

### Low Input Voltage 3A LDO Regulator

NO.EA-203-150817

## OUTLINE

The RP108J is a CMOS-based voltage regulator IC featuring 3A output with low ON-resistance.

The RP108J consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a fold-back protection circuit, and a thermal shutdown circuit. The RP108J features both low supply current and high output current, and the dropout voltage is much smaller than bi-polar's. The minimum input voltage is as low as 1.6V and the output voltage can be set from 0.8V, therefore it can be connected with the DC/DC converter as the latter power supply for high density LSI that is operated by low output voltage.

The output voltage of RP108J081x is externally adjustable by using external divide resistors. The CE pin of the RP108J can switch the regulator to standby mode. In addition to a fold-back protection circuit, which is already built in the conventional regulators, The RP108J contains a thermal shutdown circuit, a constant slope circuit as a soft-start function and a reverse current protection circuit. Ceramic capacitors can be used.

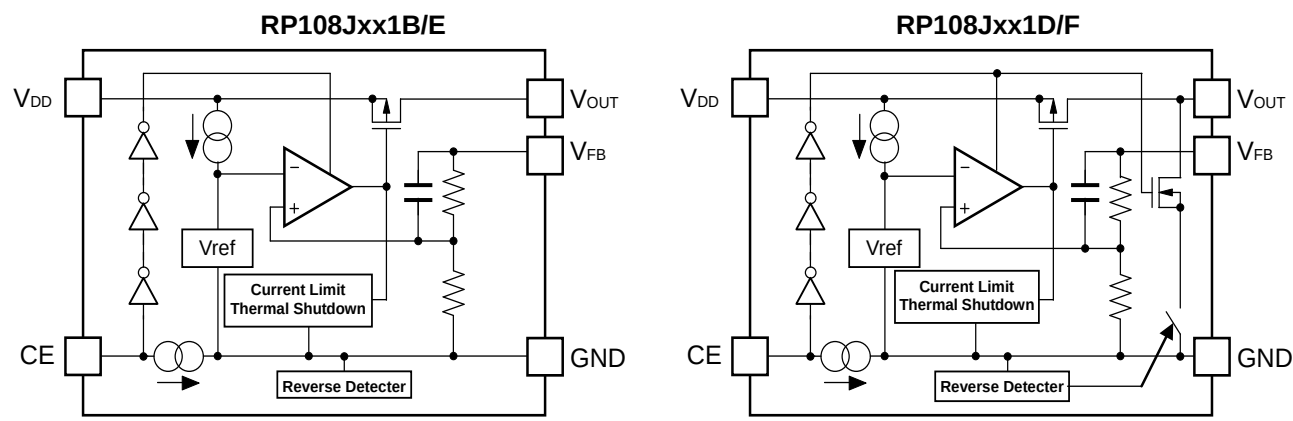
## FEATURES

- Output Current ..... Min. 3A
- Supply Current ..... Typ. 350 $\mu$ A
- Standby Current ..... Typ. 2 $\mu$ A
- Input Voltage Range ..... 1.6V to 5.25V
- Output Voltage Range ..... Fixed Output Voltage Type: 0.8V to 4.2V (0.1V steps)  
 \* Refer to *MARK INFORMATION*S for other voltages.  
 Adjustable Output Voltage Type: 0.8V to 4.2V
- Output Voltage Accuracy .....  $\pm 1.0\%$  ( $\pm 15$ mV accuracy, When  $V_{SET} \leq 1.5$ V)
- Output Voltage Temperature-drift Coefficient ..... Typ.  $\pm 100$ ppm/ $^{\circ}$ C
- Ripple Rejection ..... Typ. 65dB ( $f = 1$ kHz,  $V_{SET} = 2.8$ V)
- Dropout Voltage ..... Typ. 0.51V ( $V_{SET} = 2.8$ V)
- Line Regulation ..... Typ. 0.1%/V
- Package ..... TO-252-5-P2
- Built-in Fold-back Protection Circuit ..... Typ. 220mA
- Built-in Thermal Shutdown Circuit ..... Stops at 165 $^{\circ}$ C
- Built-in Constant Slope Circuit
- Built-in Reverse Current Protection Circuit
- Ceramic capacitors are recommended to be used with this IC .... 10 $\mu$ F or more

## APPLICATIONS

- Power source for battery-powered equipments.
- Power source for portable communication equipments such as cameras and VCRs.
- Power source for electrical home appliances.

BLOCK DIAGRAMS



SELECTION GUIDE

The output voltage, auto discharge function, and the soft-start time for the ICs can be selected at the user's request.

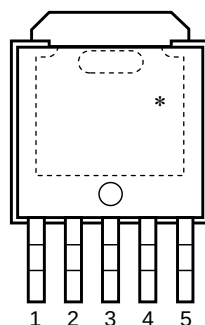
| Product Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Package     | Quantity per Reel | Pb Free | Halogen Free |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------------|---------|--------------|
| RP108Jxx1*(y) -T1-FE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | TO-252-5-P2 | 3,000 pcs         | Yes     | Yes          |
| <p>xx: The set output voltage (<math>V_{SET}</math>) can be designated in the range of 0.8V(08) to 4.2V(42) in 0.1V steps.</p> <p>y: If the output voltage includes the 3rd digit, indicate the digit of 0.01V.</p> <p>(1.25V, 1.85V, 2.85V)</p> <p>Ex. If the output voltage is 1.25V, RP108J121*5-T1-FE.</p> <p>    If the output voltage is 1.85V, RP108J181*5-T1-FE.</p> <p>    If the output voltage is 2.85V, RP108J281*5-T1-FE.</p> <p>*: Designation of auto-discharge function at off state and the soft-start time</p> <p>(B) No auto-discharge function, soft start time typ. 180 <math>\mu</math>s</p> <p>(D) Auto-discharge function, soft start time typ. 180 <math>\mu</math>s</p> <p>(E) No auto-discharge function, soft start time typ. 570 <math>\mu</math>s</p> <p>(F) Auto-discharge function, soft start time typ. 570 <math>\mu</math>s</p> |             |                   |         |              |

Auto-discharge function quickly lowers the output voltage to 0V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

Refer to *CONSTANT SLOPE CIRCUIT* for detailed information on the difference of soft-start time and its effect.

## PIN DESCRIPTIONS

TO-252-5-P2



TO-252-5-P2

| Pin No. | Symbol           | Description                  |
|---------|------------------|------------------------------|
| 1       | CE               | Chip Enable Pin ("H" Active) |
| 2       | V <sub>DD</sub>  | Input Pin                    |
| 3       | GND              | Ground Pin                   |
| 4       | V <sub>OUT</sub> | Output Pin                   |
| 5       | V <sub>FB</sub>  | Feedback Pin                 |

\*1 The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

The V<sub>OUT</sub> pin should be connected to the V<sub>FB</sub> pin when using RP108J as an internal fixed output voltage type. In case of using RP108J as an external adjustable type, please refer to "Adjustable Output Voltage Type Settings".

**ABSOLUTE MAXIMUM RATINGS**

| Symbol           | Item                                |                           | Rating                       | Unit |
|------------------|-------------------------------------|---------------------------|------------------------------|------|
| V <sub>IN</sub>  | Input Voltage                       |                           | 6.0                          | V    |
| V <sub>CE</sub>  | Input Voltage (CE Input Pin)        |                           | −0.3 to 6.0                  | V    |
| V <sub>FB</sub>  | Input Voltage (V <sub>FB</sub> Pin) |                           | −0.3 to 6.0                  | V    |
| V <sub>OUT</sub> | Output Voltage                      |                           | −0.3 to V <sub>IN</sub> +0.3 | V    |
| P <sub>D</sub>   | Power Dissipation (TO-252-5-P2)*1   | High Wattage Land Pattern | 3800                         | mW   |
|                  |                                     | Standard Land Pattern     | 1900                         |      |
| T <sub>a</sub>   | Operating Temperature               |                           | −40 to 85                    | °C   |
| T <sub>stg</sub> | Storage Temperature                 |                           | −55 to 125                   | °C   |

\*1 For Power Dissipation, please refer to *PACKAGE INFORMATION*.

**ABSOLUTE MAXIMUM RATINGS**

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages 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.

## ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{SET} + 1.0V$ ,  $I_{OUT} = 1mA$ ,  $C_{IN} = C_{OUT} = 10\mu F$ , unless otherwise noted.

The specifications surrounded by   are guaranteed by design engineering at  $-40^{\circ}C \leq T_a \leq 85^{\circ}C$ .

## RP108Jxx1B/D/E/F

(Ta=25°C)

| Symbol                               | Item                                               | Conditions                                                                                                                        |                         | Min.  | Typ. | Max.  | Unit   |
|--------------------------------------|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------|------|-------|--------|
| V <sub>OUT</sub>                     | Output Voltage                                     | Ta = 25°C                                                                                                                         | V <sub>SET</sub> > 1.5V | ×0.99 |      | ×1.01 | V      |
|                                      |                                                    |                                                                                                                                   | V <sub>SET</sub> ≤ 1.5V | -15   |      | 15    | mV     |
|                                      |                                                    | -40°C ≤ Ta ≤ 85°C                                                                                                                 | V <sub>SET</sub> > 1.5V | ×0.97 |      | ×1.02 | V      |
|                                      |                                                    |                                                                                                                                   | V <sub>SET</sub> ≤ 1.5V | -45   |      | 30    | mV     |
| I <sub>LIM</sub>                     | Output Current Limit                               |                                                                                                                                   |                         | 3.0   |      |       | A      |
| ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub> | Load regulation                                    | 1mA ≤ I <sub>OUT</sub> ≤ 300mA                                                                                                    |                         | -15   | 2.0  | 20    | mV     |
|                                      |                                                    | 1mA ≤ I <sub>OUT</sub> ≤ 3000mA                                                                                                   |                         | -70   | 3.0  | 50    |        |
| V <sub>DIF</sub>                     | Dropout Voltage                                    | Please refer to <i>Dropout Voltage</i> on the next page.                                                                          |                         |       |      |       |        |
| I <sub>SS</sub>                      | Supply Current                                     | I <sub>OUT</sub> = 0mA                                                                                                            |                         |       | 350  | 500   | μA     |
| I <sub>standby</sub>                 | Standby Current                                    | V <sub>CE</sub> = 0V                                                                                                              |                         |       | 2.0  | 5.0   | μA     |
| ΔV <sub>OUT</sub> /ΔV <sub>IN</sub>  | Line Regulation                                    | V <sub>SET</sub> +0.5V ≤ V <sub>IN</sub> ≤ 5.25V, I <sub>OUT</sub> =1mA<br>(When V <sub>SET</sub> ≤ 1.1V, V <sub>IN</sub> = 1.6V) |                         |       | 0.10 | 0.15  | %/V    |
| V <sub>IN</sub>                      | Input Voltage*1                                    |                                                                                                                                   |                         | 1.6   |      | 5.25  | V      |
| RR                                   | Ripple Rejection                                   | f = 1kHz,<br>Ripple 0.2Vp-p<br>I <sub>OUT</sub> =100mA                                                                            | V <sub>SET</sub> ≤ 2.8V |       | 65   |       | dB     |
|                                      |                                                    |                                                                                                                                   | V <sub>SET</sub> > 2.8V |       | 55   |       | dB     |
| ΔV <sub>OUT</sub> /ΔTa               | Output Voltage Temperature Coefficient             | -40°C ≤ Ta ≤ 85°C                                                                                                                 |                         |       | ±100 |       | ppm/°C |
| I <sub>SC</sub>                      | Short Current Limit                                | V <sub>OUT</sub> = 0V                                                                                                             |                         |       | 220  |       | mA     |
| I <sub>PD</sub>                      | CE Pull-down Current                               |                                                                                                                                   |                         |       | 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      |
| en                                   | Output Noise                                       | BW = 10Hz to 100kHz                                                                                                               |                         |       | 70   |       | μVrms  |
| T <sub>TSD</sub>                     | Thermal Shutdown Temperature                       | Junction Temperature                                                                                                              |                         |       | 165  |       | °C     |
| T <sub>TSR</sub>                     | Thermal Shutdown Released Temperature              | Junction Temperature                                                                                                              |                         |       | 95   |       | °C     |
| R <sub>LOW</sub>                     | Auto-discharge Nch Tr. ON Resistance (D/F version) | V <sub>IN</sub> = 4.0V, V <sub>CE</sub> = 0V                                                                                      |                         |       | 30   |       | Ω      |
| I <sub>REV</sub>                     | Reverse Current Limit                              | V <sub>OUT</sub> > 0.5V, 0V ≤ V <sub>IN</sub> ≤ 5.25V                                                                             |                         |       | 10   |       | μA     |

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

\*1 The maximum input voltage listed under *Electrical Characteristics* is 5.25V. If for any reason the input voltage exceeds 5.25V, it has to be no more than 5.5V with 500 cumulative operating hours.

The specifications surrounded by   are guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$ .

