

**RP115x**

No. EC-390-201130

## APPLICATIONS

- Power supply for electronic control units such as EV inverter and battery charge control unit.

## SELECTION GUIDE

The package type, the set output voltage and the auto-discharge<sup>(1)</sup> are user-selectable options.

## Selection Guide

| Product Name        | Package    | Quantity per Reel | Pb Free | Halogen Free |
|---------------------|------------|-------------------|---------|--------------|
| RP115Lxx2*(y)-TR-#  | DFN2020-8B | 3,000 pcs         | Yes     | Yes          |
| RP115Hxx1*(y)-T1-#E | SOT-89-5   | 1,000 pcs         | Yes     | Yes          |

xx: Set Output Voltage ( $V_{SET}$ )

0.9 V (09) / 1.0 V (10) / 1.1 V (11) / 1.2 V (12) / 1.5 V (15) / 1.8 V (18) / 2.5 V (25) / 2.8 V (28) /  
3.0 V (30) / 3.3 V (33) / 3.4 V (34) / 3.9 V (39)

Note: Contact Ricoh sales representatives for other voltages.

xx, (y): Second Decimal Place of 1.25 V    RP115x12x\*5-TR-A

Second Decimal Place of 1.75 V    RP115L172\*5-TR-A

\*: Auto-discharge Option

(B) auto-discharge not included

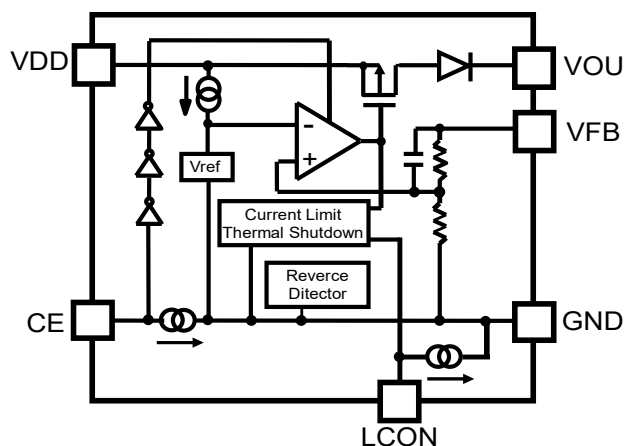
(D) auto-discharge included

#: Quality Class

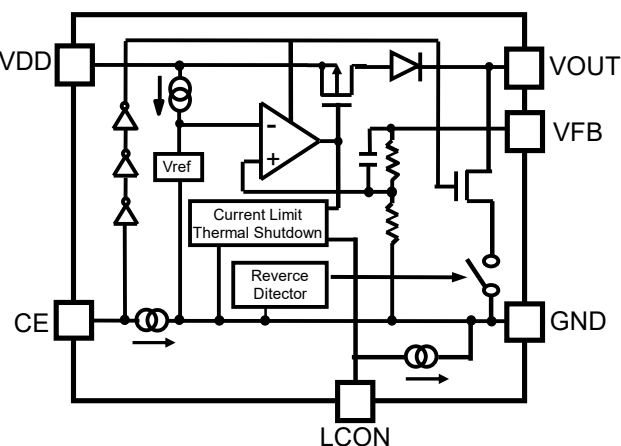
|   |                              |                   |
|---|------------------------------|-------------------|
|   | <b>Operating Temp. Range</b> | <b>Test Temp.</b> |
| A | -40°C to 105°C               | 25°C, High        |

<sup>(1)</sup> Auto-discharge function quickly lowers the output voltage to 0 V by releasing the electrical charge in the external capacitor when the chip enable signal is switched from the active mode to the standby mode.

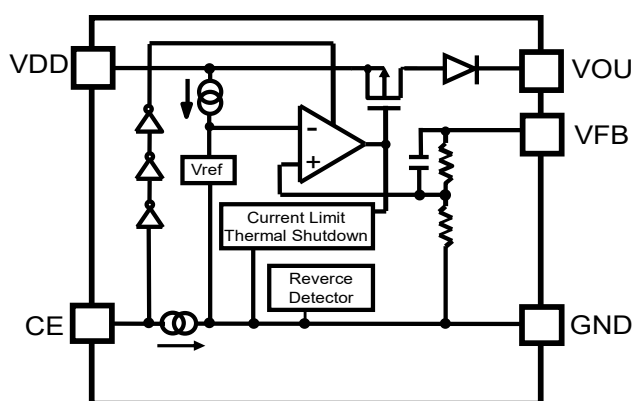
## BLOCK DIAGRAMS



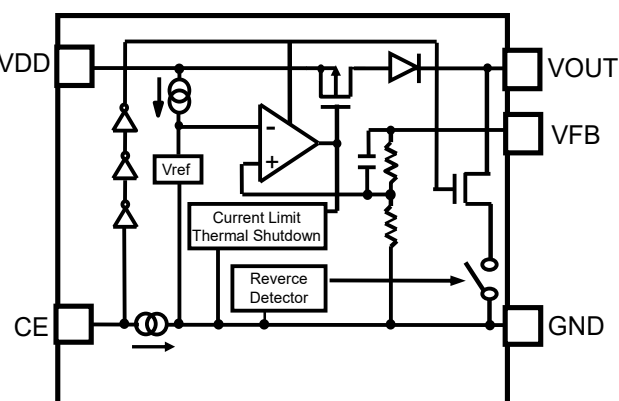
RP115Lxx2B Block Diagram



RP115Lxx2D Block Diagram



RP115Hxx1B<sup>(1)</sup> Block Diagram



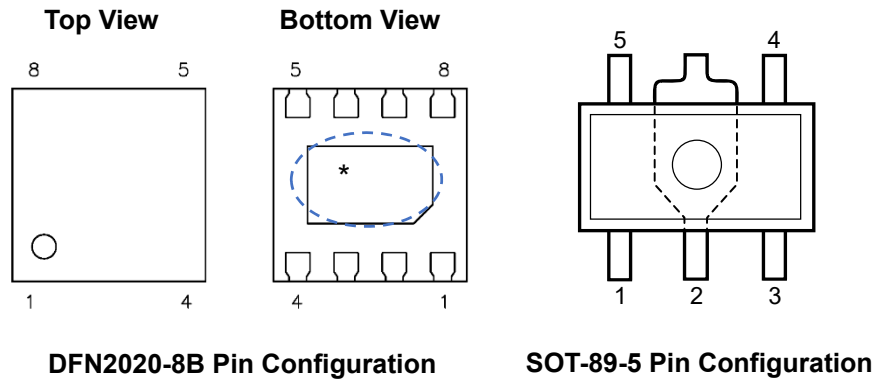
RP115Hxx1D<sup>(1)</sup> Block Diagram

<sup>(1)</sup> The RP115H does not have the LCON pin, so the output current is fixed at 1 A.

# RP115x

No. EC-390-201130

## PIN DESCRIPTION



### RP115L: DFN2020-8B

| Pin No | Symbol             | Pin Description                                              |
|--------|--------------------|--------------------------------------------------------------|
| 1      | VOU <sup>(1)</sup> | Output Pin                                                   |
| 2      | VOU <sup>(1)</sup> | Output Pin                                                   |
| 3      | LCON               | Output Current Limit Alternate Pin (“H” = 1 A, “L” = 500 mA) |
| 4      | VFB <sup>(1)</sup> | Feedback Pin                                                 |
| 5      | GND                | Ground Pin                                                   |
| 6      | CE                 | Chip Enable Pin                                              |
| 7      | VDD <sup>(2)</sup> | Input Pin                                                    |
| 8      | VDD <sup>(2)</sup> | Input Pin                                                    |

\* The tab on the bottom of the package shown by blue circle is a substrate potential (GND). It is recommended that this tab be connected to the ground plane pin on the board but it is possible to leave the tab floating.

### RP115H<sup>(3)</sup>: SOT-89-5

| Pin No | Symbol             | Pin Description |
|--------|--------------------|-----------------|
| 1      | VFB <sup>(1)</sup> | Feedback Pin    |
| 2      | GND                | Ground Pin      |
| 3      | CE                 | Chip Enable Pin |
| 4      | VDD                | Input Pin       |
| 5      | VOU <sup>(1)</sup> | Output Pin      |

<sup>(1)</sup> The VOUT and the VFB pins must be wired together when mounting on the board.

<sup>(2)</sup> The VDD pin must be wired together when mounting on the board.

<sup>(3)</sup> Output Current Limit is fixed at 1 A.

## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

| Symbol     | Parameter                        |                 | Rating      |      | Unit |
|------------|----------------------------------|-----------------|-------------|------|------|
| $V_{IN}$   | Input Voltage                    |                 | 6.0         |      | V    |
| $V_{CE}$   | CE Pin Input Voltage             |                 | -0.3 to 6.0 |      | V    |
| $V_{LCON}$ | LCON Pin Input Voltage           |                 | -0.3 to 6.0 |      | V    |
| $V_{OUT}$  | Output Voltage                   |                 | -0.3 to 6.0 |      | V    |
| $P_D$      | Power Dissipation <sup>(1)</sup> | JEDEC STD. 51-7 | DFN2020-8B  | 2800 | mW   |
|            |                                  | JEDEC STD. 51-7 | SOT-89-5    | 3200 |      |
| $T_j$      | Junction Temperature Range       |                 | -40 to 150  |      | °C   |
| $T_{stg}$  | Storage Temperature Range        |                 | -55 to 150  |      | °C   |

### ABSOLUTE MAXIMUM RATINGS

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

## RECOMMENDED OPERATING CONDITIONS

### Recommend Operating Conditions

| Symbol   | Parameter                    | Rating      | Unit |
|----------|------------------------------|-------------|------|
| $V_{IN}$ | Input Voltage <sup>(2)</sup> | 1.4 to 5.25 | V    |
| $T_a$    | Operating Temperature Range  | -40 to 105  | °C   |

### RECOMMENDED OPERATING CONDITONS

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 they are used over such ratings by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

<sup>(1)</sup> Refer to *POWER DISSIPATION* for detailed information.

<sup>(2)</sup> The maximum input voltage listed under *Electrical Characteristics* is 5.25 V. If for any reason the input voltage exceeds 5.25 V, it has to be no more than 5.5 V with 500 cumulative operating hours.

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## ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{SET}^{(1)} + 1.0 \text{ V}$ ,  $I_{OUT} = 1 \text{ mA}$ ,  $C_{IN} = C_{OUT} = 1.0 \mu\text{F}$ , unless otherwise noted.

The specifications in   are guaranteed by design engineering at  $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ .

### RP115x (-AE) Electrical Characteristics

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

| Symbol                                | Parameter                                  | Test Conditions/Comments                                                         |                           | Min.                           | Typ. | Max.   | Unit |
|---------------------------------------|--------------------------------------------|----------------------------------------------------------------------------------|---------------------------|--------------------------------|------|--------|------|
| V <sub>OUT</sub>                      | Output Voltage                             | Ta = 25°C                                                                        | V <sub>SET</sub> ≥ 1.75 V | x0.99                          |      | x1.01  | V    |
|                                       |                                            |                                                                                  | V <sub>SET</sub> < 1.75 V | -18                            |      | +18    | mV   |
|                                       |                                            | −40°C ≤ Ta ≤ 105°C                                                               | V <sub>SET</sub> ≥ 1.75 V | x0.981                         |      | x1.015 | V    |
|                                       |                                            |                                                                                  | V <sub>SET</sub> < 1.75 V | Refer to <i>Output Voltage</i> |      |        |      |
| I <sub>LIM</sub>                      | Output Current Limit                       | V <sub>IN</sub> = V <sub>SET</sub> + 0.5 V                                       | LCON = "L"                | 500                            |      |        | mA   |
|                                       |                                            |                                                                                  | LCON = "H" <sup>(2)</sup> | 1.0                            |      |        | A    |
| ΔV <sub>OUT</sub> / ΔI <sub>OUT</sub> | Load Regulation                            | V <sub>IN</sub> = V <sub>SET</sub> + 0.5 V<br>1 mA ≤ I <sub>OUT</sub> ≤ 500 mA   | LCON = "L"                |                                | 1    | 20     | mV   |
|                                       |                                            | V <sub>IN</sub> = V <sub>SET</sub> + 0.5 V<br>1mA ≤ I <sub>OUT</sub> ≤ 1.0 A     | LCON = "H" <sup>(2)</sup> |                                |      | 40     |      |
| V <sub>DIF</sub>                      | Dropout Voltage                            | Refer to <i>Dropout Voltage</i>                                                  |                           |                                |      |        |      |
| I <sub>SS</sub>                       | Supply Current                             | I <sub>OUT</sub> = 0 mA                                                          |                           |                                | 110  | 160    | μA   |
| I <sub>standby</sub>                  | Standby Current                            | V <sub>CE</sub> = 0 V                                                            |                           |                                | 0.5  | 30     | μA   |
| ΔV <sub>OUT</sub> / ΔV <sub>IN</sub>  | Line Regulation                            | V <sub>SET</sub> + 0.5 V ≤ V <sub>IN</sub> ≤ 5.25 V<br>(V <sub>IN</sub> ≥ 1.4 V) |                           |                                | 0.02 | 0.10   | %/V  |
| I <sub>SC</sub>                       | Short Current Limit                        | V <sub>OUT</sub> = 0 V <sup>(3)</sup>                                            | LCON = "L"                |                                | 60   | 95     | mA   |
|                                       |                                            |                                                                                  | LCON = "H" <sup>(2)</sup> |                                | 110  | 155    |      |
| I <sub>CE</sub>                       | CE Pull-down Current                       |                                                                                  |                           | 0.05                           | 0.3  | 0.6    | μA   |
| V <sub>CEH</sub>                      | CE Input Voltage "H"                       |                                                                                  |                           | 1.0                            |      |        | V    |
| V <sub>CEL</sub>                      | CE Input Voltage "L"                       |                                                                                  |                           |                                |      | 0.4    | V    |
| I <sub>LCON</sub>                     | LCON Pull-down Current<br>(RP115L only)    |                                                                                  |                           | 0.05                           | 0.3  | 0.6    | μA   |
| V <sub>LCONH</sub>                    | LCON Input Voltage "High"<br>(RP115L only) |                                                                                  |                           | 1.0                            |      |        | V    |
| V <sub>LCONL</sub>                    | LCON Input Voltage "Low"<br>(RP115L only)  |                                                                                  |                           |                                |      | 0.4    | V    |

<sup>(1)</sup>  $V_{SET}$  = Set Output Voltage

<sup>(2)</sup> RP115H: Same Electrical Characteristics as LCON = "H".

