrush current and start-up slope requirement. In addition, the auto discharge function option will contribute to make the output shutdown fast to discharge output capacitance with internal discharge FET.
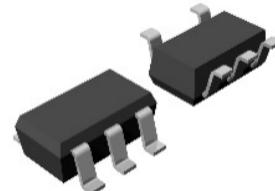


SOT-23-5-DC
2.9 × 2.8 × 1.1(㎜)

## TYPICAL APPLICATIONS



$C_{IN}$ = Ceramic 1.0 µF
$C_{OUT}$ = Ceramic 1.0 µF

## PSRR TYPICAL CHARACTERISTICS



Iout=100mA

$V_{IN}$ = 5V, $V_{SET}$ = 3.3V
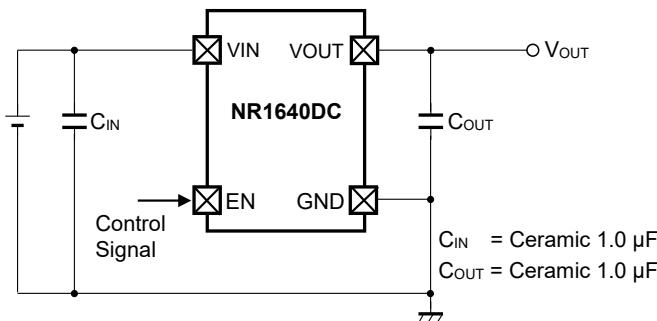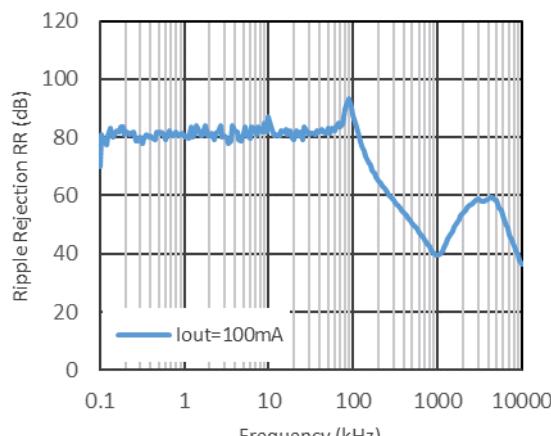
## ■ PRODUCT NAME INFORMATION

**NR1640 aa    bbb    c    dd    e**

Description of configuration

| composition | Item | Description |
|---|---|---|
| aa | Package Code | Indicates the package. Refer to the order information. |
| bbb | Output Voltage | Set Output Voltage ($V_{SET}$)<br>We have a lineup of major voltages in the range of 2.5 V (250) to 4.8 V (480). |
| c | Version | Indicates Slope of Output Voltage at Start-up and the selection of the auto discharge function. |
| dd | Packing | Refer to the packing specifications. |
| e | Grade | Indicates the quality grade. |

Version

| c | Slope of Output Voltage at Start-up | Auto-discharge Function |
|---|---|---|
| A | 55 µs/V | Yes |
| B | 110 µs/V | Yes |
| C | 220 µs/V | Yes |
| D | 440 µs/V | Yes |
| E | 55 µs/V | No |
| F | 110 µs/V | No |
| G | 220 µs/V | No |
| H | 440 µs/V | No |

Grade

| e | Applications | Operating Temperature Range | Test Temperature |
|---|---|---|---|
| P | Chassis, Body control and In-vehicle | −40°C to 125°C | 25°C, 125°C |
| Q | Powertrain and Safety driving related | −40°C to 125°C | -40°C, 25°C, 125°C |

## ■ ORDER INFORMATION

| PRODUCT NAME | PACKAGE | RoHS | HALOGEN-FREE | Plating Composition | MARKING | WEIGHT (mg) | Quantity per Reel (pcs) |
|---|---|---|---|---|---|---|---|
| NR1640DCbbbcE1e | SOT-23-5-DC | Yes | Yes | Sn | Reference | 15 | 3000 |

Click here for details.
Note: Contact our sales representatives for other voltages.

■ **PIN DESCRIPTIONS**
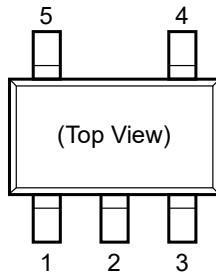


**SOT-23-5-DC Pin Configuration**

| Pin No. | Pin Name | I/O | Description |
|---------|----------|-----|-------------|
| 1 | VIN | Power | Power Supply Input Pin<br>Connect the input capacitor between the VIN pin and GND. |
| 2 | GND | - | Ground Pin |
| 3 | EN | I | Enable Pin (Active-high)<br>Can be set the active state with "High" input, the shutdown state with "Low".<br>This pin is pulled down internally. |
| 4 | NC | - | No Connection<br>It is recommended to make it open to prevent short circuit with adjacent pins during mounting. |
| 5 | VOUT | O | Output Pin<br>Connect the output capacitor ($C_{OUT}$) between VOUT pin and GND. |

Please refer to "*TYPICAL APPLICATION CIRCUIT*" or "*OPERATION*" for details.

■ **Internal Equivalent Circuit Diagram of Pin**
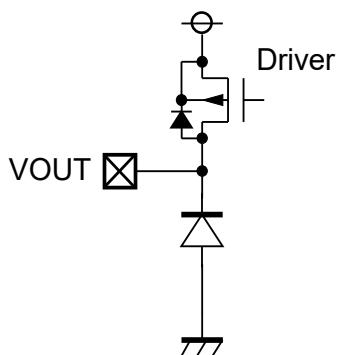


**Internal equivalent circuit diagram of VOUT pin**          **Internal equivalent circuit diagram of EN pin**

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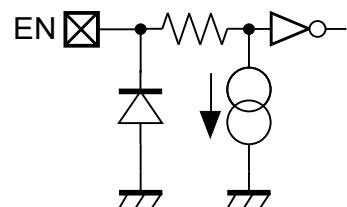
## ■ ABSOLUTE MAXIMUM RATINGS

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Input Voltage | $V_{IN}$ | −0.3 to 6.5 | V |
| EN Pin Input Voltage | $V_{EN}$ | −0.3 to 6.5 | V |
| Output Voltage | $V_{OUT}$ | −0.3 to $V_{IN}$ + 0.3 | V |
| Junction Temperature Range [*1] | $T_j$ | −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] 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*" for the thermal resistance under our measurement board conditions.

## ■ THERMAL CHARACTERISTIC

| Item | Measurement Result |
|---|---|
| Thermal Resistance (θja) | θja = 150°C/W |
| Thermal Characterization Parameter (ψjt) | ψjt = 51°C/W |

θja : Junction-to-Ambient Thermal Resistance

ψjt : Junction-to-Top Thermal Characterization Parameter

## ■ ELECTROSTATIC DISCHARGE(ESD) PROTECTION VOLTAGE

| Symbol | Conditions | Protection Voltage |
|---|---|---|
| $V_{HBM}$ | HBM : C = 100 pF, R = 1.5 kΩ | ±2000 V |
| $V_{CDM}$ | CDM | ±1000 V |

| ELECTROSTATIC DISCHARGE RATINGS |
|---|
| The electrostatic discharge test is done based on JESD47.<br>In the HBM method, ESD is applied using the power supply pin and GND pin as reference pins. |

## ■ RECOMMENDED OPERATING CONDITIONS

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Input Voltage | $V_{IN}$ | 2.7 to 5.5 | V |
| Operating Temperature Range | $T_a$ | −40 to 125 | °C |
| Output Current | $I_{OUT}$ | 0 to 200 | mA |

| RECOMMENDED OPERATING CONDITIONS |
|---|
| All of 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 when 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

$V_{IN}$ = $V_{SET}$ + 1 V (Max. 5.5 V) , $I_{OUT}$ = 1 mA, $C_{IN}$ = 1.0 µF, $C_{OUT}$ = 1.0 µF
Unless otherwise specified.
For parameter that do not describe the temperature condition, the MIN / MAX value under the condition of
−40 °C ≤ $T_a$ ≤ 125 °C is described.

**NR1640DCxxxxE1x**

| Parameter | Symbol | Conditions | | MIN | TYP | MAX | Unit |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_{OUT}$ | $T_a$ = 25°C | | ×0.99 | - | ×1.01 | V |
| | | −40°C ≤ $T_a$ ≤ 125°C | | ×0.985 | - | ×1.015 | V |
| Quiescent Current | $I_Q$ | $V_{IN}$ = $V_{SET}$ + 1 V (Max. 5.5 V) $I_{OUT}$ = 0 mA | | - | 350 | 450 | µA |
| Shutdown Current | $I_{SD}$ | $V_{IN}$ = 5.5 V, $V_{EN}$ = 0 V | | - | 0.1 | 2.0 | µA |
| Load Regulation | $\Delta V_{OUT}/\Delta I_{OUT}$ | 1 mA ≤ $I_{OUT}$ ≤ 200 mA | | - | - | 20 | mV |
| Line Regulation | $\Delta V_{OUT}/\Delta V_{IN}$ | 2.5 V ≤ $V_{SET}$ ≤ 3.9 V, $V_{SET}$ + 0.5 V ≤ $V_{IN}$ ≤ 5.5 V $I_{OUT}$ = 1 mA | | - | - | 0.1 | %/V |
| | | 3.9 V < $V_{SET}$ < 4.5 V, $V_{SET}$ + 0.5 V ≤ $V_{IN}$ ≤ 5.5 V $I_{OUT}$ = 1 mA | | | | 0.15 | |
| | | 4.5 V ≤ $V_{SET}$ ≤ 4.8 V, $V_{SET}$ + 0.3 V ≤ $V_{IN}$ ≤ 5.5 V $I_{OUT}$ = 1 mA | | - | - | 0.15 | |
| Dropout Voltage | $V_{DO}$ | $I_{OUT}$ = 200 mA | 2.5 V ≤ $V_{SET}$ < 2.9 V | - | 0.15 | 0.23 | V |
| | | | 2.9 V ≤ $V_{SET}$ < 4 V | - | 0.13 | 0.2 | |
| | | | 4 V ≤ $V_{SET}$ ≤ 4.8 V | - | 0.095 | 0.15 | |
| Ripple Rejection | RR | f = 1 kHz | | - | 80 | - | dB |
| | | f = 100 kHz | | - | 80 | - | dB |
| Output Noise Voltage | $V_{NOISE}$ | f = 10 Hz to 100 kHz, $I_{OUT}$ = 100 mA | | - | 6 | - | µVrms |
| UVLO Release Voltage[*1] | $V_{UVLOREL}$ | $V_{IN}$ = Rising | | - | - | 2.7 | V |
| UVLO Detection Voltage[*1] | $V_{UVLODET}$ | $V_{IN}$ = Falling | | 2.5 | - | - | V |
| Output Current Limit | $I_{LIM}$ | $V_{IN}$ = $V_{SET}$ + 1 V (Max. 5.5 V) | | 200 | 280 | - | mA |
| Short Current Limit | $I_{SC}$ | $V_O$ = 0 V | | 40 | 75 | 100 | mA |
| Limit Current at Start-up | $I_{LIMRISE}$ | $V_O$ = 0 V | | 100 | 140 | 180 | mA |
| Slope of Output Voltage at Start-up | $V_{OUTSS}$ | NR1640DCxxxA/E | | 37.5 | 55 | 72.5 | µs/V |
| | | NR1640DCxxxB/F | | 75 | 110 | 145 | |
| | | NR1640DCxxxC/G | | 150 | 220 | 290 | |
| | | NR1640DCxxxD/H | | 300 | 440 | 580 | |
| EN Pin High Input Voltage | $V_{ENH}$ | | | 1.0 | - | - | V |
| EN Pin Low Input Voltage | $V_{ENL}$ | | | 0 | - | 0.4 | V |
| EN Pin Current | $I_{EN}$ | $V_{IN}$ = $V_{EN}$ = 5.5 V | | 0.05 | 0.37 | 0.6 | µA |
| Discharge FET On-resistance (ver. A/B/C/D) | $R_{ONDIS}$ | $V_{IN}$ = 3.6 V, $V_{EN}$ = 0 V, $V_O$ = 0.1 V | | - | 15 | 30 | Ω |
| Thermal shutdown detection temperature | $T_{SDDET}$ | $T_j$ = Rising | | 150 | 165 | - | °C |
| Thermal shutdown release temperature | $T_{SDREL}$ | $T_j$ = Falling | | 125 | 135 | - | °C |

All test parameters listed in Electrical Characteristics are done under the following conditions, except for ripple removal and output noise voltage.

NR1640DCxxxxxxP   $T_j$ ≈ $T_a$ = 25°C, 125°C
NR1640DCxxxxxxQ   $T_j$ ≈ $T_a$ = -40°C, 25°C, 125°C

*1 Due to the circuit configuration, $V_{UVLOF}$ ≥ $V_{UVLOR}$ does not hold. The hysteresis is Typ.0.08 V

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■ ELECTRICAL CHARACTERISTICS

| PRODUCT NAME | $V_{OUT}$ ($T_a$ = 25°C) | | | $V_{OUT}$ (-40 ≤ $T_a$ ≤ 125°C) | | |
|---|---|---|---|---|---|---|
| | MIN | TYP | MAX | MIN | TYP | MAX |
| NR1640DC250xxxx | 2.475 | 2.5 | 2.525 | 2.462 | 2.5 | 2.538 |
| NR1640DC280xxxx | 2.772 | 2.8 | 2.828 | 2.758 | 2.8 | 2.842 |
| NR1640DC300xxxx | 2.970 | 3.0 | 3.030 | 2.955 | 3.0 | 3.045 |
| NR1640DC330xxxx | 3.267 | 3.3 | 3.333 | 3.250 | 3.3 | 3.350 |
| NR1640DC340xxxx | 3.366 | 3.4 | 3.434 | 3.349 | 3.4 | 3.451 |
| NR1640DC480xxxx | 4.752 | 4.8 | 4.848 | 4.728 | 4.8 | 4.872 |

Above parameters are all tested under the following conditions:

NR1640DCxxxxxxP   $T_j$ ≈ $T_a$ = 25°C, 125°C
NR1640DCxxxxxxQ   $T_j$ ≈ $T_a$ = -40°C, 25°C, 125°C

## ■ TYPICAL APPLICATION CIRCUIT
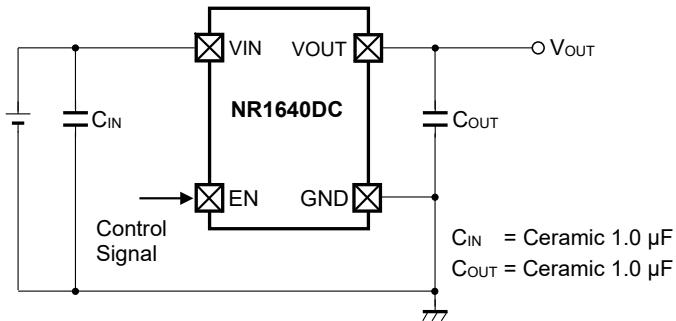


**NR1640DC Typical Application Circuit**

### Technical Notes Related to External Components

Ensure the VIN and GND lines are sufficiently robust. If their impedances are too high, noise pickup or unstable operation may result. Connect a 1.0 µF or more input capacitor ($C_{IN}$) between the VIN and GND pins with shortest-distance wiring.

