RICOH

RP402K501A-EV

High Efficiency Small Packaged Step-up DC/DC Converter Evaluation Board

No. EEV-317-K501A-190212

RP402K501A-EV is the evaluation board for RP402 which has the below features, benefits and specifications.

OUTLINE

The RP402K is a high efficiency step-up DC/DC converter with synchronous rectifier. The device can start up with low voltage of typically 0.7 V which is ideal for the applications powered by either one-cell or two-cell alkaline, nickel-metal-hydride (NiMH) or one-cell Lithium-ion (Li+) batteries.

Internally, the RP402K consists of an oscillator, a reference voltage unit with soft start, a chip enable circuit, an error amplifier, phase compensation circuits, a slope circuit, a PWM control circuit, a start-up circuit, a PWM/VFM mode control circuit, internal switches and protection circuits.

The RP402K is employing synchronous rectification for improving the efficiency or 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.

The RP402K is available in either internally fixed output voltage type or adjustable output voltage type. The RP402Kxxxx is the internally fixed output voltage type.

The RP402K provides the forced PWM control and the PWM/VFM auto switching control. Either one of these can be selected by inputting a signal to the MODE pin. The forced PWM control switches at fixed frequency rate in low output current in order to reduce noise. Likewise, the PWM/VFM auto switching control automatically switches from PWM mode to VFM mode in low output current in order to achieve high efficiency.

The RP402K has a soft-start time of typically 0.5 ms.
The RP402K features the complete output disconnect shutdown option and the input-to-output bypass shutdown option. The RP402KxxxA/ B/ E/ F incorporates the complete output disconnect shutdown option, which allows the output to be disconnected from the input. The RP402KxxxC/ D/ G/ H incorporates the input-to-output bypass shutdown option, which allows the output to be connected to the input.

The RP402K is protected against damage by a short-current protection, an over-voltage lockout, an over voltage protection, an anti-ringing switch and a latch-type protection. An anti-ringing switch prevents the occurrence of noise when an inductor current reaches a discontinuous mode. The RP402K provides optional Latch function with current limit detection which can turn off the power in case the limit values are detected for a fixed time and current limit circuit controls peak inductor currents in every clock. The latch-type protection can be released by switching the CE pin from high to low while the power is turned on.

FEATURES

- Low Voltage Start-up ····· Typ. 0.7 V
- Input Voltage Range ····· Fixed Output Voltage Type: 0.6 V to 4.8 V
- High Efficiency ····· 94% (100 mA/ 5.0 V, V_{IN} = 3.6 V, 25°C)
  90% (1 mA/ 5.0 V, V_{IN} = 3.6 V, 25°C)
- Output Current ····· 800 mA: V_{IN} = 3.6 V, V_{OUT} = 5.0 V
- L_X Driver ON Resistance ····· NMOS/ PMOS: 0.20 Ω (V_{OUT} = 5.0 V, 25°C)
- PWM Oscillator Frequency ····· 1.2 MHz (Normal PWM), 1.0 MHz (Forced PWM)
- Output Voltage Range ····· Fixed Output Voltage Type: 1.8 V to 5.5 V, 0.1 V step
- OVLO Detector Threshold ····· Typ. 5.1 V
- OVP Detector Threshold ····· Typ. 6.0 V
- L_X Peak Current Limit ····· Typ. 1.5 A
- Latch Protection Delay Time ····· Typ. 3.3 ms (RP402Kxx1x)
  Typ. 4.1 ms (RP402Kxx2x)
- Soft-start Time ····· Typ. 0.5 ms
- EMI Suppression (Built-in Anti-ringing Switch) (RP402Kxx1x)
- Voltage Regulation at V_{IN} > V_{OUT}
- Zero Input Complete Shutdown at V_{IN} = 0 V
- Input-to-Output Bypass Shutdown Option at CE = L (RP402KxxxC/ D/ G/ H)
- Ceramic Capacitor Capable
- Package ····· DFN(PLP)2020-8
- For more details on RP402 IC, please refer to
  https://www.e-devices.ricoh.co.jp/en/products/power/dcdc/rp402/rp402-ea.pdf.

Part Number Information

Product Name	Package
RP402Kxx#$	DFN(PLP)2020-8

xx: Specify the set output voltage (V_{SET}).
xx: Fixed Output Voltage Type , 50: V_{SET} = 5.0 V

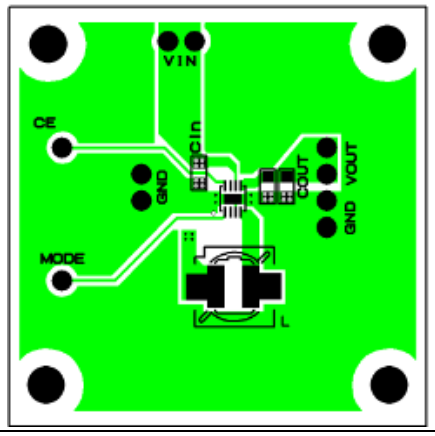
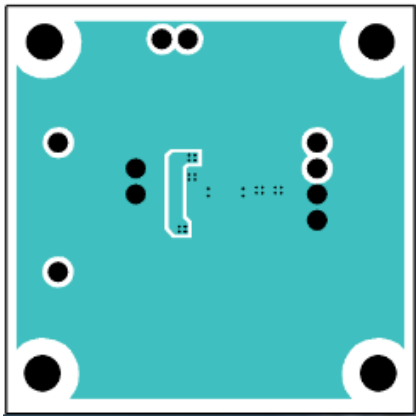
#: Specify the PWM control type.
1: Normal PWM operation

$: Specify the combination of the shutdown option and the operation option at the current limit protection.