<sup>(3)</sup> Short Current is the value when  $V_{OUT}$  and GND are short-circuited after the device starts up. Inrush Current flows when the device starts up while  $V_{OUT}$  and GND are short-circuited.

**ELECTRICAL CHARACTERISTICS (continued)**

$V_{IN} = V_{SET}^{(1)} + 1.0\text{ V}$ ,  $I_{OUT} = 1\text{ mA}$ ,  $C_{IN} = C_{OUT} = 1.0\text{ }\mu\text{F}$ , unless otherwise noted.

The specifications in   are guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ .

**RP115x (-AE) Electrical Characteristics**

(Ta = 25°C)

| Symbol               | Parameter                                               | Test Conditions/Comments                                         |                              | Min. | Typ. | Max.                                                             | Unit               |
|----------------------|---------------------------------------------------------|------------------------------------------------------------------|------------------------------|------|------|------------------------------------------------------------------|--------------------|
| $T_{TSD}$            | Thermal Shutdown Threshold Temperature                  | $T_j$ , Rising                                                   |                              |      | 165  |                                                                  | $^{\circ}\text{C}$ |
| $T_{TSR}$            | Thermal Shutdown Threshold Temperature                  | $T_j$ , Falling                                                  |                              |      | 110  |                                                                  | $^{\circ}\text{C}$ |
| $I_{REV}$            | Reverse Current                                         | $V_{OUT} = V_{SET} + 1.0\text{ V}$                               | $V_{SET} \geq 1.75\text{ V}$ |      | 7.5  |                                                                  | $\mu\text{A}$      |
|                      |                                                         | $0 \leq V_{IN} \leq V_{OUT}$                                     | $V_{SET} < 1.75\text{ V}$    |      | 10   |                                                                  |                    |
| $V_{REV\_DET}^{(2)}$ | Detection Offset in Reverse Current Mode <sup>(3)</sup> | $V_{OUT} \geq 0.7\text{ V}$ , $0 \leq V_{IN} \leq 5.25\text{ V}$ |                              |      | 20   |                                                                  | mV                 |
| $V_{REV\_REL}^{(4)}$ | Release Offset in Reverse Current Mode <sup>(3)</sup>   | $V_{OUT} \geq 0.7\text{ V}$ , $0 \leq V_{IN} \leq 5.25\text{ V}$ |                              |      | 30   | <span style="border: 1px solid black; padding: 0 2px;">50</span> | mV                 |
| $R_{LOW}$            | Low-output Nch Tr. ON Resistance (RP115xxxD only)       | $V_{IN} = 4.0\text{ V}$ , $V_{CE} = 0\text{ V}$                  |                              |      | 60   |                                                                  | $\Omega$           |
| $I_{RUSH}$           | Inrush limited Current                                  | CC mode <sup>(5)</sup>                                           | LCON = "L"                   |      | 300  |                                                                  | mA                 |
|                      |                                                         |                                                                  | LCON = "H" <sup>(6)</sup>    |      | 500  |                                                                  |                    |

All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_j \approx T_a = 25^{\circ}\text{C}$ ) except Output Noise, Ripple Rejection, and Output Voltage Temperature Coefficient.

<sup>(1)</sup>  $V_{SET}$  = Set Output Voltage

<sup>(2)</sup>  $V_{REV\_DET} = V_{IN} - V_{OUT}$

<sup>(3)</sup> Guaranteed operating range of reverse current protection circuit is  $V_{OUT} \geq 0.7\text{ V}$ . When  $V_{IN} = V_{OUT} = 0\text{ V}$ , reverse current protection mode is constantly active.

<sup>(4)</sup>  $V_{REV\_REL} = V_{IN} - V_{OUT}$

<sup>(5)</sup> For CC (Constant Current) Mode, please refer to *Start-up Characteristics*.

<sup>(6)</sup> RP115H: Same Electrical Characteristics as LCON = "High".

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### Output Voltage

| Product Name | Output Voltage $V_{OUT}$ (V) |      |       |
|--------------|------------------------------|------|-------|
|              | Min.                         | Typ. | Max.  |
| RP115x09x    | 0.862                        | 0.9  | 0.930 |
| RP115x10x    | 0.960                        | 1.0  | 1.031 |
| RP115x11x    | 1.058                        | 1.1  | 1.133 |
| RP115x12x    | 1.156                        | 1.2  | 1.234 |
| RP115x12x5   | 1.205                        | 1.25 | 1.285 |
| RP115x15x    | 1.449                        | 1.5  | 1.538 |

### Dropout Voltage

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

| Set Output<br>Voltage $V_{SET}$ (V) | Dropout Voltage $V_{DIF}$ (V) |       |                            |       |                            |       |
|-------------------------------------|-------------------------------|-------|----------------------------|-------|----------------------------|-------|
|                                     | RP115L                        |       |                            |       | RP115H                     |       |
|                                     | $I_{OUT} = 500\text{ mA}$     |       | $I_{OUT} = 1000\text{ mA}$ |       | $I_{OUT} = 1000\text{ mA}$ |       |
|                                     | Typ.                          | Max.  | Typ.                       | Max.  | Typ.                       | Max.  |
| 0.9 V, 1.0 V                        | *                             | *     | *                          | *     | *                          | *     |
| 1.1 V                               | *                             | *     | *                          | 0.375 | *                          | 0.365 |
| 1.2 V, 1.25 V                       | *                             | *     | 0.195                      | 0.355 | 0.235                      | 0.345 |
| 1.5 V                               | 0.085                         | 0.170 | 0.165                      | 0.320 | 0.205                      | 0.310 |
| 1.75 V, 1.8 V, 2.5 V                | 0.075                         | 0.160 | 0.150                      | 0.295 | 0.190                      | 0.285 |
| 2.8 V, 3.0 V                        | 0.065                         | 0.145 | 0.130                      | 0.265 | 0.170                      | 0.255 |
| 3.3 V, 3.4 V, 3.9 V                 | 0.060                         | 0.135 | 0.125                      | 0.250 | 0.165                      | 0.240 |

If the dropout voltage falls below the release offset value of reverse current protection mode ( $V_{REV\_REL}$ ), the reverse current protection circuit may repeat the detection and release operations. Please refer to *Reverse Current Protection*.

\* Input voltage should be equal or more than the minimum operating voltage (1.4 V).

## THEORY OF OPERATION

### Reverse Current Protection

The RP115x includes a reverse current protection circuit in order to stop the reverse current from V<sub>OUT</sub> pin to V<sub>DD</sub> pin or to GND pin when V<sub>OUT</sub> becomes higher than V<sub>IN</sub>.

Usually, the LDO using Pch output transistor contains a parasitic diode between V<sub>DD</sub> pin and V<sub>OUT</sub> pin.

Therefore, if V<sub>OUT</sub> is higher than V<sub>IN</sub>, the parasitic diode becomes forward direction. As a result, the current flows from V<sub>OUT</sub> pin to V<sub>DD</sub> pin.

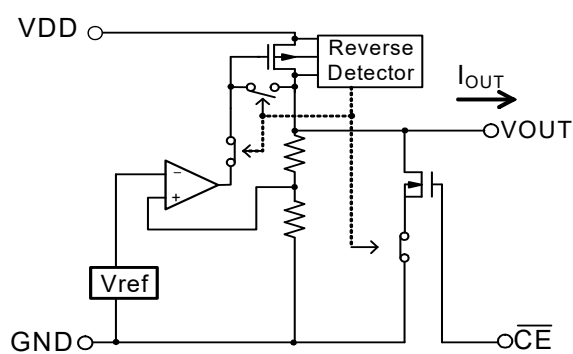
The RP115x switches the mode to the reverse current protection mode before V<sub>IN</sub> becomes lower than V<sub>OUT</sub> by connecting the parasitic diode of Pch output transistor to the backward direction, and connecting the gate to V<sub>OUT</sub> pin. As a result, the Pch output transistor is turned off. However, from V<sub>OUT</sub> pin to GND pin, via the internal divider resistors, very small current I<sub>REV</sub> flows.

Switching to either the normal mode or to the reverse current protection mode is determined by the magnitude of V<sub>IN</sub> voltage and V<sub>OUT</sub> voltage. For the stable operation, offset and hysteresis are set as the threshold. The detector threshold is set to V<sub>REV\_DET</sub> and the released voltage is set to V<sub>REV\_REL</sub>. Therefore, the minimum dropout voltage under the small load current condition is restricted by the value of V<sub>REV\_REL</sub>.

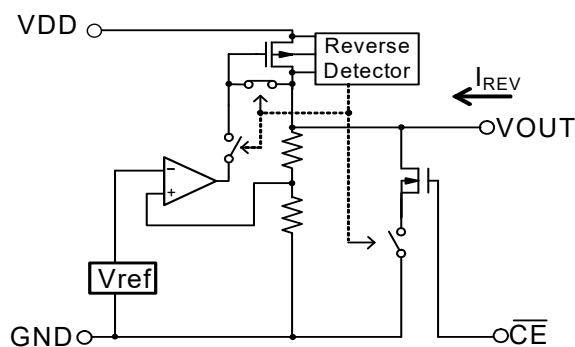
Following figures show the diagrams of each mode, and the load characteristics of each mode. When giving the V<sub>OUT</sub> pin a constant-voltage and decreasing V<sub>IN</sub>, the dropout voltage will become lower than V<sub>REV\_DET</sub>. As a result, the reverse current protection starts to function to stop the load current.

By increasing the dropout voltage higher than V<sub>REV\_REL</sub>, the protection mode will be released to let the load current to flow. If the dropout voltage to be used is lower than V<sub>REV\_REL</sub>, the detection and the release may be repeated.

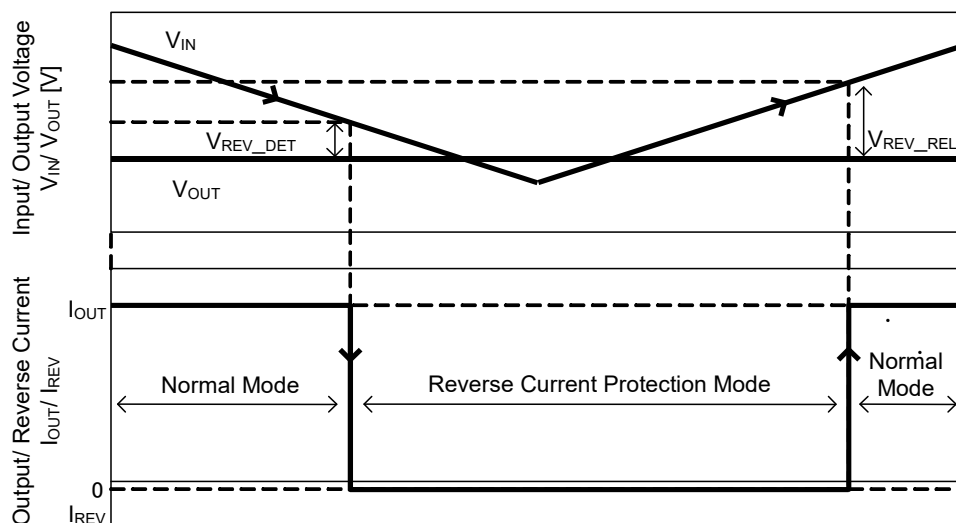
The operating voltage guaranteed level of the reverse current protection circuit is for V<sub>OUT</sub> ≥ 0.7 V. If V<sub>IN</sub> = 0 V, the reverse current protection mode becomes always active.



Normal Operation Mode



Reverse Current Protection Mode



Detection/ Release Timing of Reverse Current Protection Function

## Constant Slope for Start-Up Characteristics

The RP115x includes a constant slope circuit in order to prevent the overshoot of the output voltage. The start-up time ( $t_{ON}$ ) is 100  $\mu$ s (Typ.). If inrush current increases due to the large capacitance of  $C_{OUT}$ , the operation mode will be shifted from Constant Slope (CS) mode to Constant Current (CC) mode. The CC mode maintains a constant level of inrush current. In the CC mode,  $t_{ON}$  varies according to the size of  $C_{OUT}$  and the amount of load current.

