

### 1A PWM/VFM Step-down DC/DC Converter with Synchronous Rectifier Evaluation Board

No. EEV-362-N001D033-200220

**RP509N001D033-EV is the evaluation board for RP509 which has the below features, benefits and specifications.**

## OUTLINE

The RP509N is a low supply current PWM/VFM step-down DC/DC converter with synchronous rectifier featuring 0.5 A/1 A output current<sup>(1)</sup>. Internally, a single converter consists of a reference voltage unit, an error amplifier, a switching control circuit, a mode control circuit, a soft-start circuit, an undervoltage lockout (UVLO) circuit, a thermal shutdown circuit, and switching transistors. The RP509N is employing synchronous rectification for improving the efficiency of rectification by replacing diodes with built-in switching transistors. Using synchronous rectification not only increases circuit performance but also allows a design to reduce parts count. Output voltage controlling method is selectable between a PWM/VFM auto-switching control type and a forced PWM control type, which further reduces noise than a normal PWM control under a light load, and these types can be set by the MODE pin. Output voltage type is selectable between an internally fixed output voltage type and an externally adjustable output voltage type. Protection circuits in the RP509N is current limit circuit and thermal shutdown circuit. LX current limit value (Typ.) is selectable between 1.6 A and 1.0 A.

## FEATURES

- Input Voltage Range (Maximum Rating) ..... 2.3 V to 5.5 V (6.5 V)
- Output Voltage Range (Fixed Output Voltage Type) ..... 0.6 V to 3.3 V, settable in 0.1 V steps  
(Adjustable Output Voltage Type) ..... 0.6 V to 5.5 V
- Output Voltage Accuracy (Fixed Output Voltage Type) .....  $\pm 1.5\%$  ( $V_{SET}^{(2)} \geq 1.2$  V),  $\pm 18$  mV ( $V_{SET} < 1.2$  V)
- Feedback Voltage Accuracy (Adjustable Output Voltage Type) ....  $\pm 9$  mV ( $V_{FB} = 0.6$  V)
- Output Voltage/Feedback Voltage Temperature Coefficient ....  $\pm 100$  ppm/ $^{\circ}$ C
- Selectable Oscillator Frequency ..... Typ. 6.0 MHz
- Oscillator Maximum Duty ..... Min. 100%
- Built-in Driver ON Resistance ( $V_{IN} = 3.6$  V) ..... Typ. Pch. 0.195  $\Omega$ , Nch. 0.175  $\Omega$  (RP509N)
- Standby Current ..... Typ. 0  $\mu$ A
- UVLO Detector Threshold ..... Typ. 2.0 V
- Soft-start Time ..... Typ. 0.15 ms
- Inductor Current Limit Circuit ..... Typ. 1.6 A/1.0 A, selectable Current Limit
- Package ..... SOT-23-6 ( 2.9 mm x 2.8 mm x 1.1 mm )

<sup>(1)</sup> This is an approximate value. The output current is dependent on conditions and external components.

<sup>(2)</sup>  $V_{SET}$  = Set Output Voltage

- For more details on RP509 IC, please refer to <https://www.n-redc.co.jp/en/pdf/datasheet/rp509-ea.pdf>.

## Part Number Information

Product Name	Package
RP509N001D033	SOT-23-6

00: Specify the set output voltage ( $V_{SET}$ )

Adjustable Output Voltage Type: 00 only

1: Specify the LX Current Limit ( $I_{LXLIM}$ )