### Dropout Voltage by Output Voltage

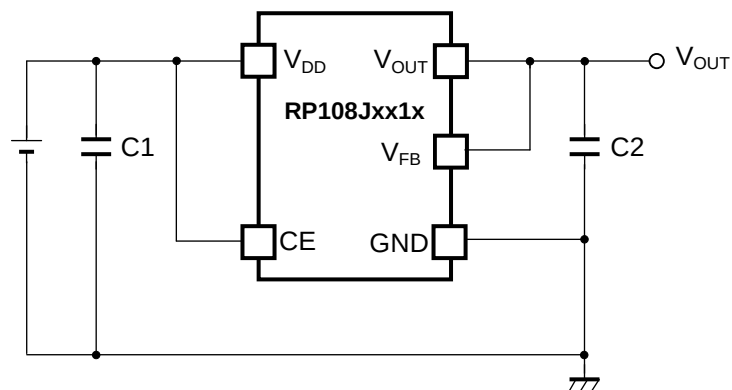
( $T_a=25^{\circ}\text{C}$ )

| Output Voltage<br>$V_{\text{SET}}$ (V) | Dropout Voltage<br>$V_{\text{DIF}}$ (V) |       |                                                                     |
|----------------------------------------|-----------------------------------------|-------|---------------------------------------------------------------------|
|                                        | Condition                               | Typ.  | Max.                                                                |
| $0.8 \leq V_{\text{SET}} < 0.9$        | $I_{\text{OUT}}=3000\text{mA}$          | 0.910 | <span style="border: 1px solid black; padding: 0 5px;">1.110</span> |
| $0.9 \leq V_{\text{SET}} < 1.0$        |                                         | 0.865 | <span style="border: 1px solid black; padding: 0 5px;">1.000</span> |
| $1.0 \leq V_{\text{SET}} < 1.1$        |                                         | 0.810 | <span style="border: 1px solid black; padding: 0 5px;">0.950</span> |
| $1.1 \leq V_{\text{SET}} < 1.2$        |                                         | 0.755 | <span style="border: 1px solid black; padding: 0 5px;">0.895</span> |
| $1.2 \leq V_{\text{SET}} < 1.5$        |                                         | 0.720 | <span style="border: 1px solid black; padding: 0 5px;">0.840</span> |
| $1.5 \leq V_{\text{SET}} < 2.5$        |                                         | 0.630 | <span style="border: 1px solid black; padding: 0 5px;">0.760</span> |
| $2.5 \leq V_{\text{SET}} < 3.3$        |                                         | 0.510 | <span style="border: 1px solid black; padding: 0 5px;">0.600</span> |
| $3.3 \leq V_{\text{SET}} \leq 4.2$     |                                         | 0.480 | <span style="border: 1px solid black; padding: 0 5px;">0.560</span> |

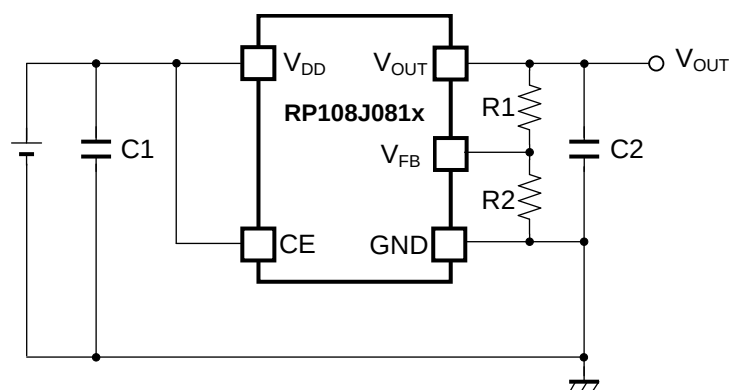
### RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

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.

## TYPICAL APPLICATIONS



Typical Application



Typical application for adjustable output voltage type

External Components :

| Symbol | Descriptions                                   |
|--------|------------------------------------------------|
| C1, C2 | 10 $\mu$ F (Ceramic), CM21X7R106M06AB, KYOCERA |

## TECHNICAL NOTES

When using the RP108J as an internally fixed output voltage type, please connect the  $V_{OUT}$  pin to the  $V_{FB}$  pin. However, when using it as the Adjustable Output Voltage Type, The output voltage of the externally adjustable output voltage type should be set to 4.2V or less. Also, total resistors value of R1 and R2 should be 20k $\Omega$  or less.

### Phase Compensation

In the IC, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a 10 $\mu$ F or more capacitor C2.

In case of using a tantalum capacitor and its ESR is large, the output may be unstable. Therefore, select C2 carefully considering its frequency characteristics.

The recommended temperature characteristics for C1 and C2 capacitors are the followings.

- B Characteristics: Temperature range from  $-25^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Capacitance change of  $\pm 10\%$
- X5R Characteristics: Temperature range from  $-55^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ , Capacitance change of  $\pm 15\%$
- X7R Characteristics: Temperature range from  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ , Capacitance change of  $\pm 15\%$

The recommended capacitor's tolerable voltage is twice as large as the voltage of use (C1: Input voltage, C2: Output voltage). The upper limit of the capacitance value for C2 is 100 $\mu$ F.

However, the increase of C2 leads to the increase of inrush current. Refer to *CONSTANT SLOPE CIRCUIT* for detailed information.

### PCB Layout

Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result.

Connect a capacitor C1 with a capacitance value as much as 10 $\mu$ F or more between  $V_{DD}$  and GND pin, and as close as possible to the pins.

Set external components, especially the output capacitor C2, as close as possible to the ICs and make wiring as short as possible.

### Transient Response

When using the Adjustable Output Voltage Type, the transient response could be affected by the external resistors. Evaluate the circuit taking the actual conditions of use into account.



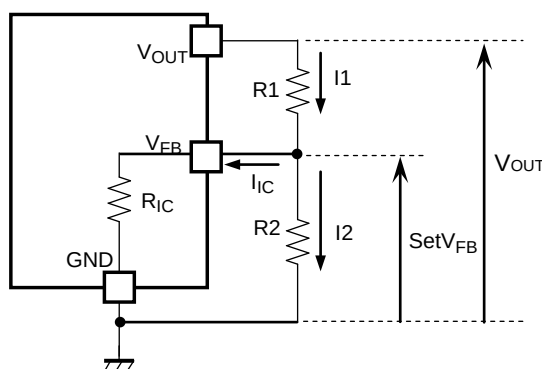
## ADJUSTABLE OUTPUT VOLTAGE TYPE SETTINGS

### • Output Voltage Setting Method

RP108J081x can be adjusted the output voltage by using the external divider resistors.

If the  $V_{FB}$  voltage fixed into the IC is described as  $SetV_{FB}$ , the output voltage can be set by using the following equations

$SetV_{FB}$  is equal to 0.8V. The  $V_{OUT}$  pin of RP108J081x should be connected to the  $V_{FB}$  pin.



$$I_1 = I_{IC} + I_2 \dots\dots\dots (1)$$

$$I_2 = SetV_{FB} / R_2 \dots\dots\dots (2)$$

Thus,

$$I_1 = I_{IC} + SetV_{FB} / R_2 \dots\dots\dots (3)$$

Therefore,

$$V_{OUT} = SetV_{FB} \times R_1 \times I_1 \dots\dots\dots (4)$$

Put Equation (3) into Equation (4), then

$$V_{OUT} \dots\dots\dots = SetV_{FB} + R_1(I_{IC} + SetV_{FB} / R_2) \dots\dots\dots (5)$$

In Equation (5),  $R_1 \times I_{IC}$  is the error-causing factor in  $V_{OUT}$ .

As for  $I_{IC}$ ,

$$I_{IC} = SetV_{FB} / R_{IC} \dots\dots\dots (6)$$

Therefore, the error-causing factor  $R_1 \times I_{IC}$  can be described as follows.

$$R_1 \times I_{IC} \dots\dots\dots = R_1 \times SetV_{FB} / R_{IC} \dots\dots\dots (7)$$

For better accuracy, choosing  $R_1 \ll R_{IC}$  reduces this error.

Without the error-causing factor  $R_1 \times I_{IC}$ , the output voltage can be calculated by the following equation

$$V_{OUT} = SetV_{FB} \times ((R_1 + R_2) / R_2) \dots\dots\dots (8)$$

$R_{IC}$  of RP108J is approximately Typ.1.6M $\Omega$  ( $T_a=25^\circ\text{C}$ , this value is guaranteed by design.).

The value could be affected by the temperature, therefore evaluate the circuit taking the actual conditions of use into account.

## REVERSE CURRENT PROTECTION CIRCUIT

The RP108J includes a Reverse Current Protection Circuit, which stops the reverse current from  $V_{OUT}$  pin to  $V_{DD}$  pin or to GND pin when  $V_{OUT}$  becomes higher than  $V_{IN}$ .

Usually, the LDO using Pch output transistor contains a parasitic diode between  $V_{DD}$  pin and  $V_{OUT}$  pin. Therefore, if  $V_{OUT}$  is higher than  $V_{IN}$ , the parasitic diode becomes forward direction. As a result, the current flows from  $V_{OUT}$  pin to  $V_{DD}$  pin.

The RP108J switches the mode to the reverse current protection mode before  $V_{IN}$  becomes lower than  $V_{OUT}$  by connecting the parasitic diode of Pch output transistor to the backward direction, and connecting the gate to  $V_{OUT}$  pin. As a result, the Pch output transistor is turned off and the all the current pathways from  $V_{OUT}$  pin to GND pin are shut down to maintain the reverse current lower than  $10\mu\text{A}$ .

Switching to either the normal mode or to the reverse current protection mode is determined by the magnitude of  $V_{IN}$  voltage and  $V_{OUT}$  voltage. For the stable operation, offset and hysteresis are set as the threshold. Offset is set to 30mV (Typ.25°C) and hysteresis is set to 5mV (Typ.25°C).

Therefore, the minimum dropout voltage under the small load current condition is restricted by the value of 35mV (Typ.25°C).

Fig.1 and Fig.2 show the diagrams of each mode, and Fig.3 shows the load characteristics of each mode. When giving the  $V_{OUT}$  pin a constant-voltage and decreasing the  $V_{IN}$  voltage, the dropout voltage will become lower than 30mV (Typ.25°C). As a result, the reverse current protection starts to function to stop the load current. By increasing the dropout voltage higher than 35mV (Typ.25°C), the protection mode will be released to let the load current to flow. If the dropout voltage to be used is lower than 30mV (Typ.25°C), the detection and the release may be repeated.

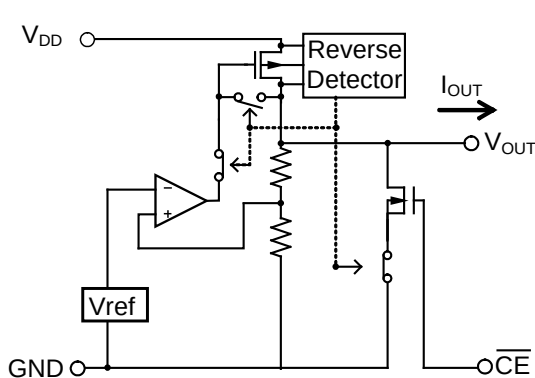


Fig.1 Normal Mode

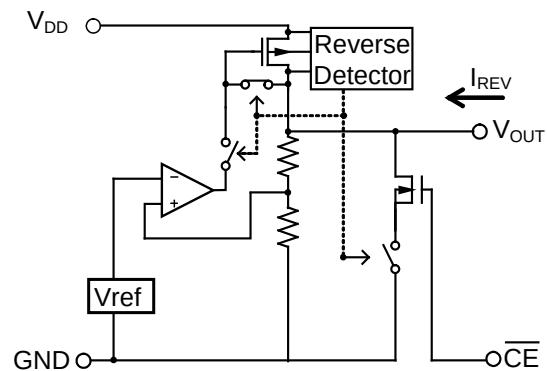


Fig.2 Reverse Current Protection Mode

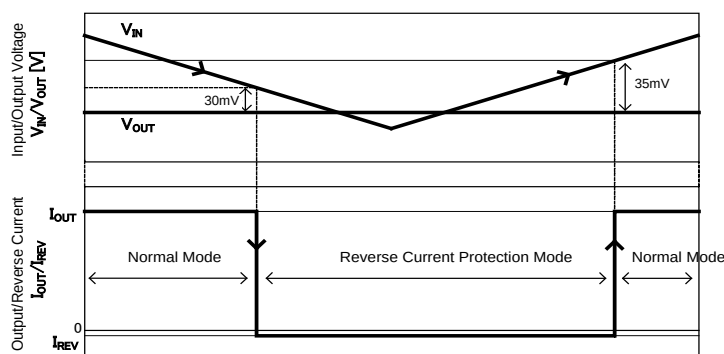


Fig. 3 Reverse Current Protection Mode Detection/ Release & Reverse Current/ Output Current Characteristics

## CONSTANT SLOPE CIRCUIT (RP108Jxx1B/xx1D)

RP108Jxx1B/xx1D has a Constant Slope Circuit (soft-start circuit) which allows the output voltage to start-up gradually. The capacitor to create the start-up slope is built-in the IC so that it does not require any external components. The upper limit of inrush current during the start-up is controlled by the short current ISC and the output current limit ILIM.