## Start-up Time and Inrush Current Estimations

Start-up time and inrush current in the CS mode and the CC mode can be estimated as follows. The following is described the how to estimate when using the RP115L. The RP115H has the same electrical characteristics as LCON = "H" in the RP115L.

### [CS Mode]

Start-up Time ( $t_{ON}$ ): 100  $\mu$ s (Typ.)

Inrush Current ( $I_{RUSH}$ ):  $C_{OUT} \cdot V_{SET} / t_{ON} + I_{OUT}$  <sup>(1)</sup>

Note: If the result of the above calculation is more than the following values, the operation mode will be shifted from the CS mode to the CC mode.

LCON = "L" ..... 300 mA (Typ.)

LCON = "H" ..... 500 mA (Typ.)

### [CC Mode]

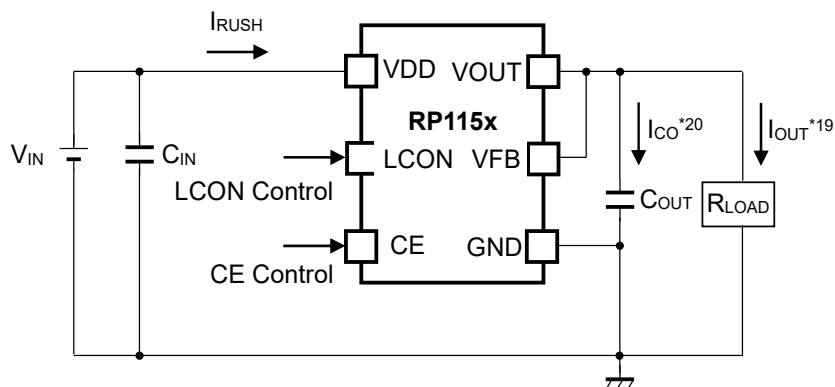
Start-up Time ( $t_{ON}$ ):  $C_{OUT} \cdot V_{SET} / I_{CO}$  <sup>(2)</sup>

Inrush Current ( $I_{RUSH}$ ): LCON = "L" ..... 300 mA (Typ.)

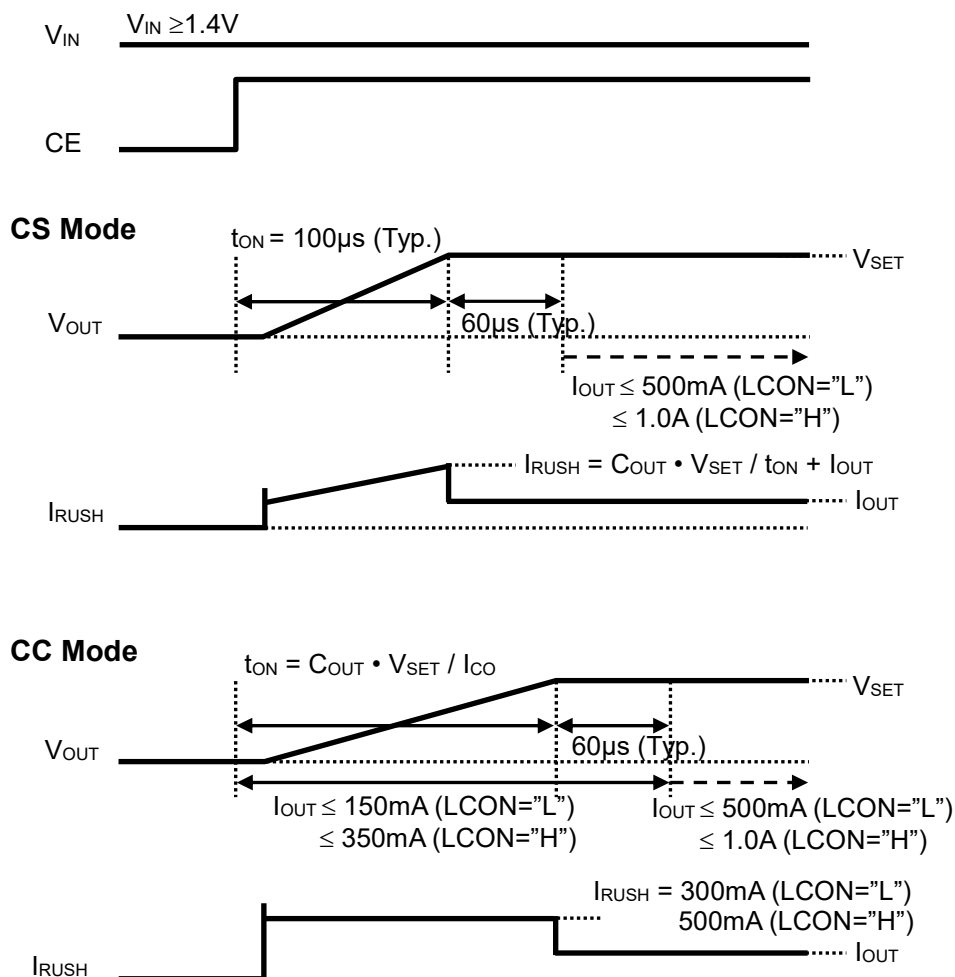
LCON = "H" ..... 500 mA (Typ.)

<sup>(1)</sup>  $I_{OUT}$ : When  $R_{LOAD}$  is connected to load,  $I_{OUT}$  can be calculated by  $R_{LOAD} = V_{SET} / I_{OUT}$ .

<sup>(2)</sup>  $I_{CO}$ :  $I_{CO}$  is a charge current of  $C_{OUT}$  and can be calculated roughly by  $I_{RUSH} \approx I_{CO} + I_{OUT}$ .



Circuit Example of RP115L



Start-up Operation Diagram

**Precautions before Use**

During the start-up, the inrush current limit circuit is in operation; therefore, the load current ( $I_{OUT}$ ) should be drawn after the output voltage ( $V_{OUT}$ ) reached the preset value (Best timing:  $t_{ON} + 60\mu s$  or more). If the load current is drawn during the start-up, it should be within the following values.

LCON = "L" .....  $I_{OUT} \leq 150 \text{ mA}$

LCON = "H" .....  $I_{OUT} \leq 350 \text{ mA}$

In the CC mode,  $I_{RUSH}$  is limited until  $V_{OUT}$  reaches the preset value.  $I_{RUSH} \approx I_{CO} + I_{OUT}$  is true; therefore, if large  $I_{OUT}$  is drawn during the start-up, the charge current ( $I_{CO}$ ) of  $C_{OUT}$  decreases and  $t_{ON}$  becomes longer. Please refer to *Start-up Time and Inrush Current Estimations*.

In order to control the start-up operation by using the CS mode or CC mode, input "H" into the CE pin while  $V_{IN} \geq 1.4 \text{ V}$ . If "H" is input into the CE pin while  $V_{IN}$  is less than the minimum operating voltage, the operation may not be controlled by the CS mode or CC mode.

When starting up the device while the short circuit is occurring between the  $V_{OUT}$  pin and GND, the short current protection circuit does not control the current but the current limit circuit does.

When there's excessive heat generation in the device, thermal shutdown circuit shuts down the circuitry before the device overheats dangerously.

**LCON Pin Operation (RP115L Only)**

By alternating the LCON pin between "H" or "L", the RP115L can choose the output current limit either 1.0 A or 500 mA. Please note that during start-up ( $t_{ON} + 60 \mu s$  (Typ.)), do not change the logic of the LCON pin.

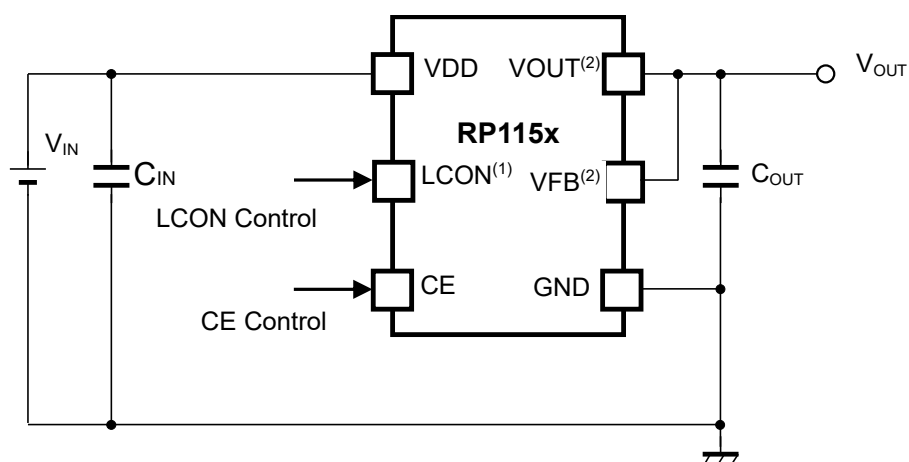
LCON = "L" ..... 500 mA

LCON = "H" ..... 1.0 A

**Application Example**

Even when using the RP115L with LCON = "H",  $I_{RUSH}$  in the CC mode can be reduced from 500 mA (Typ.) to 300 mA (Typ.) by starting up the IC with LCON = "L". Please refer to *Start-Up Characteristics*.

## APPLICATION INFORMATION



RP115x Typical Application Circuit

### External Components Example:

| Symbol           | Descriptions                                                                                                             |
|------------------|--------------------------------------------------------------------------------------------------------------------------|
| C <sub>IN</sub>  | 1.0 $\mu$ F, Ceramic Capacitor, CGA3E1X7R1C105K080AC (TDK)                                                               |
| C <sub>OUT</sub> | 1.0 $\mu$ F, Ceramic Capacitor, CGA3E1X7R1C105K080AC (TDK)<br>2.2 $\mu$ F, Ceramic Capacitor, CGA4J3X7R1C225K125AB (TDK) |

### Precautions When Selecting External Components

- Connect a capacitor of 1.0  $\mu$ F or more as C<sub>OUT</sub> to secure stable operation even when the load current is varied. (for phase compensation)
- Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit taking actual characteristics into account. Especially for the 1.75-V-output product, it is recommended to use 2.2  $\mu$ F or higher output capacitor when the product is used under the low-temperature environment such as -20°C or lower.
- If using a tantalum type capacitor and the ESR value of the capacitor is large, the output might be unstable. Evaluate your circuit including consideration of frequency characteristics.

<sup>(3)</sup> The LCON pin is only included in RP115L (DFN2020-8B).

<sup>(4)</sup> The VOUT pin and the VFB pin should be wired together when mounting on the board.

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## RP115x

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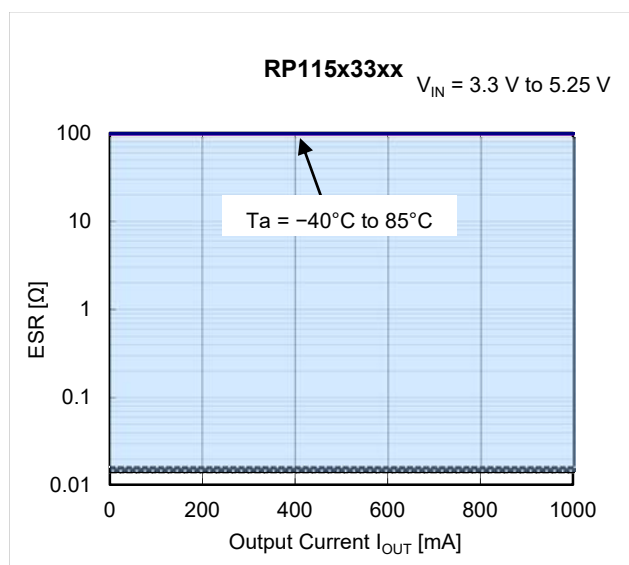
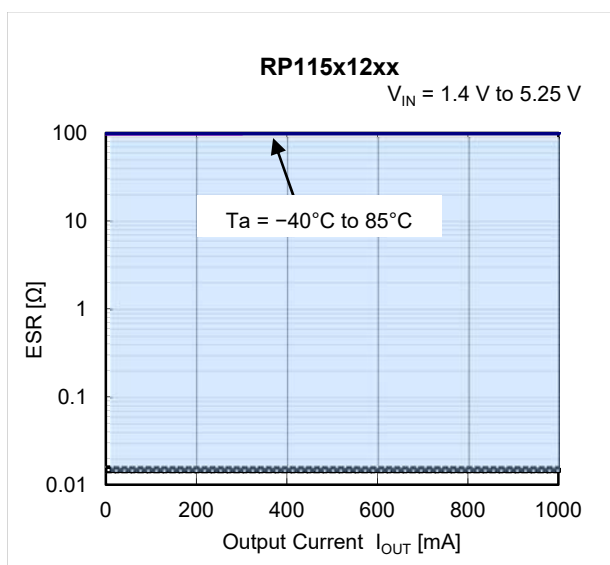
No. EC-390-201130

### Equivalent Series Resistance (ESR) vs. Output Current

Ceramic type output capacitor is recommended for the RP115x but any capacitor with low ESR can be used. The graphs below show the relation between  $I_{OUT}$  and ESR (noise level: average 40  $\mu$ V or less).