1: Typ. 1.6 A

D: Specify the version

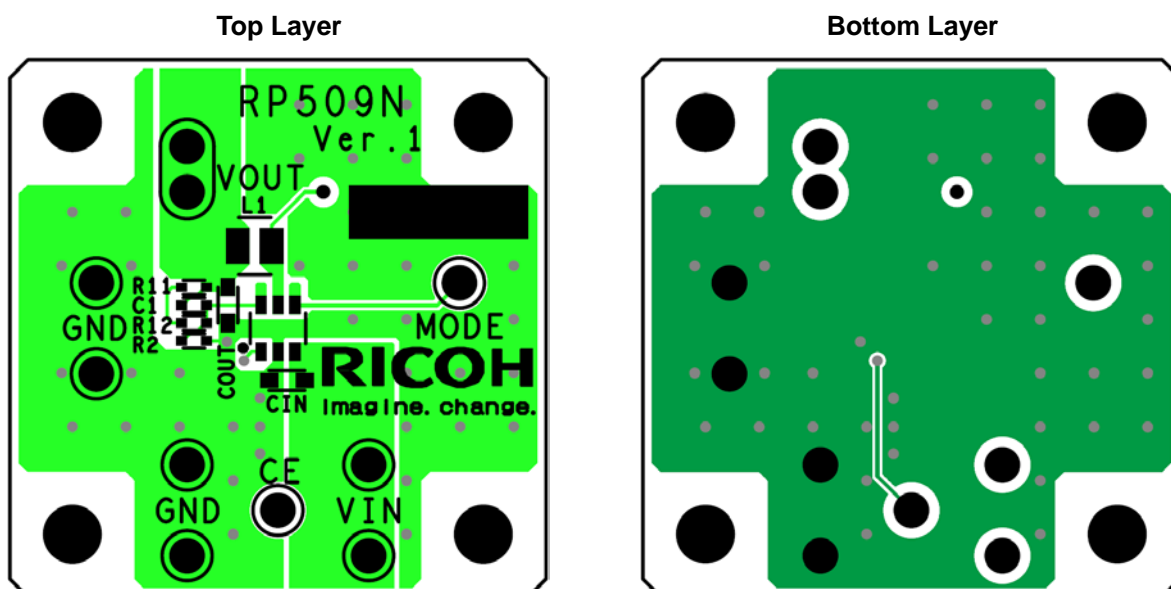
D: with Auto-discharge, Oscillator Frequency = 6.0 MHz

033: Output voltage

033: 3.3 V, Output voltage

## PCB LAYOUT

Adjustable Output Voltage Type (RP509N00XC/D)



## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

(GND = 0 V)

Symbol	Item			Rating	Unit
$V_{IN}$	Input Voltage			-0.3 to 6.5	V
$V_{LX}$	LX Pin Voltage			-0.3 to $V_{IN} + 0.3$	V
$V_{CE}$	CE Pin Voltage			-0.3 to 6.5	V
$V_{MODE}$	MODE Pin Voltage			-0.3 to 6.5	V
$V_{OUT}/V_{FB}$	VOUT/VFB Pin Voltage			-0.3 to 6.5	V
$I_{LX}$	LX Pin Output Current			1.6	A
$P_D$	Power Dissipation <sup>(1)</sup>	SOT-23-6	JEDEC STD. 51-7 Test Land Pattern	892	mW
$T_j$	Junction Temperature			-40 to 125	°C
$T_{stg}$	Storage Temperature Range			-55 to 125	°C

### ABSOLUTE MAXIMUM RATINGS

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

## RECOMMENDED OPERATING CONDITIONS

Symbol	Item	Rating	Unit
$V_{IN}$	Input Voltage	2.3 to 5.5	V
$T_a$	Operating Temperature Range	-40 to 85	°C

### RECOMMENDED OPERATING CONDITIONS

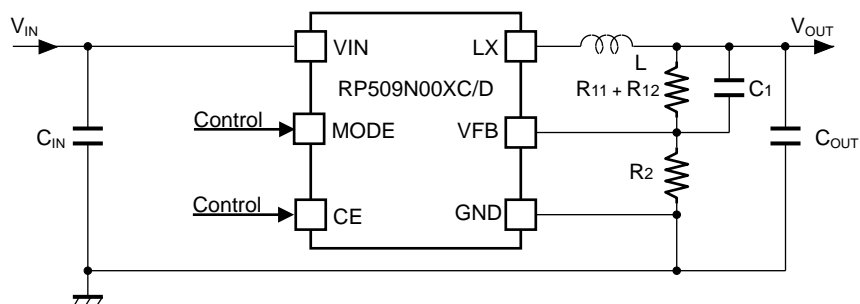
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic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