In the following characteristics  $C_{OUT} = 10 \mu\text{F}$  ( $R_{LOAD} = 380\Omega$ ), the inrush current  $I_{RUSH}$  is not controlled by the short current ISC and the output current limit ILIM. Therefore the output voltage rises with the soft-start time ( $T_{SLOPE}$ ) set inside IC, and it enables to control the overshoot of the output voltage and the inrush current.  $T_{SLOPE}$  is typ. 180  $\mu\text{s}$ .

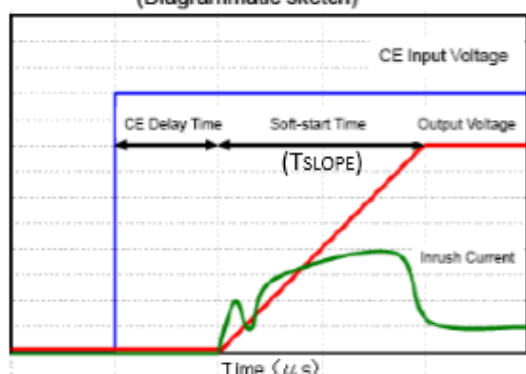
In the characteristics  $C_{OUT} = 20 \mu\text{F}$ ,  $I_{RUSH}$  at the low output voltage is controlled by the short current ISC. After the current is released from ISC, the output voltage rises with the soft-start time ( $T_{SLOPE}$ ).

In the characteristics  $C_{OUT} = 100 \mu\text{F}$ ,  $I_{RUSH}$  at the low output voltage is controlled by the short current ISC. After the current is released from ISC, it is controlled by the output current limit. The output voltage rises with the soft-start time ( $T_{SLOPE}$ ) or longer.

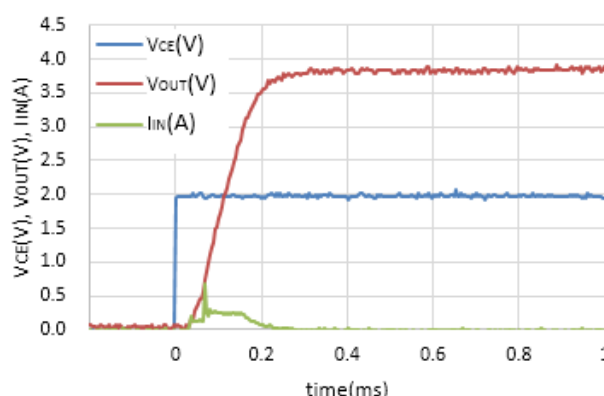
The relation of the inrush current and the constant slope depends on the output voltage since the inrush current is a sum of the charge current of  $C_{OUT}$  and the load current. Use RP108Jxx1E/xx1F to avoid an influence on peripheral components due to the inrush current generated in the use environment conditions ( $C_{OUT}$  and output voltage).

### RP108J381B/D Inrush current characteristics

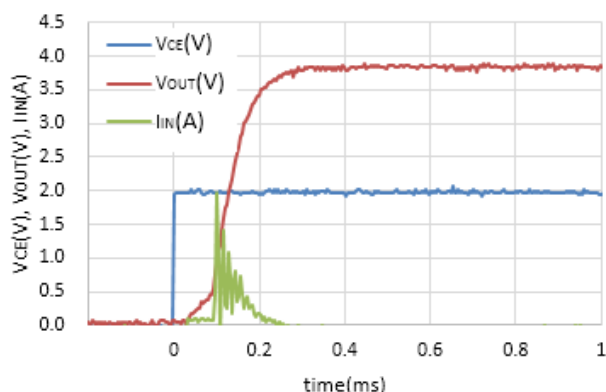
**Constant Slope Circuit**  
(Diagrammatic sketch)



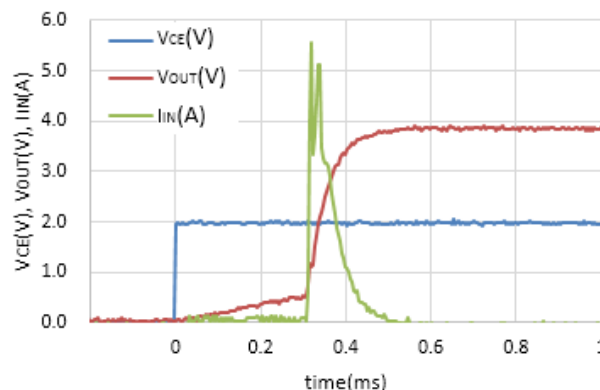
$C_{IN}=4.7\mu\text{F}$ ,  $C_{OUT}=10\mu\text{F}$ ,  $T_{opt}=25^\circ\text{C}$ ,  $R_{LOAD}=380\Omega$



$C_{IN}=4.7\mu\text{F}$ ,  $C_{OUT}=20\mu\text{F}$ ,  $T_{opt}=25^\circ\text{C}$ ,  $R_{LOAD}=380\Omega$



$C_{IN}=4.7\mu\text{F}$ ,  $C_{OUT}=100\mu\text{F}$ ,  $T_{opt}=25^\circ\text{C}$ ,  $R_{LOAD}=380\Omega$



## CONSTANT SLOPE CIRCUIT (RP108Jxx1E/xx1F)

RP108Jxx1E/xx1F has a constant slope circuit (soft-start circuit) which allows the output voltage to start-up gradually. The capacitor to create the start-up slope is built-in the IC so that it does not require any external components. The upper limit of inrush current during the start-up is controlled by the output current limit  $I_{LIM}$ .

As shown in the following Foldback Characteristics, the inrush current is not controlled by the short current  $I_{SC}$  during the soft-start time at the start-up. Therefore the output voltage rises with the soft-start time ( $T_{SLOPE}$ ) set inside IC, and it enables to control the overshoot of the output voltage and the inrush current.  $T_{SLOPE}$  is typ. 570  $\mu s$  (max. 900  $\mu s/85^{\circ}C$ ). Use RP108Jxx1B/xx1D to avoid an influence on peripheral components due to the output start-up time is slow in the system.

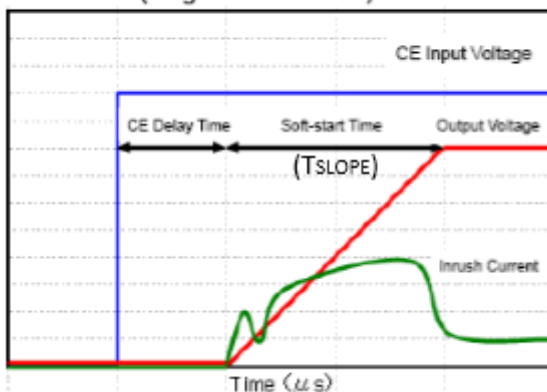
In the characteristics  $C_{OUT} = 20 \mu F$ , the inrush current is lower or equal to the output current limit  $I_{LIM}$ . The output voltage rises with the soft-start time ( $T_{SLOPE}$ ).

Similarly in the characteristics  $C_{OUT} = 100 \mu F$ , the inrush current is lower or equal to the output current limit  $I_{LIM}$ . The output voltage rises with the soft-start time ( $T_{SLOPE}$ ).

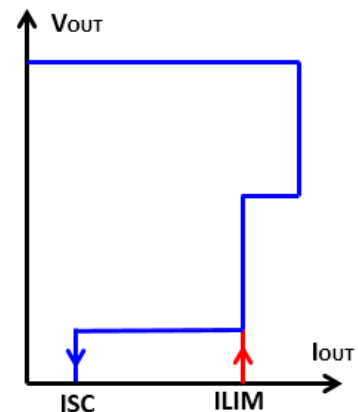
The relation of the inrush current and the constant slope depends on the output voltage since the inrush current is a sum of the charge current of  $C_{OUT}$  and the load current.

### RP108J381E/F Inrush current characteristics

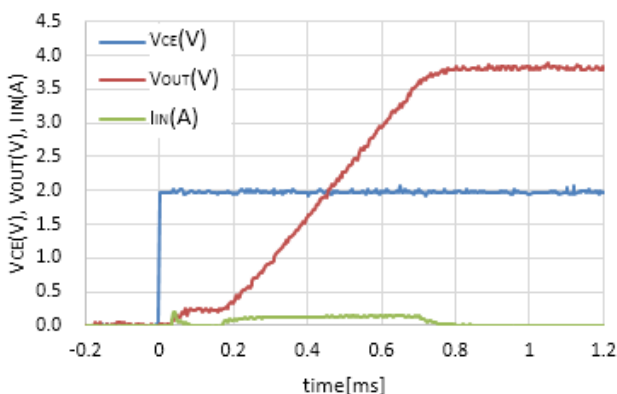
**Constant Slope Circuit**  
(Diagrammatic sketch)



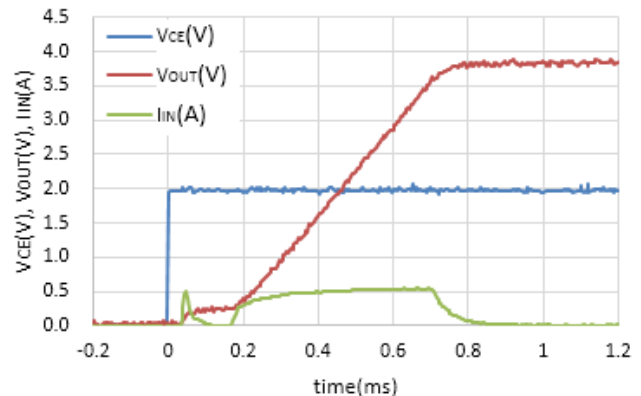
**Foldback Characteristics**  
(Diagrammatic sketch)



$C_{IN}=4.7\mu F$ ,  $C_{OUT}=20\mu F$ ,  $T_{opt}=25^{\circ}C$ ,  $R_{LOAD}=380\Omega$



$C_{IN}=4.7\mu F$ ,  $C_{OUT}=100\mu F$ ,  $T_{opt}=25^{\circ}C$ ,  $R_{LOAD}=380\Omega$



## PACKAGE INFORMATION

### Power Dissipation (TO-252-5-P2)

Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the Measurement Conditions below.

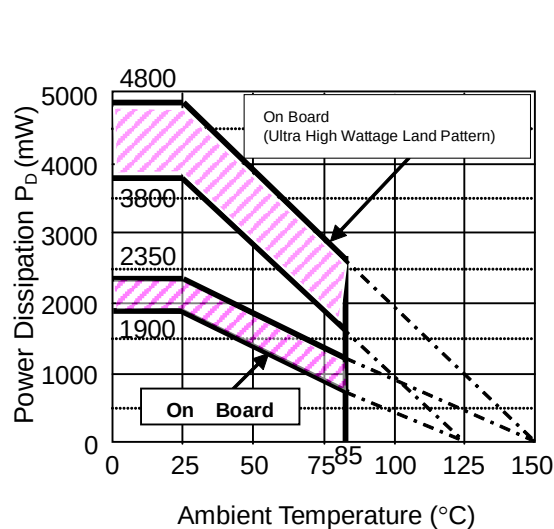
#### Measurement conditions

|                  | Ultra High Wattage Land Pattern                                                                               | Standard Land Pattern                            |
|------------------|---------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Environment      | Mounting on board (Wind velocity 0m/s)                                                                        |                                                  |
| Board Material   | Glass cloth epoxy plastic (Four-layers)                                                                       | Glass cloth epoxy plastic (Double layers)        |
| Board Dimensions | 76.2mm x 114.3mm x 0.8mm                                                                                      | 50mm x 50mm x 1.6mm                              |
| Copper Ratio     | Top, Back side: 50mm Square, Approx.96%,<br>2 <sup>nd</sup> , 3 <sup>rd</sup> Layer: 50mm Square, Approx.100% | Top side: Approx. 50%,<br>Back side: Approx. 50% |
| Through - Hole   | $\phi$ 0.4mm x 30pcs                                                                                          | $\phi$ 0.5mm x 24pcs                             |

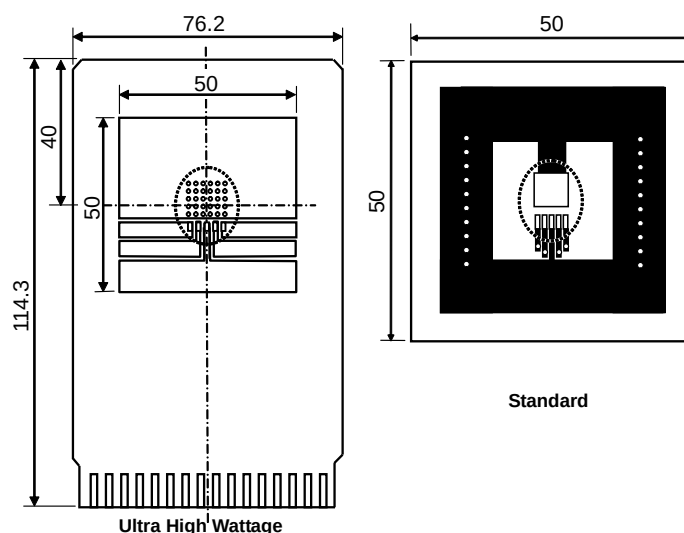
#### Measurement Results

( $T_a=25^\circ\text{C}$ ,  $T_{j\text{max}}=125^\circ\text{C}$ )

|                    | Ultra High Wattage Land Pattern                                         | Standard Land Pattern                                                   |
|--------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Power Dissipation  | 3800mW                                                                  | 1900mW                                                                  |
| Thermal Resistance | $\theta_{ja} = (125-25^\circ\text{C})/3.8\text{W} = 26^\circ\text{C/W}$ | $\theta_{ja} = (125-25^\circ\text{C})/1.9\text{W} = 53^\circ\text{C/W}$ |
|                    | $\theta_{jc} = 7^\circ\text{C/W}$                                       | $\theta_{jc} = 17^\circ\text{C/W}$                                      |



Power Dissipation



Measurement Board Pattern

○ IC Mount Area (Unit: mm)

The above graph shows the Power Dissipation of the package based on  $T_{j\text{max}}=125^\circ\text{C}$  and  $T_{j\text{max}}=150^\circ\text{C}$ . Operating the IC in the shaded area in the graph might have an influence its lifetime.

