

RTKA223012DR0050BU, RTKA223012DR0060BU

The [RAA223012](#) demonstration boards (RTKA223012DR0050BU and RTKA223012DR0060BU) are high voltage buck or buck/boost converters that demonstrate low-cost high performance non-isolated AC/DC conversion from a universal input of $85V_{AC}$ to $265V_{AC}$, to a 5V output or a -5V with the output current up to 150mA.

The board can be configured to a Buck or a Buck/Boost converter by using jumper (JP1) without changing the output polarity. It has built-in overcurrent, short-circuit, input brownout, and over-temperature protection, and is designed on a compact PCB with a low-cost half-wave input rectification. It is pre-compliant with conducted and radiated EMI requirements by EN55022/CISPR22 and the 1.5kV surge test by IEC61000-4-5 standard.

RTKA223012DR0050BU comes with a RAA223012 in a SO8 package. RTKA223012DR0060BU comes with a RAA223012 in a SOT23-5 package.

Features

- Universal input range
- Compact PCB with low-cost external components
- EMI compliance for EN55022/CISPR22
- Surge test compliance to IEC61000-4-5 up to 1.5kV
- Standby power less than 10mW
- No audible noise

Specifications

This board is optimized for the following operating conditions:

- Input voltage: $85V_{AC} \sim 265V_{AC}$
- Output voltage: $5V_{DC}$ or $-5V_{DC}$
- Output current: 150mA maximum
- Output power: 0.75W
- Efficiency: >62.5% at 100% load; 65% at 50% load (Buck); >61% at 100% load; 63% at 50% load (Buck/Boost)
- No-load power: <10mW at $230V_{AC}$
- Load regulation: -3%, load range 10% to 100%
- Operating temperature: $-45 \sim 85^{\circ}C$
- Board dimension: 48mm x 29mm

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1. Functional Description

The RTKA223012DR0050BU and RTKA223012DR0060BU are high-side float-switching buck regulators when JP1 is on Pin 1 and Pin 2, and can be configured to a Buck/Boost converter when JP1 is on Pin 2 and Pin3, as shown on the schematic and connection diagram (Figure 1 and Figure 6). Its input has D1 and D6 as a low-cost rectification (with optional full-bridge rectifier footprint). FR is a 1W fusible resistor providing input overcurrent protection and inrush current limiting. It also helps to absorb the input line surge energy together with DC buffer caps, C1 and C2.

C1, L1, and C2 consists of the input filter that provides the energy buffer after rectification and reduces conducted EMI noises to the input. L2, D,2 and COUT are the buck converter components. RFB1, RFB2, CFB2, and CFB1 provide the output feedback signal to the IC. D4 and R2 provide V_{CC} biasing current after startup to increase the efficiency. They can be optional for low-cost low power applications. C_{VCC} is the IC supply capacitor.

1.1 Recommended Equipment

- AC Power supply capable of generating AC voltage from 85V_{AC} to 265V_{AC} at 60Hz/50Hz, with at least 100mA output current capability.
- Load resistor box with adjustable value of 33Ω and up, or an electronics load that can emulate a resistor load or current load up to 150mA.
- Multimeters to measure the output voltage and current.
- Power meter to measure the AC input power.

1.2 Setup and Configuration

- Program the AC power supply with a voltage between 85V_{AC} and 265V_{AC} at the corresponding frequency of 60Hz or 50Hz.
- While the AC power supply is off, connect the output cables of the AC power supply to the L and N terminal of the RTKA223012DR0050BU (or RTKA223012DR0060BU). An optional power meter can be added in between the AC power supply output and the input of the board.
- Connect the load to the output terminals VOUT+ and VOUT-.
- Connect a voltage meter to VOUT+ and VOUT-, and connect a current meter between board outputs and the load.
- Turn on the AC power supply.