It is recommended to use a ceramic capacitor of 6.3 V and more such as the X7R having small temperature dependence to ESR, ESL, and capacitance.

Phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, use a ceramic capacitor of 1.0 µF or more with ESR (Equivalent Series Resistance) of up to 300 mΩ to connect an output capacitor ($C_{OUT}$) between the VOUT and GND pins with shortest-distance wiring. 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 ($V_{SET}$) | Effective Capacity |
|---|---|
| 2.5 V ≤ $V_{SET}$ ≤ 3.3 V | 0.7 µF |
| 3.3 V < $V_{SET}$ ≤ 4.8 V | 0.6 µF |

In case of using an output capacitor of 1.0 µF or more, place a 1.0 µF ceramic capacitor as close as possible.
When using a capacitor with a large ESR such as a tantalum capacitor, select a component that satisfies the stability of the ESR. When using a capacitor with a large ESR such as a tantalum capacitor, select a component that satisfies the stability of the ESR. It is recommend using a low ESR capacitor that is sufficient for stable operation.

■ **BLOCK DIAGRAMS**
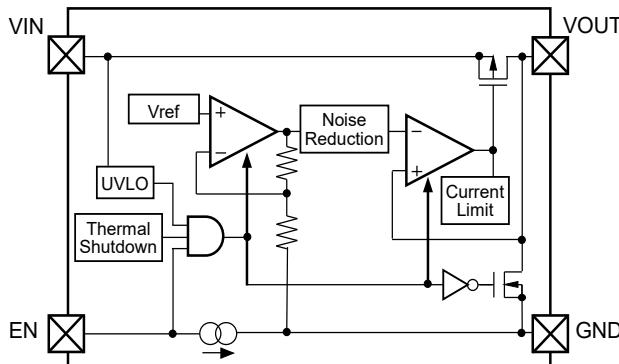


NR1640DCxxxA/B/C/D　Block Diagram
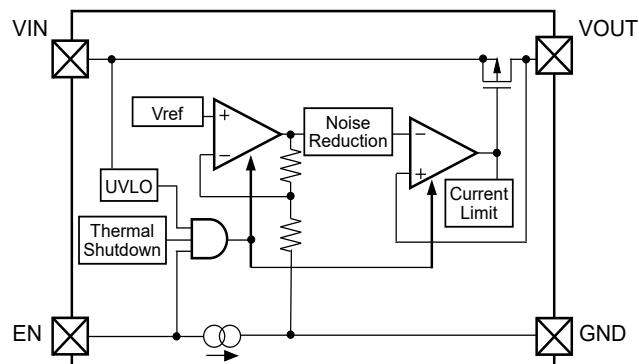
NR1640DCxxxE/F/G/H　Block Diagram

■ **BLOCK DIAGRAMS**

● **Enable Function**

Forcing above designated "High" voltage to EN pin, the NR1640 becomes active. Forcing below designated "Low" voltage to EN pin shuts down the NR1640. The EN pin is pulled down with a constant current of Typ.0.37 μA inside the IC. In shutdown condition, all functions are disabled except Auto Discharge function. (Option) With Auto-Discharge option, the MOSFET to discharge the output capacitor turns on and the output is pulled down to GND. Without Auto-Discharge option, the output becomes "Hi-Z". EN pin can accept input range voltage regardless of the input of VIN pin. If Enable function is not necessary, tie EN pin to VIN pin or other designated "High" voltage node at start-up.

● **Auto Discharge Function**

When turned off, the Vout voltage drops rapidly to near 0V by discharging the charge stored in the output capacitor through the MOSFET connected between the VOUT and GND pins. The auto discharge function is enabled when the EN pin = "low" or the thermal shutdown detection. This function is effective when the input voltage aboves the minimum operating voltage. On-resistance of MOSFET is Typ.15Ω.

● **Thermal Shutdown**

When the junction temperature exceeds the thermal shutdown detection temperature (Typ.165°C), this IC cuts off the output and suppresses the self-heating. When the junction temperature falls below the thermal shutdown release temperature (Typ.135°C), this IC will restart with the soft start operation.

● Soft-start / Inrush Current Limit

The soft start function is a function that makes the rise of the output voltage ($V_{SET}$) a fixed time ($V_{SET}$ x $V_{OUTSS}$) by starting up the internal reference voltage generated inside the IC with the selected slope of output voltage at start-up ($V_{OUTSS}$) .
By this function, the output voltage at start-up rises up slowly and the inrush current at start-up can be suppressed. NR1640 builts in the Inrush current limit circuit. After the EN pin becomes "High", the inrush current which flows at charging the $C_{OUT}$, is limited at Typ.140 mA.
If an effective capacitance value of the connected $C_{OUT}$ is larger than 0.14 x $V_{OUTSS}$, the charging current is limited. So, the output voltage rises more slowly than the selected slope of output voltage at start-up ($V_{OUTSS}$). If the load current ($I_{LOAD}$) is smaller than the charging current to the $C_{OUT}$, the output voltage ramp up time is determined by the inrush current limit value and $C_{OUT}$ value. When the effective capacity value of $C_{OUT}$ is about 0.14 x $V_{OUTSS}$ or more, the output turning on time ($t_{ON}$) can be calculated from the following equation:

$t_{ON}$ = $t_D$ + $C_{OUT}$ x $V_{SET}$ / $I_{LIMRISE}$
$t_D$ :        Delay Time at Start-up 35µs
$V_{SET}$ :     Set Output Voltage
$I_{LIMRISE}$ : Limit Current at Start-up    Typ.140mA

If the load current ($I_{LOAD}$) exists other than the charge current to $C_{OUT}$ during start-up, the start-up time is extended.
The load current over $I_{LIMRISE}$ may interfere charging of $C_{OUT}$ and the output does not rise up.
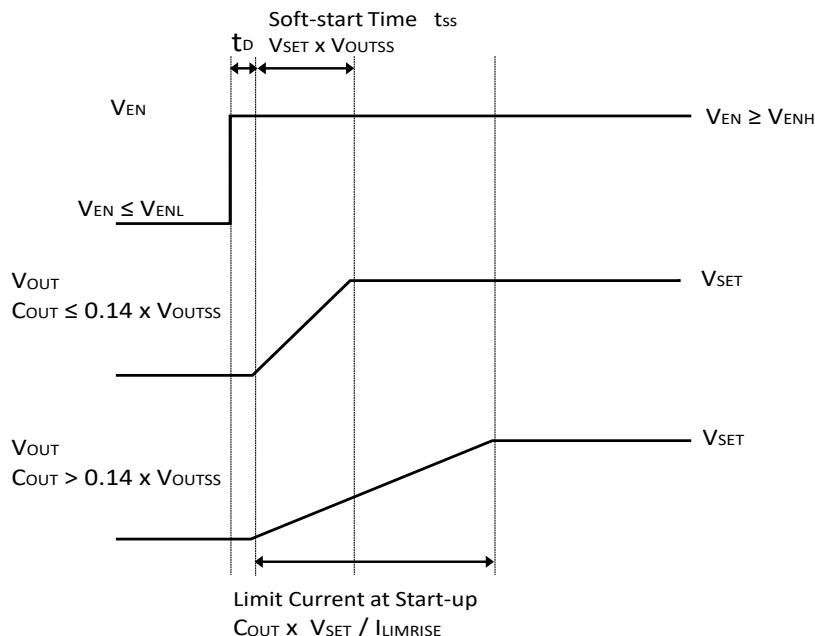
## ■THERMAL CHARACTERISTICS

Thermal characteristics depend on the mounting conditions.
The following measurement conditions are based on JEDEC STD. 51-7.

### Measurement Conditions

| Item | Measurement Conditions |
|---|---|
| Measurement status | Mounting on Board (Wind Velocity = 0 m/s) |
| Board material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board size | 76.2 mm × 114.3 mm × 0.8 mm |
| Wiring rate | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through hole | $\phi$ 0.3 mm ×7 pcs |

### Measurement Result

| Item | Measurement Result |
|---|---|
| Thermal Resistance ($\theta$ja) | $\theta$ja = 150°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 51°C/W |

$\theta$ja：Junction-to-Ambient Thermal Resistance

$\psi$jt：Junction-to-Top Thermal Characterization Parameter
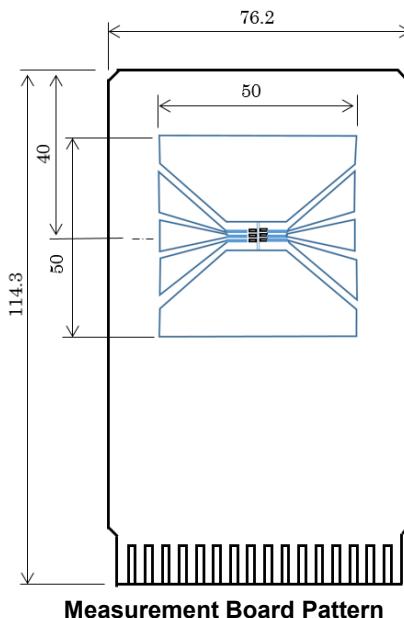
**Measurement Board Pattern**

## ■CALCULATION METHOD OF JUNCTION TEMPERATURE

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

$T_j = T_a + \theta ja \times P$
$T_j = T_c (top) + \psi jt \times P$

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

# Nisshinbo Micro Devices Inc.

■ ORDER INFORMATION（ALL）

| PRODUCT NAME | PACKAGE | RoHS | HALOGEN-FREE | Plating Composition | MARKING | WEIGHT (mg) | Quantity per Reel (pcs) |
|---|---|---|---|---|---|---|---|
| NR1640DC250AE1e | | | | | A00 | | |
| NR1640DC280AE1e | | | | | A01 | | |
| NR1640DC300AE1e | | | | | A02 | | |
| NR1640DC330AE1e | | | | | A03 | | |
| NR1640DC340AE1e | | | | | A04 | | |
| NR1640DC480AE1e | | | | | A05 | | |
| NR1640DC250BE1e | | | | | B00 | | |
| NR1640DC280BE1e | | | | | B01 | | |
| NR1640DC300BE1e | | | | | B02 | | |
| NR1640DC330BE1e | | | | | B03 | | |
| NR1640DC340BE1e | | | | | B04 | | |
| NR1640DC480BE1e | | | | | B05 | | |
| NR1640DC250CE1e | | | | | C00 | | |
| NR1640DC280CE1e | | | | | C01 | | |
| NR1640DC300CE1e | | | | | C02 | | |
| NR1640DC330CE1e | | | | | C03 | | |
| NR1640DC340CE1e | | | | | C04 | | |
| NR1640DC480CE1e | | | | | C05 | | |
| NR1640DC250DE1e | | | | | D00 | | |
| NR1640DC280DE1e | | | | | D01 | | |
| NR1640DC300DE1e | SOT-23-5-DC | Yes | Yes | Sn | D02 | 15 | 3000 |
| NR1640DC330DE1e | | | | | D03 | | |
| NR1640DC340DE1e | | | | | D04 | | |
| NR1640DC480DE1e | | | | | D05 | | |
| NR1640DC250EE1e | | | | | E00 | | |
| NR1640DC280EE1e | | | | | E01 | | |
| NR1640DC300EE1e | | | | | E02 | | |
| NR1640DC330EE1e | | | | | E03 | | |
| NR1640DC340EE1e | | | | | E04 | | |
| NR1640DC480EE1e | | | | | E05 | | |
| NR1640DC250FE1e | | | | | F00 | | |
| NR1640DC280FE1e | | | | | F01 | | |
| NR1640DC300FE1e | | | | | F02 | | |
| NR1640DC330FE1e | | | | | F03 | | |
| NR1640DC340FE1e | | | | | F04 | | |
| NR1640DC480FE1e | | | | | F05 | | |
| NR1640DC250GE1e | | | | | G00 | | |
| NR1640DC280GE1e | | | | | G01 | | |
| NR1640DC300GE1e | | | | | G02 | | |
| NR1640DC330GE1e | | | | | G03 | | |
| NR1640DC340GE1e | | | | | G04 | | |
| NR1640DC480GE1e | | | | | G05 | | |

| PRODUCT NAME | PACKAGE | RoHS | HALOGEN-FREE | Plating Composition | MARKING | WEIGHT (mg) | Quantity per Reel (pcs) |
|---|---|---|---|---|---|---|---|
| NR1640DC250HE1e | SOT-23-5-DC | Yes | Yes | Sn | H00 | 15 | 3000 |
| NR1640DC280HE1e | | | | | H01 | | |
| NR1640DC300HE1e | | | | | H02 | | |
| NR1640DC330HE1e | | | | | H03 | | |
| NR1640DC340HE1e | | | | | H04 | | |
| NR1640DC480HE1e | | | | | H05 | | |

# ■ APPLICATION NOTES

### Phase Compensation

Phase compensation is provided to secure stable operation even when the load current is varied by utilizing capacity of the output ceramic capacitor and Equivalent Series Resistance (ESR). For this purpose, use a capacitor for Cout with the capacity of equal or more than 1.0 µF. Depending on the ESR, the output may oscillate, so evaluate carefully including the temperature characteristics and frequency characteristics. Connect a capacitor (CIN) of 1.0 µF or more between the VDD and GND pins, and keep the wiring as short as possible.

### Thermal Shutdown Function

The thermal shutdown function prevents the IC from fuming and ignition but does not ensure the IC's reliability or keep the IC below the absolute maximum ratings.

The thermal shutdown function does not operate on the heat generated by other than the normal IC operation such as latch-up and overvoltage application.

The thermal shutdown function operates in a state over the absolute maximum ratings, therefore the thermal shutdown function should not be used for a system design.