Operating time must be within the time limit described in the table below, in case of operating in the shaded area.

| Operating Time | Estimated years<br>(Operating 4 hours/day) |
|----------------|--------------------------------------------|
| 13,000 hours   | 9 years                                    |



**RP108J Mark Specification Table (TO-252-5-P2)**
**RP108Jxx1B**

| Part Number | ①②③④⑤⑥⑦⑧               | V <sub>SET</sub> |
|-------------|------------------------|------------------|
| RP108J081B  | <b>E 1 J 0 8 1 B</b>   | 0.8V             |
| RP108J091B  | <b>E 1 J 0 9 1 B</b>   | 0.9V             |
| RP108J101B  | <b>E 1 J 1 0 1 B</b>   | 1.0V             |
| RP108J111B  | <b>E 1 J 1 1 1 B</b>   | 1.1V             |
| RP108J121B  | <b>E 1 J 1 2 1 B</b>   | 1.2V             |
| RP108J131B  | <b>E 1 J 1 3 1 B</b>   | 1.3V             |
| RP108J141B  | <b>E 1 J 1 4 1 B</b>   | 1.4V             |
| RP108J151B  | <b>E 1 J 1 5 1 B</b>   | 1.5V             |
| RP108J161B  | <b>E 1 J 1 6 1 B</b>   | 1.6V             |
| RP108J171B  | <b>E 1 J 1 7 1 B</b>   | 1.7V             |
| RP108J181B  | <b>E 1 J 1 8 1 B</b>   | 1.8V             |
| RP108J191B  | <b>E 1 J 1 9 1 B</b>   | 1.9V             |
| RP108J201B  | <b>E 1 J 2 0 1 B</b>   | 2.0V             |
| RP108J211B  | <b>E 1 J 2 1 1 B</b>   | 2.1V             |
| RP108J221B  | <b>E 1 J 2 2 1 B</b>   | 2.2V             |
| RP108J231B  | <b>E 1 J 2 3 1 B</b>   | 2.3V             |
| RP108J241B  | <b>E 1 J 2 4 1 B</b>   | 2.4V             |
| RP108J251B  | <b>E 1 J 2 5 1 B</b>   | 2.5V             |
| RP108J261B  | <b>E 1 J 2 6 1 B</b>   | 2.6V             |
| RP108J271B  | <b>E 1 J 2 7 1 B</b>   | 2.7V             |
| RP108J281B  | <b>E 1 J 2 8 1 B</b>   | 2.8V             |
| RP108J291B  | <b>E 1 J 2 9 1 B</b>   | 2.9V             |
| RP108J301B  | <b>E 1 J 3 0 1 B</b>   | 3.0V             |
| RP108J311B  | <b>E 1 J 3 1 1 B</b>   | 3.1V             |
| RP108J321B  | <b>E 1 J 3 2 1 B</b>   | 3.2V             |
| RP108J331B  | <b>E 1 J 3 3 1 B</b>   | 3.3V             |
| RP108J341B  | <b>E 1 J 3 4 1 B</b>   | 3.4V             |
| RP108J351B  | <b>E 1 J 3 5 1 B</b>   | 3.5V             |
| RP108J361B  | <b>E 1 J 3 6 1 B</b>   | 3.6V             |
| RP108J371B  | <b>E 1 J 3 7 1 B</b>   | 3.7V             |
| RP108J381B  | <b>E 1 J 3 8 1 B</b>   | 3.8V             |
| RP108J391B  | <b>E 1 J 3 9 1 B</b>   | 3.9V             |
| RP108J401B  | <b>E 1 J 4 0 1 B</b>   | 4.0V             |
| RP108J411B  | <b>E 1 J 4 1 1 B</b>   | 4.1V             |
| RP108J421B  | <b>E 1 J 4 2 1 B</b>   | 4.2V             |
| RP108J121B5 | <b>E 1 J 1 2 1 B 5</b> | 1.25V            |
| RP108J181B5 | <b>E 1 J 1 8 1 B 5</b> | 1.85V            |
| RP108J281B5 | <b>E 1 J 2 8 1 B 5</b> | 2.85V            |

**RP108Jxx1D**

| Part Number | ①②③④⑤⑥⑦⑧               | V <sub>SET</sub> |
|-------------|------------------------|------------------|
| RP108J081D  | <b>E 1 J 0 8 1 D</b>   | 0.8V             |
| RP108J091D  | <b>E 1 J 0 9 1 D</b>   | 0.9V             |
| RP108J101D  | <b>E 1 J 1 0 1 D</b>   | 1.0V             |
| RP108J111D  | <b>E 1 J 1 1 1 D</b>   | 1.1V             |
| RP108J121D  | <b>E 1 J 1 2 1 D</b>   | 1.2V             |
| RP108J131D  | <b>E 1 J 1 3 1 D</b>   | 1.3V             |
| RP108J141D  | <b>E 1 J 1 4 1 D</b>   | 1.4V             |
| RP108J151D  | <b>E 1 J 1 5 1 D</b>   | 1.5V             |
| RP108J161D  | <b>E 1 J 1 6 1 D</b>   | 1.6V             |
| RP108J171D  | <b>E 1 J 1 7 1 D</b>   | 1.7V             |
| RP108J181D  | <b>E 1 J 1 8 1 D</b>   | 1.8V             |
| RP108J191D  | <b>E 1 J 1 9 1 D</b>   | 1.9V             |
| RP108J201D  | <b>E 1 J 2 0 1 D</b>   | 2.0V             |
| RP108J211D  | <b>E 1 J 2 1 1 D</b>   | 2.1V             |
| RP108J221D  | <b>E 1 J 2 2 1 D</b>   | 2.2V             |
| RP108J231D  | <b>E 1 J 2 3 1 D</b>   | 2.3V             |
| RP108J241D  | <b>E 1 J 2 4 1 D</b>   | 2.4V             |
| RP108J251D  | <b>E 1 J 2 5 1 D</b>   | 2.5V             |
| RP108J261D  | <b>E 1 J 2 6 1 D</b>   | 2.6V             |
| RP108J271D  | <b>E 1 J 2 7 1 D</b>   | 2.7V             |
| RP108J281D  | <b>E 1 J 2 8 1 D</b>   | 2.8V             |
| RP108J291D  | <b>E 1 J 2 9 1 D</b>   | 2.9V             |
| RP108J301D  | <b>E 1 J 3 0 1 D</b>   | 3.0V             |
| RP108J311D  | <b>E 1 J 3 1 1 D</b>   | 3.1V             |
| RP108J321D  | <b>E 1 J 3 2 1 D</b>   | 3.2V             |
| RP108J331D  | <b>E 1 J 3 3 1 D</b>   | 3.3V             |
| RP108J341D  | <b>E 1 J 3 4 1 D</b>   | 3.4V             |
| RP108J351D  | <b>E 1 J 3 5 1 D</b>   | 3.5V             |
| RP108J361D  | <b>E 1 J 3 6 1 D</b>   | 3.6V             |
| RP108J371D  | <b>E 1 J 3 7 1 D</b>   | 3.7V             |
| RP108J381D  | <b>E 1 J 3 8 1 D</b>   | 3.8V             |
| RP108J391D  | <b>E 1 J 3 9 1 D</b>   | 3.9V             |
| RP108J401D  | <b>E 1 J 4 0 1 D</b>   | 4.0V             |
| RP108J411D  | <b>E 1 J 4 1 1 D</b>   | 4.1V             |
| RP108J421D  | <b>E 1 J 4 2 1 D</b>   | 4.2V             |
| RP108J121D5 | <b>E 1 J 1 2 1 D 5</b> | 1.25V            |
| RP108J181D5 | <b>E 1 J 1 8 1 D 5</b> | 1.85V            |
| RP108J281D5 | <b>E 1 J 2 8 1 D 5</b> | 2.85V            |

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**RP108J**

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NO.EA-203-150817

**RP108Jxx1E**

| Part Number | ①②③④⑤⑥⑦⑧               | V <sub>SET</sub> |
|-------------|------------------------|------------------|
| RP108J081E  | <b>E 1 J 0 8 1 E</b>   | 0.8V             |
| RP108J091E  | <b>E 1 J 0 9 1 E</b>   | 0.9V             |
| RP108J101E  | <b>E 1 J 1 0 1 E</b>   | 1.0V             |
| RP108J111E  | <b>E 1 J 1 1 1 E</b>   | 1.1V             |
| RP108J121E  | <b>E 1 J 1 2 1 E</b>   | 1.2V             |
| RP108J131E  | <b>E 1 J 1 3 1 E</b>   | 1.3V             |
| RP108J141E  | <b>E 1 J 1 4 1 E</b>   | 1.4V             |
| RP108J151E  | <b>E 1 J 1 5 1 E</b>   | 1.5V             |
| RP108J161E  | <b>E 1 J 1 6 1 E</b>   | 1.6V             |
| RP108J171E  | <b>E 1 J 1 7 1 E</b>   | 1.7V             |
| RP108J181E  | <b>E 1 J 1 8 1 E</b>   | 1.8V             |
| RP108J191E  | <b>E 1 J 1 9 1 E</b>   | 1.9V             |
| RP108J201E  | <b>E 1 J 2 0 1 E</b>   | 2.0V             |
| RP108J211E  | <b>E 1 J 2 1 1 E</b>   | 2.1V             |
| RP108J221E  | <b>E 1 J 2 2 1 E</b>   | 2.2V             |
| RP108J231E  | <b>E 1 J 2 3 1 E</b>   | 2.3V             |
| RP108J241E  | <b>E 1 J 2 4 1 E</b>   | 2.4V             |
| RP108J251E  | <b>E 1 J 2 5 1 E</b>   | 2.5V             |
| RP108J261E  | <b>E 1 J 2 6 1 E</b>   | 2.6V             |
| RP108J271E  | <b>E 1 J 2 7 1 E</b>   | 2.7V             |
| RP108J281E  | <b>E 1 J 2 8 1 E</b>   | 2.8V             |
| RP108J291E  | <b>E 1 J 2 9 1 E</b>   | 2.9V             |
| RP108J301E  | <b>E 1 J 3 0 1 E</b>   | 3.0V             |
| RP108J311E  | <b>E 1 J 3 1 1 E</b>   | 3.1V             |
| RP108J321E  | <b>E 1 J 3 2 1 E</b>   | 3.2V             |
| RP108J331E  | <b>E 1 J 3 3 1 E</b>   | 3.3V             |
| RP108J341E  | <b>E 1 J 3 4 1 E</b>   | 3.4V             |
| RP108J351E  | <b>E 1 J 3 5 1 E</b>   | 3.5V             |
| RP108J361E  | <b>E 1 J 3 6 1 E</b>   | 3.6V             |
| RP108J371E  | <b>E 1 J 3 7 1 E</b>   | 3.7V             |
| RP108J381E  | <b>E 1 J 3 8 1 E</b>   | 3.8V             |
| RP108J391E  | <b>E 1 J 3 9 1 E</b>   | 3.9V             |
| RP108J401E  | <b>E 1 J 4 0 1 E</b>   | 4.0V             |
| RP108J411E  | <b>E 1 J 4 1 1 E</b>   | 4.1V             |
| RP108J421E  | <b>E 1 J 4 2 1 E</b>   | 4.2V             |
| RP108J121E5 | <b>E 1 J 1 2 1 E 5</b> | 1.25V            |
| RP108J181E5 | <b>E 1 J 1 8 1 E 5</b> | 1.85V            |
| RP108J281E5 | <b>E 1 J 2 8 1 E 5</b> | 2.85V            |