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

## APPLICATION INFORMATION

### Typical Application Circuits

**MODE = High: Forced PWM Control, MODE = Low: PWM/VFM Auto-switching Control**



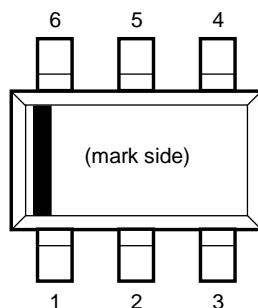
**RP509N00XC/RP509N00XD ( Adjustable Output Voltage Type)**

### Recommended External Components<sup>\*1</sup>

Symbol	Size
C <sub>IN</sub>	10 μF
C <sub>OUT</sub>	10 μF
L	0.47 μH
R <sub>11</sub>	200 kohm
R <sub>12</sub>	12 kohm
R <sub>2</sub>	47 kohm
C <sub>1</sub>	6.8 pF

<sup>\*1</sup> The bill of materials will be attached on the shipment of each purchased evaluation board.

## PIN DESCRIPTION



**SOT-23-6 Pin Configurations**

### SOT-23-6 Pin Description

Pin No.	Symbol	Description
1	CE	Chip Enable Pin, Active-high
2	GND	Ground Pin
3	VIN	Input Voltage Pin
4	MODE	Mode Control Pin (High: Forced PWM Control, Low: PWM/VFM Auto-switching Control)
5	LX	Switching Pin
6	VOUT/VFB	Output/Feedback Voltage Pin

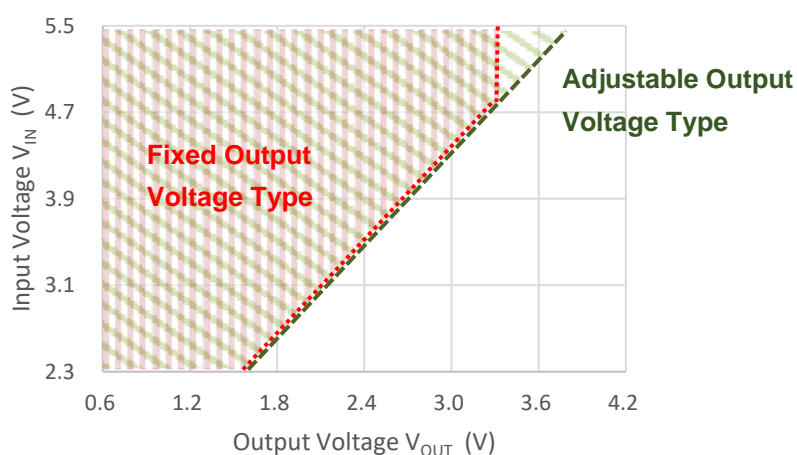
## TECHNICAL NOTES

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

- Set the external components as close as possible to the IC and minimize the wiring between the components and the IC. Especially, place a capacitor ( $C_{IN}$ ) as close as possible to the VIN pin and GND.
- Ensure the VIN and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result.
- The VIN line, the GND line, the VOUT line, an inductor, and LX should make special considerations for the large switching current flows.
- The wiring between a resistor for setting output voltage (R1) and L (RP509x00XC/RP509x00XD) should be separated from the wiring between L and Load.
- Over current protection circuit may be affected by self-heating or power dissipation environment.
- For any setting type of output voltage, the input/output voltage ratio must meet the following requirement to achieve a stable VFM mode at light load when the MODE pin is “Low” (at PWM/VFM Auto Switching):

$$V_{OUT} / V_{IN} < 0.7$$

$V_{MODE} = \text{Low}$ , PWM/VFM Auto Switching



Available Voltage Area with Stable VFM Mode



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