### Evaluation Board / PCB Layout
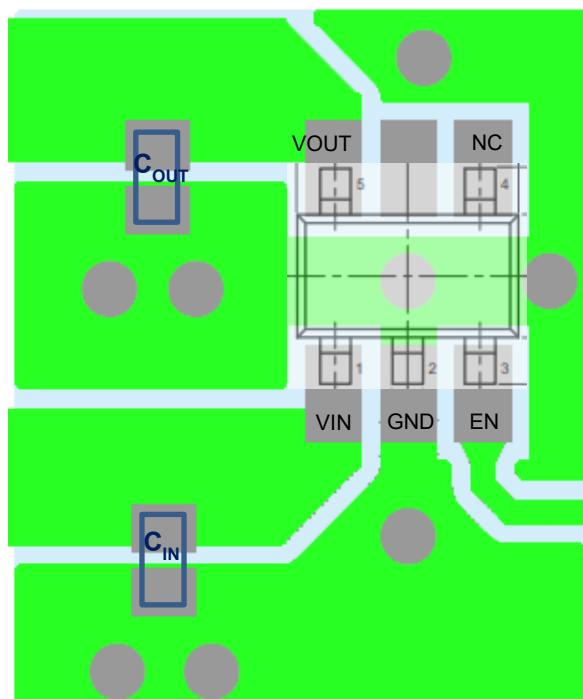
■ **TYPICAL CHARACTERISTICS**

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs Temperature
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), $I_{OUT} = 1$ mA, $C_{IN} = C_{OUT} = 1.0$ µF
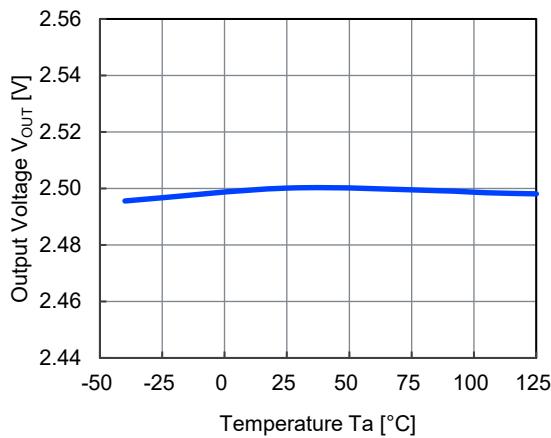
NR1640DC250x
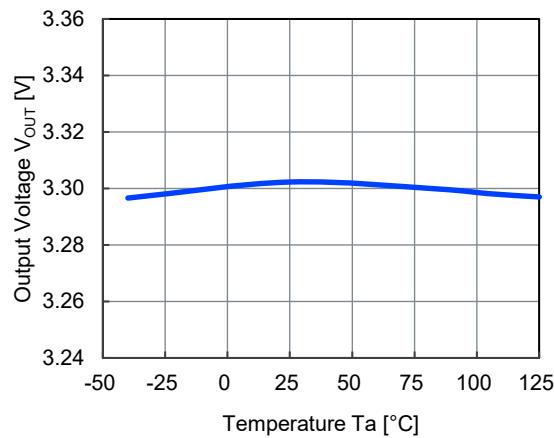


NR1640DC330x
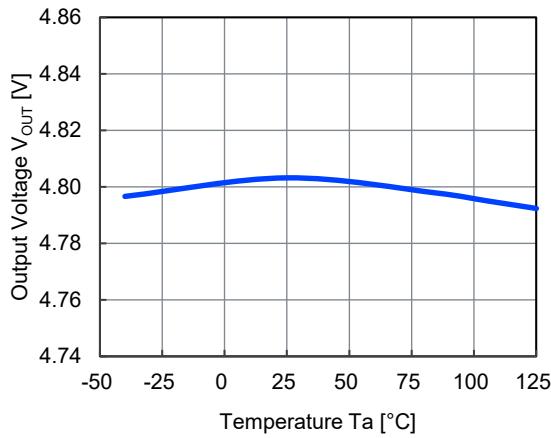


NR1640DC480x



2) Quiescent Current vs Temperature
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), $C_{IN} = C_{OUT} = 1.0$ µF

NR1640DC250x



NR1640DC330x



NISSHINBO

# Nisshinbo Micro Devices Inc.
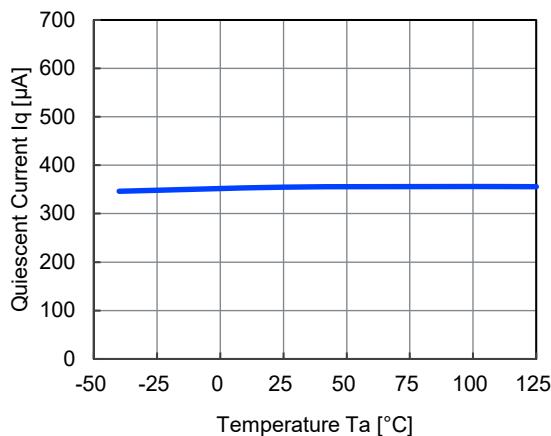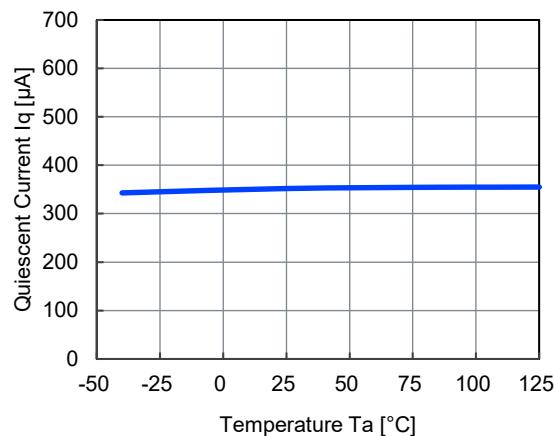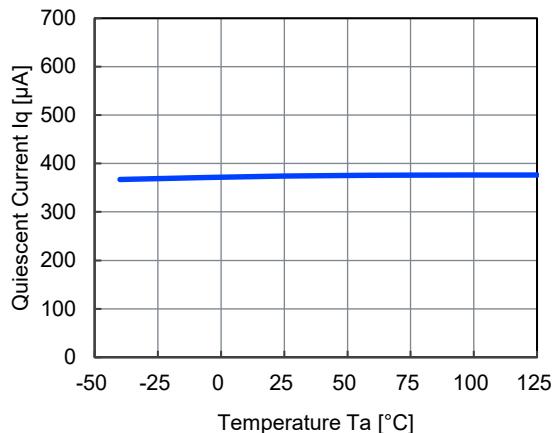
NR1640DC480x



3) Dropout Voltage vs Output Current
$C_{IN} = C_{OUT} = 1.0 \ \mu F$
NR1640DC330x
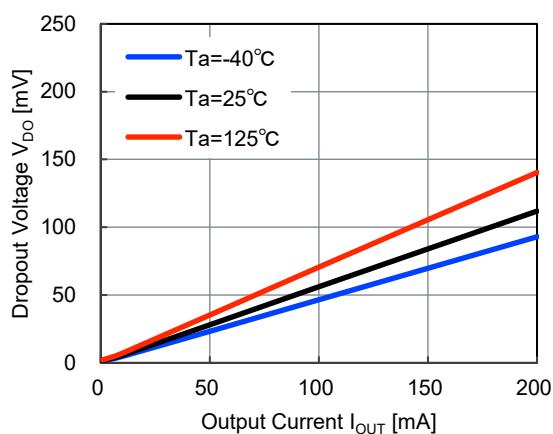


NR1640DC480x
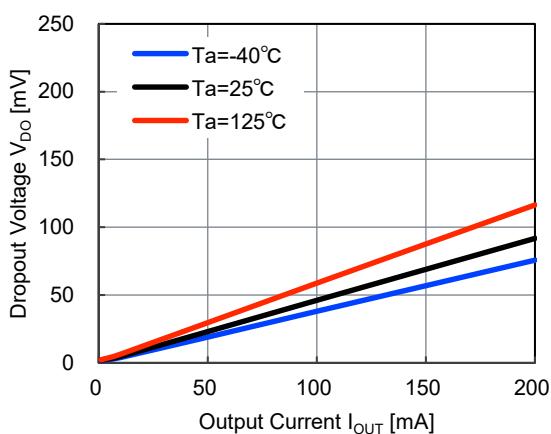


4) Dropout Voltage vs Set Output Voltage
$C_{IN} = C_{OUT} = 1.0 \ \mu F$, $T_a = 25°C$
NR1640DCxxxx
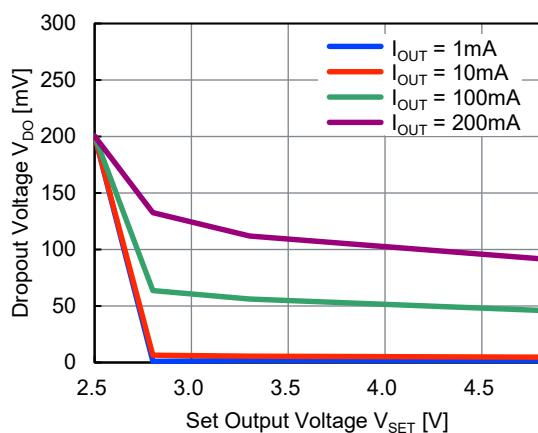
5) Output Voltage vs Output Current
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), $C_{IN} = C_{OUT} = 1.0$ µF, Ta = 25°C

NR1640DC250x
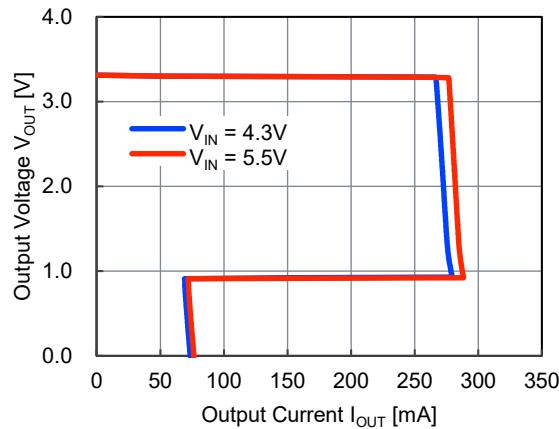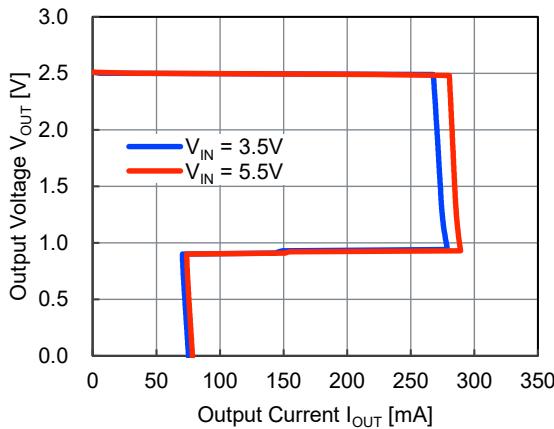
NR1640DC330x
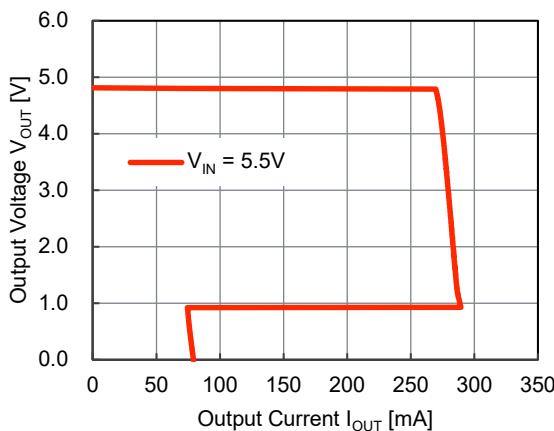
NR1640DC480x

6) Output Voltage vs Input Voltage
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V) to 0 V, $C_{IN} = C_{OUT} = 1.0$ µF, $T_a = 25$°C

NR1640DC250x,（$V_{IN}$＝2.5V to 3.5V）

NR1640DC250x,（$V_{IN}$＝2.3V to 2.8V）
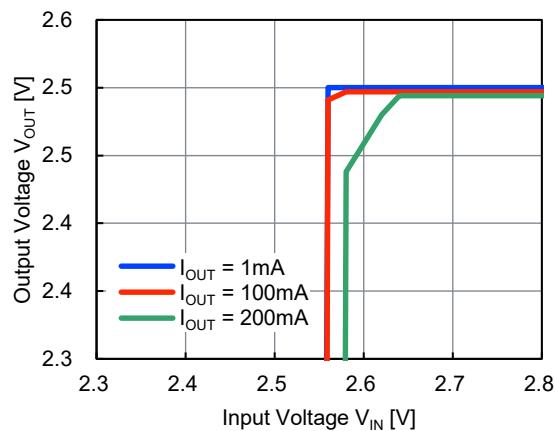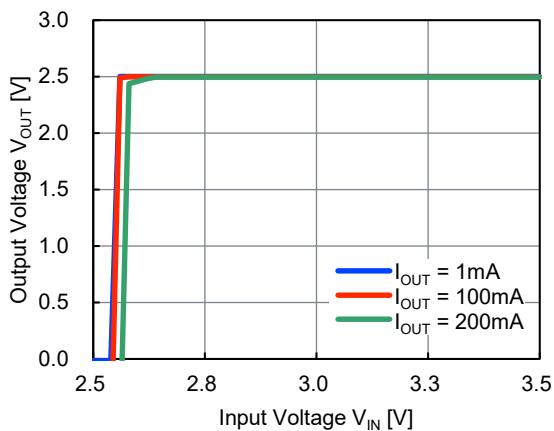
NR1640DC330x,（V_IN＝2.5V to 4.3V）
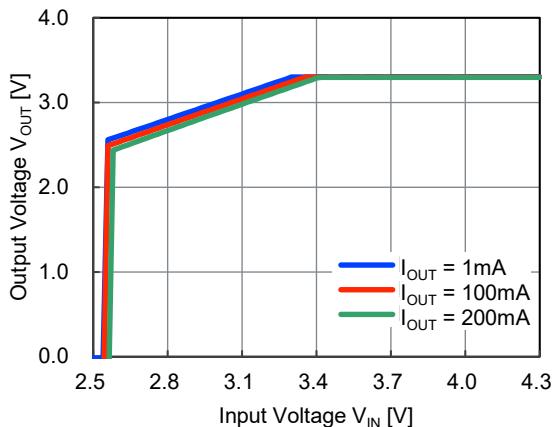