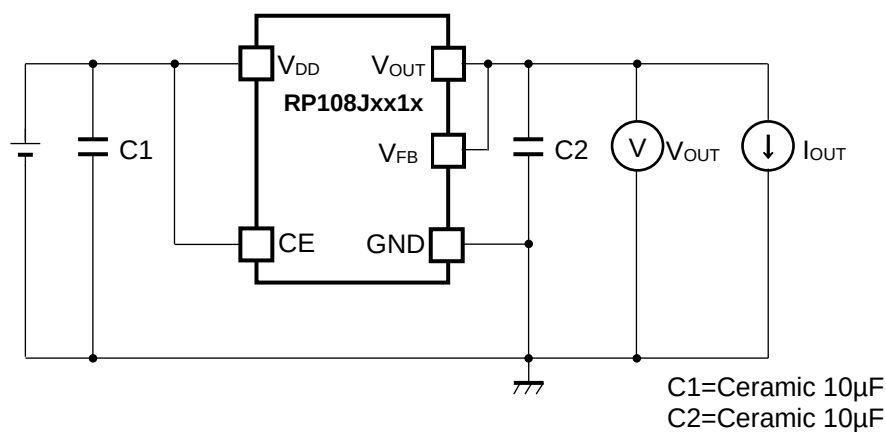
**RP108Jxx1F**

| Part Number | ①②③④⑤⑥⑦⑧               | V <sub>SET</sub> |
|-------------|------------------------|------------------|
| RP108J081F  | <b>E 1 J 0 8 1 F</b>   | 0.8V             |
| RP108J091F  | <b>E 1 J 0 9 1 F</b>   | 0.9V             |
| RP108J101F  | <b>E 1 J 1 0 1 F</b>   | 1.0V             |
| RP108J111F  | <b>E 1 J 1 1 1 F</b>   | 1.1V             |
| RP108J121F  | <b>E 1 J 1 2 1 F</b>   | 1.2V             |
| RP108J131F  | <b>E 1 J 1 3 1 F</b>   | 1.3V             |
| RP108J141F  | <b>E 1 J 1 4 1 F</b>   | 1.4V             |
| RP108J151F  | <b>E 1 J 1 5 1 F</b>   | 1.5V             |
| RP108J161F  | <b>E 1 J 1 6 1 F</b>   | 1.6V             |
| RP108J171F  | <b>E 1 J 1 7 1 F</b>   | 1.7V             |
| RP108J181F  | <b>E 1 J 1 8 1 F</b>   | 1.8V             |
| RP108J191F  | <b>E 1 J 1 9 1 F</b>   | 1.9V             |
| RP108J201F  | <b>E 1 J 2 0 1 F</b>   | 2.0V             |
| RP108J211F  | <b>E 1 J 2 1 1 F</b>   | 2.1V             |
| RP108J221F  | <b>E 1 J 2 2 1 F</b>   | 2.2V             |
| RP108J231F  | <b>E 1 J 2 3 1 F</b>   | 2.3V             |
| RP108J241F  | <b>E 1 J 2 4 1 F</b>   | 2.4V             |
| RP108J251F  | <b>E 1 J 2 5 1 F</b>   | 2.5V             |
| RP108J261F  | <b>E 1 J 2 6 1 F</b>   | 2.6V             |
| RP108J271F  | <b>E 1 J 2 7 1 F</b>   | 2.7V             |
| RP108J281F  | <b>E 1 J 2 8 1 F</b>   | 2.8V             |
| RP108J291F  | <b>E 1 J 2 9 1 F</b>   | 2.9V             |
| RP108J301F  | <b>E 1 J 3 0 1 F</b>   | 3.0V             |
| RP108J311F  | <b>E 1 J 3 1 1 F</b>   | 3.1V             |
| RP108J321F  | <b>E 1 J 3 2 1 F</b>   | 3.2V             |
| RP108J331F  | <b>E 1 J 3 3 1 F</b>   | 3.3V             |
| RP108J341F  | <b>E 1 J 3 4 1 F</b>   | 3.4V             |
| RP108J351F  | <b>E 1 J 3 5 1 F</b>   | 3.5V             |
| RP108J361F  | <b>E 1 J 3 6 1 F</b>   | 3.6V             |
| RP108J371F  | <b>E 1 J 3 7 1 F</b>   | 3.7V             |
| RP108J381F  | <b>E 1 J 3 8 1 F</b>   | 3.8V             |
| RP108J391F  | <b>E 1 J 3 9 1 F</b>   | 3.9V             |
| RP108J401F  | <b>E 1 J 4 0 1 F</b>   | 4.0V             |
| RP108J411F  | <b>E 1 J 4 1 1 F</b>   | 4.1V             |
| RP108J421F  | <b>E 1 J 4 2 1 F</b>   | 4.2V             |
| RP108J121F5 | <b>E 1 J 1 2 1 F 5</b> | 1.25V            |
| RP108J181F5 | <b>E 1 J 1 8 1 F 5</b> | 1.85V            |
| RP108J281F5 | <b>E 1 J 2 8 1 F 5</b> | 2.85V            |

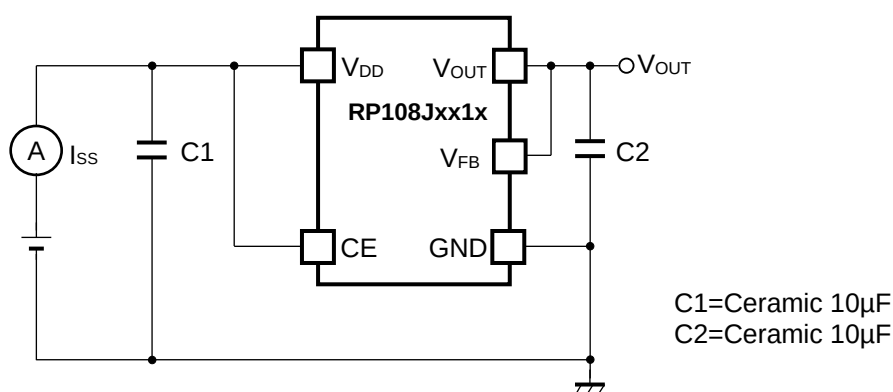


## TEST CIRCUITS

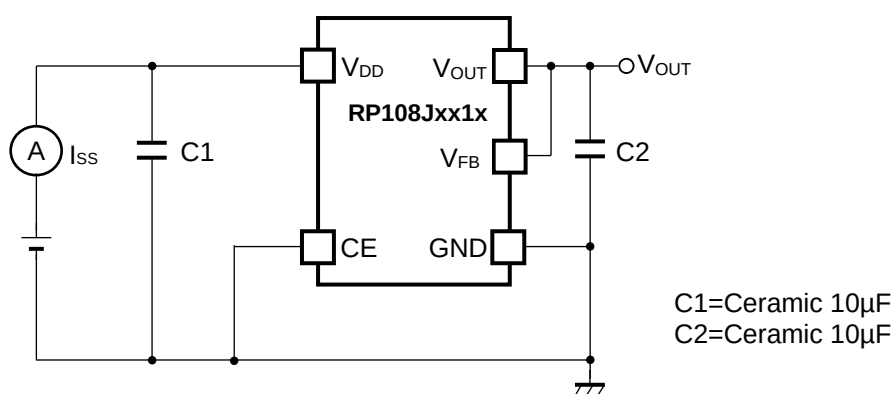
### Fixed Output Voltage Type (RP108Jxx1x)



Basic Test Circuit

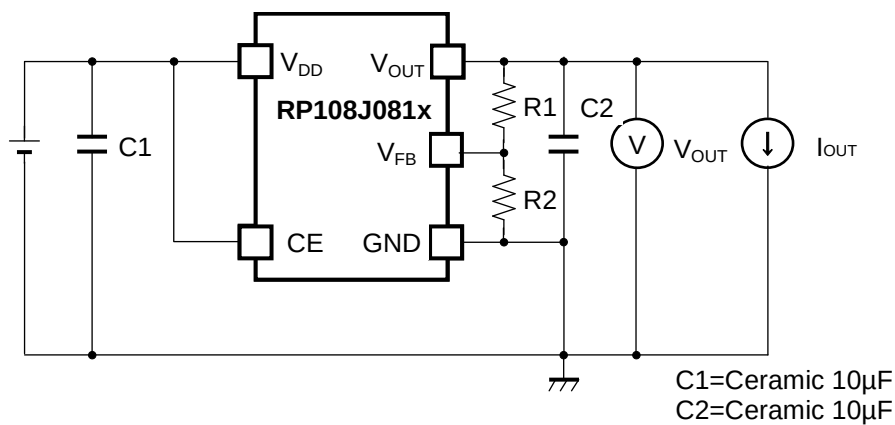


Test Circuit for Supply Current

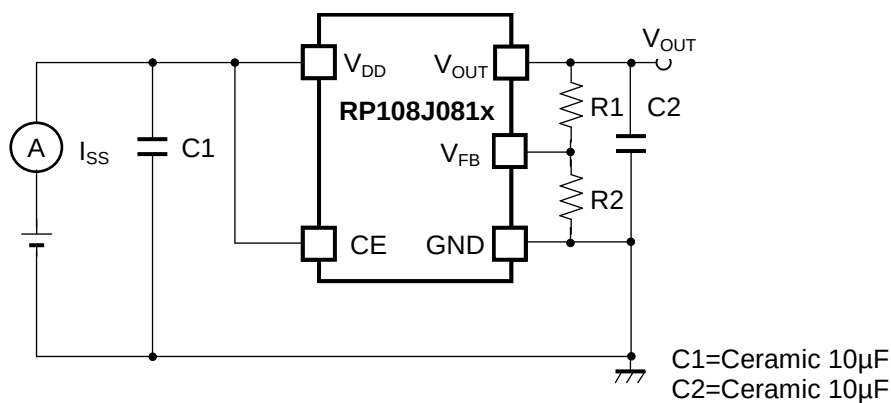


Test Circuit for Standby Current

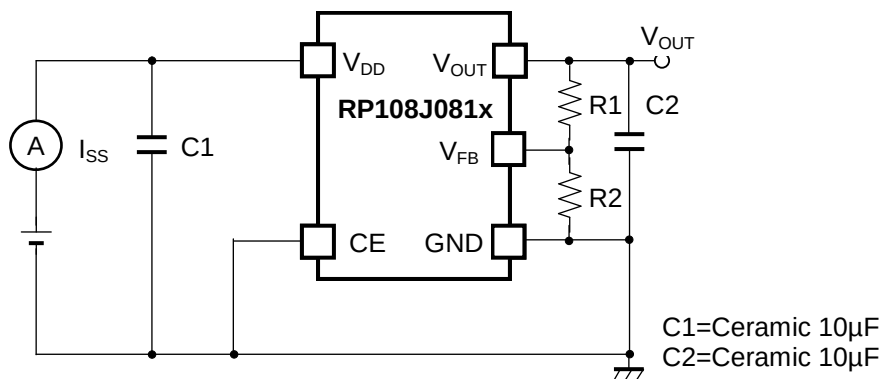
**Adjustable Output Voltage Setting Type (RP108J081x)**



**Basic Test Circuit**



**Test Circuit for Supply Current**



**Test Circuit for Standby Current**

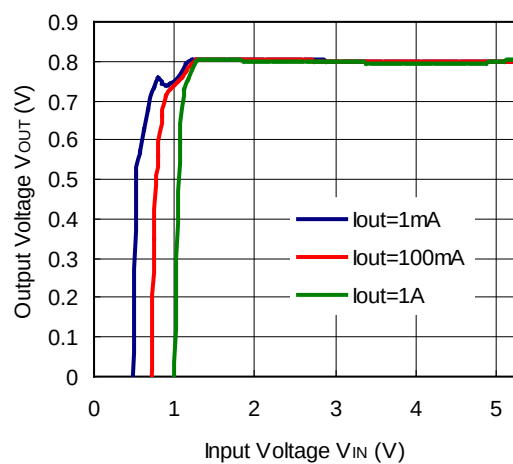
**Note :** Refer to *Adjustable Output Voltage Type Settings* for R1 and R2.

