

## 1.5 A Buck-Boost DC/DC Converter with Synchronous Rectifier

NO. EA-353-150422

### OUTLINE

The RP602Z is a CMOS-based 1.5 A<sup>\*1</sup> buck-boost DC/DC converter with synchronous rectifier. Internally, a single converter consists of an oscillator, a reference voltage unit, an error amplifier, a switching control circuit, a mode control circuit, a soft-start circuit, an undervoltage lockout (UVLO) circuit, an overvoltage protection (OVP) circuit, an overcurrent protection circuit, a thermal shutdown circuit and switching transistors.

The RP602Z offers two power controlling methods, forced PWM control type and PWM/VFM auto switching control type. The power controlling method can be selected by inputting a signal to the MODE pin. In low output current, forced PWM control switches at fixed frequency rate in order to reduce noise. Likewise, in low output current, PWM/VFM auto switching control automatically switches from PWM mode to VFM mode in order to achieve high efficiency.

Output voltage is internally fixed type which allows output voltages that range from 2.7 to 4.2 V in 0.1 V step. The output voltage accuracy is as high as  $\pm 1.5\%$ . Protection circuits included in the RP602Z are overcurrent protection circuit and thermal shutdown circuit.

The RP602Z is offered in a 20-bump WLCSP package measuring 2.305 mm x 1.700 mm which can achieve the smallest possible footprint solution on board where area is limited.

<sup>\*1</sup> The output current can be affected by environmental conditions or external components. This is an approximate value.

### FEATURES

- Input Voltage Range (Absolute Maximum Ratings) .....2.3 V to 5.5 V (6.5 V)
- Output Voltage Range .....2.7 V to 4.2 V, Adjustable in 0.1 V steps
- Output Voltage Accuracy ..... $\pm 1.5\%$
- Line Regulation .....Typ. 0.5%, PWM Mode
- Load Regulation .....Typ. 0.1% at  $I_{OUT} = 0$  mA to 500 mA, PWM Mode
- Maximum Output Current .....Typ. 1.5 A,  $PV_{IN} = 3$  V,  $VO_{UT} = 3.3$  V
- Maximum Burst Current.....2.7 A,  $PV_{IN} = 3$  V,  $VO_{UT} = 3.3$  V, Duty = 10%,  $t = 2.0$  ms
- Overcurrent Limit Protection .....Typ. 4.2 A
- Oscillator Frequency.....Typ. 2.6 MHz
- Built-in Driver ON Resistance .....Typ. Pch. 80 m $\Omega$ , Nch. 80 m $\Omega$ ,  $V_{IN} = 3.6$  V
- Device Quiescent Current .....Typ. 27.5  $\mu$ A, VFM mode, non-switching
- UVLO Detector Threshold .....Typ. 2.0 V
- Soft-start Time .....Typ. 1.0 ms
- Thermal Shutdown Temperature .....Typ. 150°C
- Inductor .....1.0  $\mu$ H
- Package .....20-bump WLCSP, 2.305 mm x 1.700 mm

### APPLICATIONS

- Power source for portable equipment such as laptops, PDAs, DSCs, cellular phones, and smartphones
- Power source for Li-ion battery-used equipment

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## SELECTION GUIDE

### Selection Guide

| Product Name     | Package     | Quantity per Reel | Pb Free | Halogen Free |
|------------------|-------------|-------------------|---------|--------------|
| RP602Zxxx\$-E2-F | WLCSP-20-P1 | 5,000 pcs         | Yes     | Yes          |

xxx: Specify the set output voltage ( $V_{SET}$ ) within the range of 2.7 V to 4.2 V in 0.1 V<sup>\*1</sup> steps

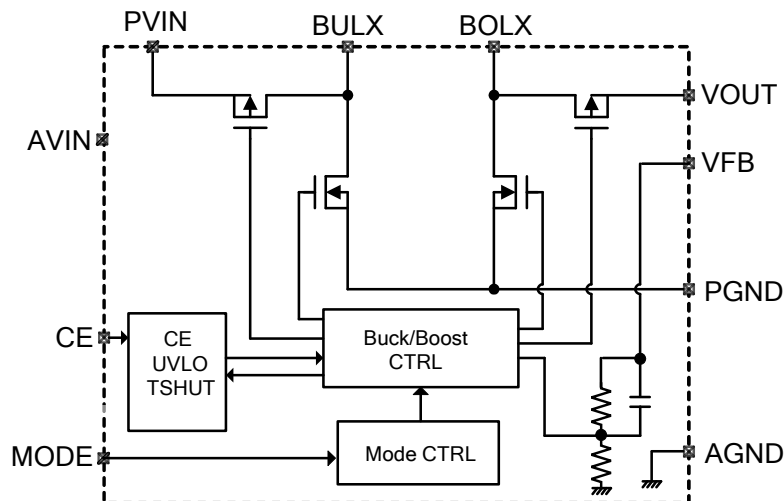
\$: Specify the combination of the auto-discharge option and the protection function option.

| Symbol          | Auto-discharge Function | Latch-type Protection | Reset-type Protection | Short-circuit Protection |
|-----------------|-------------------------|-----------------------|-----------------------|--------------------------|
| A <sup>*2</sup> | Yes                     | Yes                   | No                    | Yes                      |
| B <sup>*2</sup> | No                      | Yes                   | No                    | Yes                      |
| C               | Yes                     | No                    | Yes                   | Yes                      |
| D <sup>*2</sup> | No                      | No                    | Yes                   | Yes                      |
| E <sup>*2</sup> | Yes                     | No                    | No                    | Yes                      |
| F <sup>*2</sup> | No                      | No                    | No                    | Yes                      |

\*1 0.05 V step is also available as a custom code.

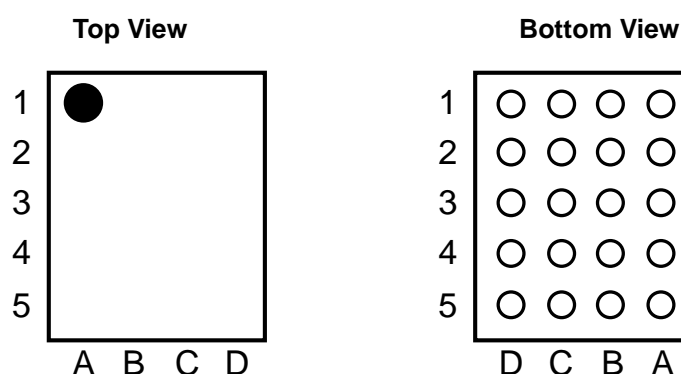
\*2 The mass production is scheduled.

## BLOCK DIAGRAM



RP602Z Block Diagram

## PIN DESCRIPTION



WLCSP-20 Pin Configuration

### Pin Description

| Pin No                   | Symbol | Pin Description   |
|--------------------------|--------|---|
| A5, B5, C5 <sup>*1</sup> | VOUT   | Output Voltage Pin  |
| A4, B4, C4 <sup>*1</sup> | BOLX   | Boost Switching Output Pin  |
| A3, B3, C3 <sup>*2</sup> | PGND   | Power GND Pin   |
| A2, B2, C2 <sup>*1</sup> | BULX   | Buck Switching Output Pin   |
| A1, B1, C1 <sup>*1</sup> | PVIN   | Power Input Voltage Pin   |
| D1 <sup>*1</sup>         | AVIN   | Analog Power Input Voltage Pin  |
| D2                       | CE     | Chip Enable Pin, Active-high  |
| D3                       | MODE   | Mode Control Pin,<br>Forced PWM Control: L, PWM/VFM Auto Switching Control: H |
| D4 <sup>*2</sup>         | AGND   | Analog GND Pin  |
| D5                       | VFB    | Output Voltage Feedback Pin   |

<sup>\*1</sup> The pin numbers sharing the same pin symbol must be connected together: A4, B4, and C4 of the BOLX pin, A2, B2, and C2 of the BULX pin, A5, B5, and C5 of the VOUT pin. D1 of the AVIN pin and A1, B1, and C1 of the PVIN pin must be connected together.

<sup>\*2</sup> D4 of the AGND pin and A3, B3, and C3 of the PGND pin must be connected to the ground.

### Pin Truth Table

| CE Pin | MODE Pin <sup>*1</sup> | Operation                            |
|--------|------------------------|--------------------------------------|
| "L"    | -                      | OFF                                  |
| "H"    | "H"                    | PWM/ VFM Auto Switching Control Mode |
|        | "L"                    | Forced PWM Control Mode              |

<sup>\*1</sup> The logic to the MODE pin should not be changed while CE = "H".