NR1640DC330x,（V_IN＝3.1V to 3.7V）
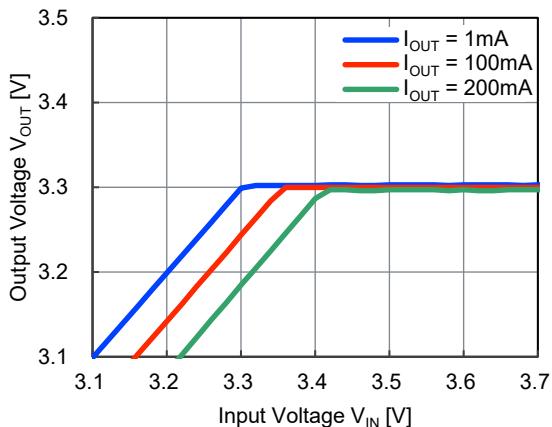


NR1640DC480x,（V_IN＝2.5V to 5.5V）
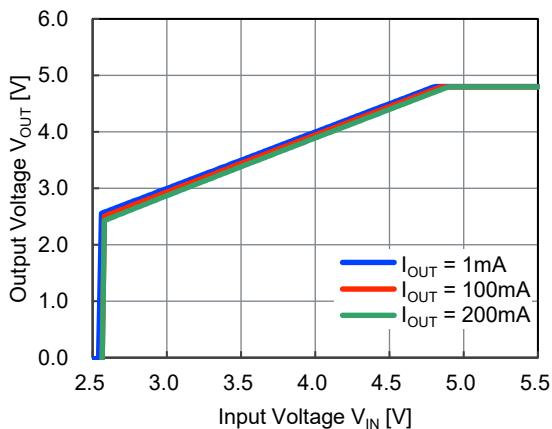


NR1640DC480x,（V_IN＝4.6V to 5.5V）
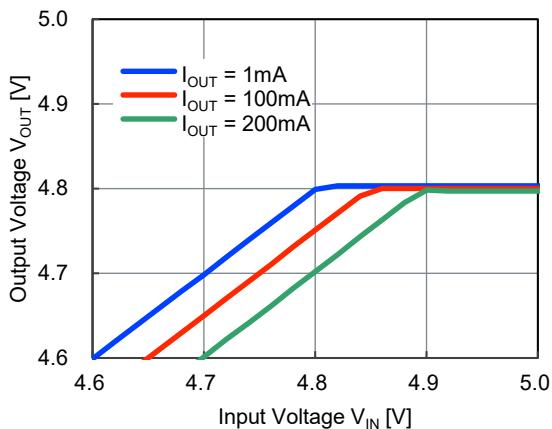


7) Quiescent Current  vs  Input Voltage
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V) to 0 V, $C_{IN} = C_{OUT} = 1.0$ µF, $T_a = 25°C$

NR1640DC250x



NR1640DC330x
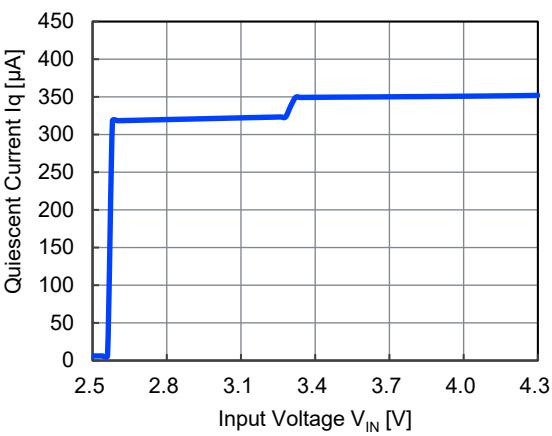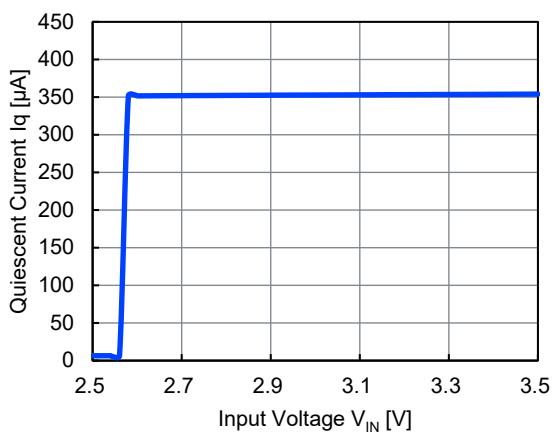
NR1640DC480x
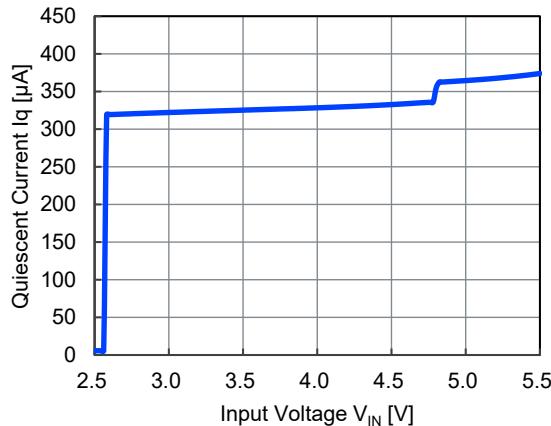


8) EN "High / Low" Input Voltage vs Temperature
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), $C_{IN} = C_{OUT} = 1.0$ µF
NR1640DCxxxx, EN = "High"
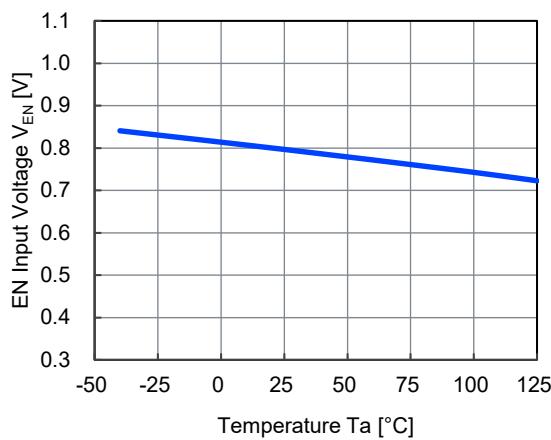
NR1640DCxxxx, EN = "Low"
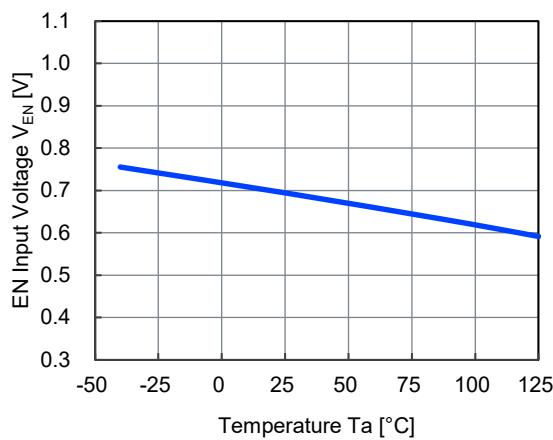


9) Ripple Rejection vs Frequency
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), Vripple = 0.2 Vp-p, $C_{OUT} = 1.0$ µF, $T_a = 25$°C
NR1640DC250x
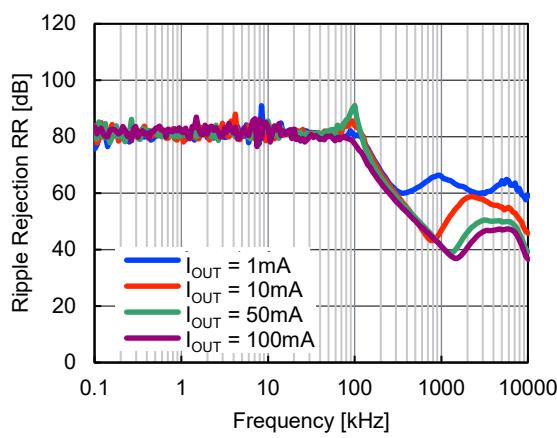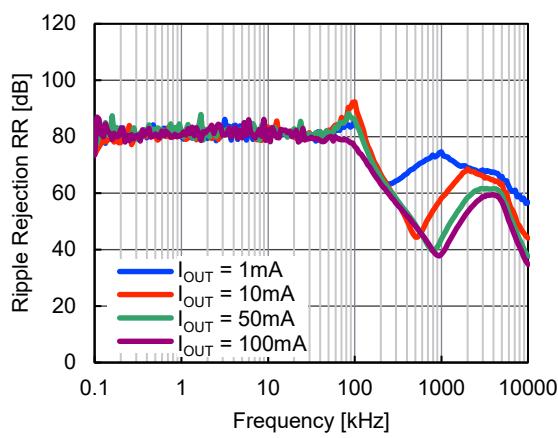
NR1640DC290x

NR1640DC330x
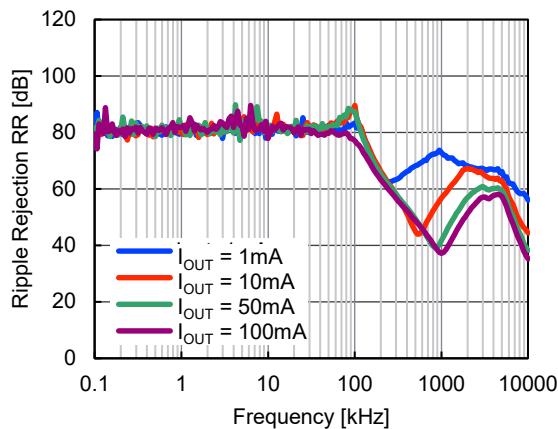


NR1640DC480x
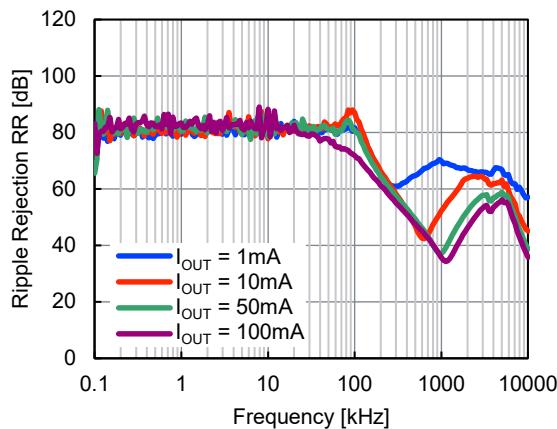


10) Ripple Rejection  vs  Input Voltage
$V_{IN}$ = $V_{SET}$ to 5.5 V (Min = 2.7 V), Vripple = 0.2 Vp-p, $C_{OUT}$ = 1.0 µF, $T_a$ = 25°C

NR1640DC250x, $I_{OUT}$ = 1 mA



NR1640DC250x, $I_{OUT}$ = 10 mA
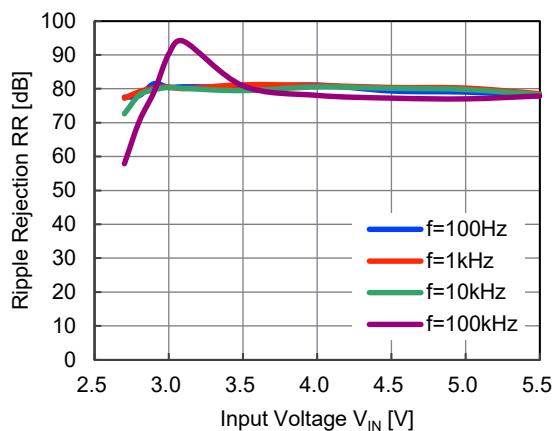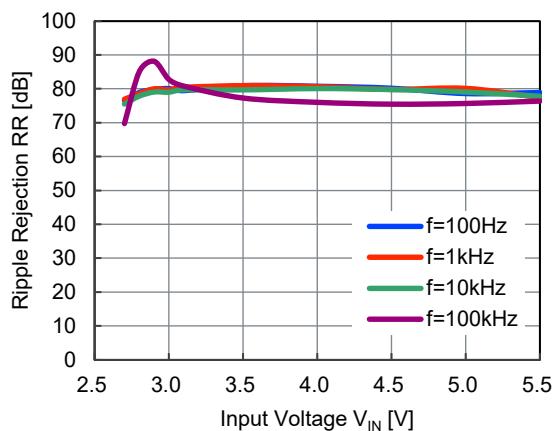


NR1640DC250x, $I_{OUT}$ = 50 mA



NR1640DC250x, $I_{OUT}$ = 100 mA

# Nisshinbo Micro Devices Inc.
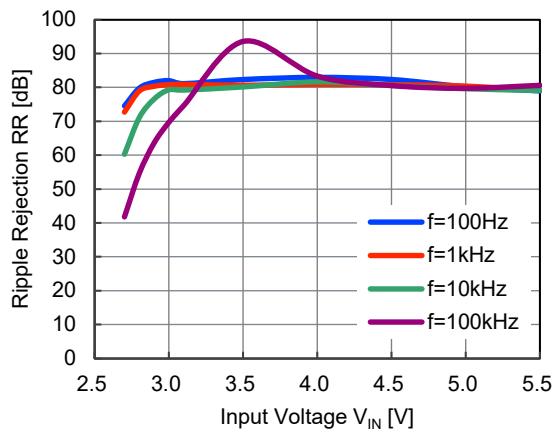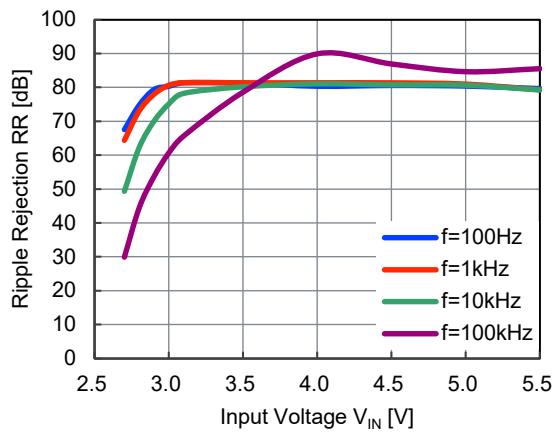
NR1640DC290x, I_OUT = 1 mA
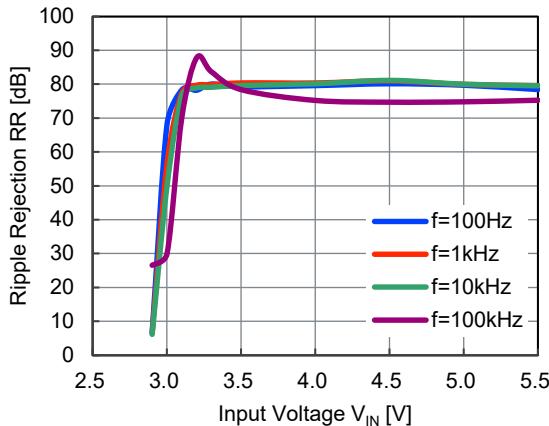