## TYPICAL CHARACTERISTICS

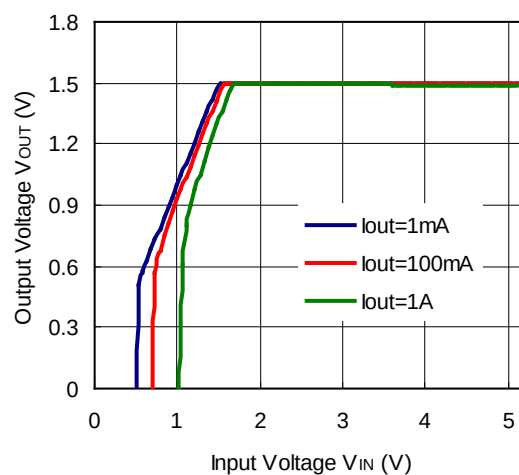
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

### 1) Output Voltage vs. Input Voltage ( $C_1=C_2$ =Ceramic10 $\mu$ F, $T_a=25^\circ\text{C}$ )

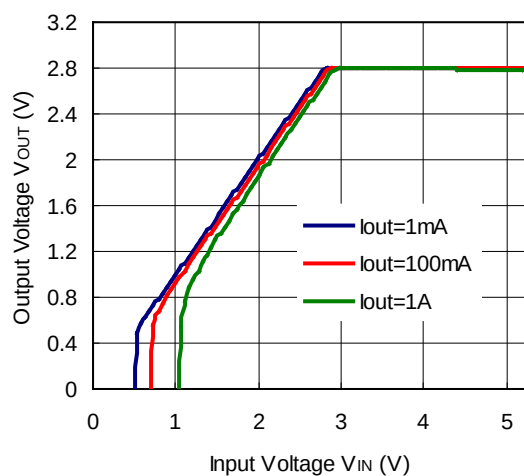
RP108J081x



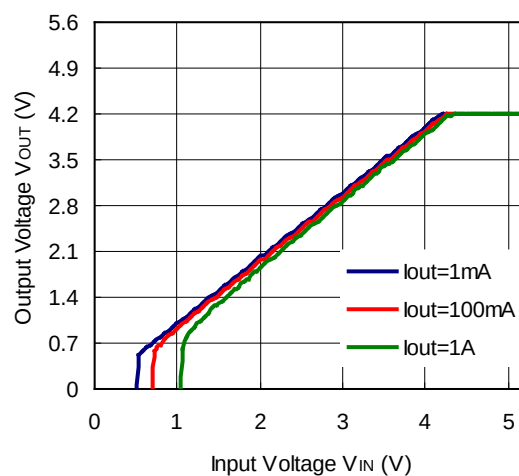
RP108J151x



RP108J281x



RP108J421x

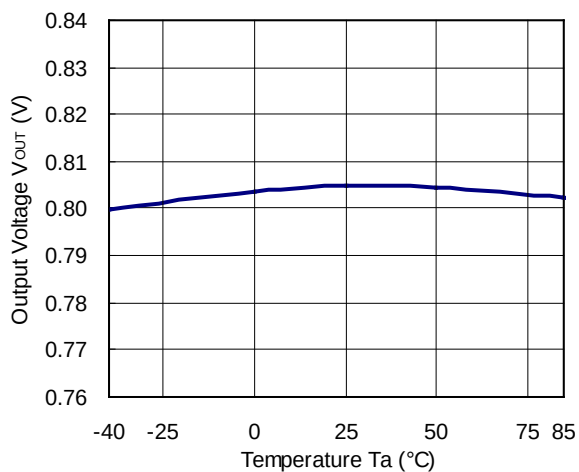


## RP108J

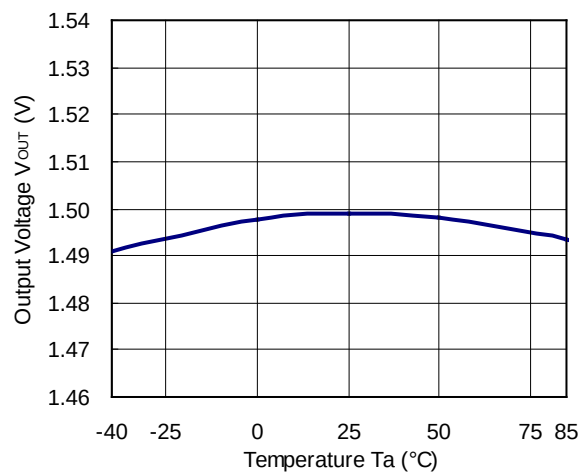
NO.EA-203-150817

### 2) Output Voltage vs. Temperature (C1=C2=Ceramic10 $\mu$ F, -40°C $\leq$ Ta $\leq$ 85°C)

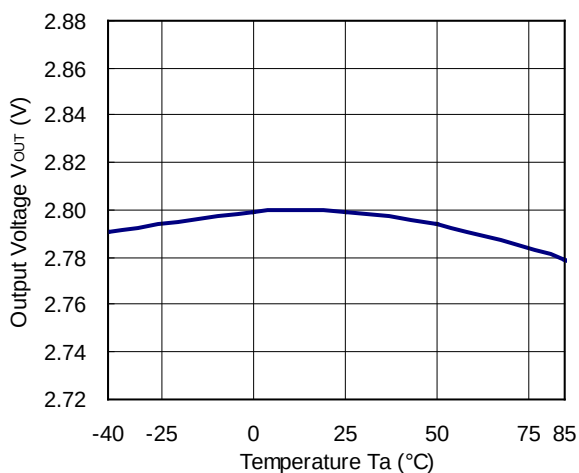
RP108J081x



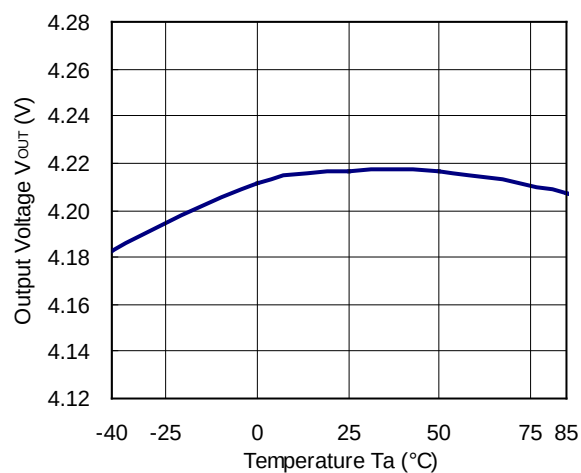
RP108J151x



RP108J281x

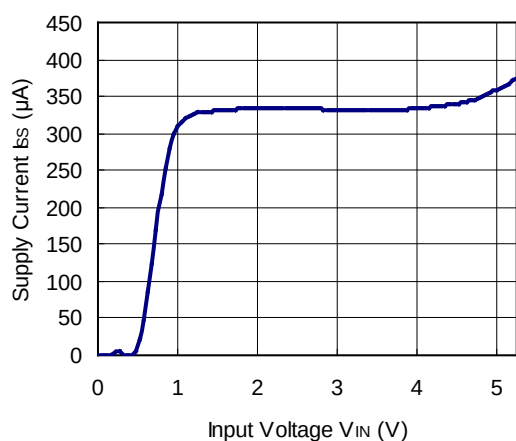


RP108J421x

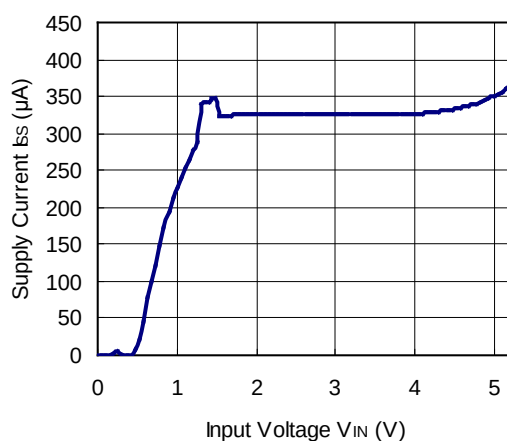


### 3) Supply Current vs. Input Voltage (C1=C2=Ceramic 10 $\mu$ F, $I_{OUT}$ =0mA, $T_a$ =25°C)

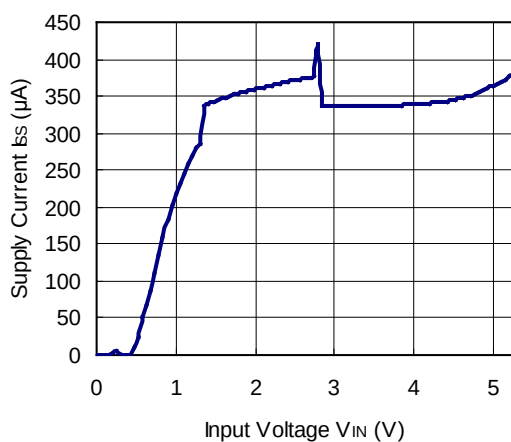
RP108J081x



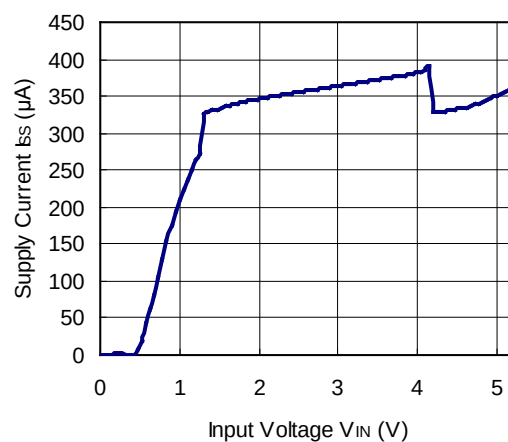
RP108J151x



RP108J281x



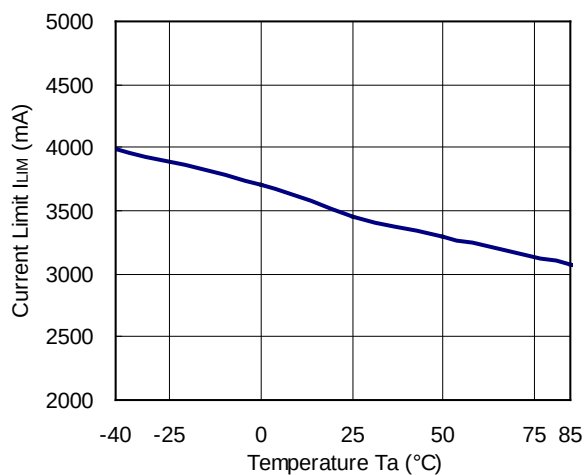
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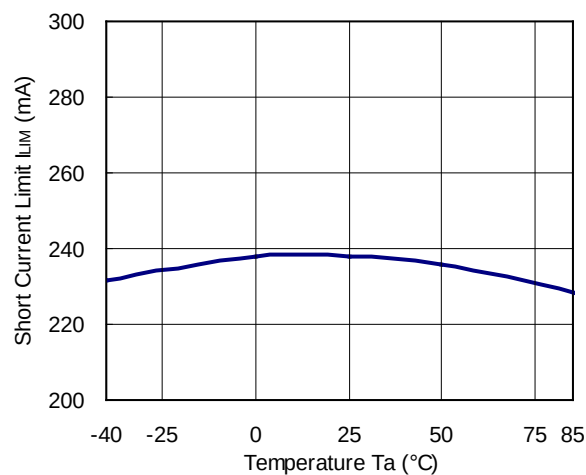
#### 4) Short Current Limit vs. Temperature/ Current Limit vs. Temperature

RP108J includes a Fold-back Protection Circuit. Under conditions during a Fold-back Protection Circuit works, Thermal Shutdown Circuit starts to operate in order to prevent the self-heat generation. Therefore, RP108J isn't able to test "Output voltage vs. Output Current".