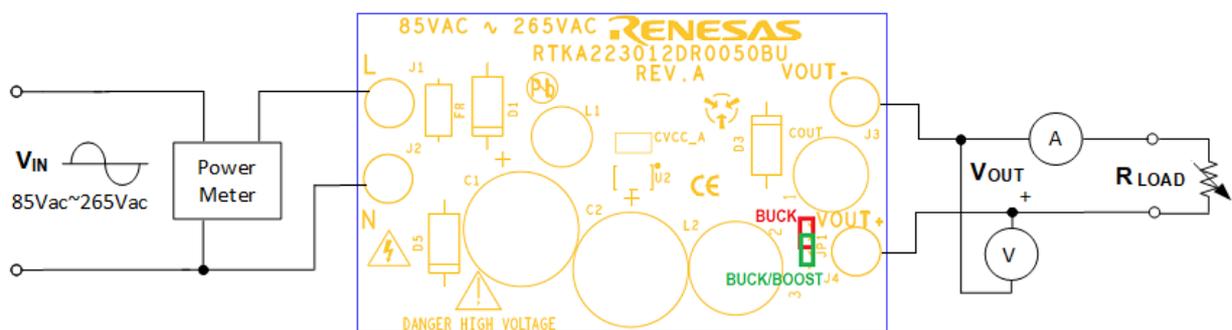


Figure 1. RTKA223012DR0050BU/RTKA223012DR0060BU Connection Diagram

2. Board Design

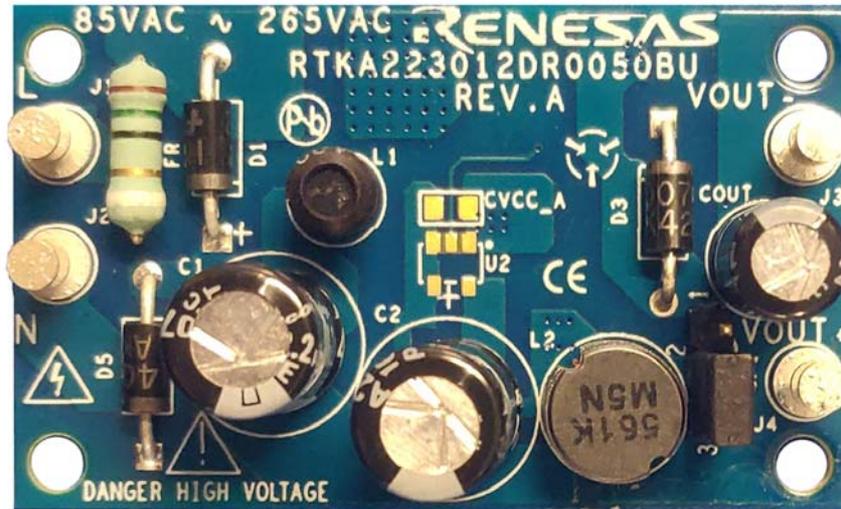


Figure 2. RTKA223012DR0050BU Evaluation Board (Top)

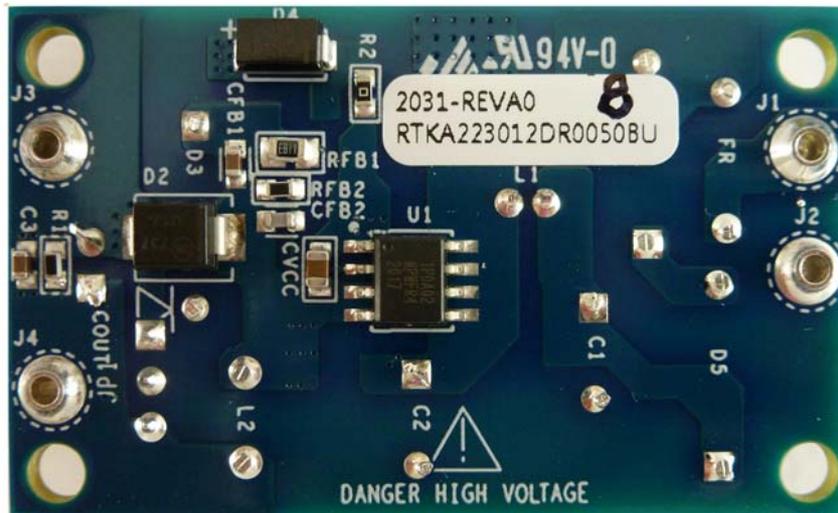


Figure 3. RTKA223012DR0050BU Evaluation Board (Bottom)



Figure 4. RTKA223012DR0060BU Evaluation Board (Top)



Figure 5. RTKA223012DR0060BU Evaluation Board (Bottom)

2.1 Layout Guidelines

For detailed PCB guidelines, see the RAA223012 datasheet.