NR1640DC290x, I_OUT = 10 mA
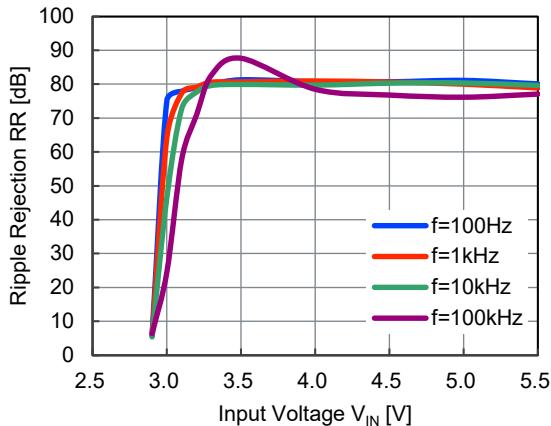


NR1640DC290x, I_OUT = 50 mA
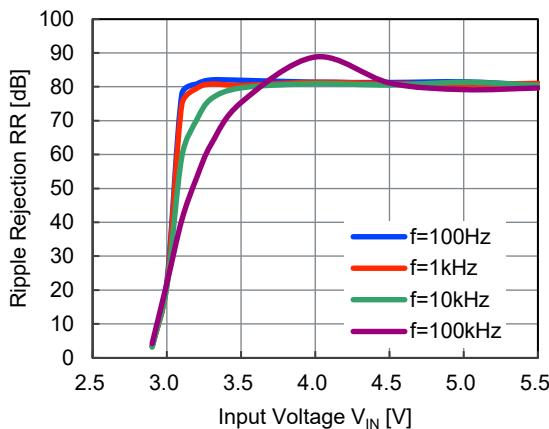


NR1640DC290x, I_OUT = 100 mA
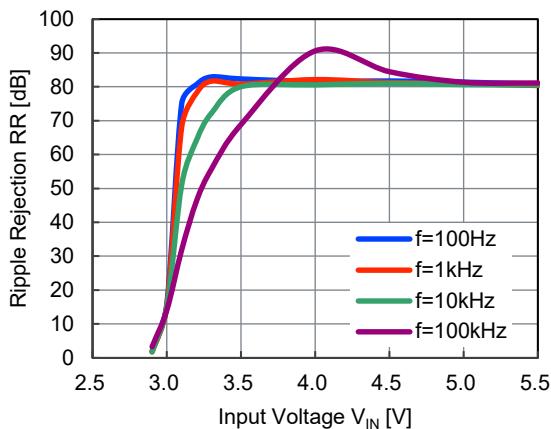


NR1640DC330x, I_OUT = 1 mA
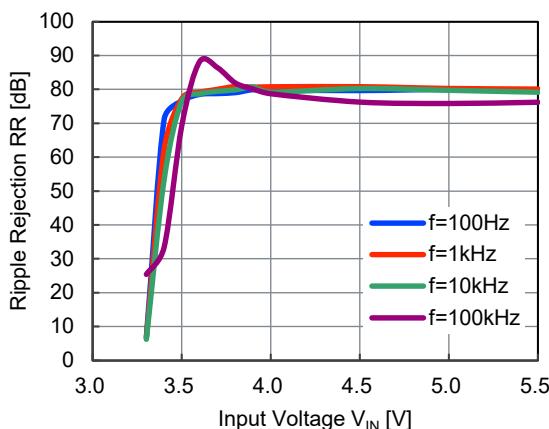


NR1640DC330x, I_OUT = 10 mA
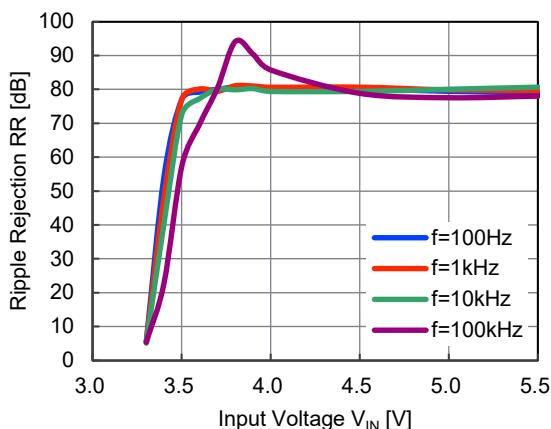
NR1640DC330x, $I_{OUT}$ = 50 mA
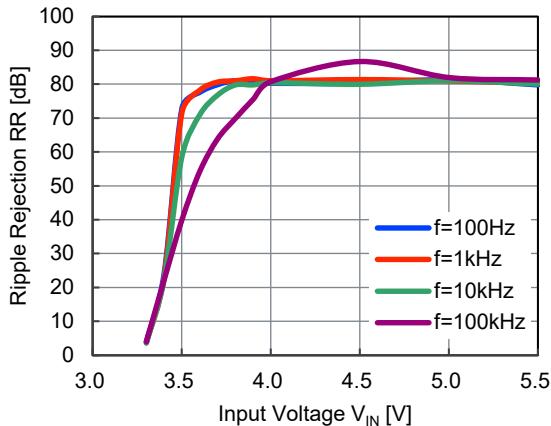


NR1640DC330x, $I_{OUT}$ = 100 mA
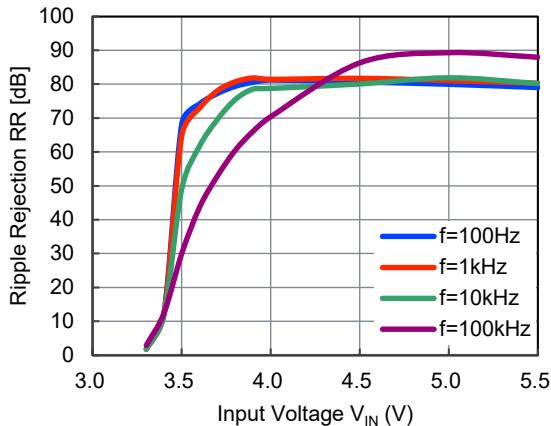


NR1640DC480x, $I_{OUT}$ = 1 mA
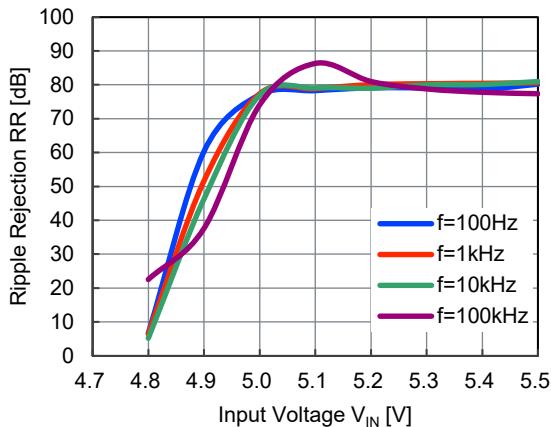


NR1640DC480x, $I_{OUT}$ = 10 mA
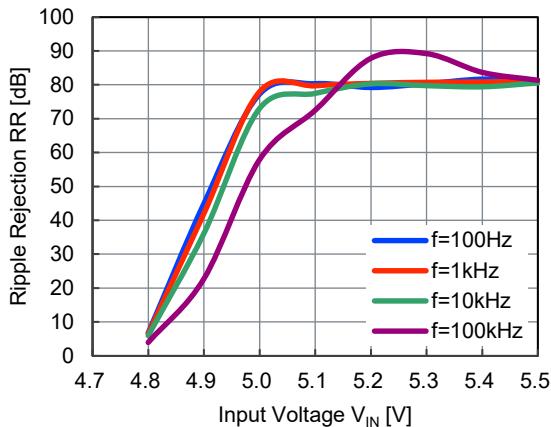


NR1640DC480x, $I_{OUT}$ = 50 mA
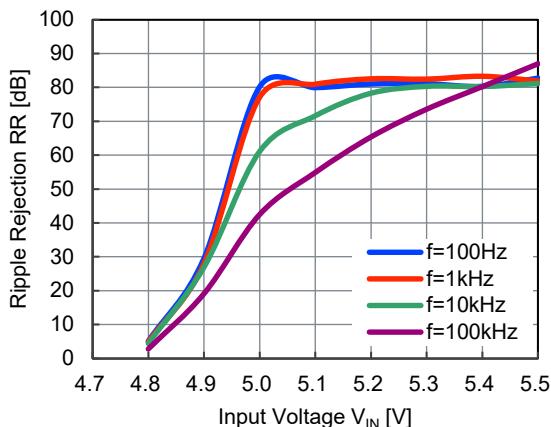


NR1640DC480x, $I_{OUT}$ = 100 mA
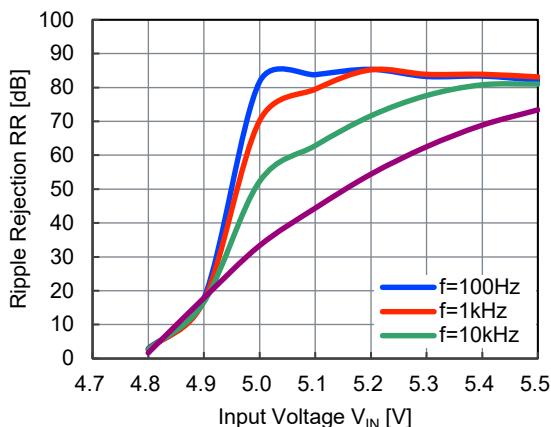
11) Output Noise Spectral Density vs Frequency
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), $C_{IN} = C_{OUT} = 1.0$ µF, $T_a = 25$°C

NR1640DC250x



NR1640DC290x



NR1640DC330x



NR1640DC480x



12) Input Transient Response
$I_{OUT} = 1$ mA, tr = tf = 5 µs, $C_{IN} = C_{OUT} = 1.0$ µF, $T_a = 25$°C
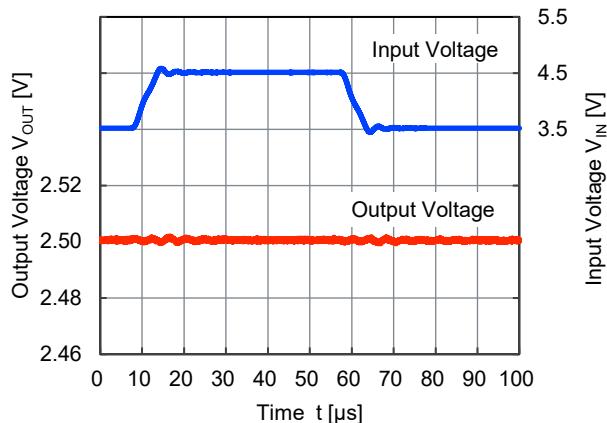
NR1640DC250x



NR1640DC330x
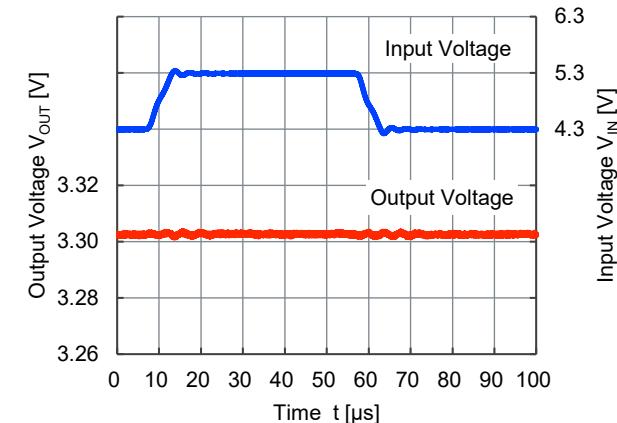
13) Load Transient Response
$V_{IN} = V_{SET} + 1$ V (Max = 5.5 V), tr = tf = 0.5 µs, $C_{IN}$ = 1.0 µF, $T_a$ = 25°C
NR1640DC250x
$C_{OUT}$ =1.0 µF, $I_{OUT}$ = 1 mA⇔100 mA
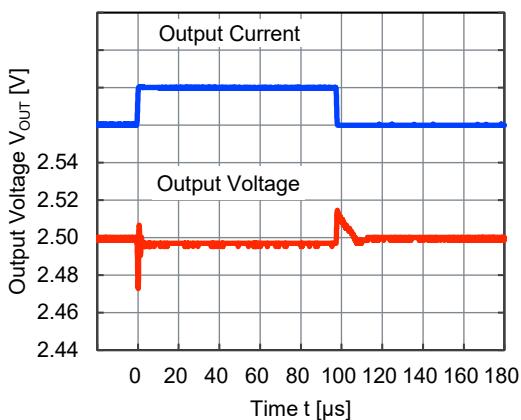
$C_{OUT}$ =10 µF, $I_{OUT}$ = 1 mA⇔100 mA
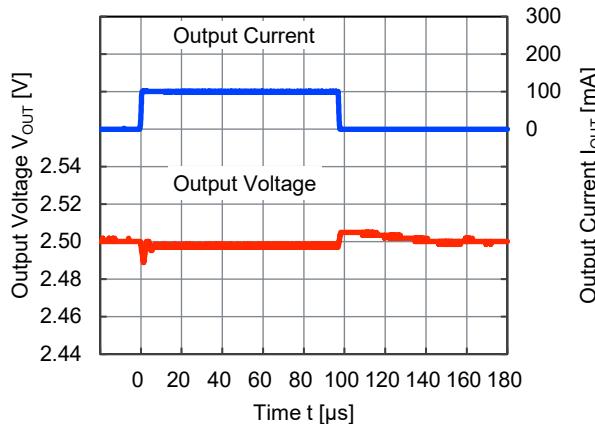


$C_{OUT}$ =1.0 µF, $I_{OUT}$ = 1 mA⇔200 mA
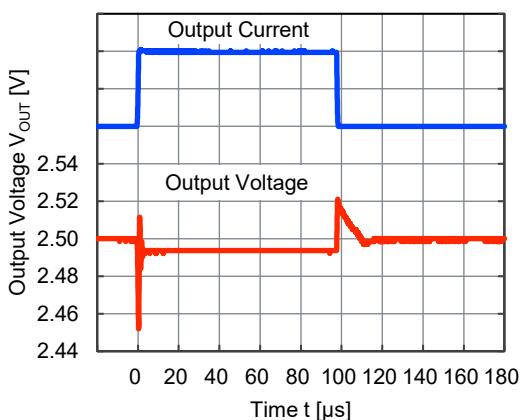
$C_{OUT}$ =10 µF, $I_{OUT}$ = 1 mA⇔200 mA