RP108J081x



RP108J081x

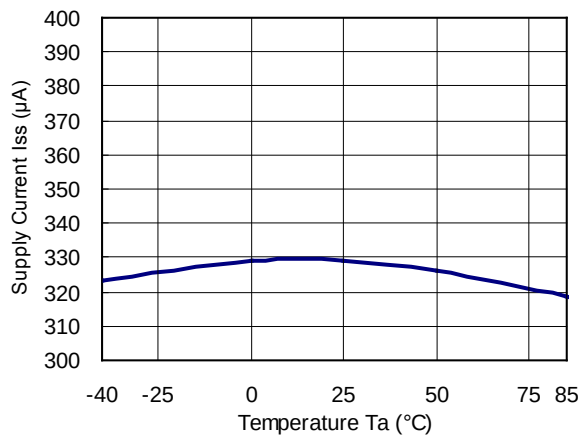


## RP108J

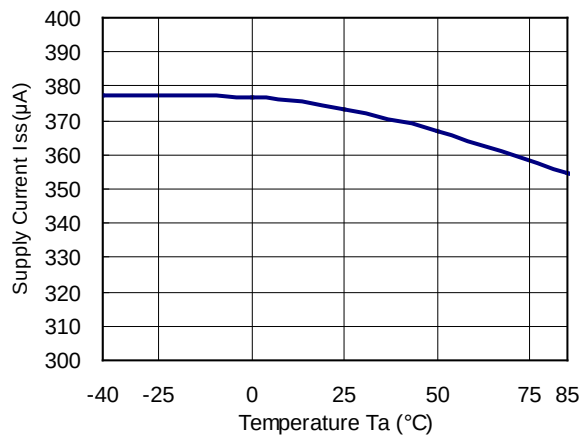
NO.EA-203-150817

### 5) Supply Current vs. Temperature (C1= C2=Ceramic 10 $\mu$ F, I<sub>OUT</sub>=0mA)

RP108J081x

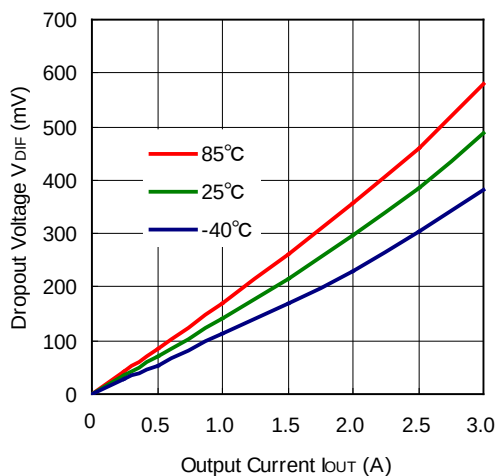


RP108J151x



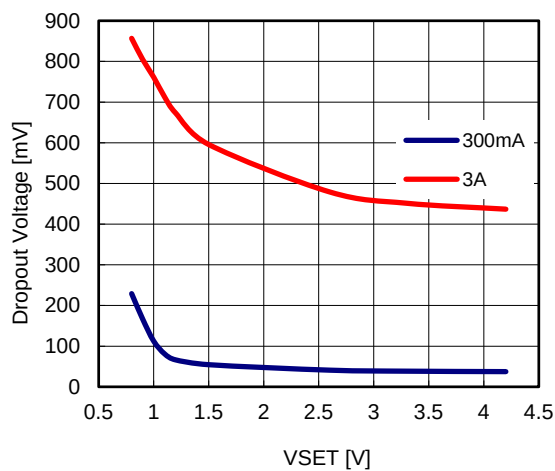
### 6) Dropout Voltage vs. Output Current (C1=C2=Ceramic 10 $\mu$ F)

RP108J251x

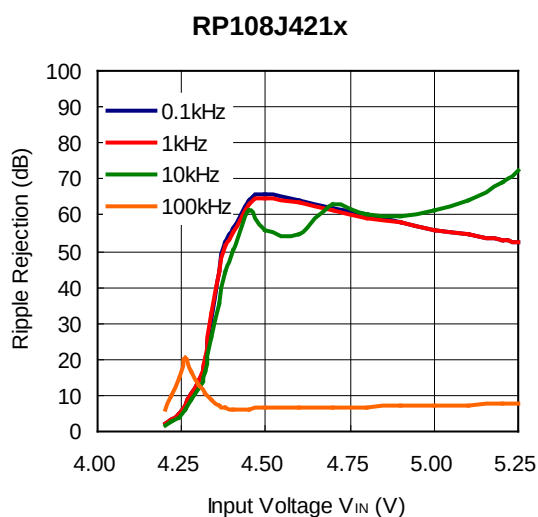
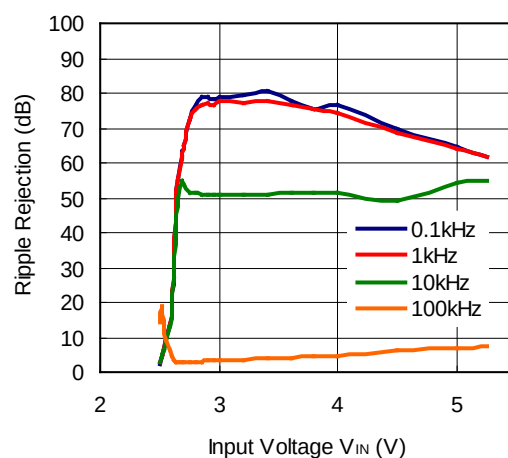
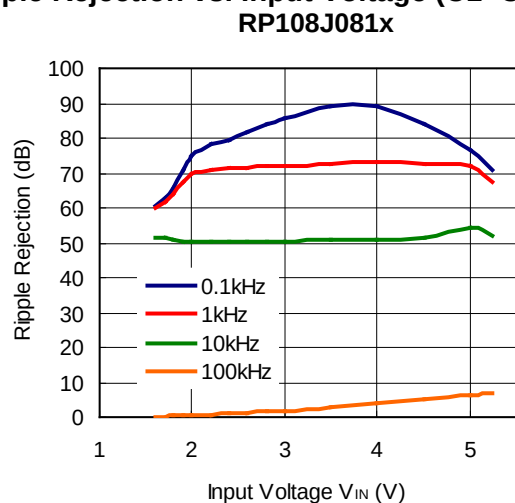


### 7) Dropout Voltage vs. Set Output Voltage (C1=C2=Ceramic 10 $\mu$ F, $T_a$ =25 $^{\circ}$ C)

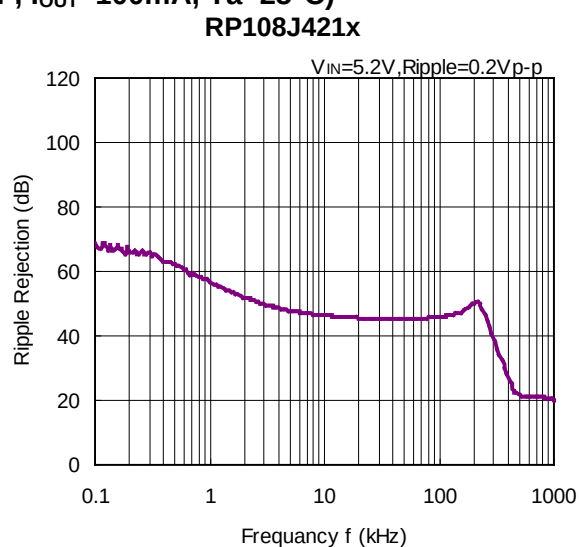
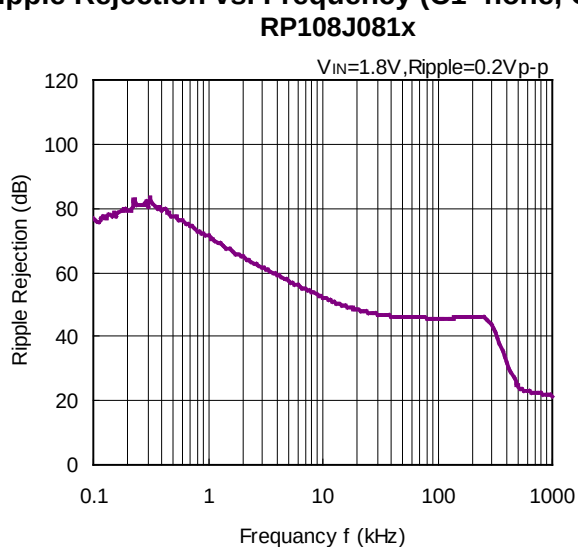
RP108J251x



8) Ripple Rejection vs. Input Voltage ( $C_1=C_2=10\mu\text{F}$ ,  $\text{Ripple}=0.2\text{Vp-p}$ ,  $I_{\text{OUT}}=100\mu\text{A}$ ,  $T_a=25^\circ\text{C}$ )



9) Ripple Rejection vs. Frequency ( $C_1=\text{none}$ ,  $C_2=10\mu\text{F}$ ,  $I_{\text{OUT}}=100\text{mA}$ ,  $T_a=25^\circ\text{C}$ )

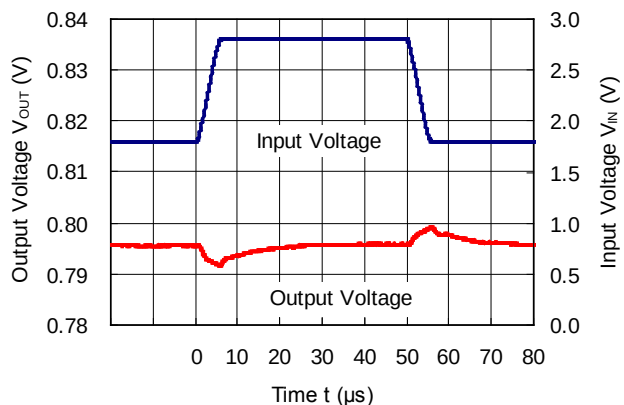


## RP108J

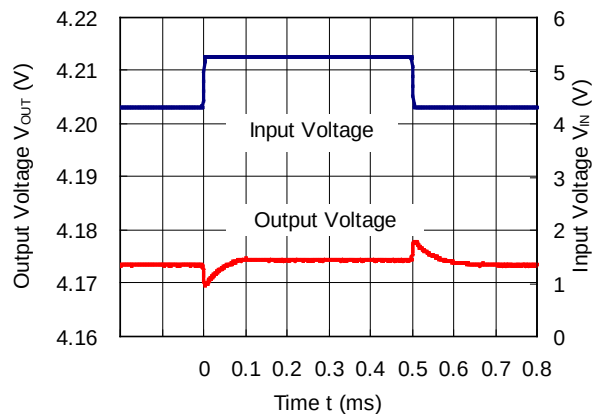
NO.EA-203-150817

### 10) Input Transient Response ( $C_1$ =none, $C_2$ =10 $\mu$ F, $I_{OUT}$ =30mA, $t_r$ = $t_f$ =5 $\mu$ s, $T_a$ =25 $^{\circ}$ C)