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**ABSOLUTE MAXIMUM RATINGS****Absolute Maximum Ratings**

| Symbol     | Item  | Rating                  | Unit |
|------------|---|-------------------------|------|
| $V_{IN}$   | AVIN/ PVIN Pin Input Voltage                | -0.3 to 6.5             | V    |
| $V_{BULX}$ | BULX Pin Voltage                            | -0.3 to $V_{IN} + 0.3$  | V    |
| $V_{BOLX}$ | BOLX Pin Voltage                            | -0.3 to $V_{OUT} + 0.3$ | V    |
| $V_{CE}$   | CE Pin Input Voltage                        | -0.3 to 6.5             | V    |
| $V_{MODE}$ | MODE Pin Input Voltage                      | -0.3 to 6.5             | V    |
| $V_{OUT}$  | VOUT Pin Voltage                            | -0.3 to 6.5             | V    |
| $V_{FB}$   | VFB Pin Voltage                             | -0.3 to 6.5             | V    |
| $I_{LX}$   | BULX/ BOLX Pin Output Current               | 4.2                     | A    |
| $P_D$      | Power Dissipation (Standard Land Pattern)*1 | 1400                    | mW   |
| $T_a$      | Operating Temperature Range                 | -40 to 85               | °C   |
| $T_{stg}$  | Storage Temperature Range                   | -55 to 125              | °C   |

\*1 Refer to *PACKAGE INFORMATION* for detailed 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.

**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.

## ELECTRICAL CHARACTERISTICS

Open-loop Measurement GND = 0 V, unless otherwise noted.

### RP602ZxxxC Electrical Characteristics

(Ta = 25°C)

| Symbol                  | Item  | Conditions   | Min.   | Typ. | Max.   | Unit   |
|-------------------------|---|--|--------|------|--------|--------|
| V <sub>IN</sub>         | Operating Input Voltage                         |  | 2.3    |      | 5.5    | V      |
| I <sub>DD</sub>         | Quiescent Current                               | V <sub>IN</sub> = 5.5 V,<br>V <sub>OUT</sub> = 4.2 V,                    |        | 27.5 | 60     | μA     |
|                         |   | V <sub>MODE</sub> = 5.5 V<br>V <sub>MODE</sub> = 0 V                     |        | 1000 | 1400   |        |
| I <sub>standby</sub>    | Standby Current                                 | V <sub>IN</sub> = 5.5 V, V <sub>CE</sub> = 0 V                           |        | 0.1  | 5.0    | μA     |
| V <sub>OUT</sub>        | Output Voltage                                  | V <sub>IN</sub> = 3.6 V  | x0.985 |      | x1.015 | V      |
| ΔV <sub>OUT</sub> / ΔTa | Output Voltage Temperature Coefficient          | -40°C ≤ Ta ≤ 85°C  |        | ±50  |        | ppm/°C |
| V <sub>OVP</sub>        | OVP Detector Threshold                          | V <sub>IN</sub> = 3.6 V, Rising  | 4.5    | 5.0  | 5.5    | V      |
|                         | OVP Released Voltage                            | V <sub>IN</sub> = 3.6 V, Falling   | 4.3    | 4.8  | 5.3    | V      |
| f <sub>osc</sub>        | Switching Frequency                             | V <sub>IN</sub> = 3.6 V  | 2.4    | 2.6  | 2.9    | MHz    |
| I <sub>LIMHS</sub>      | BULX Current Limit*1                            | V <sub>IN</sub> = 3.6 V  | 3.7    | 4.2  |        | A      |
| R <sub>ON</sub>         | High & Low Switch On Resistance                 | V <sub>IN</sub> = 3.6 V  |        | 80   |        | mΩ     |
| R <sub>DIS</sub>        | On Resistance of Discharge Tr. (RP602ZxxxA/C/E) | V <sub>IN</sub> = 3.6 V, V <sub>CE</sub> = 0 V                           |        | 80   |        | Ω      |
| I <sub>FBH</sub>        | V <sub>FB</sub> "H" Input Current               | V <sub>IN</sub> = 5.5 V, V <sub>CE</sub> = 0 V<br>V <sub>FB</sub> = 5.5V |        |      | 1      | μA     |
| I <sub>FBL</sub>        | V <sub>FB</sub> "L" Input Current               | V <sub>IN</sub> = 5.5 V, V <sub>CE</sub> = 0 V<br>V <sub>FB</sub> = 0 V  |        |      | 1      | μA     |
| V <sub>H</sub>          | CE, MODE & Input Voltage "H"                    | V <sub>IN</sub> = 5.5 V  | 1.0    |      |        | V      |
| V <sub>L</sub>          | CE, MODE & Input Voltage "L"                    | V <sub>IN</sub> = 2.3 V  |        |      | 0.4    | V      |
| I <sub>H</sub>          | CE, MODE & "H" Input Current                    | V <sub>IN</sub> = V <sub>CE</sub> = 5.5 V                                | -1     | 0    | 1      | μA     |
| I <sub>L</sub>          | CE, MODE & "L" Input Current                    | V <sub>IN</sub> = 5.5 V, V <sub>CE</sub> = 0 V                           | -1     | 0    | 1      | μA     |
| V <sub>UVLO1</sub>      | UVLO Detector Threshold                         | V <sub>IN</sub> = Falling  | 1.83   | 2.00 |        | V      |
| V <sub>UVLO2</sub>      | UVLO Released Voltage                           | V <sub>IN</sub> = Rising   |        | 2.05 | 2.25   | V      |
| T <sub>TSD</sub>        | Thermal Shutdown Threshold Temperature          | T <sub>j</sub> , Rising  |        | 150  |        | °C     |
| T <sub>TSR</sub>        |   | T <sub>j</sub> , Falling   |        | 110  |        | °C     |
| t <sub>start</sub>      | Soft-start Time                                 | V <sub>IN</sub> = 3.6 V  |        | 1    |        | ms     |
| t <sub>prot</sub>       | Protection Delay Time (RP602ZxxxA/B/C/D)        | V <sub>IN</sub> = 3.6 V  |        | 1.6  |        | ms     |
| t <sub>rst</sub>        | Delay Time for Reset Protection (RP602ZxxxC/D)  | V <sub>IN</sub> = 3.6 V  |        | 12   |        | ms     |

All test items listed under *ELECTRICAL CHARACTERISTICS* are done under the pulse load condition (T<sub>j</sub> ≈ Ta = 25°C).

\*1 BULX Current Limit vary according to the switching duty ratio.

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**Product-specific Electrical Characteristics**

(Ta = 25°C)

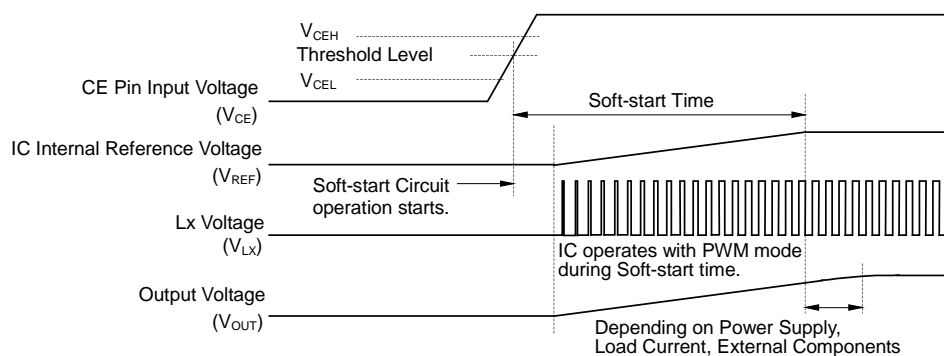
| Product Name | V <sub>OUT</sub> (V) |       |       |
|--------------|----------------------|-------|-------|
|              | Min.                 | Typ.  | Max.  |
| RP602Z270x   | 2.660                | 2.700 | 2.740 |
| RP602Z280x   | 2.758                | 2.800 | 2.842 |
| RP602Z290x   | 2.857                | 2.900 | 2.943 |
| RP602Z300x   | 2.955                | 3.000 | 3.045 |
| RP602Z310x   | 3.054                | 3.100 | 3.146 |
| RP602Z320x   | 3.152                | 3.200 | 3.248 |
| RP602Z330x   | 3.251                | 3.300 | 3.349 |
| RP602Z340x   | 3.349                | 3.400 | 3.451 |
| RP602Z350x   | 3.448                | 3.500 | 3.552 |
| RP602Z360x   | 3.546                | 3.600 | 3.654 |
| RP602Z370x   | 3.645                | 3.700 | 3.755 |
| RP602Z380x   | 3.743                | 3.800 | 3.857 |
| RP602Z390x   | 3.842                | 3.900 | 3.958 |
| RP602Z400x   | 3.940                | 4.000 | 4.060 |
| RP602Z410x   | 4.039                | 4.100 | 4.161 |
| RP602Z420x   | 4.137                | 4.200 | 4.263 |

## THEORY OF OPERATION

### Soft-start Time

#### Starting-up with CE Pin

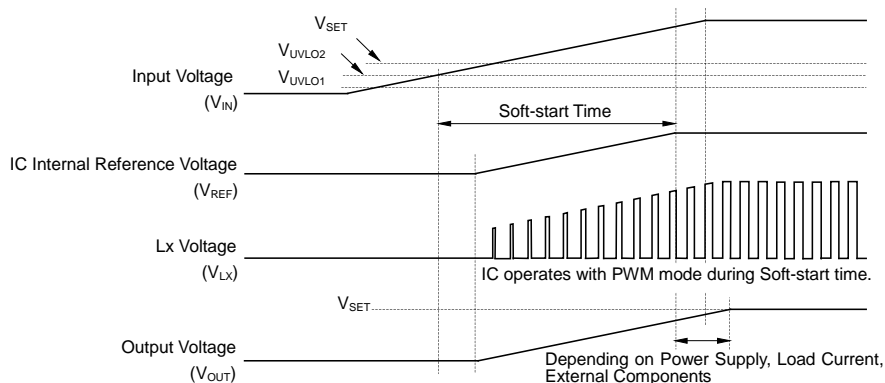
The IC starts to operate when the CE pin voltage ( $V_{CE}$ ) exceeds the threshold voltage. The threshold voltage is preset between CE "H" input voltage ( $V_{CEH}$ ) and CE "L" input voltage ( $V_{CEL}$ ). After the start-up of the IC, soft-start circuit starts to operate. Then, after a certain period of time, the reference voltage ( $V_{REF}$ ) in the IC gradually increases up to the specified value. Soft-start time ( $t_{start}$ ) starts when soft-start circuit is activated, and ends when the reference voltage reaches the specified value. Soft start time is not always equal to the turn-on speed of the DC/DC converter. Note that the turn-on speed could be affected by the power supply capacity, the output current, the inductance value and the  $C_{OUT}$  value.