NR1640DC290x
$C_{OUT}$ =1.0 µF, $I_{OUT}$ = 1 mA⇔100 mA

$C_{OUT}$ =10 µF, $I_{OUT}$ = 1 mA⇔100 mA

# Nisshinbo Micro Devices Inc.
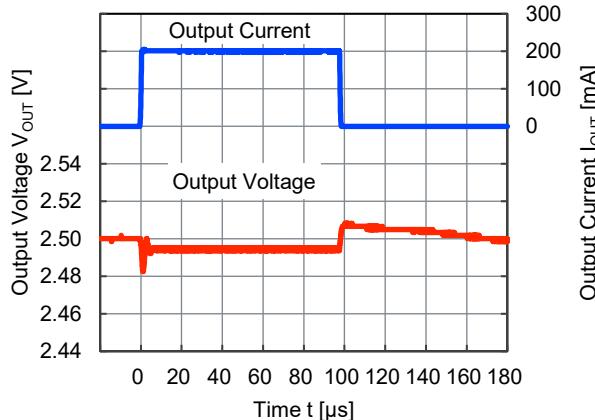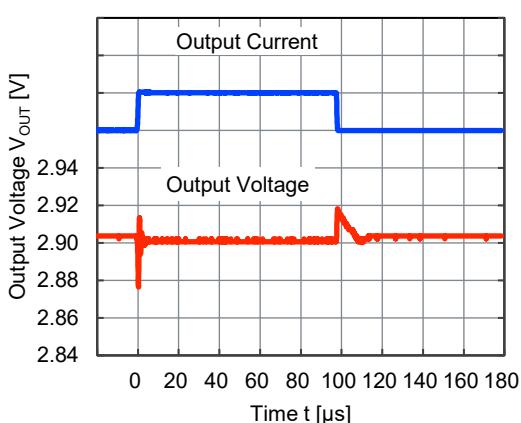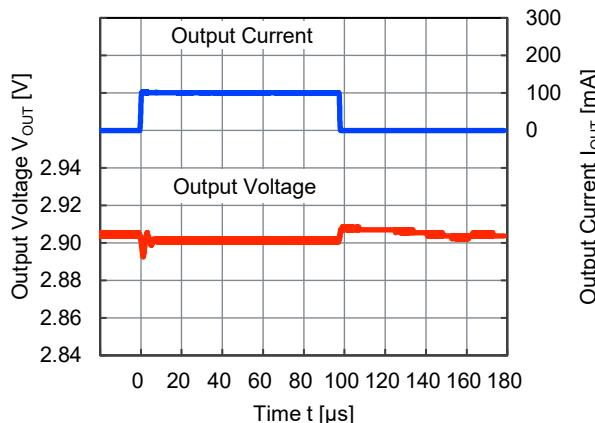
C$_{OUT}$ =1.0 µF, I$_{OUT}$ = 1 mA⇔200 mA
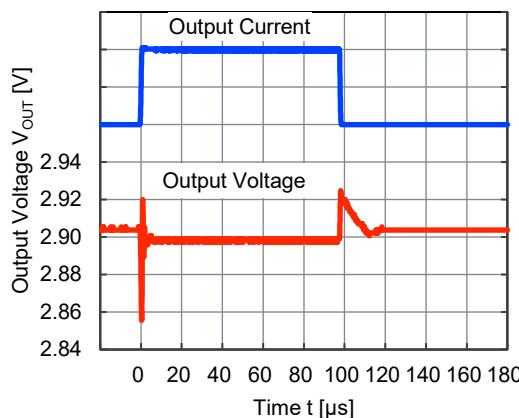
C$_{OUT}$ =10 µF, I$_{OUT}$ = 1 mA⇔200 mA
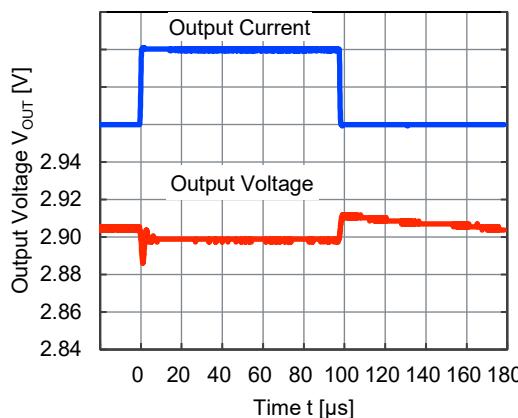
NR1640DC330x
C$_{OUT}$ = 1.0 µF, I$_{OUT}$ = 1 mA⇔100 mA
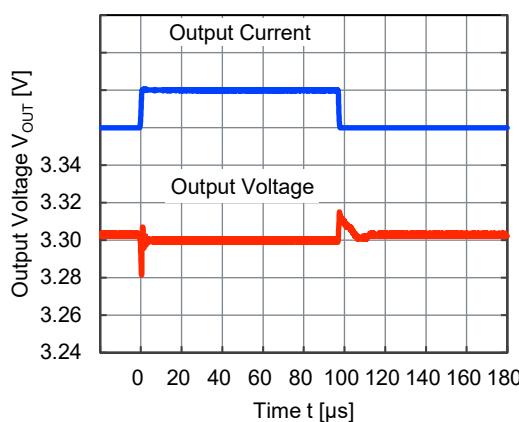
C$_{OUT}$ =10 µF, I$_{OUT}$ = 1 mA⇔100 mA
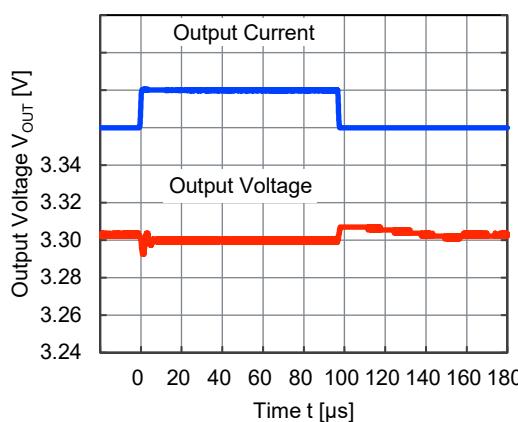
C$_{OUT}$ = 1.0 µF, I$_{OUT}$ = 1 mA⇔200 mA
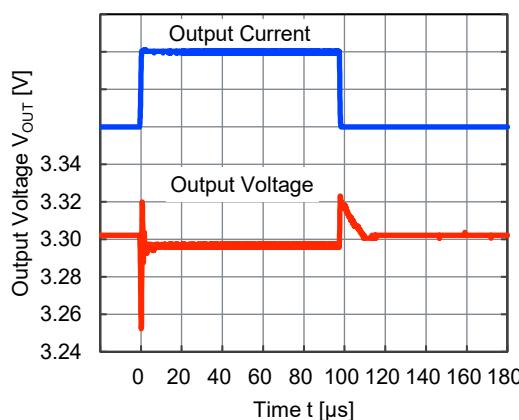
C$_{OUT}$ = 10 µF, I$_{OUT}$ = 1 mA⇔200 mA
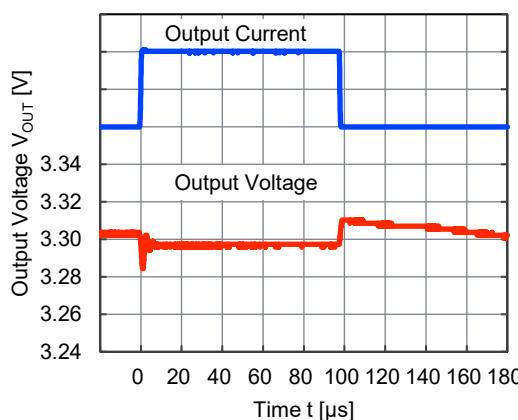
NR1640DC480x
$C_{OUT}$ = 1.0 µF, $I_{OUT}$ = 1 mA⟷100 mA
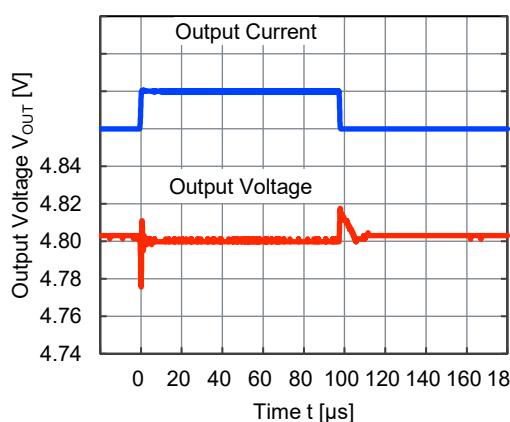


$C_{OUT}$ = 10 µF, $I_{OUT}$ = 1 mA⟷100 mA
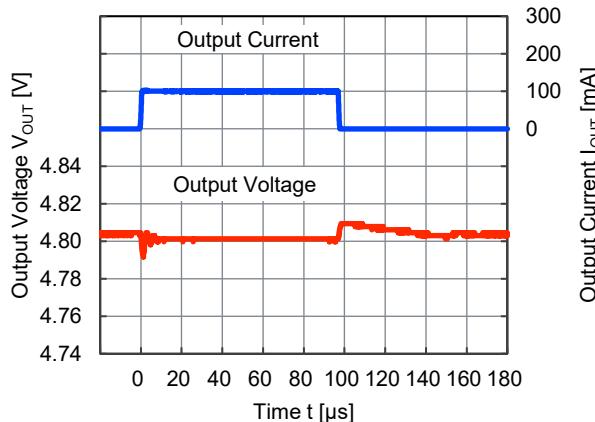


$C_{OUT}$ = 1.0 µF, $I_{OUT}$ = 1 mA⟷200 mA
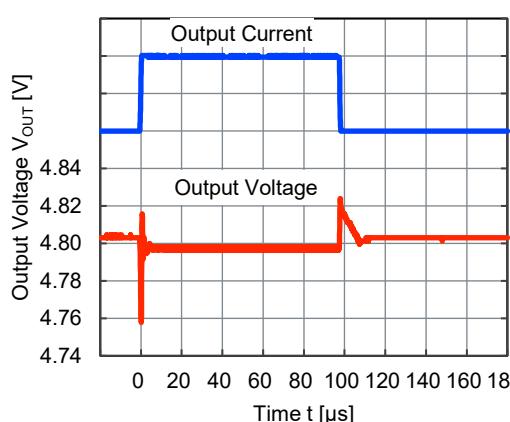


$C_{OUT}$ = 10 µF, $I_{OUT}$ = 1 mA⟷200 mA
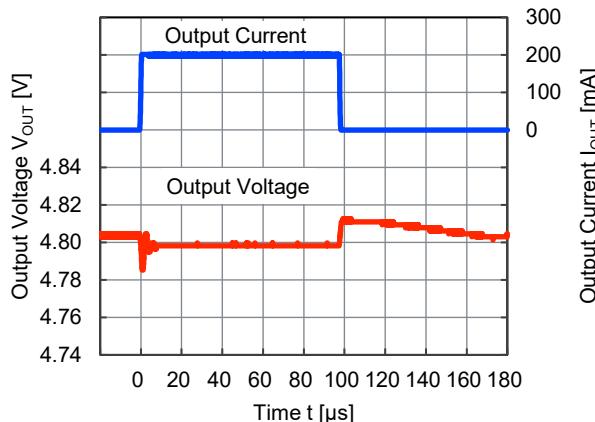


14) Turn on Speed with EN Pin
$V_{IN}$ = $V_{SET}$ + 1 V (Max = 5.5 V), $C_{IN}$ = $C_{OUT}$ = 1.0 µF, $T_a$ = 25°C

NR1640DC250A/E



NR1640DC330A/E

NR1640DC480D/H



15) Inrush Current vs Ouput Capacitor
$V_{IN} = V_{SET} + 1\ V$ (Max = 5.5 V), $C_{IN} = C_{OUT} = 1.0\ \mu F$, $T_a = 25°C$

NR1640DC250A/E



NR1640DC330A/E



NR1640DC480D/H

# Nisshinbo Micro Devices Inc.
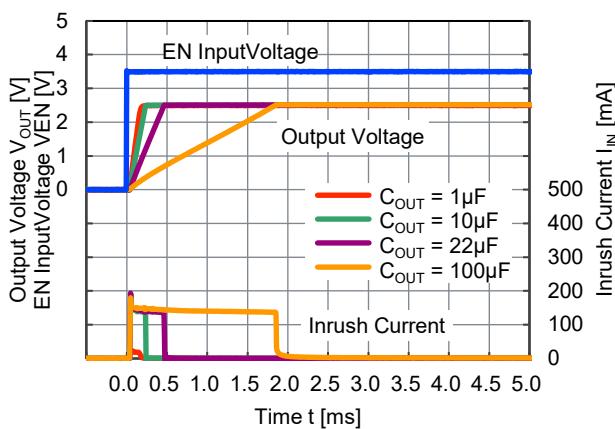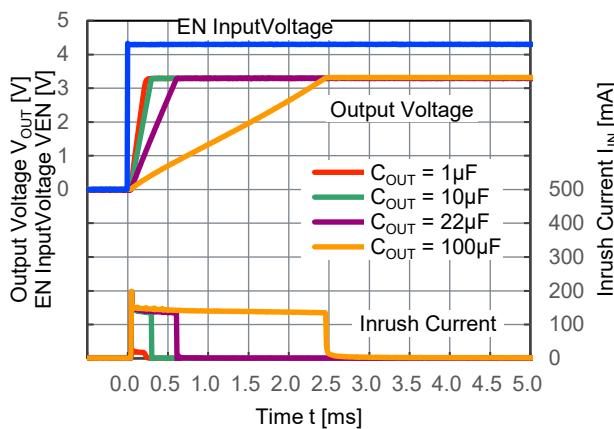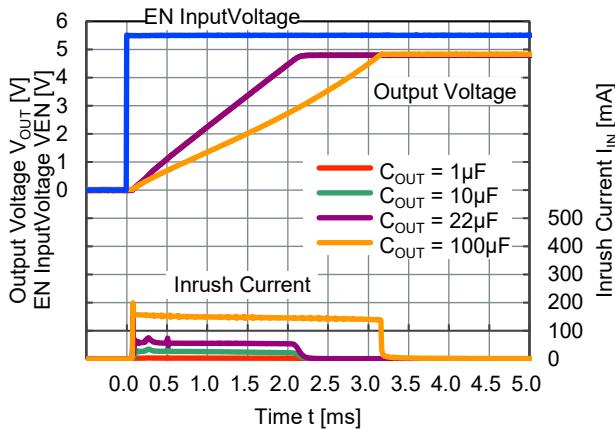
16) Turn off Speed with EN Pin