Version	Shutdown Options at CE = L	Operation at Current limit protection
A	Complete Output Disconnect	latch

PCB LAYOUT

RP402Kxxxx (PKG: DFN(PLP)2020-8pin) Typical Board Layout（for Fixed Output Voltage Type）

Top Layer	Bottom Layer
	

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
V_{IN}	V_{IN} Pin Voltage		−0.3 to 6.5	V
V_{OUT}	V_{OUT} Pin Voltage		−0.3 to 7.0	V
V_{LX}	L_X Pin Voltage		−0.3 to 6.5	V
V_{CE}	CE Pin Voltage		−0.3 to 6.5	V
V_{FB}	V_{FB} Pin Voltage (RP402K00xx only)		−0.3 to 6.5	V
V_{MODE}	MODE Pin Voltage (RP402Kxxxx only)		−0.3 to 6.5	V
P_D	Power Dissipation [1] (JEDEC STD. 51-7)	DFN(PLP)2020-8	1800	mW
Tj	Junction Temperature Range		−40 to 125	°C
Tstg	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 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 is not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

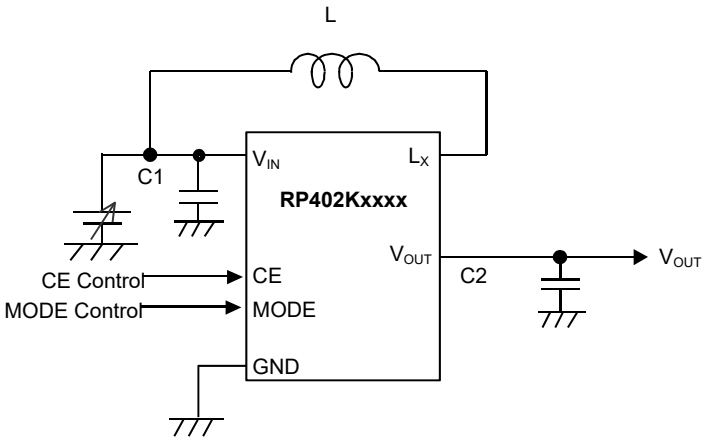
Symbol	Parameter	Rating	Unit
V_{IN}	Input Voltage	0.6 to 4.8	V
Ta	Operating Temperature	−40 to 85	°C

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.

[1] Refer to *POWER DISSIPATION* for detailed information.

APPLICATION INFORMATION



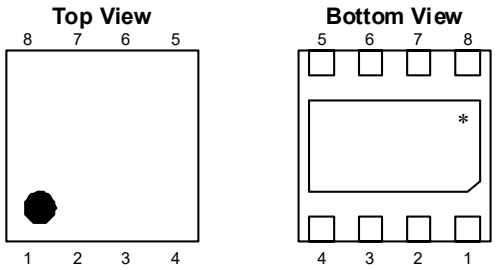
RP402Kxxxx Typical Application (Fixed Output Voltage Type)

Recommended External Components[*1]

Symbol	Value
L	2.2 µH
C1	10 µF
C2	10 µF × 2

[*1] The bill of materials will be attached on the shipment of each purchased evaluation board.

PIN DESCRIPTION



RP402K [DFN(PLP)2020-8] Pin Configuration

∗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.

RP402Kxxxx Pin Description

Pin No.	Symbol	Description
1	MODE	Mode Pin(1)
2	NC	No Connection
3	GND	Ground Pin
4	Lx	Internal NMOS Switch Drain Pin
5	V_{OUT}	Output Pin
6	V_{IN}	Power Supply Pin
7	NC	No Connection
8	CE	Chip Enable Pin, Active-high

(1) MODE Pin = “H” is recommended for RP402Kxx2x.

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. (Refer to *PCB Layout Considerations* below.)

- Ensure the V_{IN} and GND lines are firmly connected. A large switching current flows through the GND lines and the V_{IN} line. If their impedance is too high, noise pickup or unstable operation may result. When the built-in switch is 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 a 2.2 µH inductor (L) which is having a low equivalent series resistance, having enough tolerable current and which is less likely to cause magnetic saturation.
- The MODE pin is controlled with a logic voltage. To make it "H", 1.0 V or more must be forced to the MODE pin. If power supply is less than 1.0 V, MODE pin must be pulled up to V_{OUT}.
- The RP402x can reset the latch protection circuit by setting the CE signal 'L' (V_{CE} < 0.3 V) once while the power is switched on (V_{IN} > 0.8 V). If setting the CE pin when V_{IN} does not reach 0.8 V due to too large C_{IN}, the latch protection circuit cannot be reset correctly. Likewise, if starting the device up when the CE pin is shorted to the V_{IN} pin or V_{OUT} pin, the latch protection circuit cannot be reset.
- If controlling the CE pin by input voltage, the gradient of the power supply at rising must be considered. So, the CE pin must be connected via the delay circuit or the voltage detector to become the CE pin voltage less than 0.3 V until the V_{IN} becomes more than 0.8V.

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