Timing Chart: Starting-up with CE Pin

#### Starting-up with Power Supply

After the power-on, when  $V_{IN}$  exceeds the UVLO released voltage ( $V_{UVLO2}$ ), the IC starts to operate. Then, soft-start circuit starts to operate and after a certain period of time,  $V_{REF}$  gradually increases up to the specified value. Soft-start time starts when soft-start circuit is activated, and ends when  $V_{REF}$  reaches the specified value. Note that the turn-on speed of  $V_{OUT}$  could be affected by the power supply capacity, the output current, the inductance value, the  $C_{OUT}$  value and the turn-on speed of  $V_{IN}$  determined by  $C_{IN}$ .



Timing Chart: Starting-up with Power Supply

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## RP602Z

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### Undervoltage Lockout (UVLO) Circuit

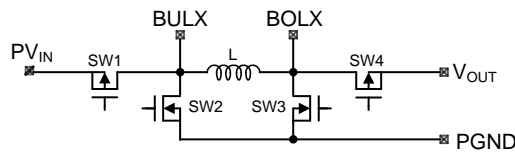
If the  $V_{IN}$  becomes lower than the UVLO detector threshold ( $V_{UVLO1}$ ), the UVLO circuit starts to operate,  $V_{REF}$  stops, and P-channel and N-channel built-in switch transistors turn "OFF". As a result,  $V_{OUT}$  drops according to the  $C_{OUT}$  capacitance value and the load. To restart the operation,  $V_{IN}$  needs to be higher than  $V_{UVLO2}$ .

### Overvoltage Protection (OVP) Circuit

If the  $V_{OUT}$  becomes higher than the OVP detector threshold ( $V_{OVP}$ ), the OVP circuit starts to operate, P-channel and N-channel built-in switch transistors turn "OFF". As a result,  $V_{OUT}$  drops according to the  $C_{OUT}$  capacitance value and the load.

### Overcurrent Protection Circuit

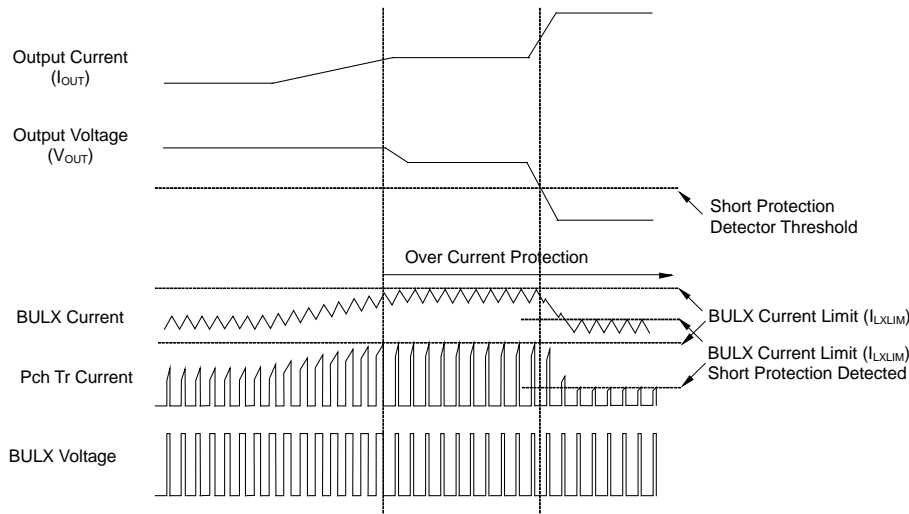
Overcurrent protection circuit supervises the inductor peak current (the peak current flowing through Pch Tr (SW1) in each switching cycle, and if the current exceeds the BULX current limit ( $I_{LXLIM}$ ), it turns off Pch Tr (SW1).  $I_{LXLIM}$  of the RP602Z is set to Typ.4200 mA.



**Simplified Diagram of Output Switches**

### Short Protection Circuit

If the  $V_{OUT}$  becomes lower than a certain threshold, the BULX current limit is reduced.



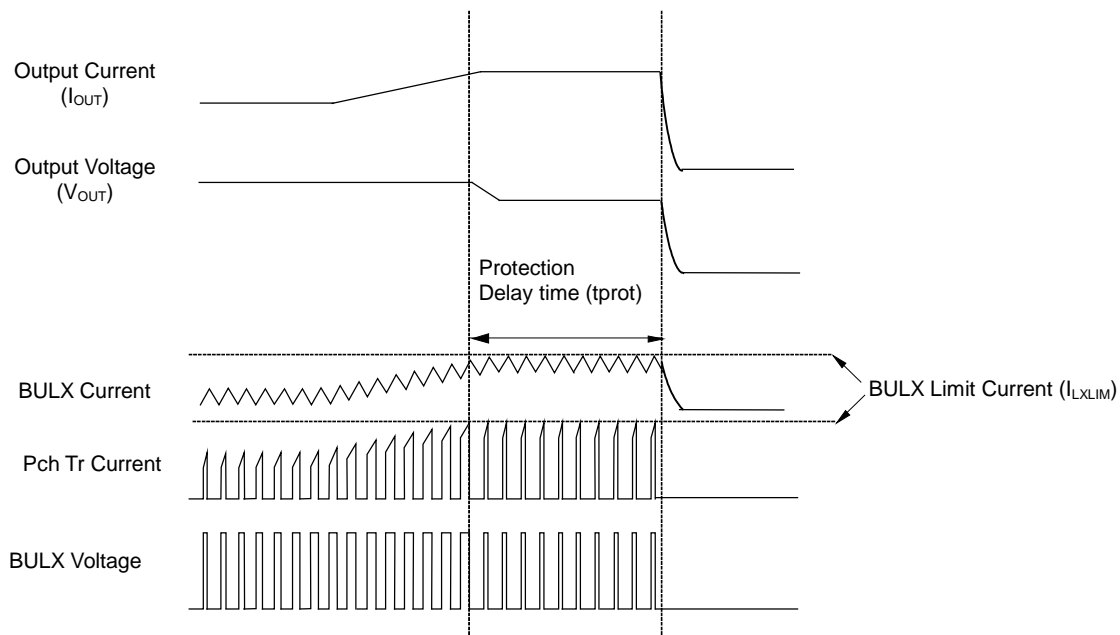
**Timing Chart: Overcurrent Protection Circuit & Short Protection Circuit**



**Latch Type Protection Circuit: RP602ZxxxA/B**

The latch type protection circuit latches the built-in drivers of SW1, SW2, SW3 and SW4 off to stop the operation of the device if the overcurrent state continues more than the protection delay time ( $t_{prot}$ ).

To release the latch-type protection, switch the CE pin from high to low to reset the device or make the input voltage ( $V_{IN}$ ) lower than the UVLO detector threshold ( $V_{UVLO1}$ ).