2.2 Schematic Diagrams

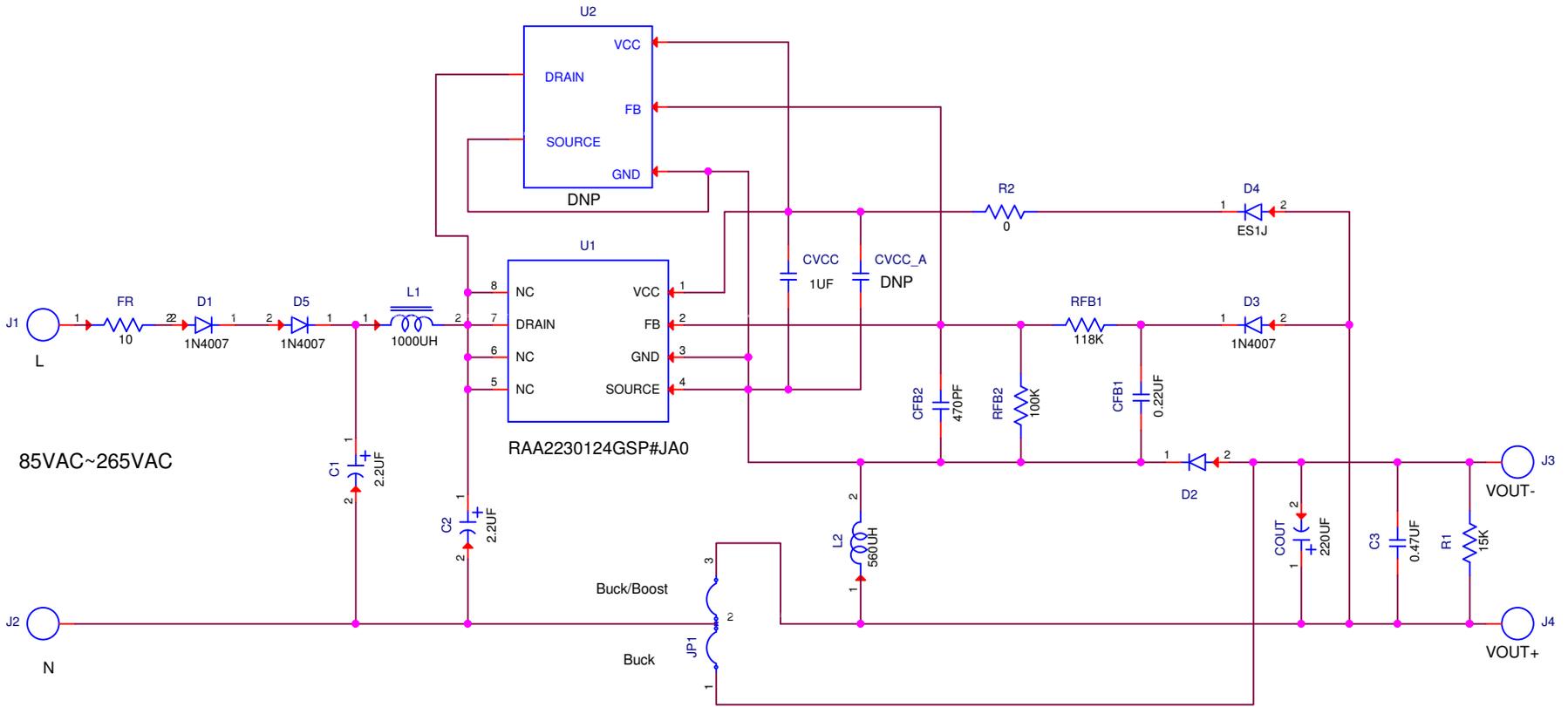


Figure 6. RTKA223012DR0050BU Schematic

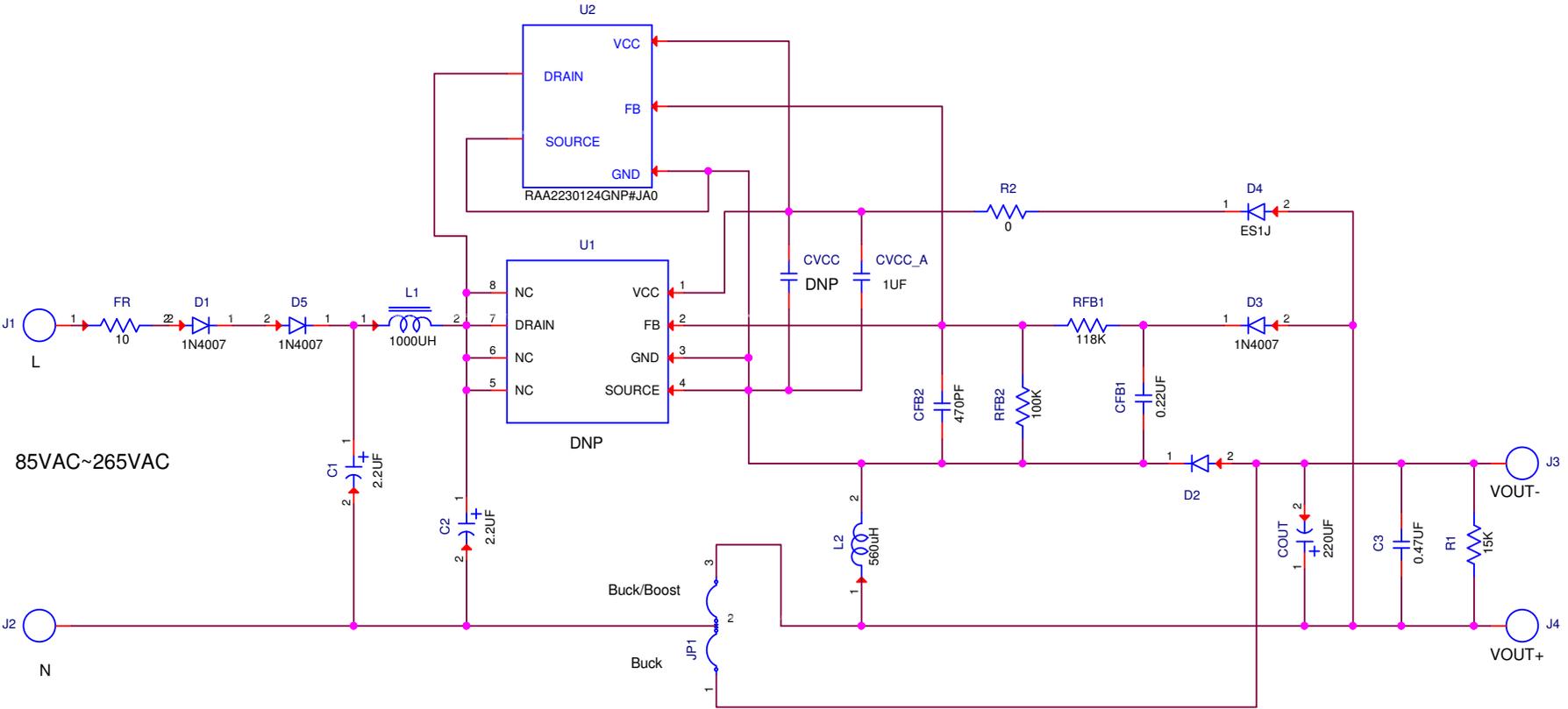


Figure 7. RTKA223012DR0060BU Schematic

2.3 Bill of Materials

2.3.1 RTKA223012DR0050BU

| Qty | Designator | Description | Manufacturer | Manufacturer Part |
|-----|------------|--|---------------------|---------------------|
| 1 | C3 | CAP, SMD, 0603, 0.47 μ F, 16V, 10%, X7R, ROHS | TDK | C1608X7R1C474K080AC |
| 1 | CFB2 | Multilayer Ceramic CAP, SMD, 0603, 470pF, 50V, 10%, ROHS | Various | Generic |
| 1 | CFB1 | CAP, SMD, 0603, 0.22 μ F, 25V, 10%, X7R, ROHS | TDK | C1608X7R1E224K |
| 1 | CVCC | CAP, SMD, 0805, 1.0 μ F, 25V, 10%, X5R, ROHS | AVX | 08053C105KAT2A |
| 2 | C1, C2 | CAP-ALUM ELEC., TH, RADIAL, 2.2 μ F, 400V, 20%, 3.5mmLS, ROHS | Rubycon | 400LLE2R2MEFC8X11.5 |
| 1 | L2 | COIL-PWR INDUCTOR, TH, RADIAL, 560 μ H, 10%, 0.16A, ROHS | Sumida | RCH855NP-561K |
| 1 | L1 | COIL-PWR INDUCTOR, TH, RADIAL, 5x7, 1000 μ H, 0.1A, WW, ROHS | Bourns | RLB0608-102KL |