#### Measurement Conditions

- Noise Frequency Band Width: 10 Hz to 2 MHz
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Hatched Area: Output noise level is average 40  $\mu$ V or less.
- $C_{IN}$ ,  $C_{OUT}$ : 1.0  $\mu$ F or more



## TECHNICAL NOTES

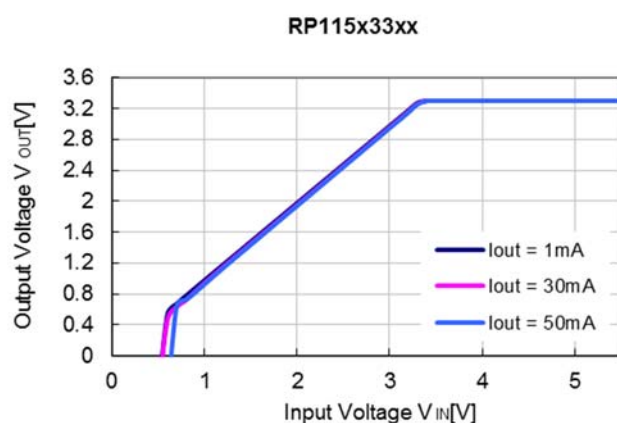
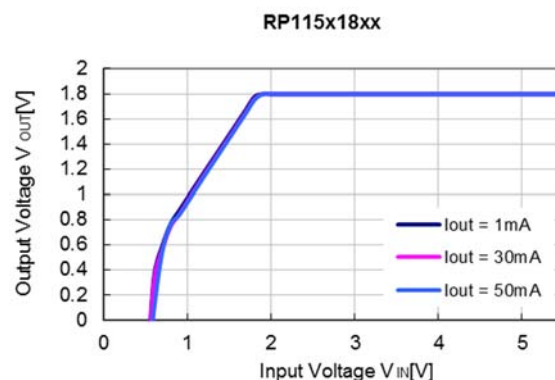
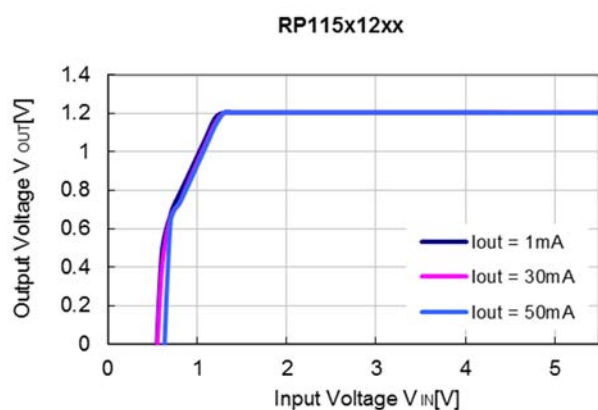
The performance of a power source circuit using this device is highly dependent on a peripheral circuit. A peripheral component or the device mounted on PCB should not exceed its rated voltage, rated current or rated power. When designing a peripheral circuit, please be fully aware of the following points.

- Ensure the  $V_{DD}$  and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. Connect a capacitor  $C_{IN}$  with 1.0  $\mu$ F or more between VDD and GND pins, and as close as possible to the pins.
- Connect  $C_{OUT}$  capacitor with suitable values between the VOUT and GND pins, and as close as possible to the pins.

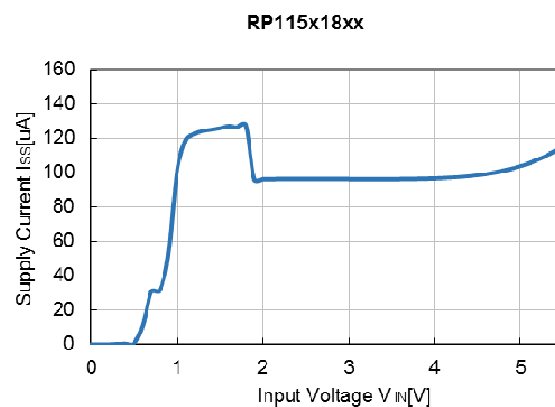
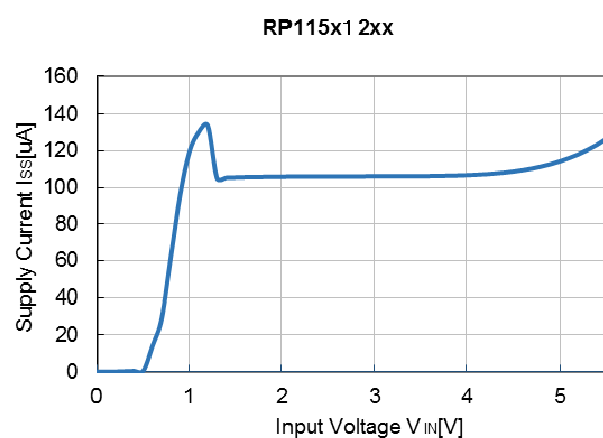
## TYPICAL CHARACTERISTICS

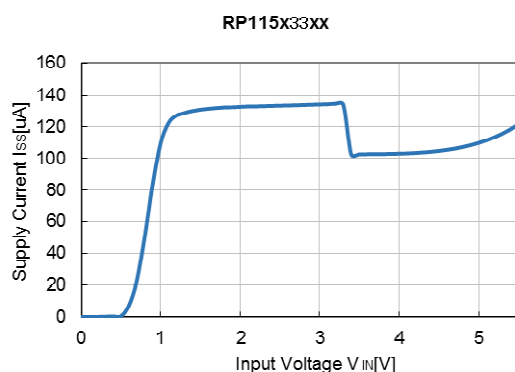
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

### 1) Output Voltage vs. Input Voltage ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, $T_a$ = 25°C)



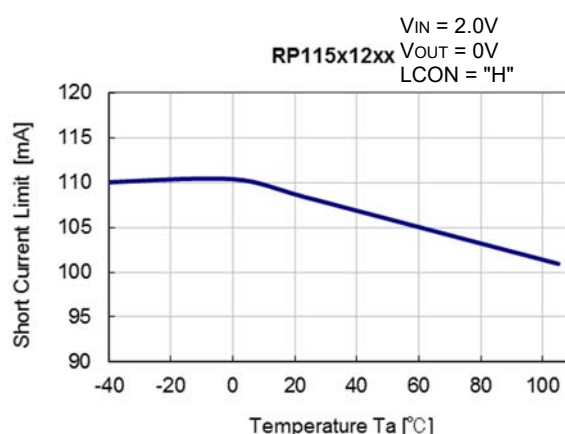
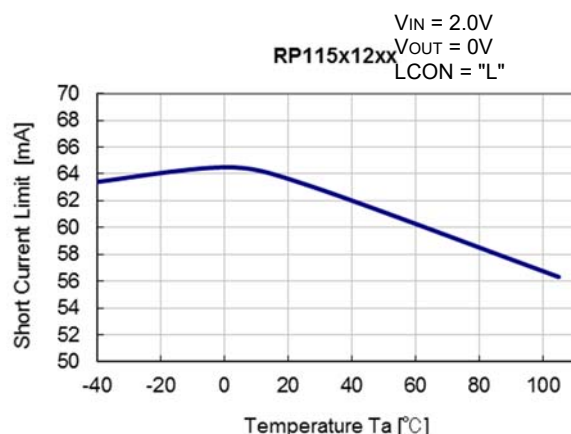
### 2) Supply Current vs. Input Voltage ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, $T_a$ = 25°C)



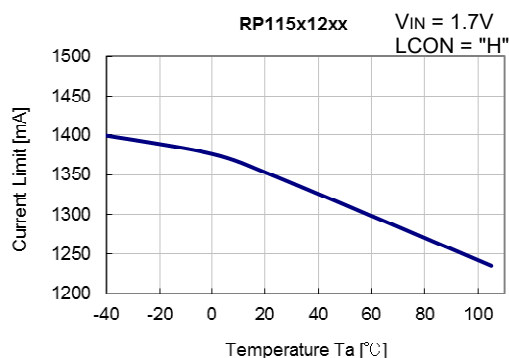
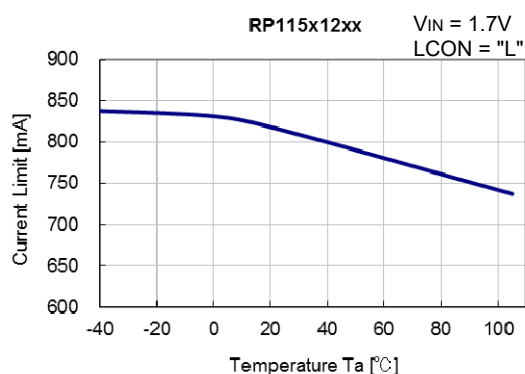


Note: The RP115x contains a peak current limit circuit which protect the regulator from damage by overcurrent if the output pin (VOUT) and the ground pin (GND) are shorted. The short-circuiting causes the overheating of the device which leads a thermal shutdown circuit to operate. If the peak current limit circuit and the thermal shutdown circuit work at the same time, fold-back type dropping characteristics cannot be measured. As for the short-circuit current and the peak current limit circuit, please refer to 3) Short Current Limit vs. Ambient Temperature and 4) Peak Current Limit vs. Ambient Temperature.

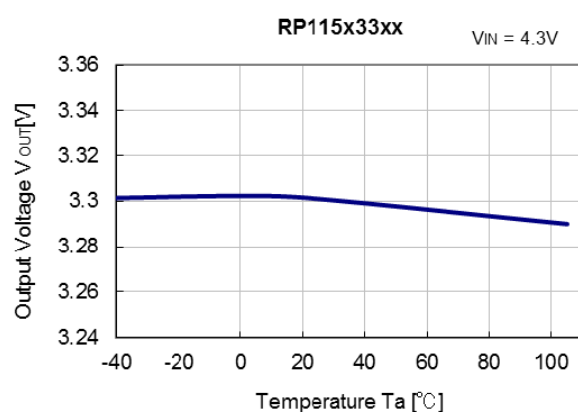
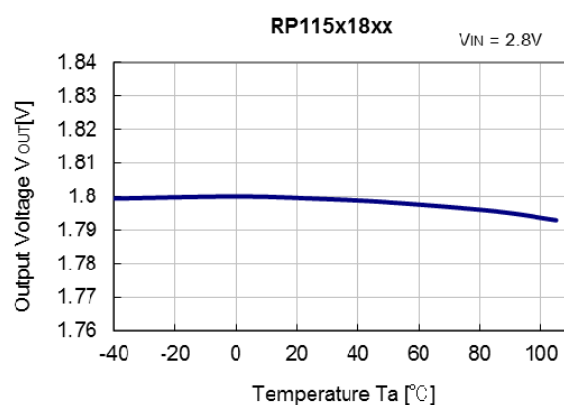
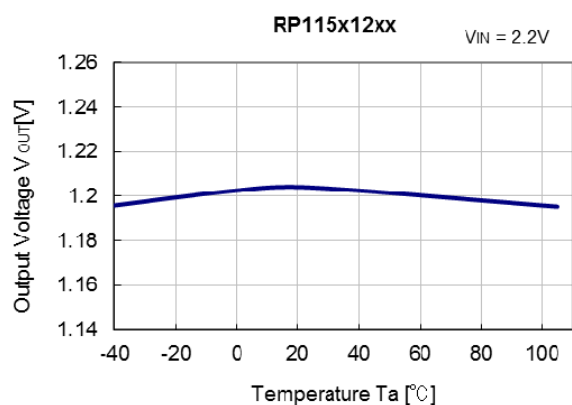
### 3) Short Current Limit vs. Ambient Temperature ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F)



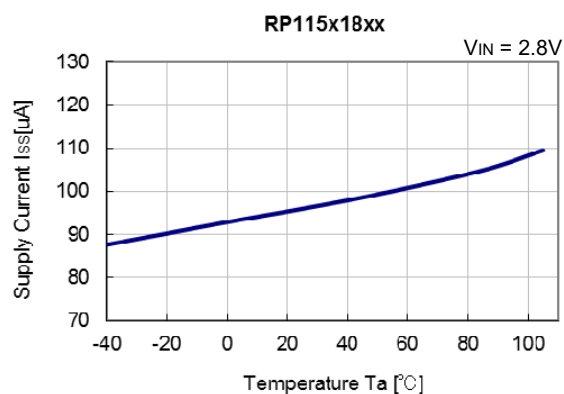
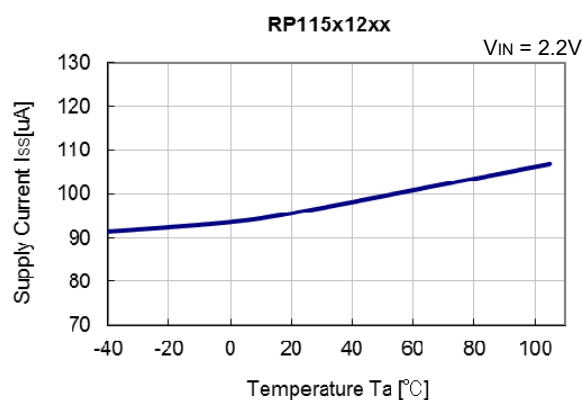
### 4) Peak Current Limit vs. Ambient Temperature ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F)



5) Output Voltage vs. Ambient Temperature ( $C_{IN}$  = Ceramic 1.0  $\mu$ F,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F,  $I_{OUT}$  = 1 mA)