**Timing Chart: RP602ZxxxA/B Latch Protection Circuit**

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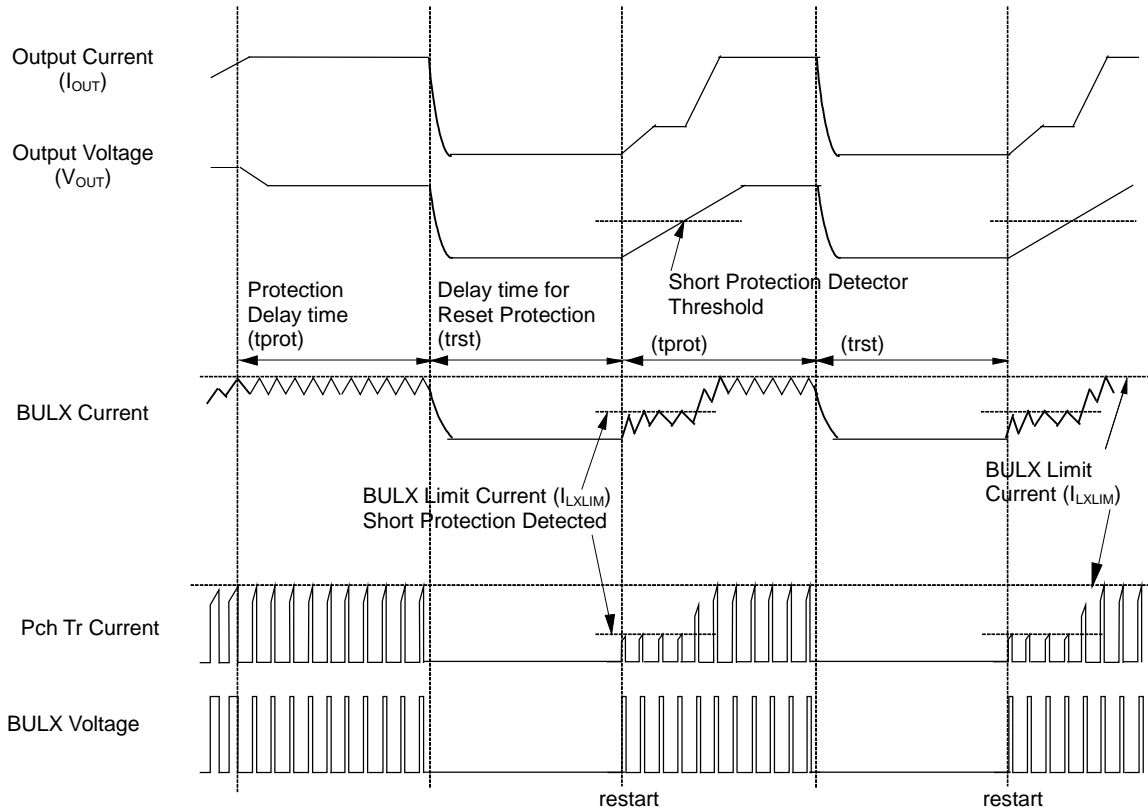
## RP602Z

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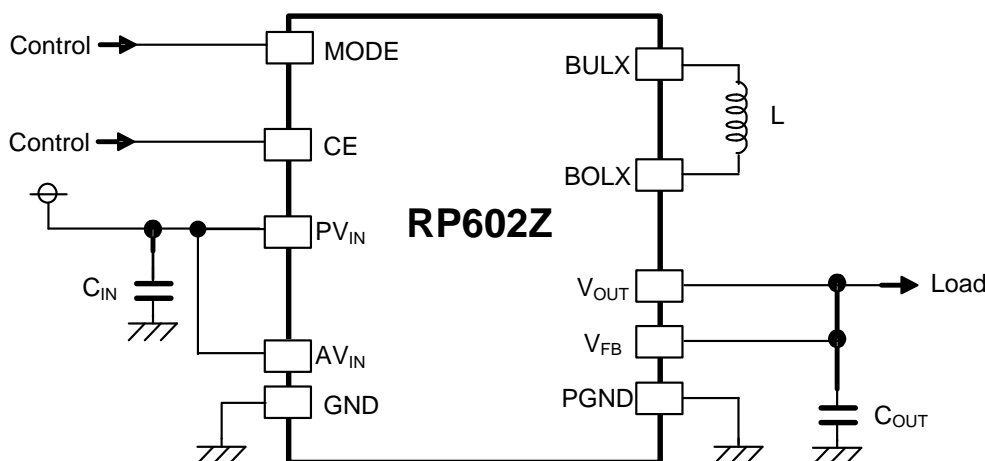
### Reset Type Protection Circuit: RP602ZxxxC/D

When the overcurrent state continues more than the protection delay time ( $t_{prot}$ ), Reset type protection circuit operates and switching stops and the built-in drivers of SW1, SW2, SW3 and SW4 turn off and restarts after delay time for reset protection ( $t_{rst}$ ). When the overcurrent state is released, the operation is automatically released and returns to normal operation.



Timing Chart: RP602ZxxxC/D Reset Protection Circuit

## APPLICATION INFORMATION



RP602ZxxxC/D Typical Application Circuit

### Recommended External Components

| Symbol         | Description   |
|----------------|---|
| $C_{IN}^{*1}$  | 10 $\mu$ F, Ceramic, GRM188R60J106ME47, Murata  |
| $C_{OUT}^{*2}$ | 22 $\mu$ F x 2, Ceramic, GRM188R60J226MEA0, Murata  |
| L              | 1.0 $\mu$ H, Inductor, DFE201610P- 1R0M, TOKO<br>1.0 $\mu$ H, Inductor, XAL4020- 102ME, Coilcraft |

\*1 Place  $C_{IN}$  as close as possible to the  $PV_{IN}$  pin.

\*2 Place  $C_{OUT}$  as close as possible to the  $V_{OUT}$  pin.

### Technical Notes on External Components Selection

- Use ceramic capacitors having a low equivalent series resistance (ESR).  $C_{OUT}$  should be paralleled with another  $C_{OUT}$ . When selecting the capacitors, consider the bias characteristics and input/ output voltage.
- When the built-in switches are turned off, the inductor may generate a spike-shaped high voltage. Use the high-breakdown voltage capacitor ( $C_{OUT}$ ) which output voltage is 1.5 times or more than the set output voltage.
- Use an inductor that has a low DC resistance, has an enough tolerable current and is less likely to cause magnetic saturation. If the inductance value is extremely small, the peak current of  $L_X$  may increase. When the peak current of  $L_X$  reaches to the  $L_X$  limit current ( $I_{LXLIM}$ ), overcurrent protection circuit starts to operate. When selecting the inductor, consider the maximum output current of  $L_X$  pin ( $I_{LXMAX}$ ). Refer to *Calculation Method of Maximum Output Current of  $L_X$  Pin ( $I_{LXMAX}$ ) in Continuous Mode* for details.

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**Calculation Method of Maximum Output Current of Lx Pin ( $I_{LXMAX}$ ) in Continuous Mode**

The maximum output current of Lx pin ( $I_{LXMAX}$ ) can be calculated as follows, in the case of an ideal converter operating in steady conditions, using the components listed in *Recommended External Components of APPLICATION INFORMATION*.

Ripple Current P-P value is described as  $I_{RP}$ , ON resistance of Pch Tr. is described as  $R_{ONP}$ , ON resistance of Nch Tr. is described as  $R_{ONN}$ , and DC resistor of the inductor is described as  $R_L$ .

First, when Pch Tr. is "ON", the following equation is satisfied.

$$V_{IN} = V_{OUT} + (R_{ONP} + R_L) \times I_{OUT} + L \times I_{RP} / t_{on} \dots\dots\dots \text{Equation 1}$$

Second, when Pch Tr. is "OFF" (Nch Tr. is "ON"), the following equation is satisfied.

$$L \times I_{RP} / t_{off} = R_{ONN} \times I_{OUT} + V_{OUT} + R_L \times I_{OUT} \dots\dots\dots \text{Equation 2}$$

Put Equation 2 into Equation 1 to solve ON duty of Pch Tr. ( $D_{ON} = t_{on} / (t_{off} + t_{on})$ ):

$$D_{ON} = (V_{OUT} + R_{ONN} \times I_{OUT} + R_L \times I_{OUT}) / (V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT}) \dots\dots\dots \text{Equation 3}$$

Ripple Current is described as follows:

$$I_{RP} = (V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON} / f_{osc} / L \dots\dots\dots \text{Equation 4}$$

Peak current that flows through L, and Lx Tr. is described as follows:

$$I_{LXmax} = I_{OUT} + I_{RP} / 2 \dots\dots\dots \text{Equation 5}$$

## 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 a rated voltage, a rated current or a rated power. When designing a peripheral circuit, please be fully aware of the following points.

- Place the bypass capacitor ( $C_{INP}$ ) between the  $V_{INP}$  pin and the GND pin with shortest-distance wiring.
- Place the output capacitor ( $C_{OUT}$ ) between the  $V_{OUT}$  pin and the GND pin with shortest-distance wiring. Connect GND of  $C_{OUT}$  to the GND pin with shortest-distance wiring.
- Make the GND plane wide.
- Ensure the  $V_{INP}$  and GND lines are firmly connected. A large switching current flows through the  $V_{INP}$ , GND, inductor, BOLX, BULX and  $V_{OUT}$  lines. If their impedance is too high, noise pickup or unstable operation may result.
- Connect the BOLX pin and the inductor and the BULX pin with shortest-distance wiring.