| 1 | JP1 | CONN-HEADER, 1x3, BREAKAWY 1x36, 2.54mm, ROHS | BERG/FCI | 68000-236HLF |
| 3 | D1, D3, D5 | DIODE-RECTIFIER, AXIAL, DO-41, 1000V, 1A, ROHS | Diodes Inc. | 1N4007 |
| 1 | D4 | DIODE-RECTIFIER, SMD, 2P, SMA, 600V, 1A, ROHS | Fairchild | ES1J |
| 1 | D2 | DIODE-RECTIFIER, SMD, SMB, 2P, 1A, 600V, ROHS | On Semiconductor | MURS160T3G |
| 1 | U1 | IC-700V BUCK REGULATOR, 8P, SOICN, 200mA, ROHS | Renesas Electronics | RAA2230124GSP#AA0 |
| 1 | FR | RES-FUSIBLE, TH, AXIAL, 3.3x9, 15 Ω , 1W, 5%, WW, ROHS | Yageo | FKN1WSJR-52-15R |
| 1 | R2 | RES, SMD, 0603, 0 Ω , 1/10W, TF, ROHS | Venkel | CR0603-10W-000T |
| 1 | RFB2 | RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-1003FT |
| 1 | R1 | RES, SMD, 0603, 15k, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF1502V |
| 1 | RFB1 | RES, SMD, 0805, 118k, 1/8W, 1%, TF, ROHS | Yageo | RC0805FR-07118KL |
| 1 | COUT | CAP, TH, RADIAL, 220 μ F, 16V, 20%, 220m Ω , ALUM.ELEC., ROHS | Rubycon | 16YXJ220MT16.3X11 |