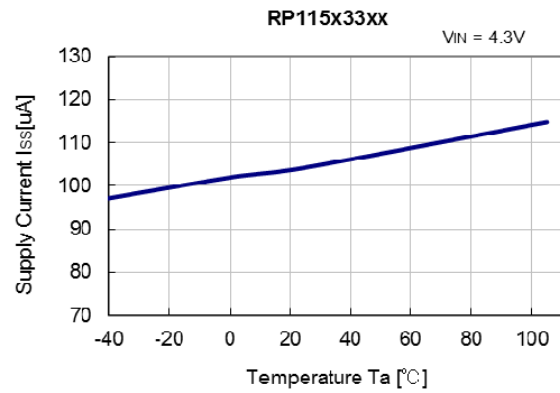


6) Supply Current vs. Ambient Temperature ( $C_{IN}$  = Ceramic 1.0  $\mu$ F,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F,  $I_{OUT}$  = 0 mA)

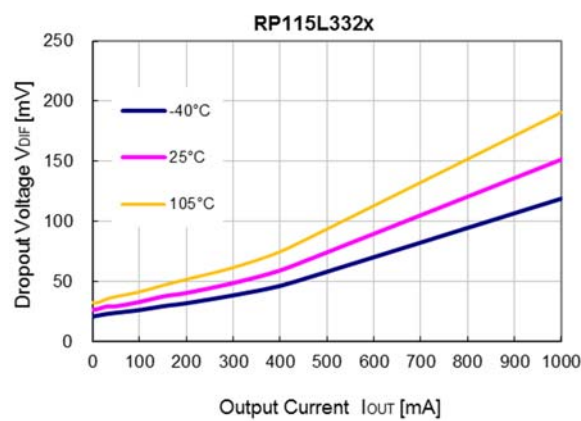
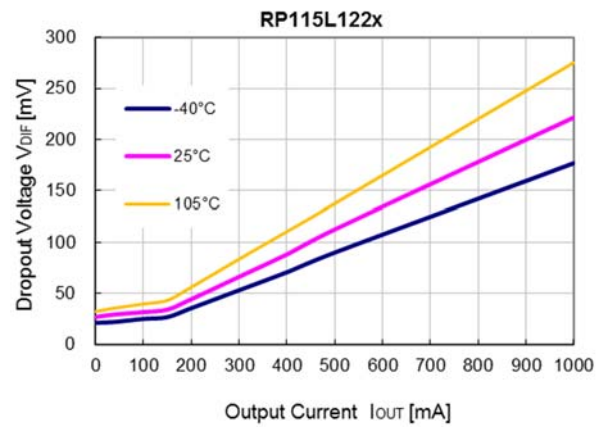
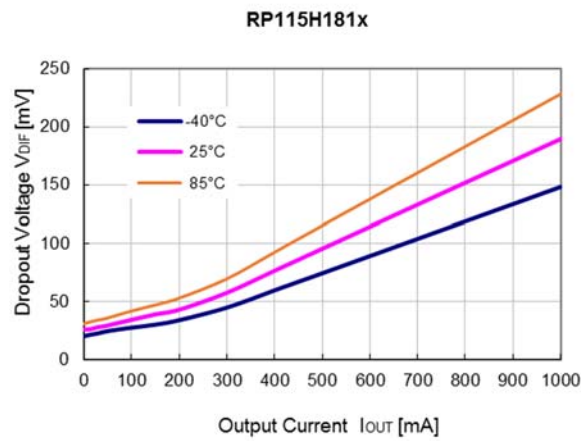


# RP115x

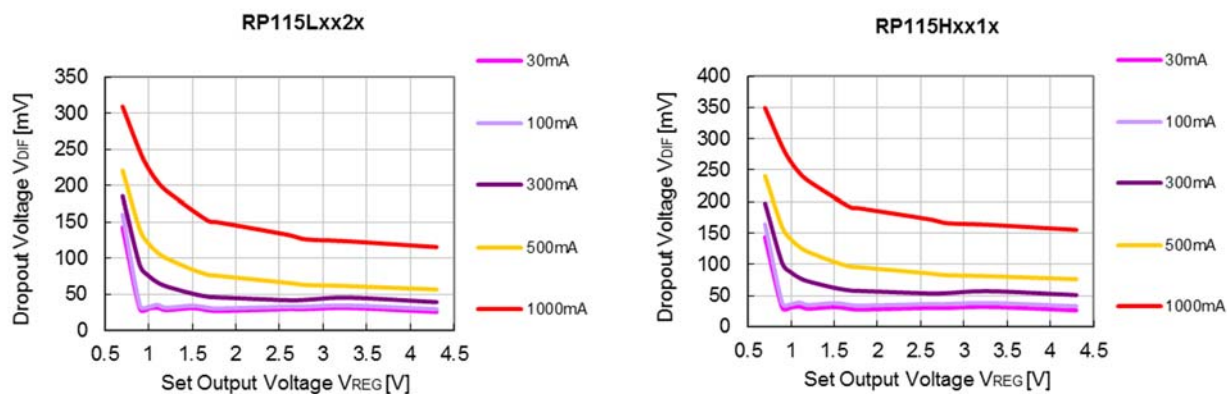
No. EC-390-201130



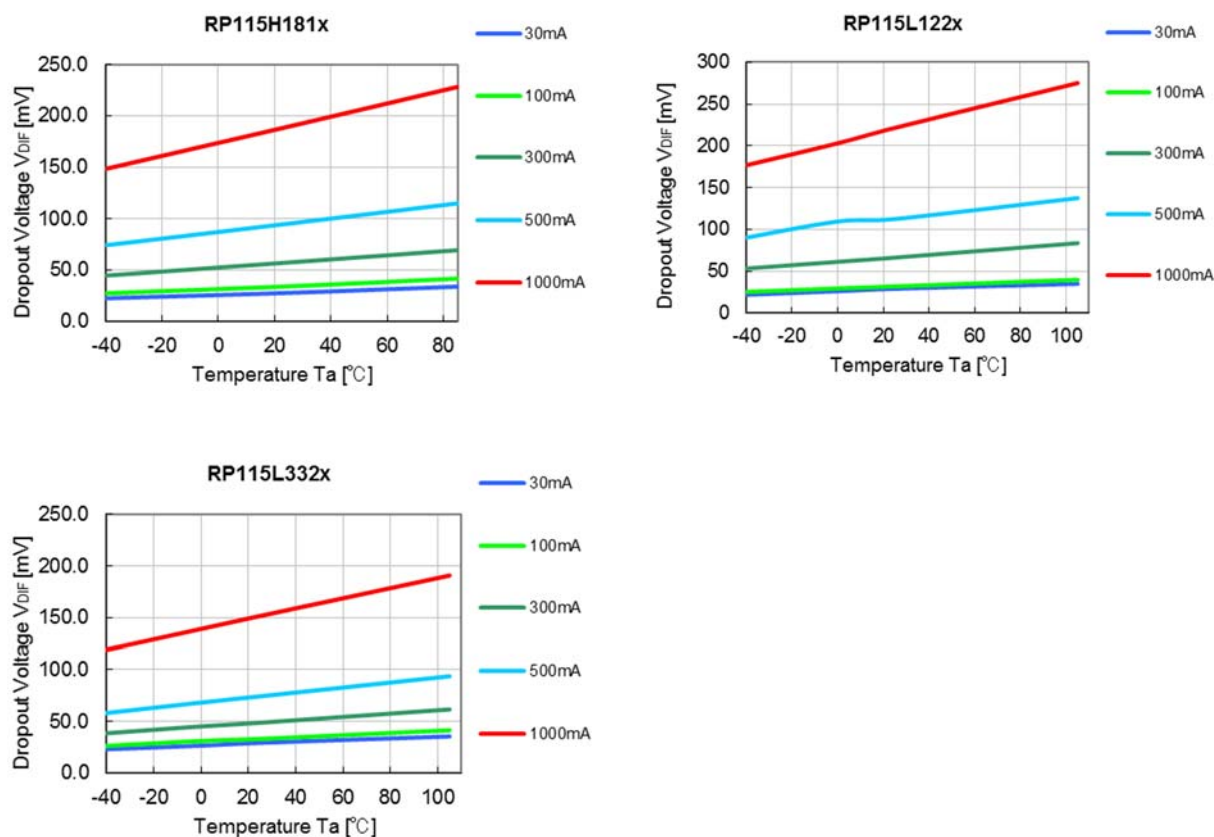
**7) Dropout Voltage vs. Output Current ( $C_{IN}$  = Ceramic 1.0  $\mu F$ ,  $C_{OUT}$  = Ceramic 1.0  $\mu F$ )**



8) Dropout Voltage vs. Set Output Voltage ( $C_{IN}$  = Ceramic 1.0  $\mu$ F,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F,  $T_a$  = 25°C)



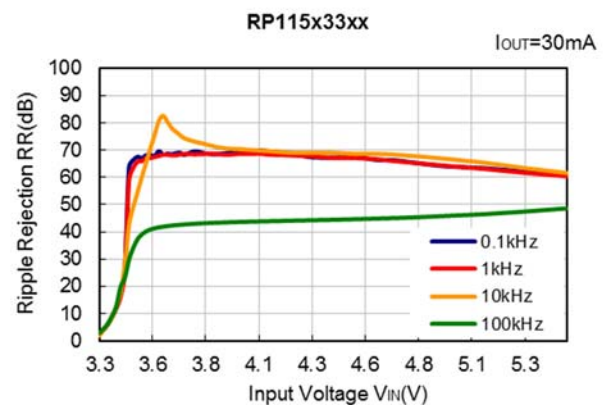
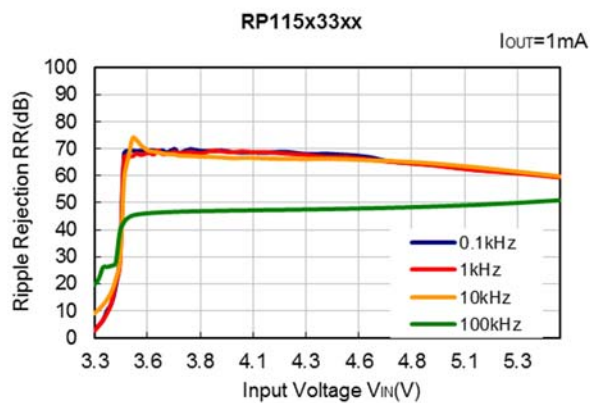
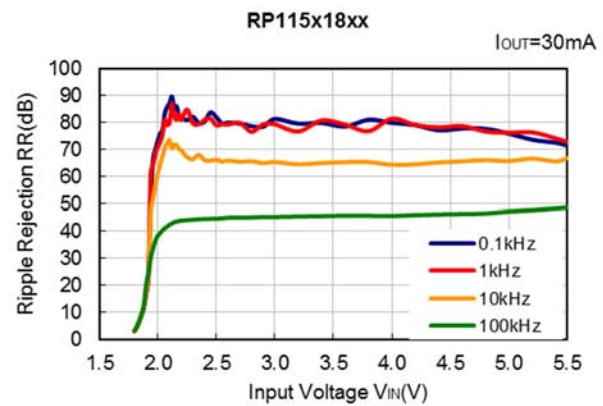
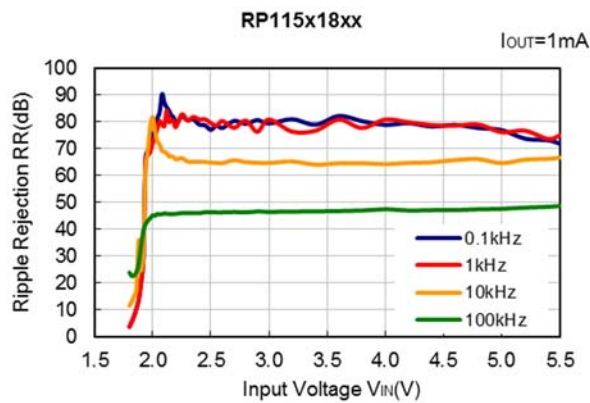
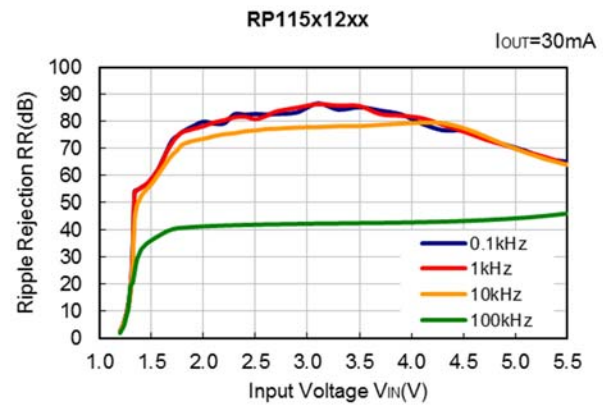
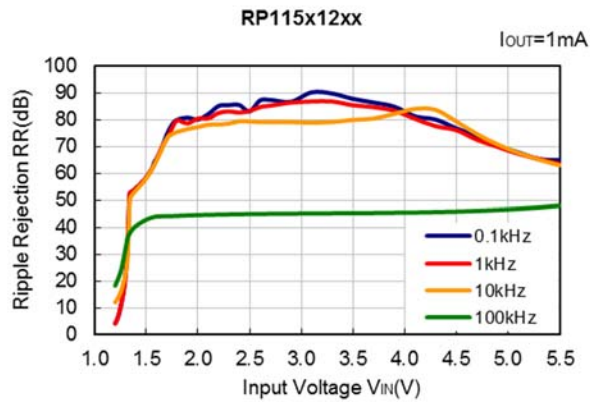
9) Dropout Voltage vs. Ambient Temperature ( $C_{IN}$  = Ceramic 1.0  $\mu$ F,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F)