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## PACKAGE INFORMATION

### POWER DISSIPATION (WLCSP-20-P1)

Power Dissipation ( $P_D$ ) of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

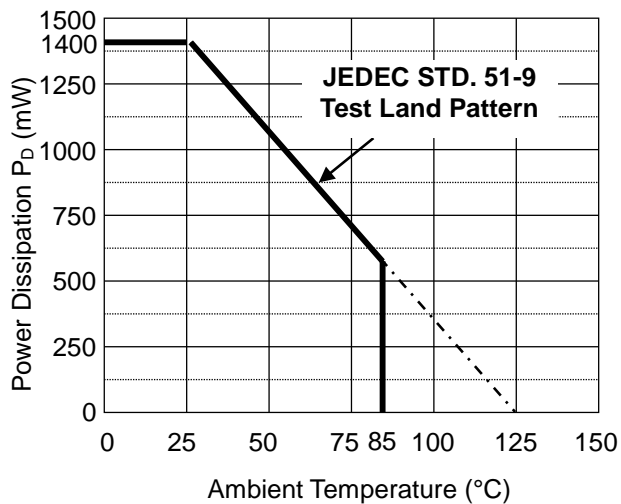
#### Measurement Conditions

|                  | JEDEC STD. 51-9 Test Land Pattern                               |
|------------------|---|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                       |
| Board Material   | Glass Cloth Epoxy Plastic (4-Layer)                             |
| Board Dimensions | 101.5 mm x 114.5 mm x 1.6 mm                                    |
| Copper Ratio     | Top-side, Back-side: Approx.60%<br>2nd, 3rd Layer: Approx. 100% |

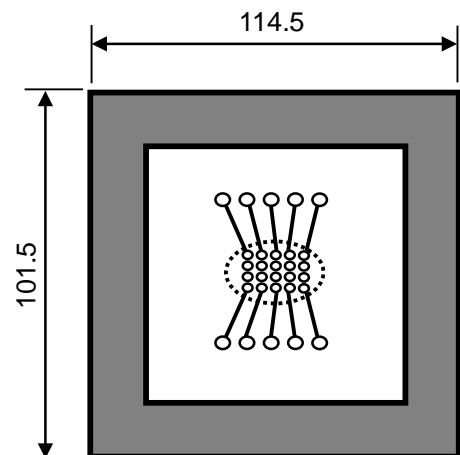
#### Measurement Result

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

|                    | JEDEC STD. 51-9 Test Land Pattern   |
|--------------------|---|
| Power Dissipation  | 1400 mW   |
| Thermal Resistance | $\theta_{ja} = (125 - 25^\circ\text{C}) / 1.4 \text{ W} = 71^\circ\text{C/W}$ |



Ambient Temperature vs. Power Dissipation

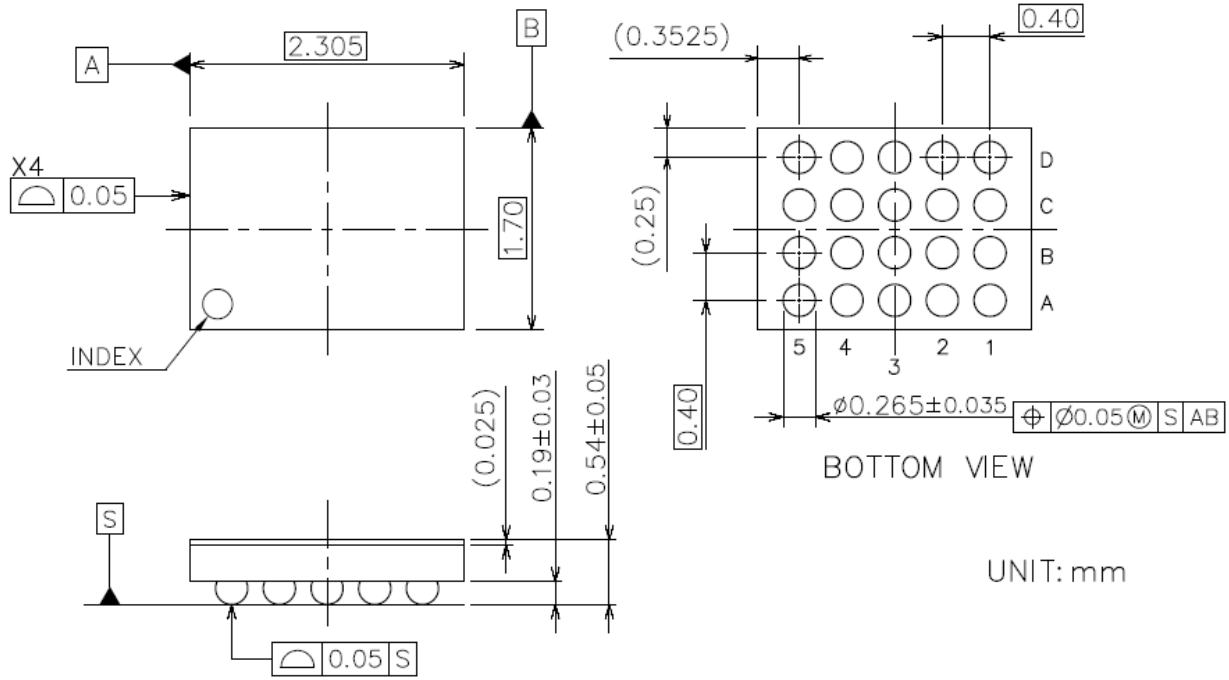


Standard Test Land Pattern

○ IC Mount Area (Unit: mm)

Measurement Board Pattern

PACKAGE DIMENSIONS (WLCSP-20-P1)



UNIT: mm

WLCSP-20-P1 Package Dimensions

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# RP602Z

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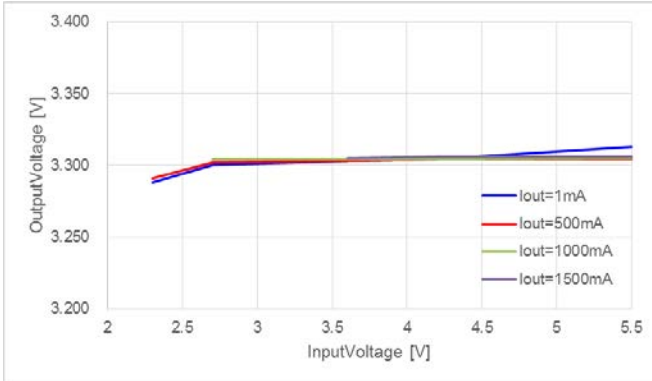
NO. EA-353-150422

## TYPICAL CHARACTERISTICS

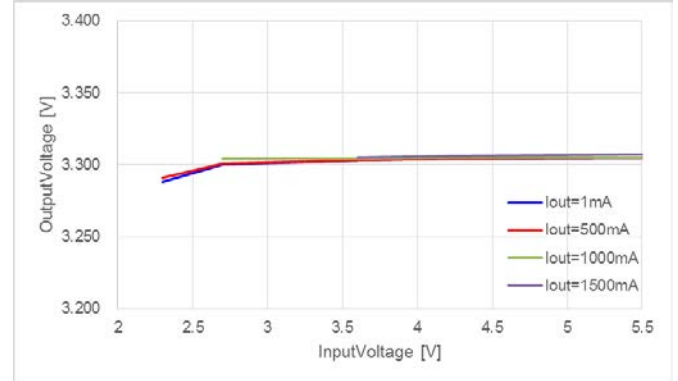
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