2.3.2 RTKA223012DR0060BU

| Qty | Designator | Description | Manufacturer | Manufacturer Part |
|-----|------------|--|---------------------|---------------------|
| 1 | C3 | CAP, SMD, 0603, 0.47 μ F, 16V, 10%, X7R, ROHS | TDK | C1608X7R1C474K080AC |
| 1 | CFB2 | Multilayer Ceramic CAP, SMD, 0603, 470pF, 50V, 10%, ROHS | Various | Generic |
| 1 | CFB1 | CAP, SMD, 0603, 0.22 μ F, 25V, 10%, X7R, ROHS | TDK | C1608X7R1E224K |
| 1 | CVCC A | CAP, SMD, 0805, 1.0 μ F, 25V, 10%, X5R, ROHS | AVX | 08053C105KAT2A |
| 2 | C1,C2 | CAP-ALUM,ELEC., TH, RADIAL, 2.2 μ F, 400V, 20%, 3.5mmLS, ROHS | Rubycon | 400LLE2R2MEFC8X11.5 |
| 1 | L2 | COIL-PWR INDUCTOR, TH, RADIAL, 560 μ H, 10%, 0.16A, ROHS | Sumida | RCH855NP-561K |
| 1 | L1 | COIL-PWR INDUCTOR, TH, RADIAL, 5x7, 1000 μ H, 0.1A, WW, ROHS | Bourns | RLB0608-102KL |
| 1 | JP1 | CONN-HEADER, 1x3, BREAKAWY 1x36, 2.54mm, ROHS | BERG/FCI | 68000-236HLF |
| 3 | D1,D3,D5 | DIODE-RECTIFIER, AXIAL, DO-41, 1000V, 1A, ROHS | Diodes Inc. | 1N4007 |
| 1 | D4 | DIODE-RECTIFIER, SMD, 2P, SMA, 600V, 1A, ROHS | Fairchild | ES1J |
| 1 | D2 | DIODE-RECTIFIER, SMD, SMB, 2P, 1A, 600V, ROHS | On Semiconductor | MURS160T3G |
| 1 | U1 | IC-700V BUCK REGULATOR, 8P, SOT23, 200mA, ROHS | Renesas Electronics | RAA2230124GP3#AA0 |
| 1 | FR | RES-FUSIBLE, TH, AXIAL, 3.3x9, 15 Ω , 1W, 5%, WW, ROHS | Yageo | FKN1WSJR-52-15R |
| 1 | R2 | RES, SMD, 0603, 0 Ω , 1/10W, TF, ROHS | Venkel | CR0603-10W-000T |
| 1 | RFB2 | RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-1003FT |
| 1 | R1 | RES, SMD, 0603, 15k, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF1502V |
| 1 | RFB1 | RES, SMD, 0805, 118k, 1/8W, 1%, TF, ROHS | Yageo | RC0805FR-07118KL |
| 1 | COUT | CAP, TH, RADIAL, 220 μ F, 16V, 20%, 220m Ω , ALUM.ELEC., ROHS | Rubycon | 16YXJ220MT16.3X11 |