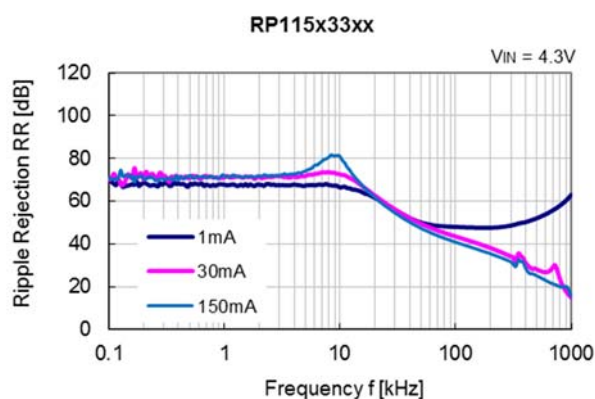
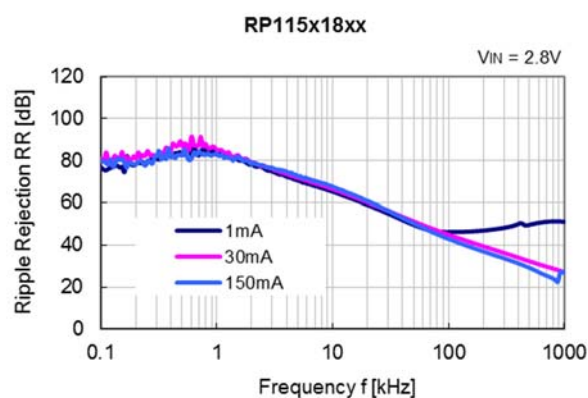
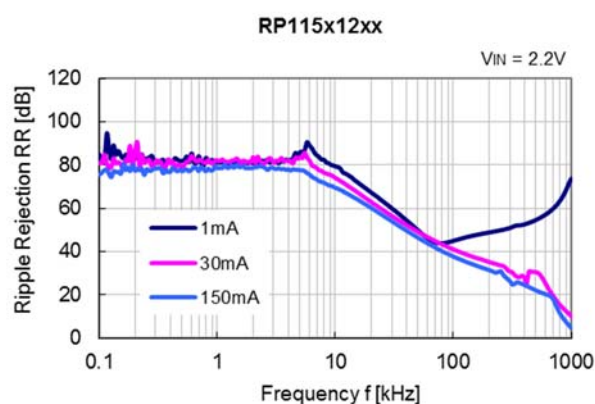
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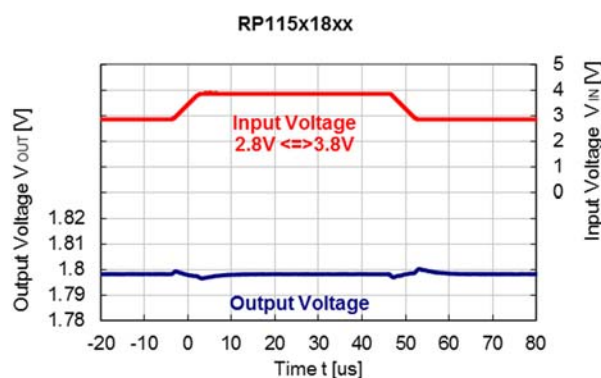
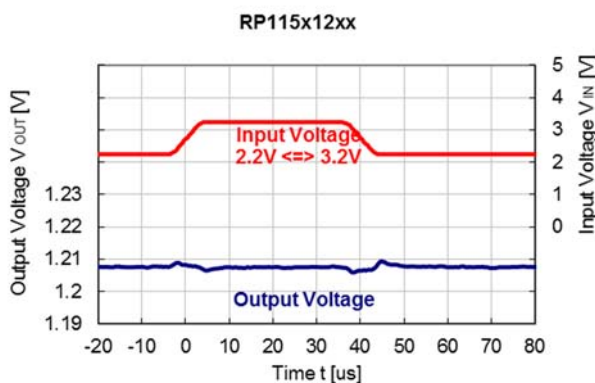
### 10) Ripple Rejection vs. Input Voltage ( $C_{IN}$ = none, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, Ripple = 0.2 Vp-p, $T_a$ = 25°C)



11) Ripple Rejection vs. Frequency ( $C_{IN}$  = none or 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F, Ripple = 0.2 Vp-p,  $T_a$  = 25°C)

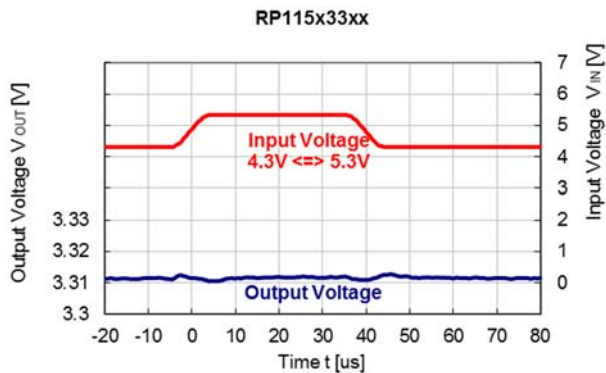


12) Line Transient Response ( $C_{IN}$  = none,  $C_{OUT}$  = Ceramic 1.0  $\mu$ F,  $I_{OUT}$  = 30 mA,  $t_r = t_f = 5 \mu$ s,  $T_a$  = 25°C)

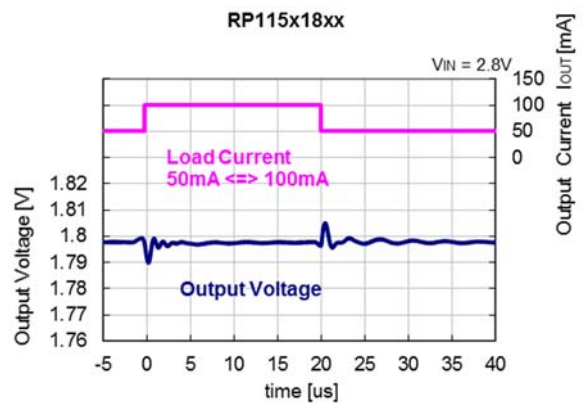
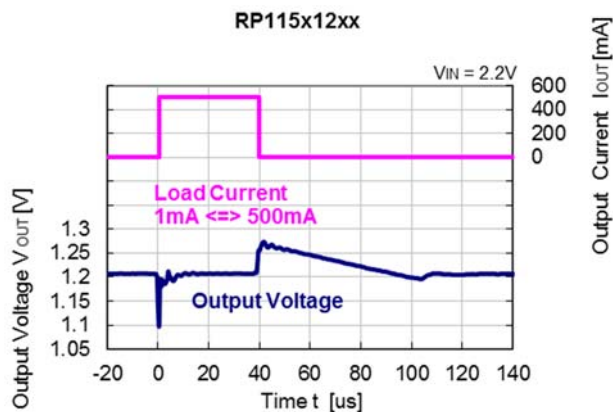
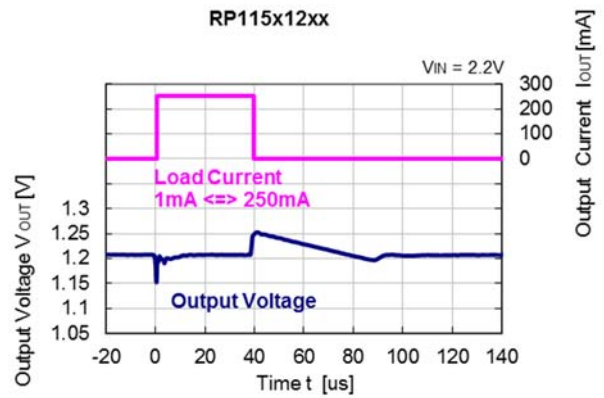
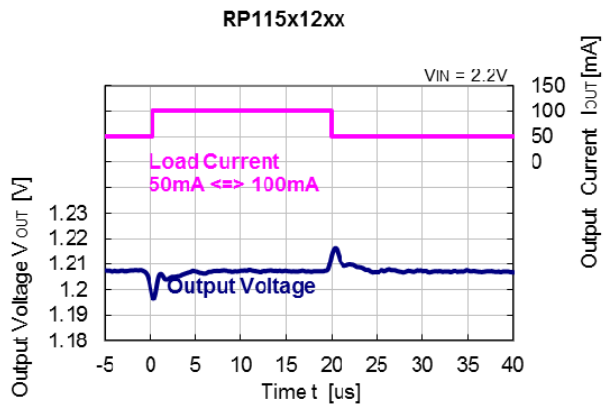


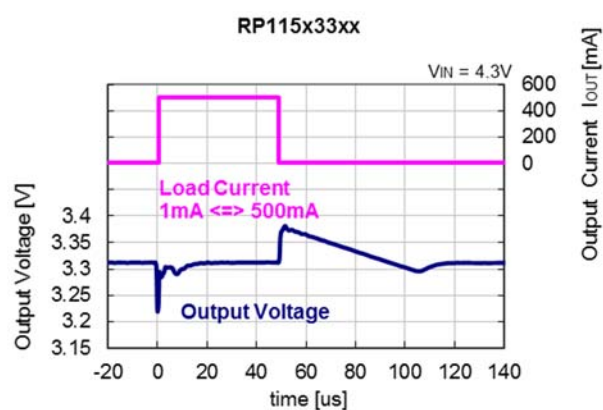
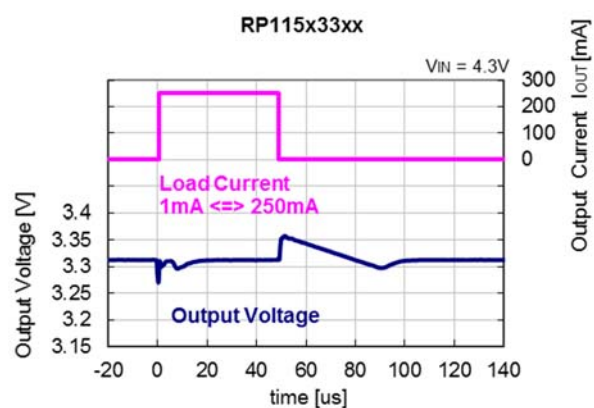
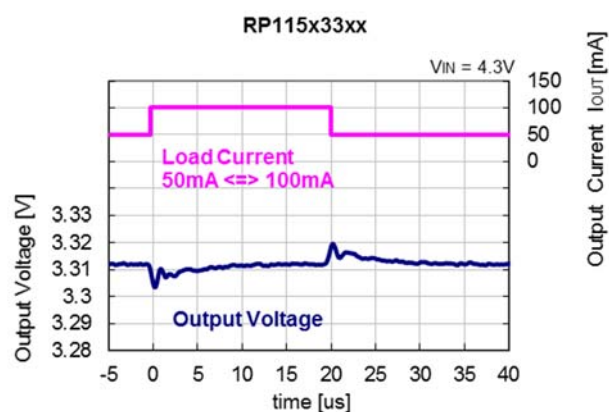
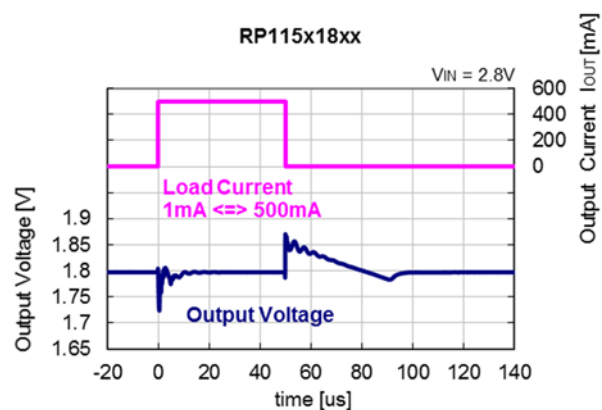
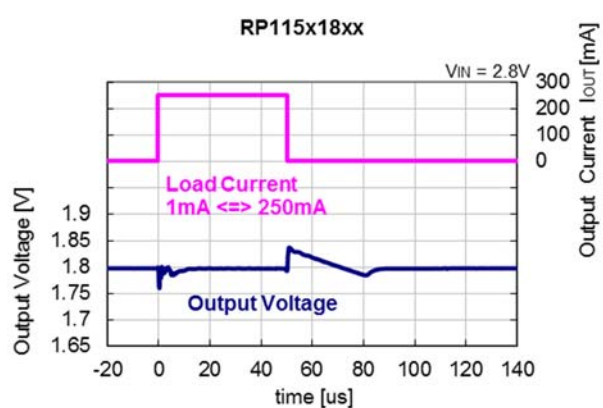
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### 13) Load Transient Response ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, $t_r = t_f = 0.5 \mu$ s, $T_a = 25^\circ\text{C}$ )