### 1) Input Voltage vs. Output Voltage

RP602Z330x, MODE = H

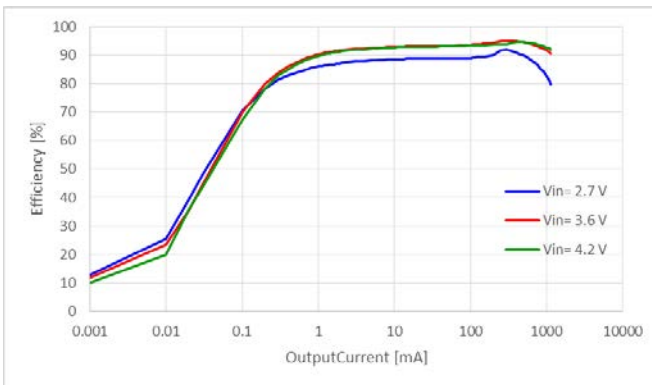


RP602Z330x, MODE = L

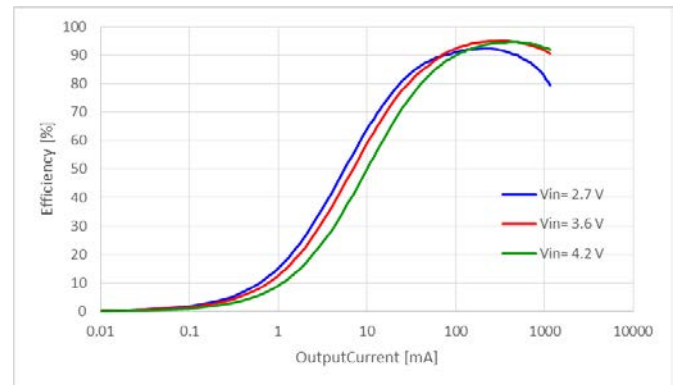


### 2) Output Current vs. Efficiency (for Different Input Voltages)

RP602Z330x, MODE = H

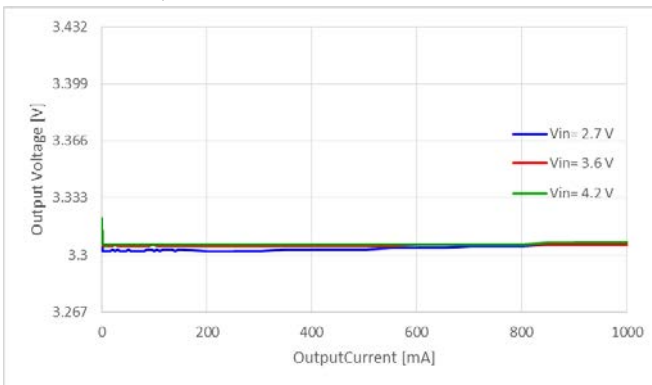


RP602Z330x, MODE = L

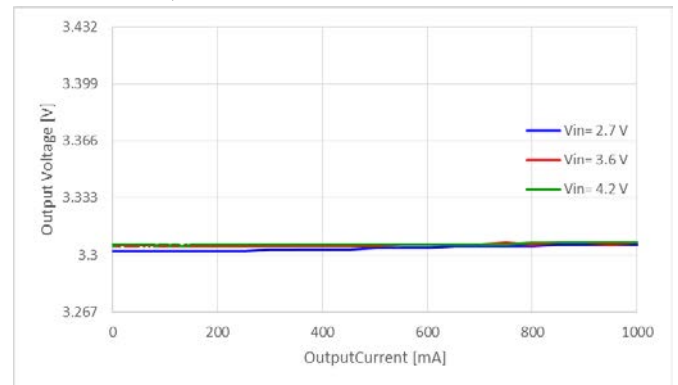


### 3) Output Current vs. Output Voltage

RP602Z330x, MODE = H

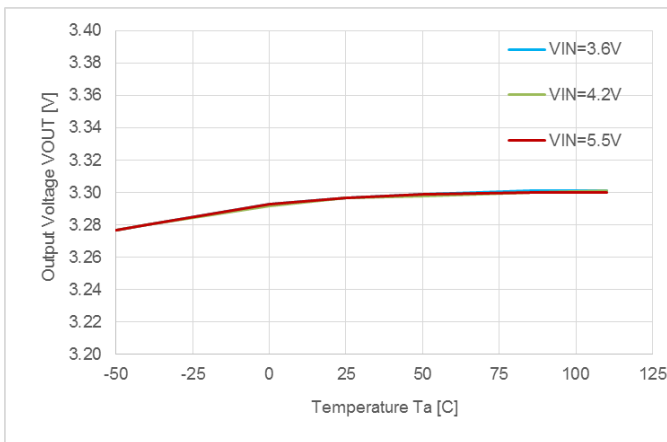


RP602Z330x, MODE = L

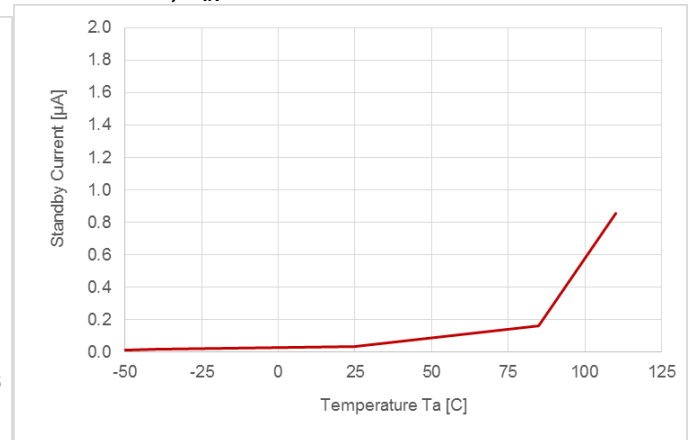




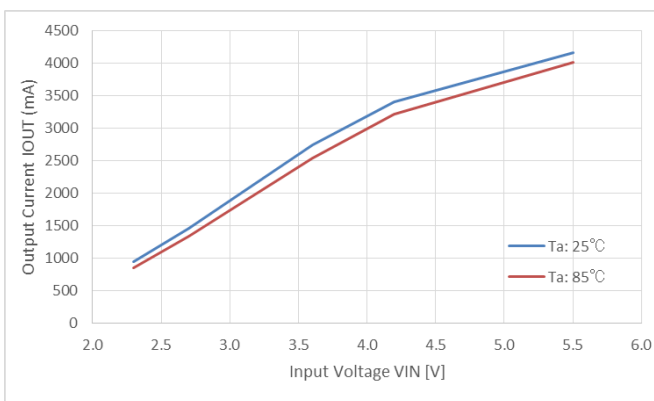
**4) Temperature vs. Output Voltage**  
**RP602Z330x**



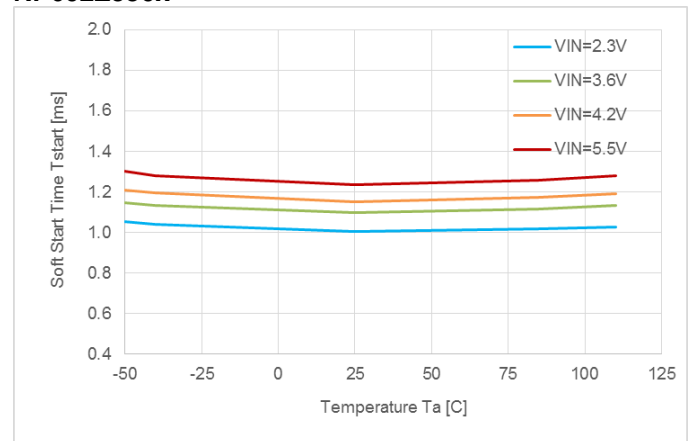
**5) Temperature vs. Standby Current**  
**RP602Z330x, VIN = 5.5 V**



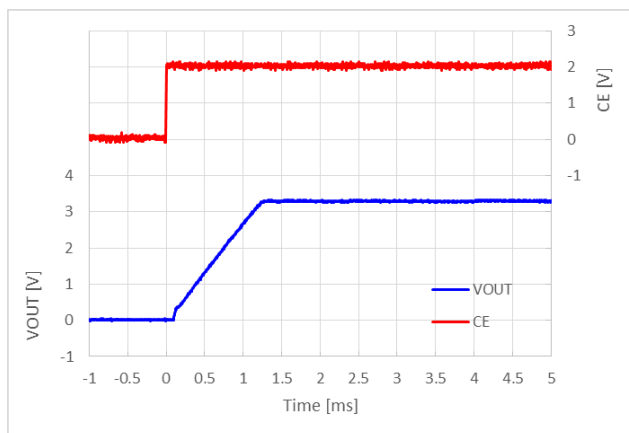
**6) Input Voltage vs. Output Current**  
**RP602Z330x, MODE = L**



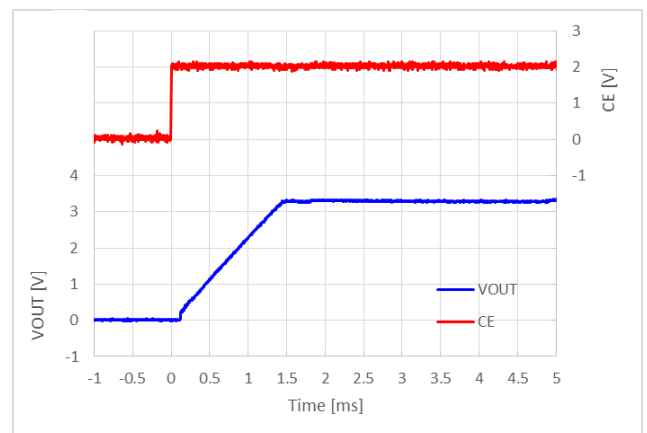
**7) Temperature vs. Soft-start Time**  
**RP602Z330x**



**8) CE Start-up Waveform**  
**RP602Z330x, VIN = 3.6 V, MODE = H**  
**IOUT = 0 mA**



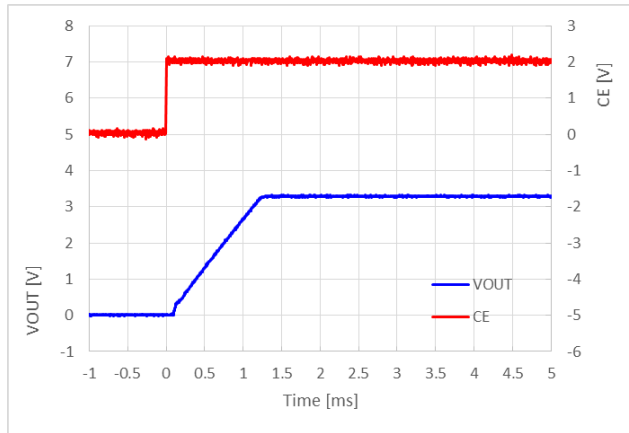
**RP602Z330x, VIN = 5.5 V, MODE = H**  
**IOUT = 0 mA**