2.4 Board Layout

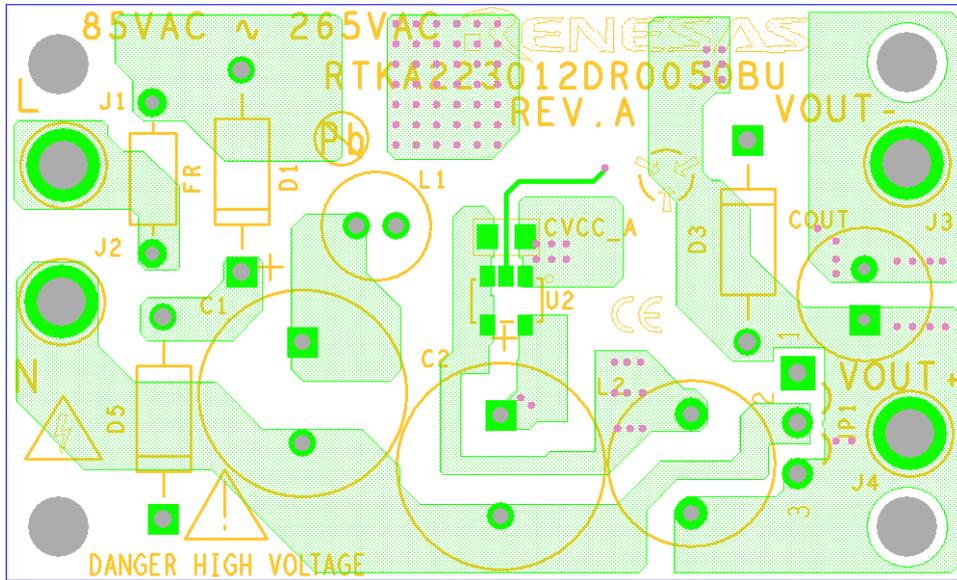


Figure 8. Top Layer

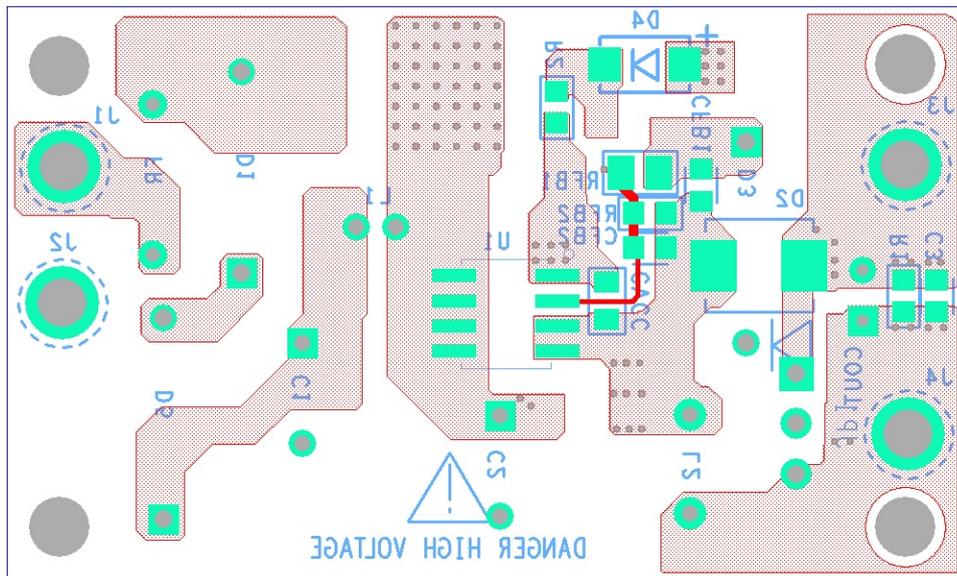


Figure 9. Bottom Layer

3. Typical Performance Graphs

$V_{IN} = 85V_{AC} \sim 265V_{AC}$, $V_{OUT} = 5V$, $I_{OUT} = 150mA$ (maximum), $T_A = +25^{\circ}C$