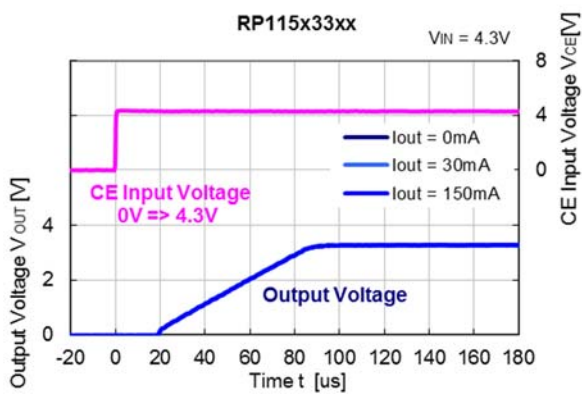
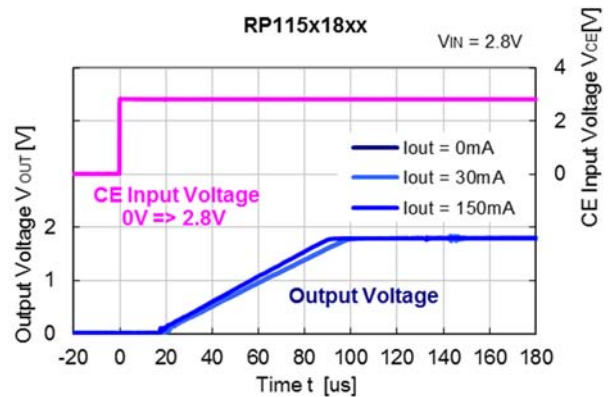
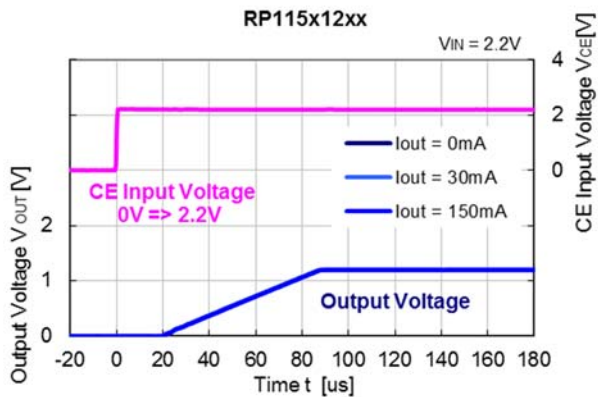




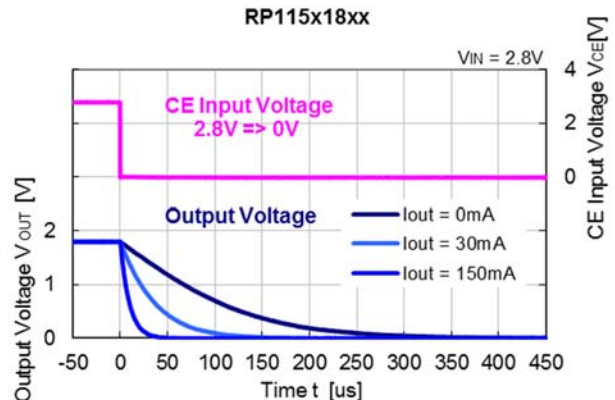
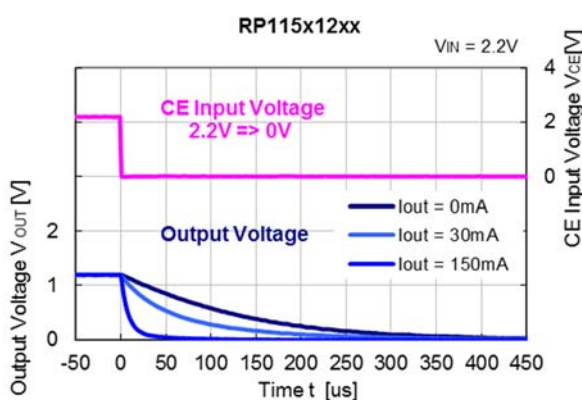
## RP115x

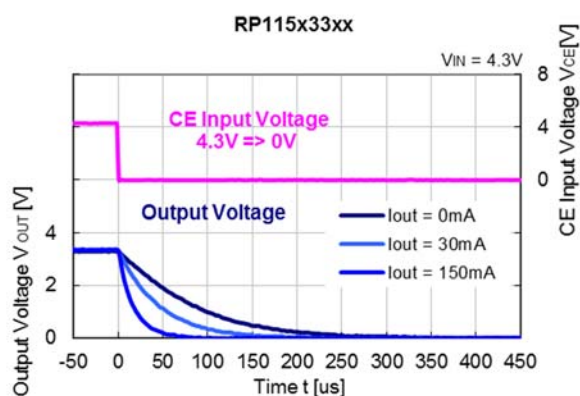
No. EC-390-201130

### 14) Turn-On Waveform Speed by CE Pin Signal ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, $T_a$ = 25°C)

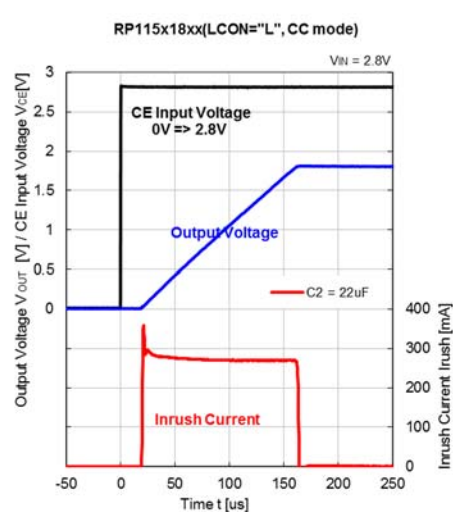
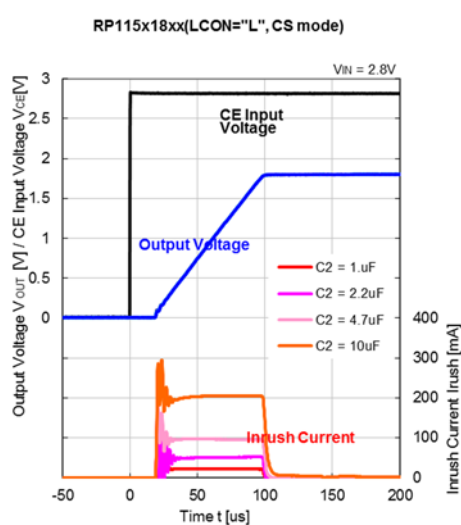
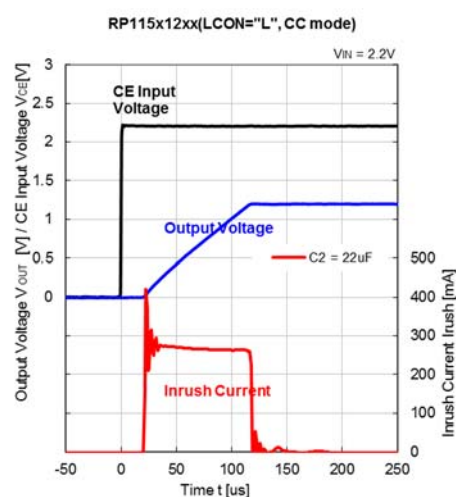
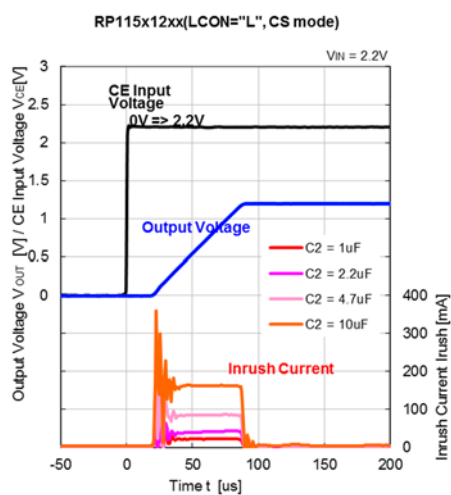


### 15) Turn-Off Waveform Speed by CE Pin Signal ( $C_{IN}$ = Ceramic 1.0 $\mu$ F, $C_{OUT}$ = Ceramic 1.0 $\mu$ F, $T_a$ = 25°C)



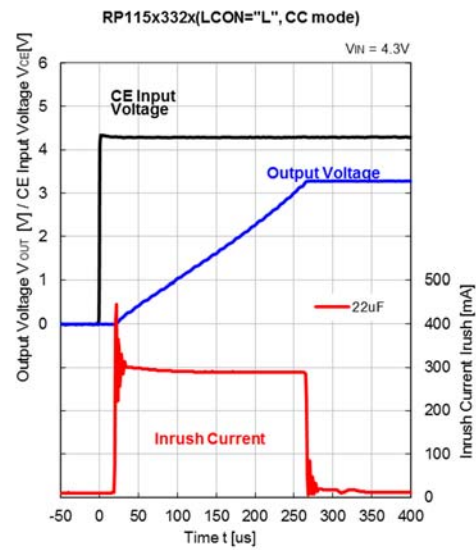
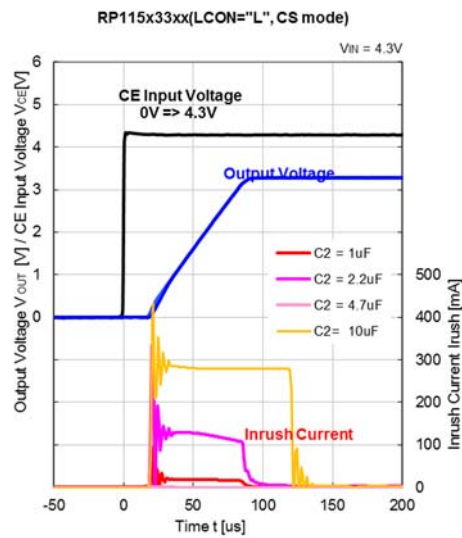


# 16) Inrush Current at Turning-On ( $C_{IN} = \text{Ceramic } 1.0 \mu F$ , $I_{OUT} = 0 mA$ , $T_a = 25^\circ C$ )

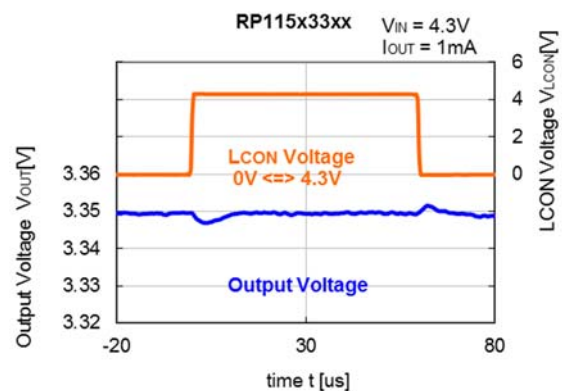
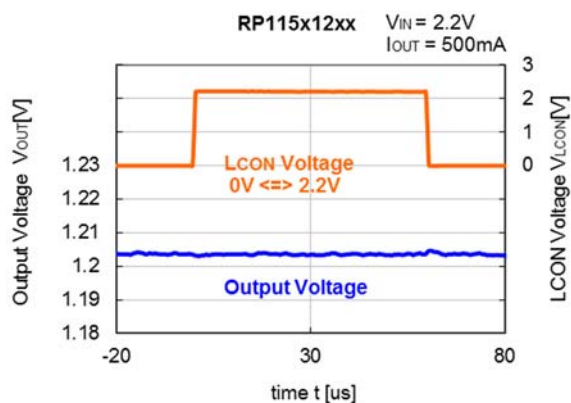
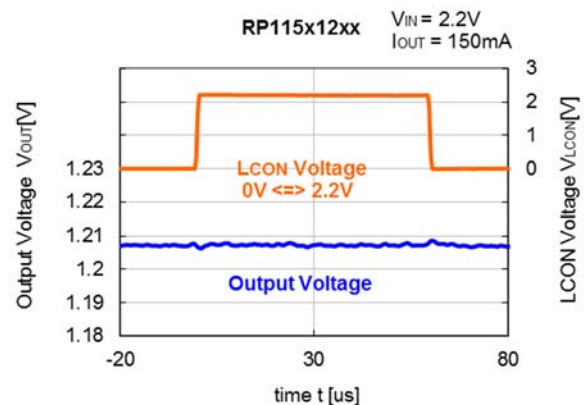
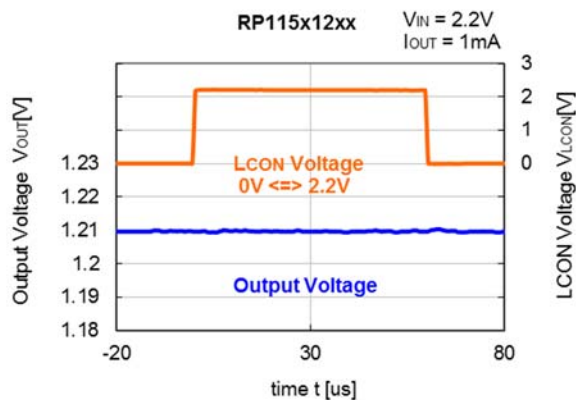