$V_{IN}$ = $V_{SET}$ + 1 V (Max = 5.5 V), $C_{IN}$ = $C_{OUT}$ = 1.0 µF, $T_a$ = 25°C

NR1640DC250A/E
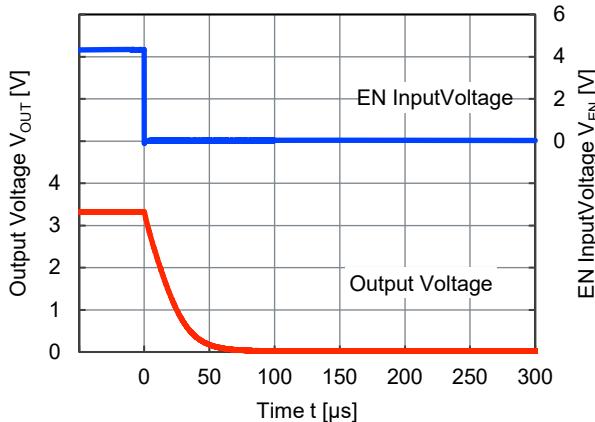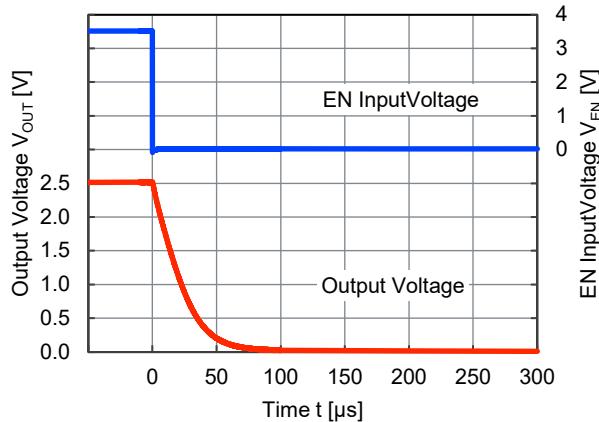
NR1640DC330A/E
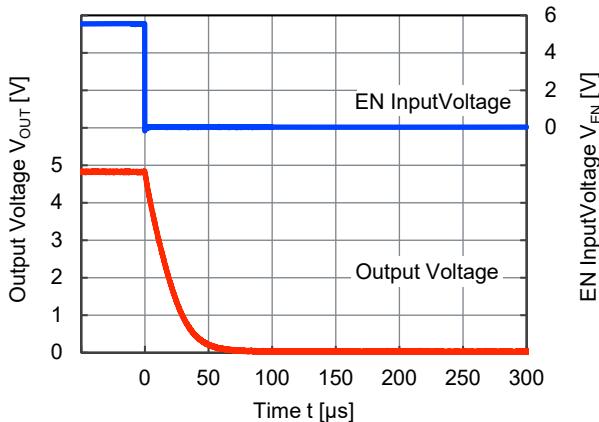


NR1640DC480D/H



17) Soft start time

$V_{IN}$ = $V_{SET}$ + 1 V (Max = 5.5 V), $C_{IN}$ = $C_{OUT}$ = 1.0 µF, $T_a$ = 25°C

NR1640DC250x

NR1640DC330x

NR1640DC480x

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■**TEST CIRCUIT**



$C_{IN}$ = Ceramic 1.0 μF
$C_{OUT}$ = Ceramic 1.0 μF
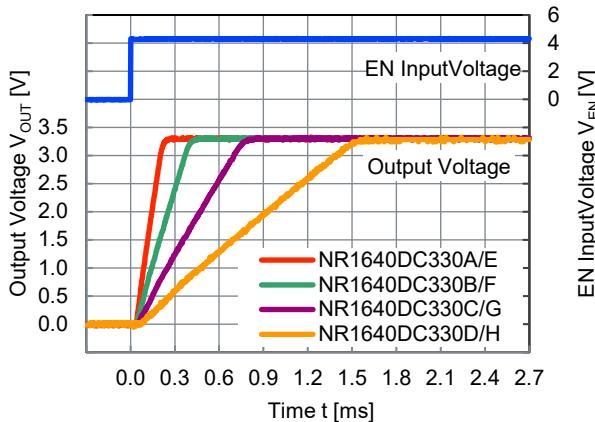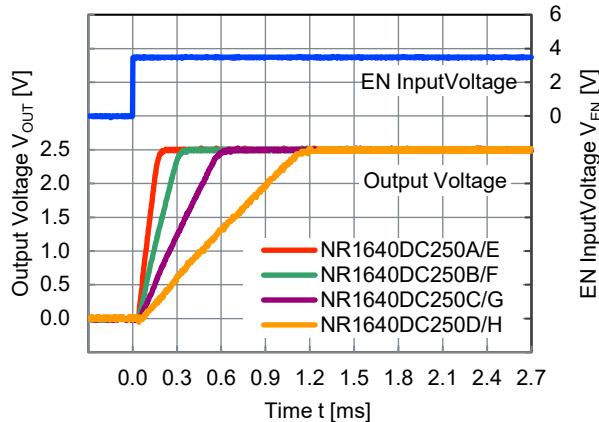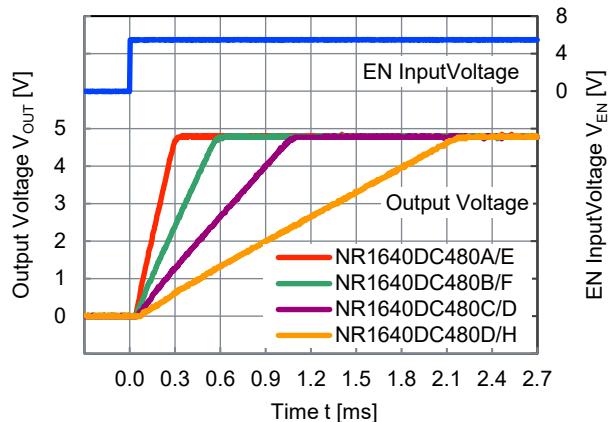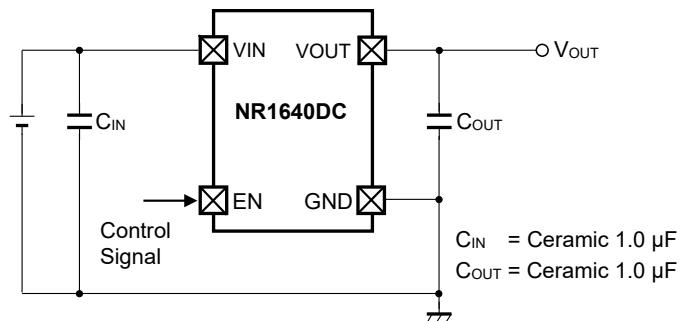
**NR1640DC Test Circuit**

【Components list for our evaluation】

| Symbol | Measurement Item | | Parts Number |
|---|---|---|---|
| $C_{IN}$ | All Items | 1 μF | GCM155C71A105K |
| $C_{OUT}$ | All Items | 1 μF | GCM155C71A105K |
| | No.12,15 | 10 μF | CGA4J1X7S1C106K |
| | No.15 | 22 μF | GCM32ER71A226KE12L |
| | No.15 | 100 μF | GRM32EE70J107ME15L |

# Nisshinbo Micro Devices Inc.

## SOT-23-5-DC

■ **PACKAGE DIMENSIONS**
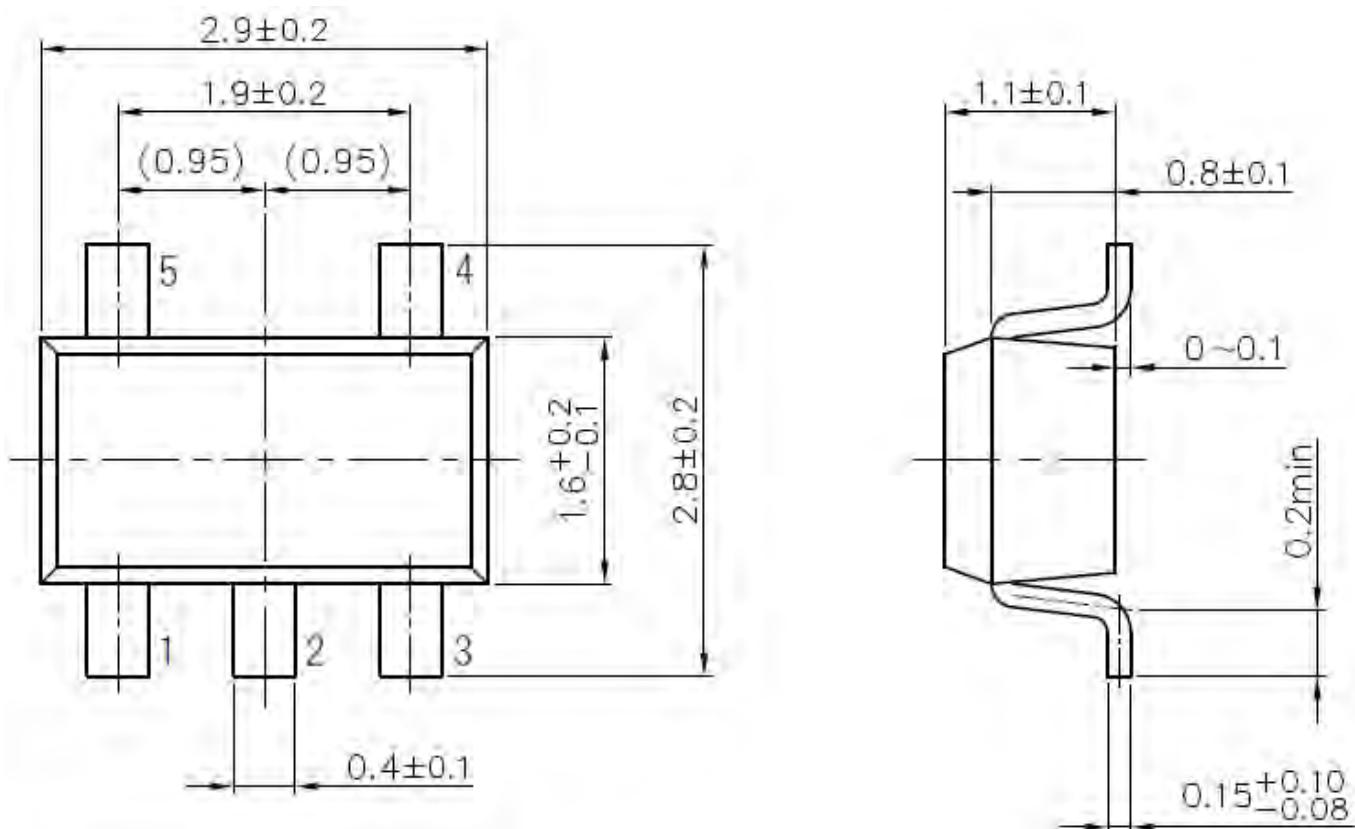


UNIT ： mm
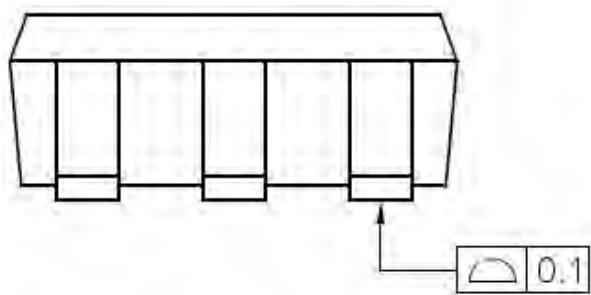
■ **FOOT PATTERN**
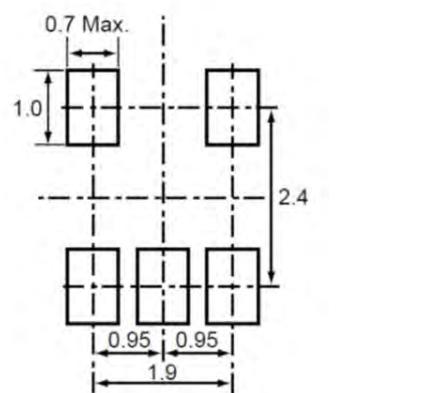


UNIT ： mm

# Nisshinbo Micro Devices Inc.

SOT-23-5-DC

## ■ PART MARKING

①②③ : Product Code (Abbreviation)
④⑤ : Lot Number ・・・ Alphanumeric Serial Number

```
   ┌───┐         ┌───┐
   │ 5 │         │ 4 │
   └───┘         └───┘
 ┌─────────────────────┐
 │ ┌─────────────────┐ │
 │ │                 │ │
 │ │  ①②③④⑤        │ │
 │ │                 │ │
 │ └─────────────────┘ │
 └─────────────────────┘
  ┌───┐  ┌───┐  ┌───┐
  │ 1 │  │ 2 │  │ 3 │
  └───┘  └───┘  └───┘
```
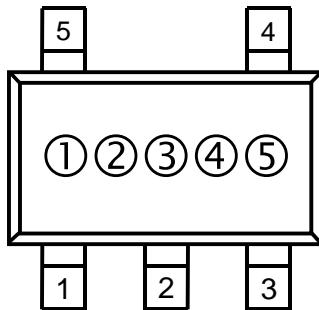
| NOTICE |
|---|
| There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI. |