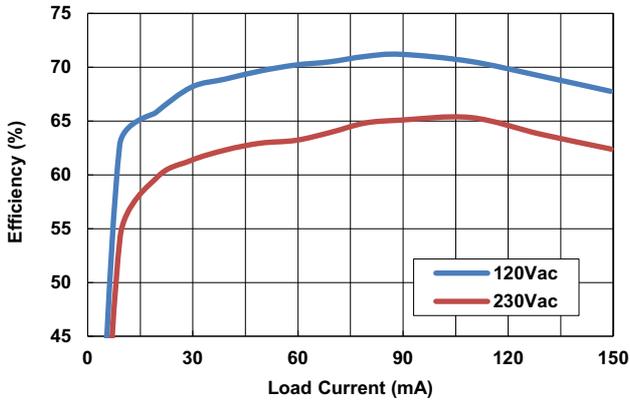


Figure 10. Buck Efficiency Overload Current

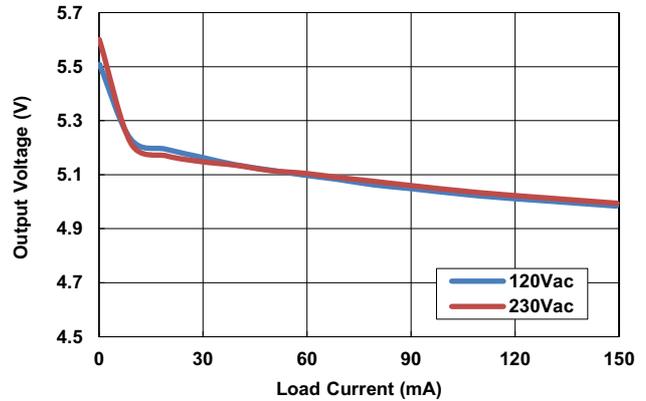


Figure 11. Load Regulation 5V Buck

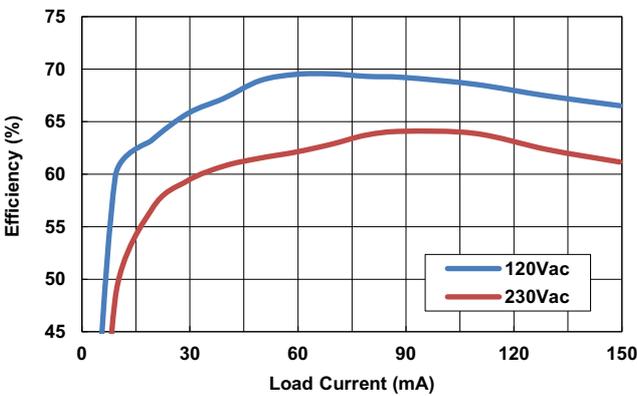


Figure 12. Buck/Boost Efficiency Overload Current

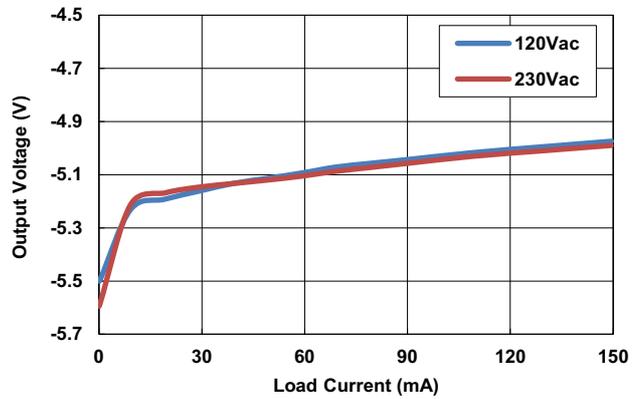


Figure 13. Load Regulation Buck/Boost

Table 1. Typical No-load Power Consumption

| Power Supply | Standby Power | Energy Star |
|--------------------------|---------------|-------------|
| 120V _{AC} /60Hz | 4.5mW | 300mW |
| 230V _{AC} /50Hz | 8.5mW | 300mW |

4. EMI Test Results

RTKA223012DR0050BU/RTKA223012DR0060BU Buck regulator is compliant to the conducted EMI requirements of FCC Part 15 and CISPR22 Class B.