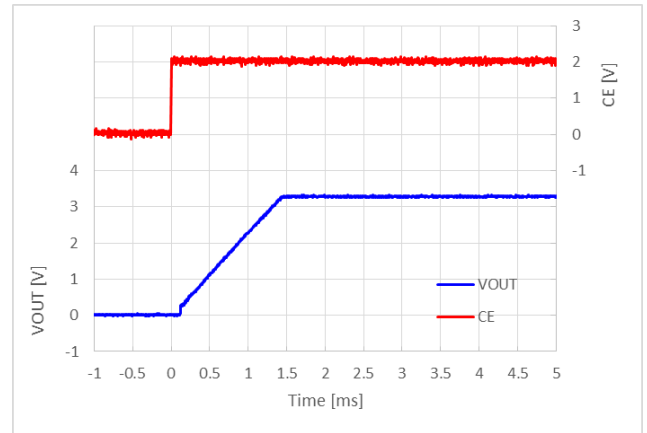
# RP602Z

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RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L  
 $I_{OUT} = 0\text{ mA}$

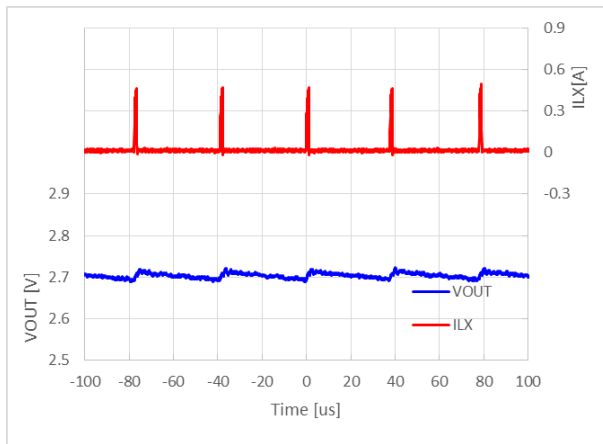


RP602Z330x,  $V_{IN} = 5.5\text{ V}$ , MODE = L  
 $I_{OUT} = 0\text{ mA}$

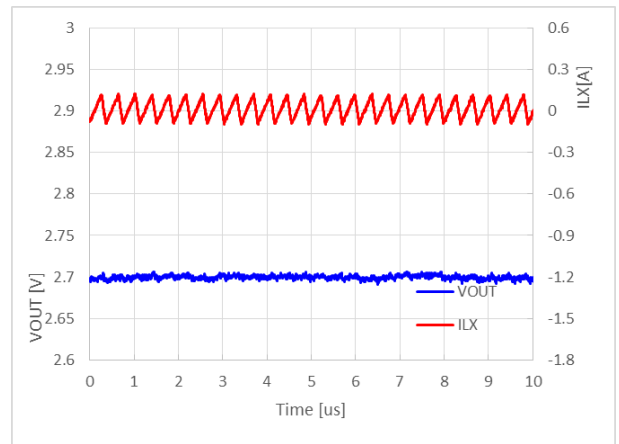


## 9) $V_{OUT}$ Waveform

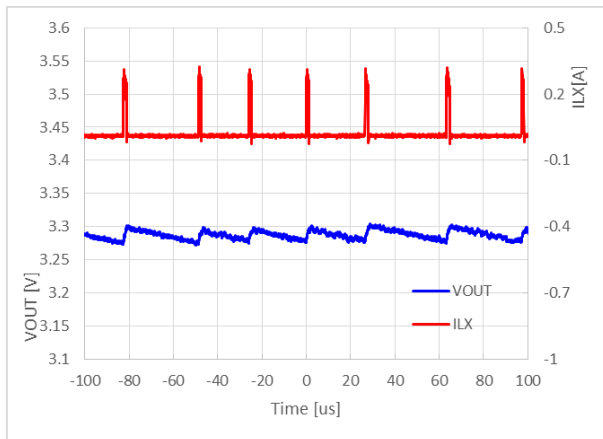
RP602Z270x,  $V_{IN} = 3.6\text{ V}$ , MODE = H  
 $I_{OUT} = 10\text{ mA}$



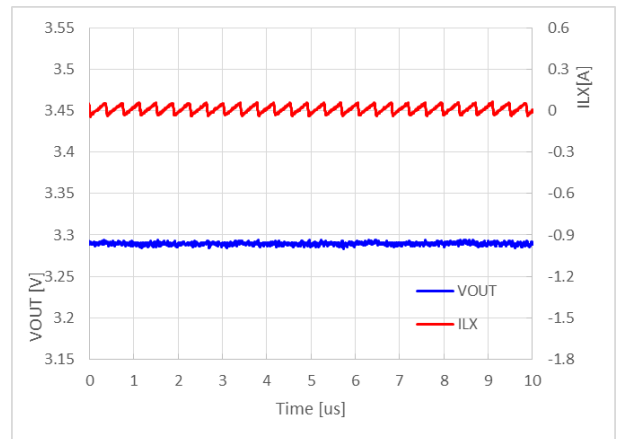
RP602Z270x,  $V_{IN} = 3.6\text{ V}$ , MODE = L  
 $I_{OUT} = 0\text{ mA}$



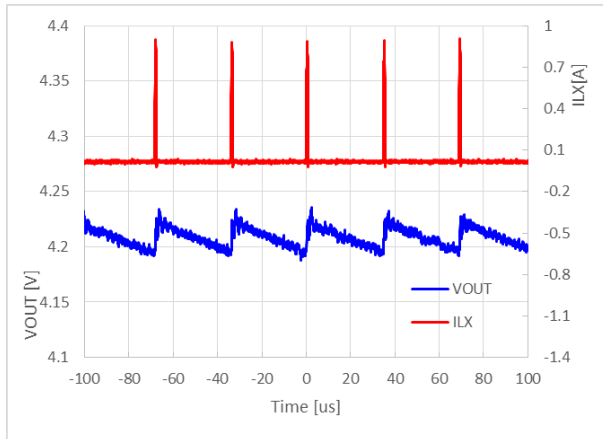
RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = H  
 $I_{OUT} = 10\text{ mA}$



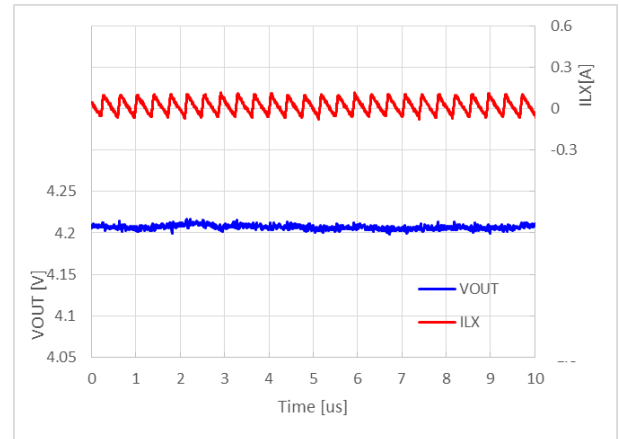
RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L  
 $I_{OUT} = 0\text{ mA}$



RP602Z420x,  $V_{IN} = 3.6\text{ V}$ , MODE = H  
 $I_{OUT} = 10\text{ mA}$

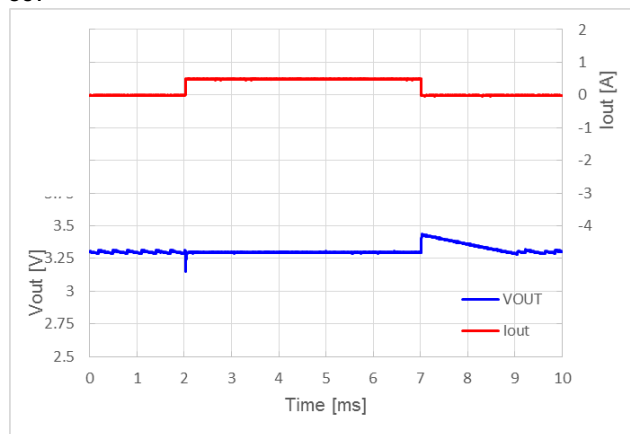


RP602Z420x,  $V_{IN} = 3.6\text{ V}$ , MODE = L  
 $I_{OUT} = 0\text{ mA}$



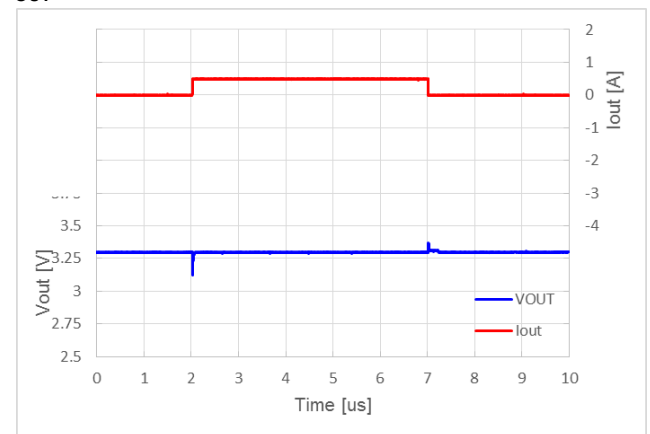
10) Load Transient Response Waveform  
 RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = H