# Nisshinbo Micro Devices Inc.

## SOT-23-5-DC

■ **PACKING SPECIFICATIONS**

TAPING SPECIFICATIONS

<u>E1 type</u>
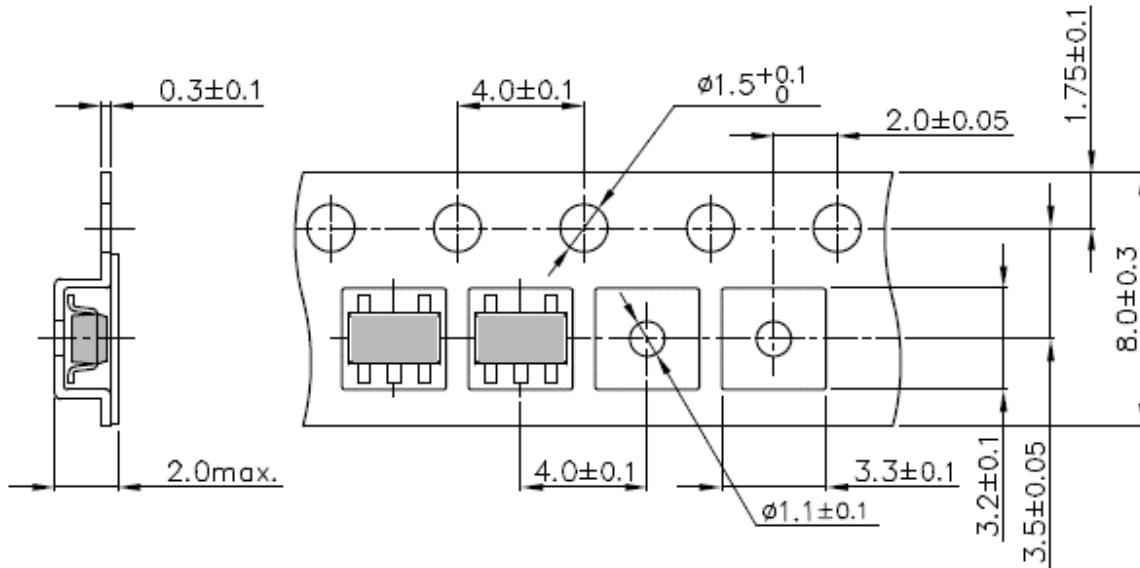


<u>E1 type</u>   User Direction of Feed. ➡         Unit : mm

<u>E2 type</u>
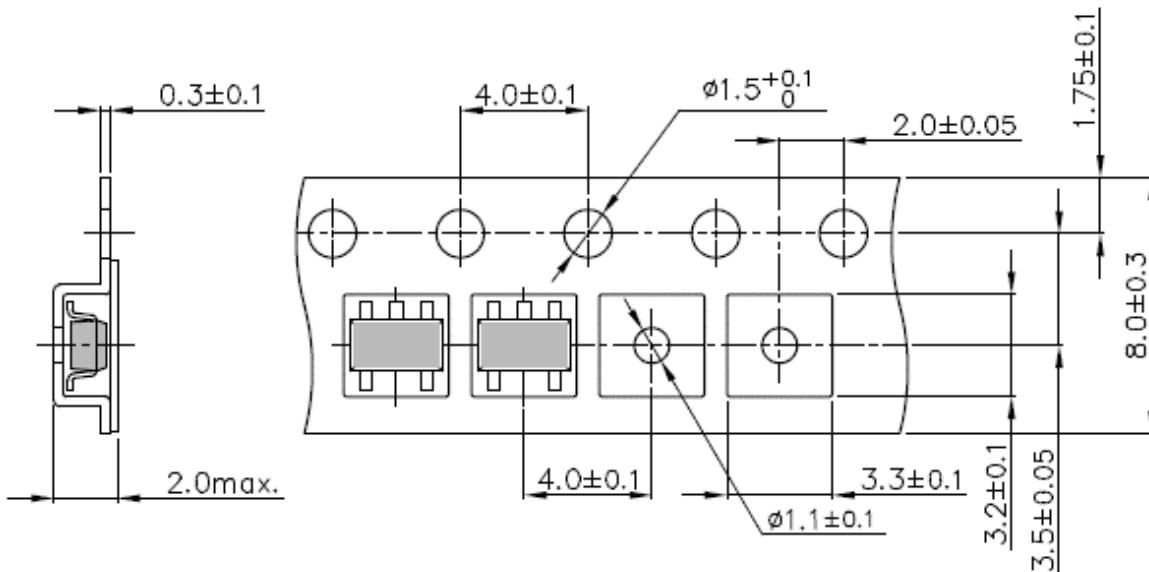


<u>E2 type</u>   User Direction of Feed. ➡         Unit : mm

# Nisshinbo Micro Devices Inc.

SOT-23-5-DC

TAPING REEL DIMENSIONS
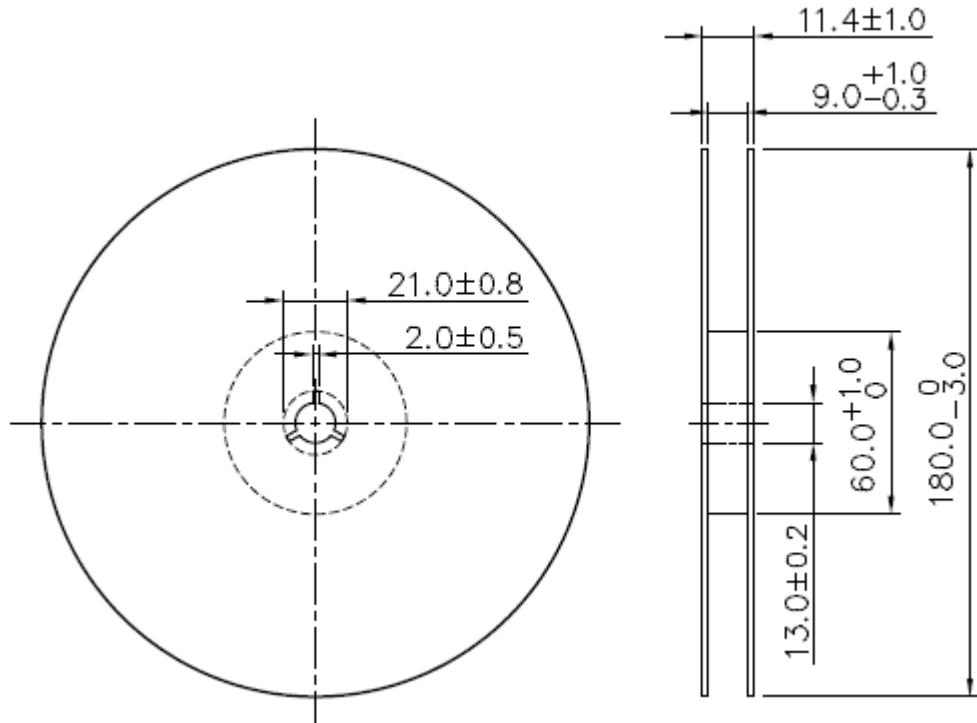
Unit : mm

TAPING PERFORMANCE

· Each of products must not adhere to the top cover tape when you take out to the product.
· Any jointing of tape, top cover tape or carrier tape, should be prohibited in the same reel.
· It is assumed that there is not a part lack.
· Carrier Tape … When a tensile force of 10 N { 1.02 kgf } is applied in the direction of unreeling the tape, the tape shall withstand this force.
· Top Cover Tape … When a tensile force 10 N { 1.02 kgf } is applied to the tape, the tape shall withstand this force.
· Peel Force of Top Cover Tape … Unless otherwise specified, the peel force of top cover tape shall be 0.1 to 0.7 N { 10.2 to 71.4 gf } when the top cover tape is pulled at a speed of 300 mm/min with the angle between the tape during peel and the direction of unreeling maintained at 165 to 180° as illustrated in Fig.1.
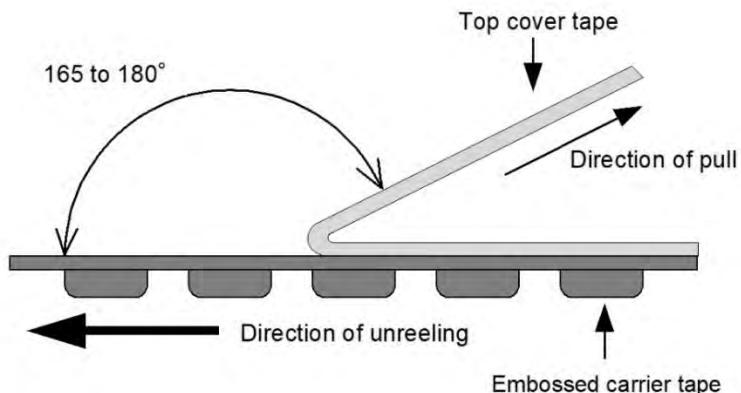
Fig.1

# Nisshinbo Micro Devices Inc.

## SOT-23-5-DC

PACKING FORM

- 1 reel = 3,000 pcs
- The end of cover tape is fixed with the adhesive tape.

* PACKING CHART

Reel

Label

Adhesive tape
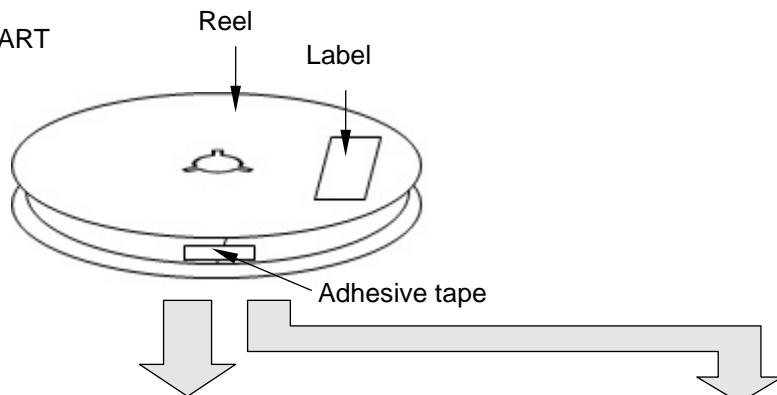
* ONE VOLUME PACKING
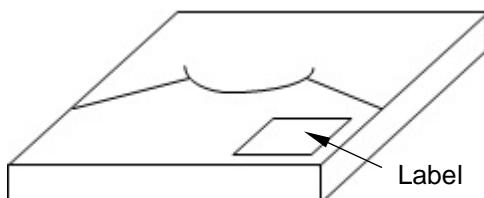
Label

- A reel is put in one volume packing box.

* FIVE VOLUME PACKING
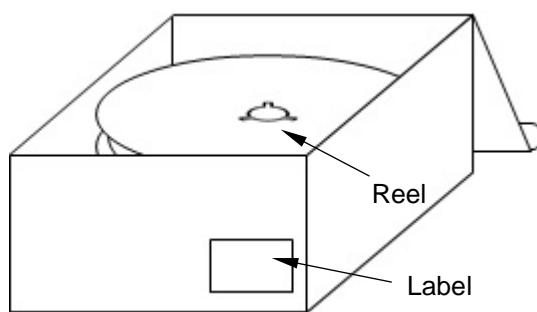
Reel

Label

- Five or less reels are put in five-volume packing.

* LABEL (EX.) :

Bar-code Label (code39) with 2D Code

```
(3N)1 XXXXXXXXX-XX   3000
(3N)2 XXXX     103060
XXXXXXXXX-XX
3,000 pcs.
QC Lot 12345678
QA PASS
Lot No. XXXXXX    2022.10.1
NISSHINBO
```

Part number , Quantity

Mark lot No. , Vendor code

Part number

Quantity

Assembly lot No.

QA passing date sign

Wafer lot No.

# Nisshinbo Micro Devices Inc.

SOT-23-5-DC

■ **REFLOW PROFILE**
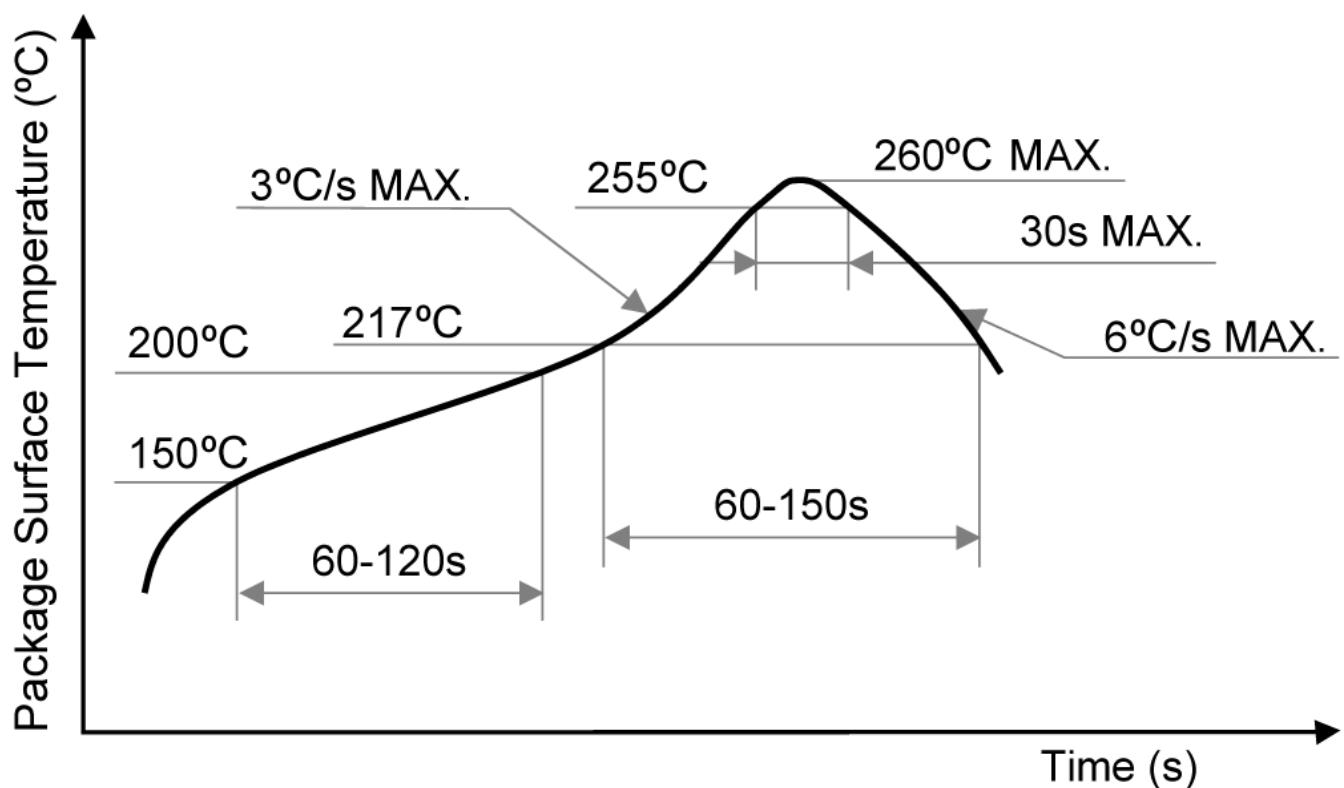
■ **Revision History**

| Date | Version | Contents of Changes |
|------|---------|---------------------|
| January 7, 2022 | Ver. 1.0 | Initial release |

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