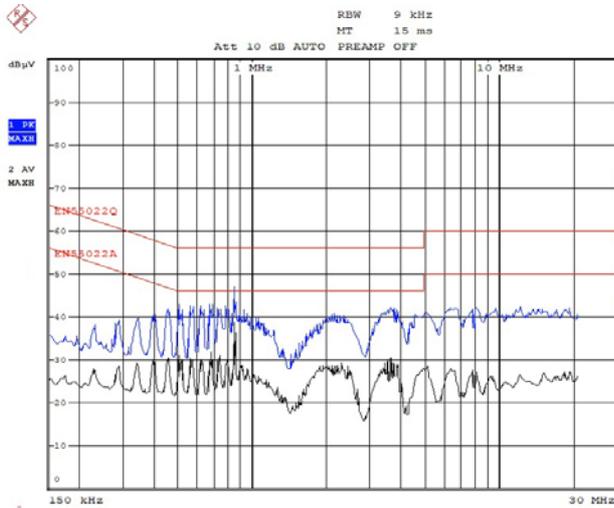


Figure 14. Line, 120V_{AC}

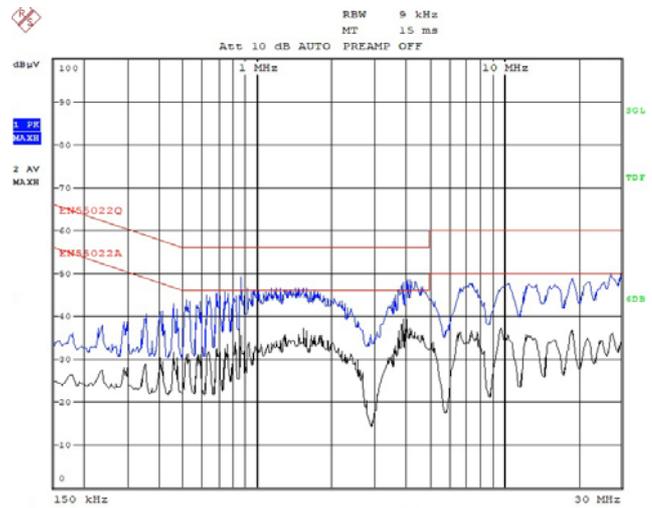


Figure 15. Line, 230V_{AC}

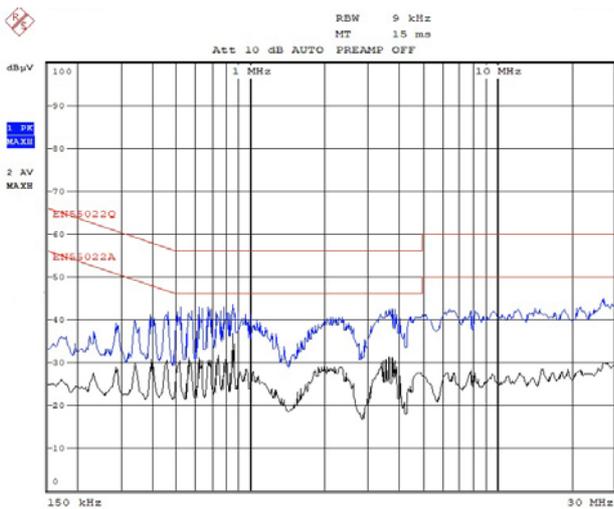


Figure 16. Neutral, 120V_{AC}

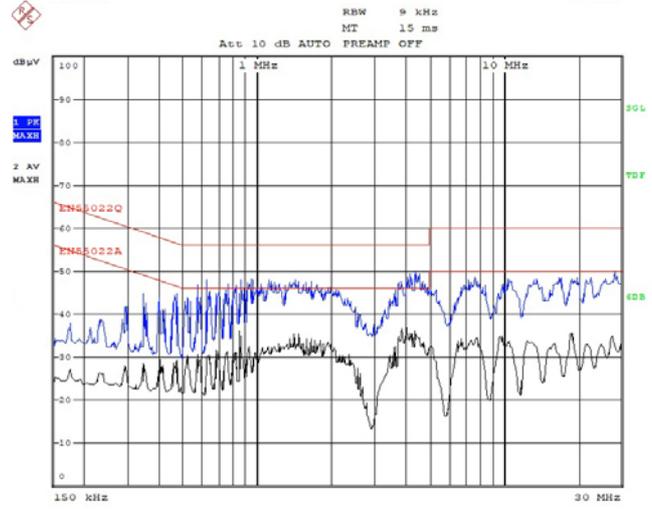


Figure 17. Neutral, 230V_{AC}

5. Ordering Information

| Part Number | Description |
|--------------------|---------------------------------------|
| RTKA223012DR0050BU | RAA223012 SOIC-8 Demonstration Board |
| RTKA223012DR0060BU | RAA223012 SOT23-5 Demonstration Board |

6. Revision History

| Revision | Date | Description |
|----------|--------------|--|
| 1.2 | Jul 28, 2021 | Updated Figure 13. Completed other minor changes. |
| 1.1 | Jun 25, 2021 | Updated Schematics Updated Bill of Materials Updated top photos. |
| 1.0 | Mar 10, 2021 | Initial release |

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

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