RP108J081x

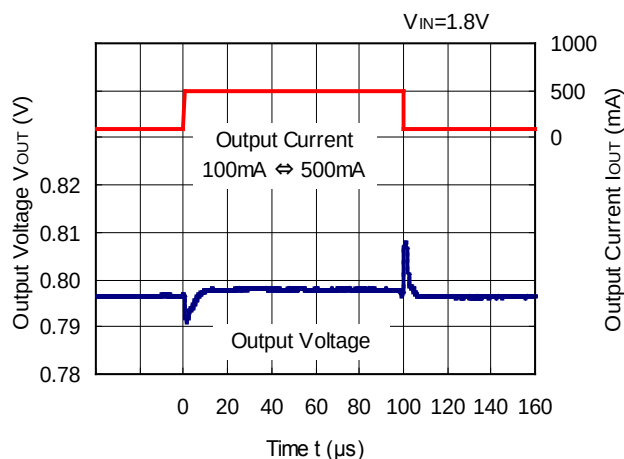


RP108J421x

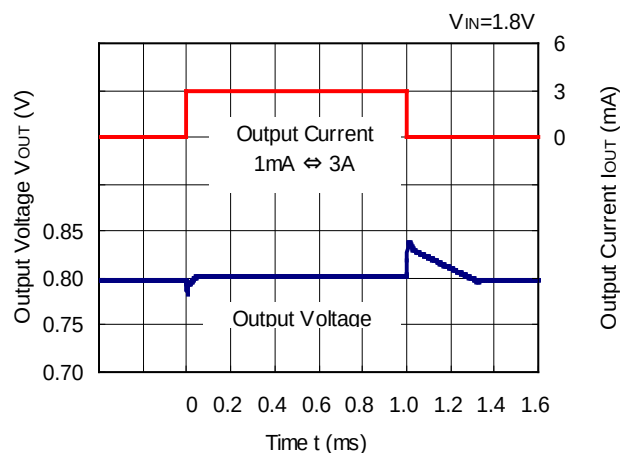


### 11) Load Transient Response ( $C_1$ = $C_2$ =10 $\mu$ F, $t_r$ = $t_f$ =0.5 $\mu$ s, $T_a$ =25 $^{\circ}$ C)

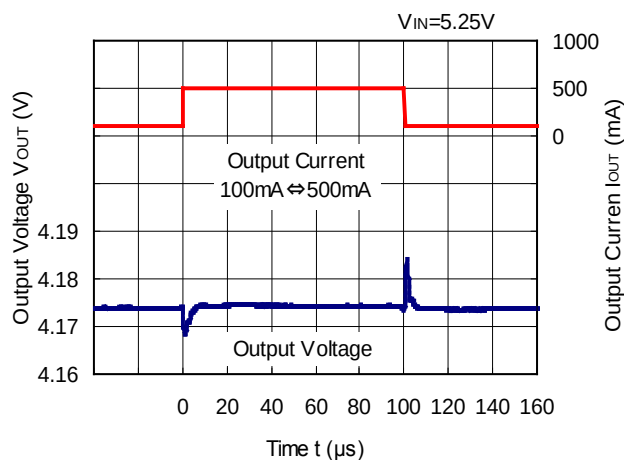
RP108J081x



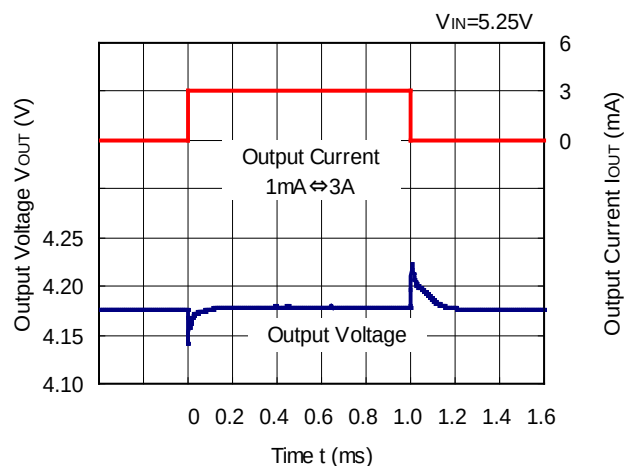
RP108J081x



RP108J421x

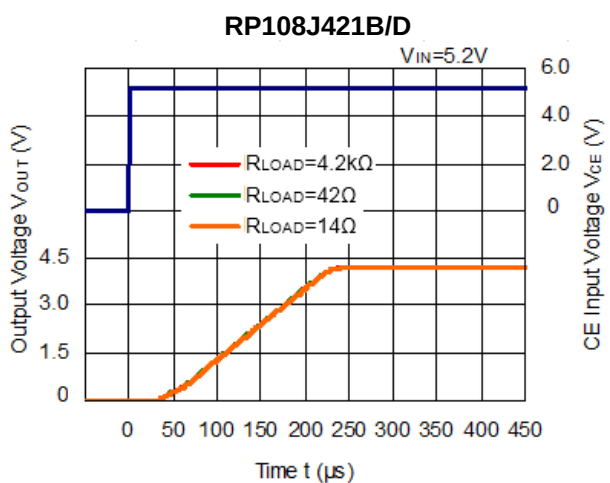
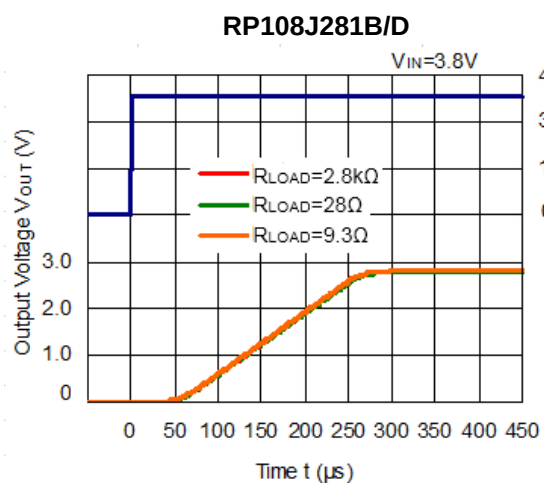
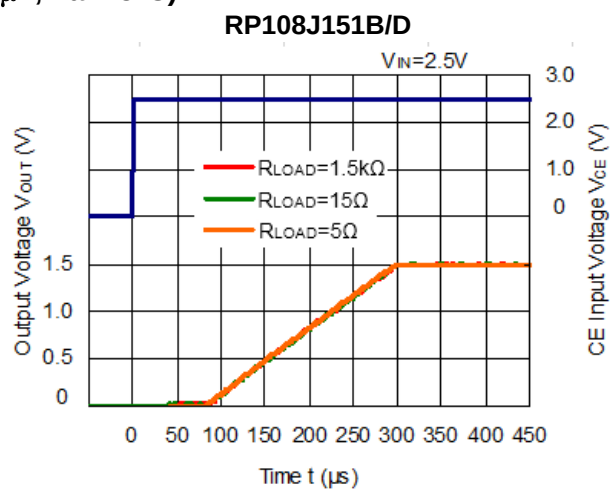
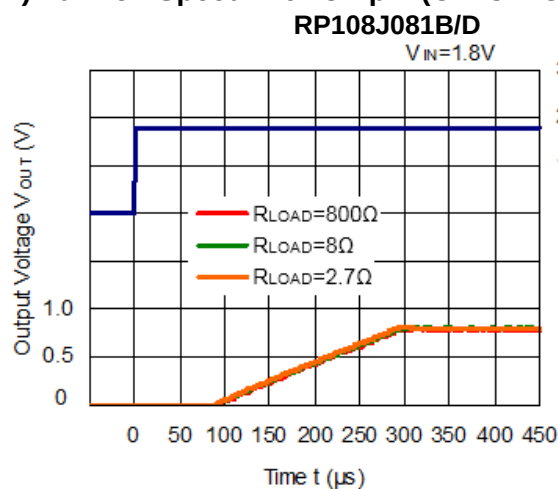


RP108J421x

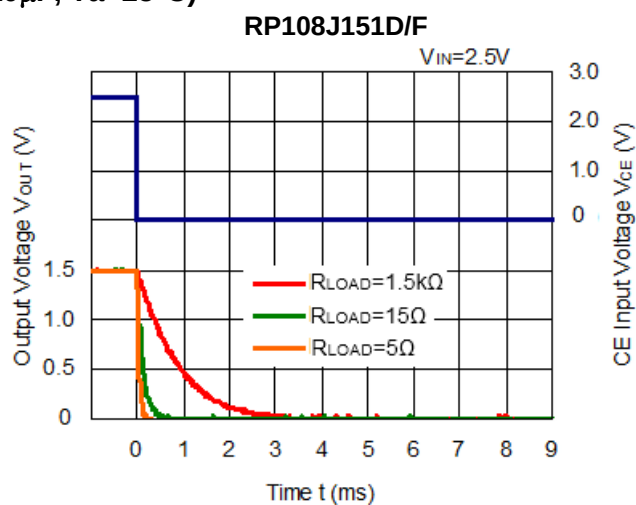
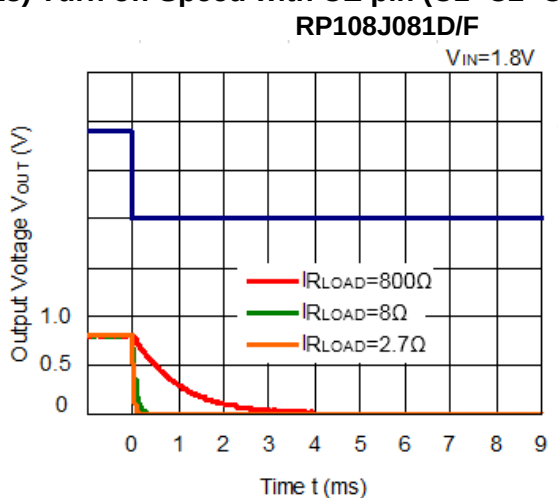




12) Turn on Speed with CE pin ( $C_1=C_2$ =Ceramic  $10\mu\text{F}$ ,  $T_a=25^\circ\text{C}$ )

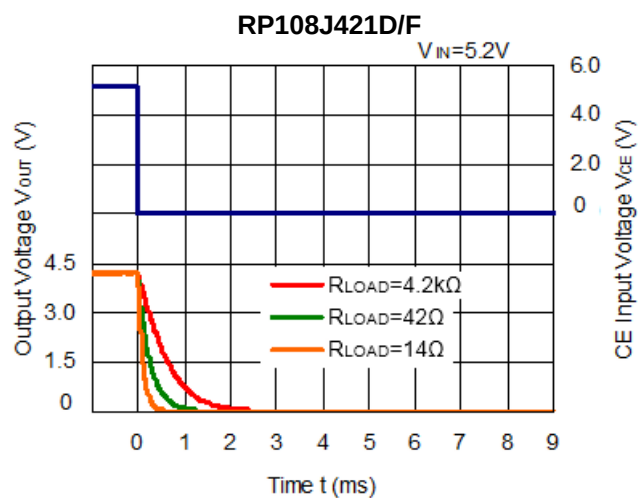
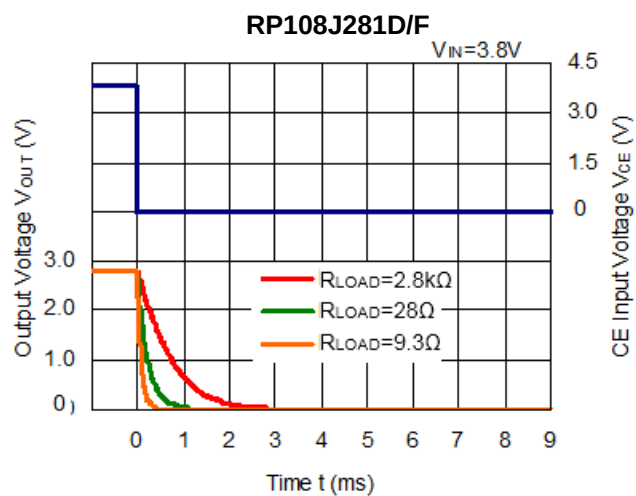


13) Turn off Speed with CE pin ( $C_1=C_2$ =Ceramic  $10\mu\text{F}$ ,  $T_a=25^\circ\text{C}$ )

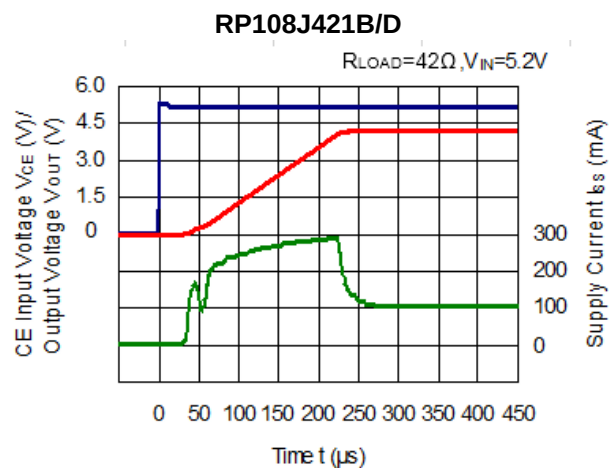
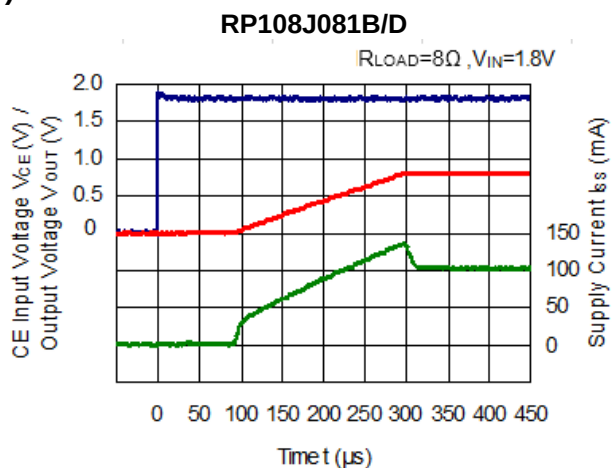


## RP108J

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### 14) Inrush Current



## ESR vs. Output Current

When using the IC, consider the following points: The relations between  $I_{OUT}$  (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is under  $40\mu\text{V}$  (Avg.) are marked as the hatched area in the graph.

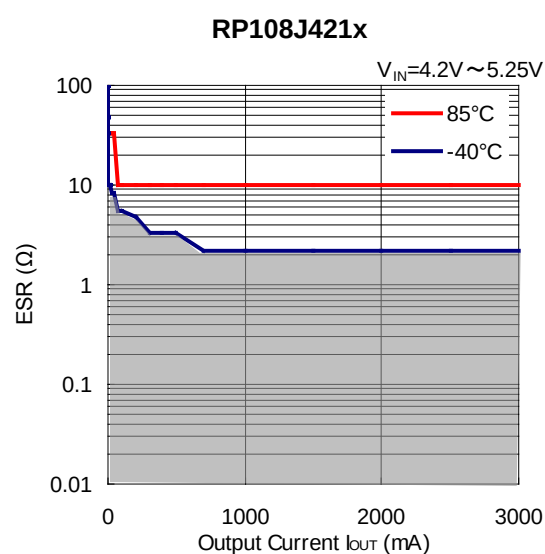
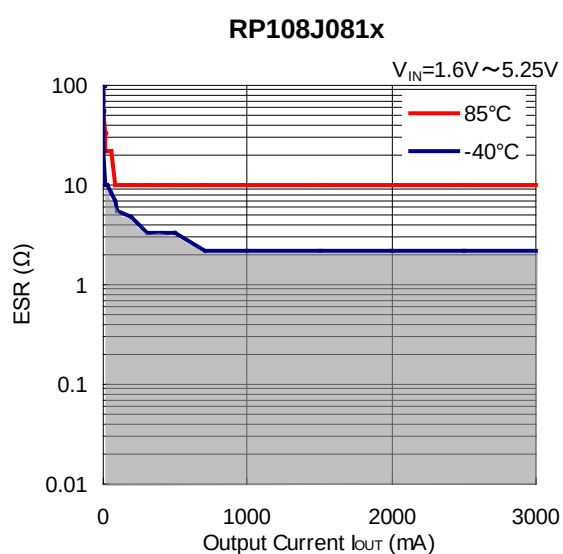
### Measurement Conditions

Frequency Band : 10Hz to 2MHz

Temperature :  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

Hatched area : Noise level is under  $40\mu\text{V}$

C1, C2 :  $10.0\mu\text{F}$  or more





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[RP108J281D-T1-FE](#) [RP108J331D-T1-FE](#)



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