$I_{OUT} = 1\text{ mA} \leftrightarrow 500\text{ mA}$



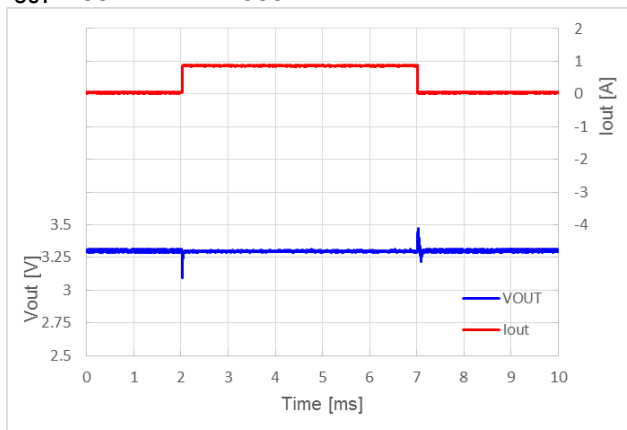
RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L

$I_{OUT} = 1\text{ mA} \leftrightarrow 500\text{ mA}$



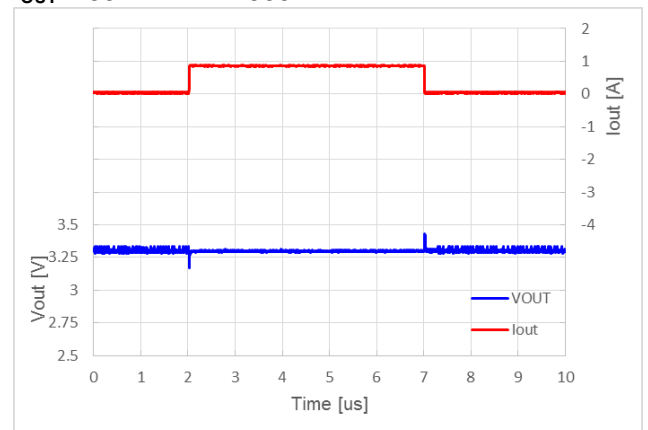
RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = H

$I_{OUT} = 50\text{ mA} \leftrightarrow 900\text{ mA}$



RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L

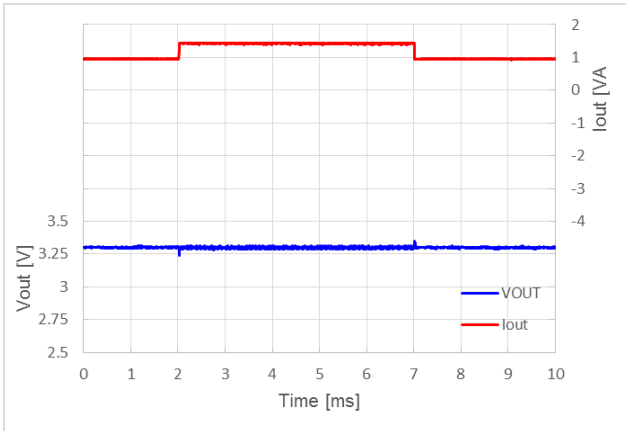
$I_{OUT} = 50\text{ mA} \leftrightarrow 900\text{ mA}$



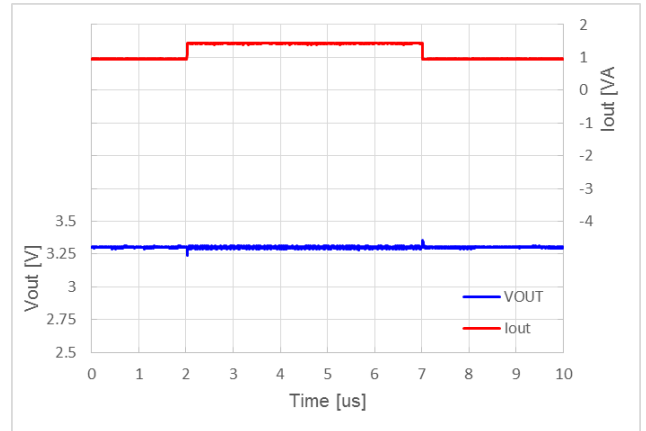
# RP602Z

NO. EA-353-150422

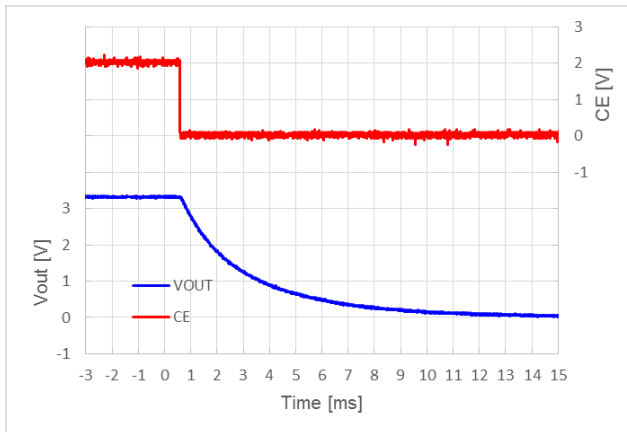
**RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = H**  
 **$I_{OUT} = 1000\text{ mA} \leftrightarrow 1500\text{ mA}$**



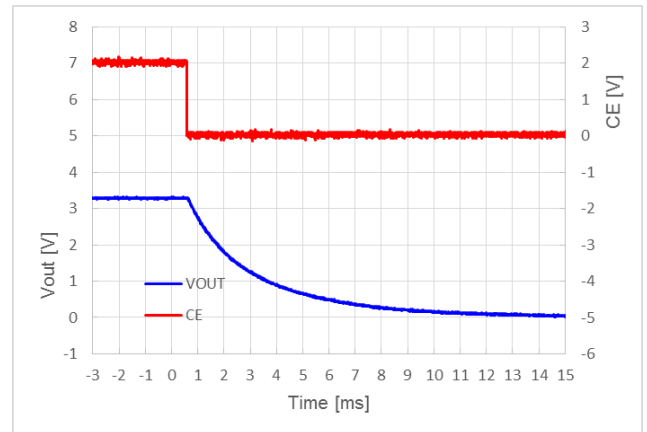
**RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L**  
 **$I_{OUT} = 1000\text{ mA} \leftrightarrow 1500\text{ mA}$**



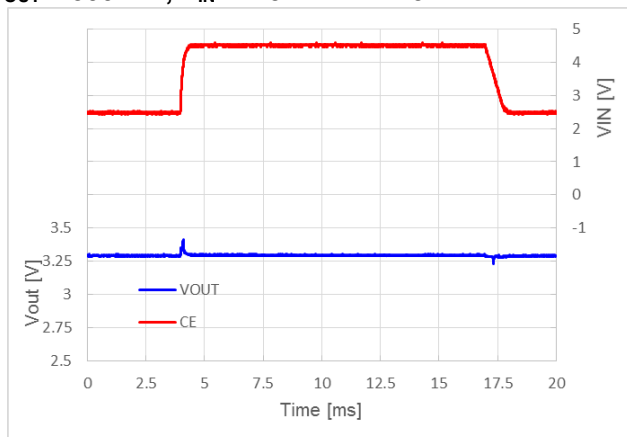
**11) CE Turn off Waveform**  
**RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = H**  
 **$I_{OUT} = 0\text{ mA}$**



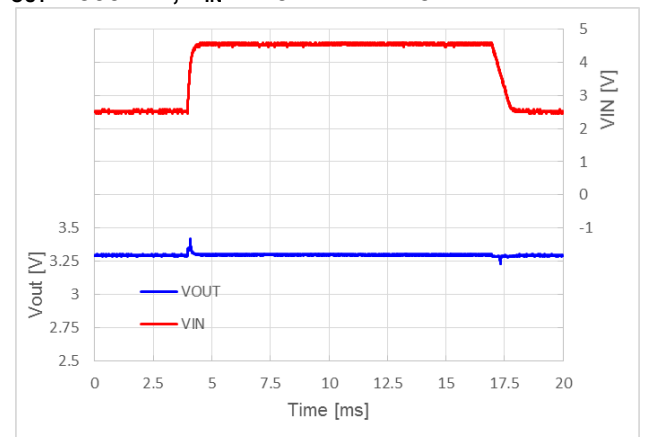
**RP602Z330x,  $V_{IN} = 3.6\text{ V}$ , MODE = L**  
 **$I_{OUT} = 0\text{ mA}$**



**12) Input Transient Response Waveform**  
**RP602Z330x, MODE = H**  
 **$I_{OUT} = 500\text{ mA}$ ,  $V_{IN} = 2.5\text{ V} \leftrightarrow 4.5\text{ V}$**



**RP602Z330x, MODE = L**  
 **$I_{OUT} = 500\text{ mA}$ ,  $V_{IN} = 2.5\text{ V} \leftrightarrow 4.5\text{ V}$**





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