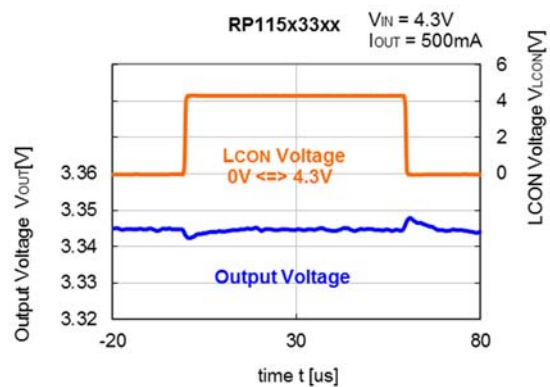
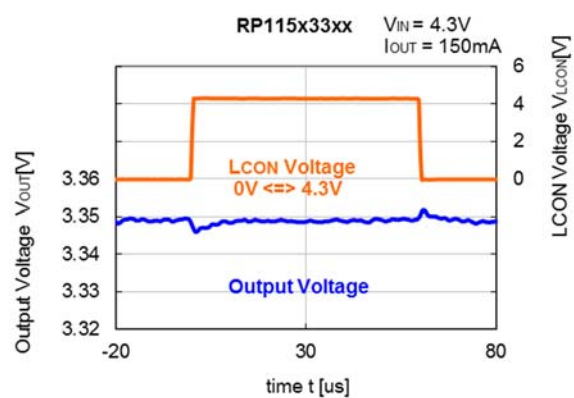
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### 17) LCON Transient Response ( $C_{IN}$ = Ceramic 1.0 $\mu F$ , $C_{OUT}$ = Ceramic 1.0 $\mu F$ , $t_r = t_f = 0.5 \mu s$ , $T_a = 25^\circ C$ )





The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

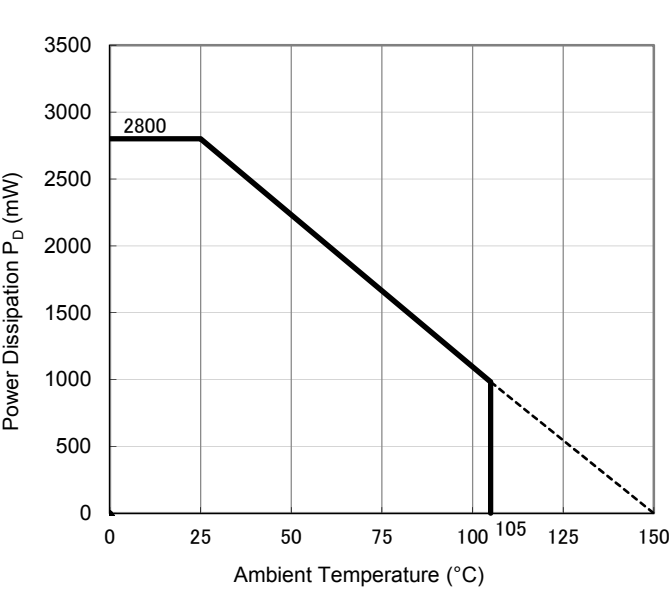
Measurement Conditions

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | 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-holes    | φ 0.3 mm × 23 pcs                                                                                                                                                                            |

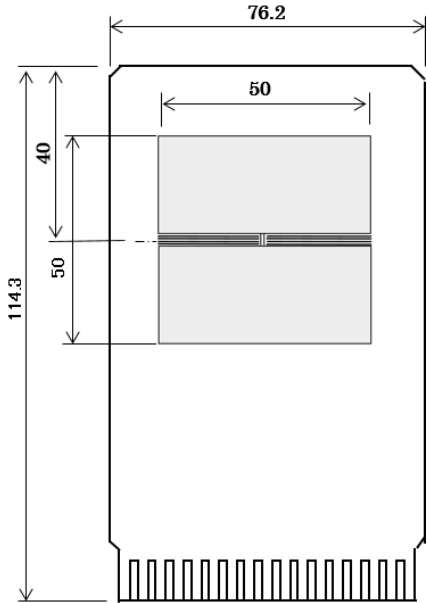
Measurement Result (Ta = 25°C, Tjmax = 150°C)

| Item                                     | Measurement Result |
|------------------------------------------|--------------------|
| Power Dissipation                        | 2800 mW            |
| Thermal Resistance (θja)                 | θja = 44°C/W       |
| Thermal Characterization Parameter (ψjt) | ψjt = 20°C/W       |

θja: Junction-to-Ambient Thermal Resistance  
ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature

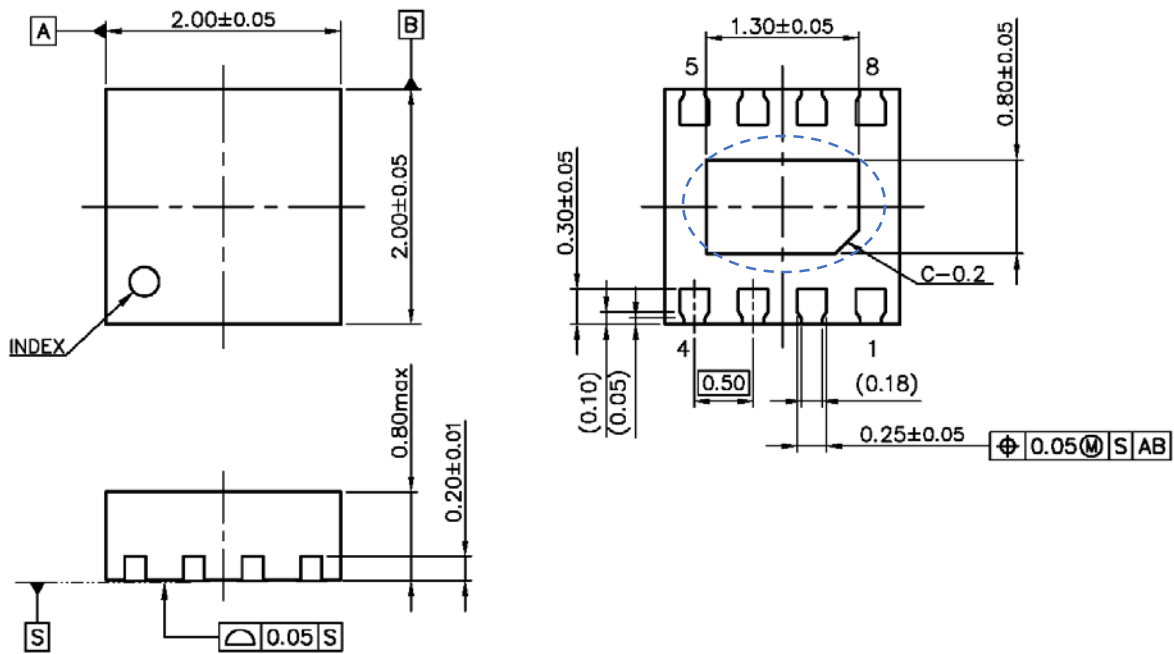


Measurement Board Pattern

## PACKAGE DIMENSIONS DFN2020-8B

## PACKAGE DIMENSIONS DFN2020-8B

Ver. A



### DFN2020-8B Package Dimensions (Unit: mm)

\* The tab on the bottom of the package is substrate level (GND). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

# RICOH

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

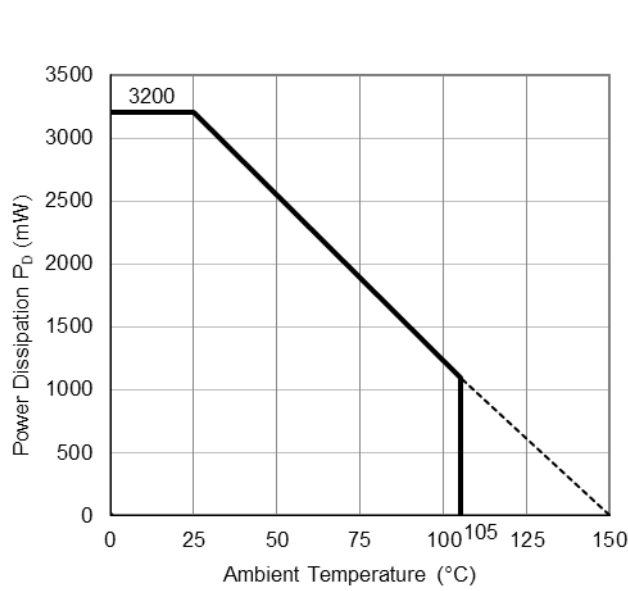
Measurement Conditions

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | 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-holes    | φ 0.3 mm × 13 pcs                                                                                                                                                                            |

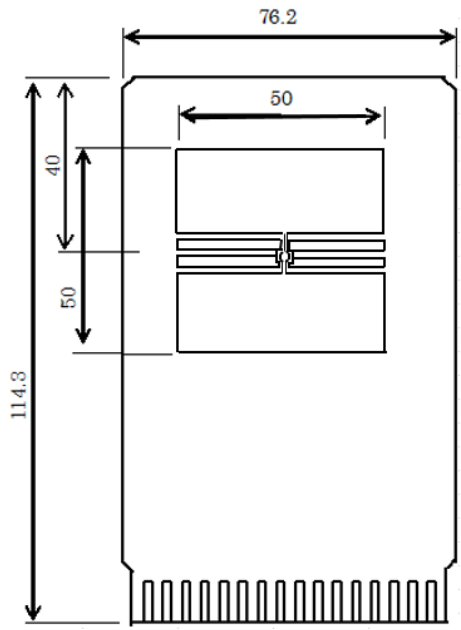
Measurement Result (Ta = 25°C, Tjmax = 150°C)

| Item                                     | Measurement Result |
|------------------------------------------|--------------------|
| Power Dissipation                        | 3200 mW            |
| Thermal Resistance (θja)                 | θja = 38°C/W       |
| Thermal Characterization Parameter (ψjt) | ψjt = 13°C/W       |

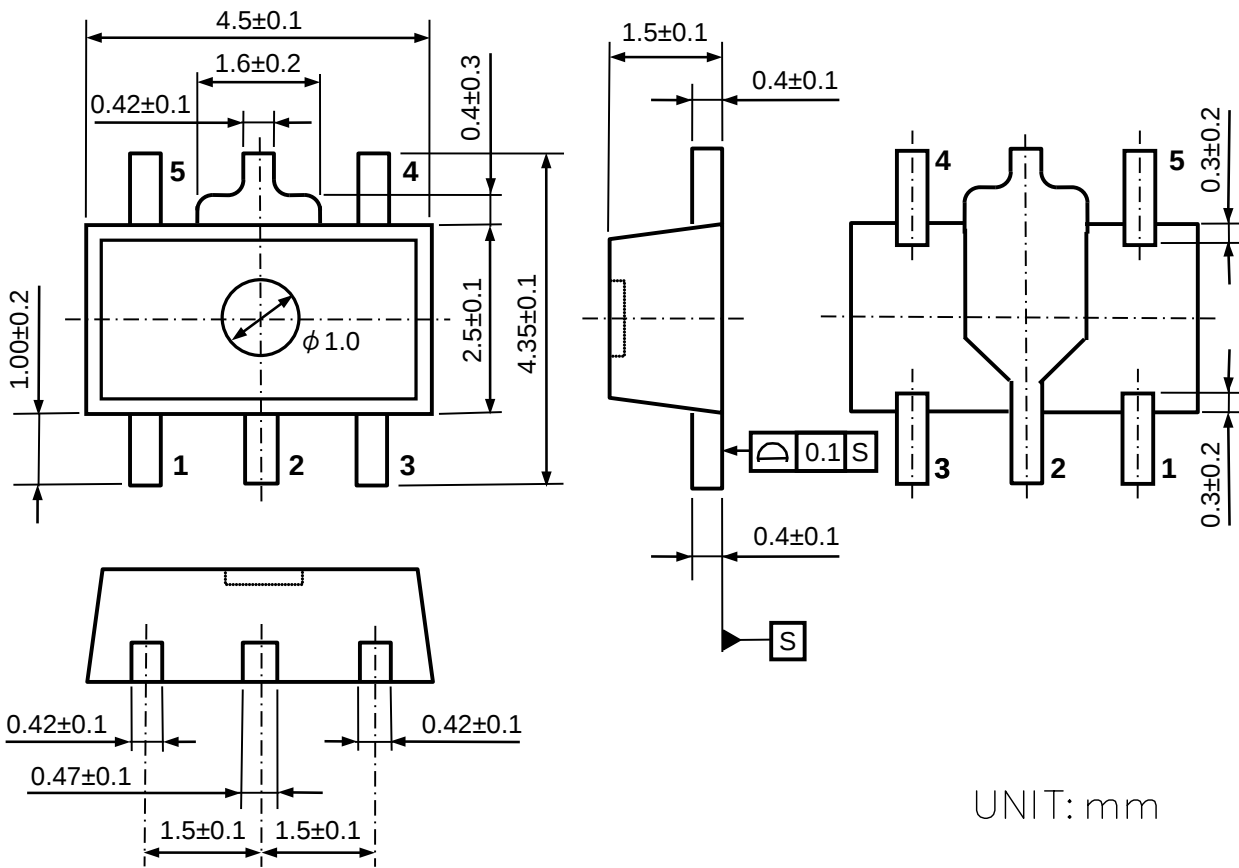
θja: Junction-to-Ambient Thermal Resistance  
ψjt: Junction-to-Top Thermal Characterization Parameter



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern



SOT-89-5 Package Dimensions



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