RTKA223021DE0000BU

The RAA223021 evaluation board (RTKA223021DE0000BU) is a high voltage buck converter that demonstrates a low-cost high performance non-isolated AC/DC conversion from an universal input of 85V_{AC} to 265V_{AC}, to a 12V output with the output current up to 667mA.

The board has built-in overcurrent, short-circuit, input brownout, and over-temperature protection, and is designed on a single side PCB with a full-wave input rectification. It is pre-compliant with conducted EMI requirements by EN55022/CISPR 22. RTKA223021DE0000BU uses the RAA223021 SOIC-7 packaged IC.

Features

- Universal input
- Single side PCB with low-cost external components
- EMI compliance for EN55022/CISPR22
- Standby power less than 20mW
- No audible noise

Specifications

This board is optimized for the following operating conditions:

- Input voltage: 85V_{AC} ~ 265V_{AC}
- Output voltage: 12V_{DC}
- Output current: 667mA max
- Output power: 8W
- Efficiency: >77% at 100% load; 80% at 50% load
- No-load power: 14mW at 120V_{AC}; 16mW at 230V_{AC}
- Load regulation: ±2.4%, load range 10% to 100%
- Operating temperature: -40~85°C
- Board dimension: 40mm x 60mm.

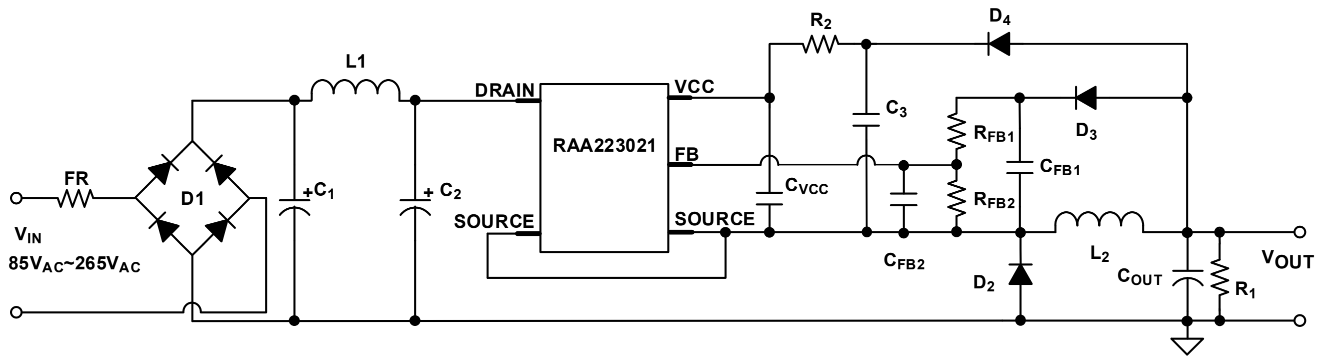

Figure 1. RTKA223021DE0000BU Block Diagram

Table 1. HV Buck of 021 Power Derating at 85°C Ambient Temperature

Output Setting Voltage (V)	120V_{AC}	230V_{AC}	90V_{AC}~265V_{AC}
3.3	0.67A	0.58A	0.56A
5	0.67A	0.66A	0.6A
9	0.64A	0.6A	0.56A
12	0.56A	0.54A	0.5A
15	0.56A	0.52A	0.5A
24	0.49A	0.5A	0.46A

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Table 2. Component Selection Guide

V_{OUT} (V)	C_{FB1} (nF)	R_{FB1} (kΩ)	R_{FB2} (kΩ)	L2 (H)	R2 (kΩ)	R1 (kΩ)
24	100	397	45	1m	30	100
15	100	397	76.5	1m	10	47
12	47	397	98.8	680µ	10	47
9	100	397	142	470µ	5.1	47
5	200	100	82	330µ	100	10
3.3	200	100	180	330µ	NC	3

Contents

1. Functional Description

The RTKA223021DE0000BU is a buck regulator implemented with a high-side float-switching topology, with switching frequency up to 43kHz. D1 is a full bridge rectifier on the input end. FR is a 1A fuse providing input overcurrent protection. As an option, you can replace the standard fuse with a fusible resistor instead to limit inrush current.

C1, L1, and C2 consist of the input filter that provides the energy buffer after rectification and reduces conducted EMI noises to the input. L2, D2, 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 and Operating Range

- 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 18Ω and up, or an electronics load that can emulate a resistor load or current load up to 667mA.
- Multi-meters to measure the output voltage and current.
- Power meter to measure the AC input power.

1.2 Setup and Configuration

1. Program the AC power supply with a voltage between $85V_{AC}$ and $265V_{AC}$ at the corresponding frequency of 60Hz or 50Hz.
2. While the AC power supply is off, connect the output cables of the AC power supply to the L and N terminal of the RTKA223021DE0000BU. An optional power meter can be added in between the AC power supply output and the input of the board.
3. Connect the load to the output terminals VOUT and GND.
4. Connect a voltage meter to VOUT and GND and connect a current meter between board outputs and the load.
5. Turn on the AC power supply.

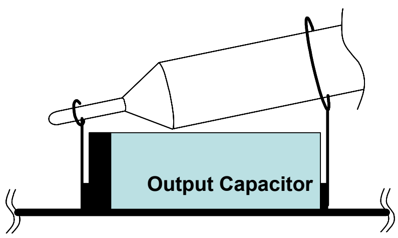

Figure 2. Proper Probe Setup to Measure Output Ripple

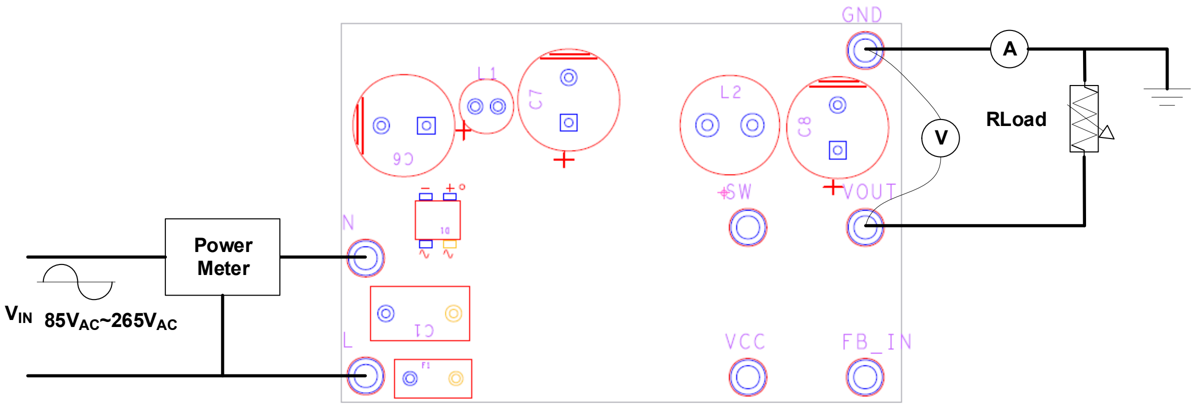

Figure 3. Proper Test Setup

2. Board Design

Figure 4. RTKA223021DE0000BU Evaluation Board (Top)

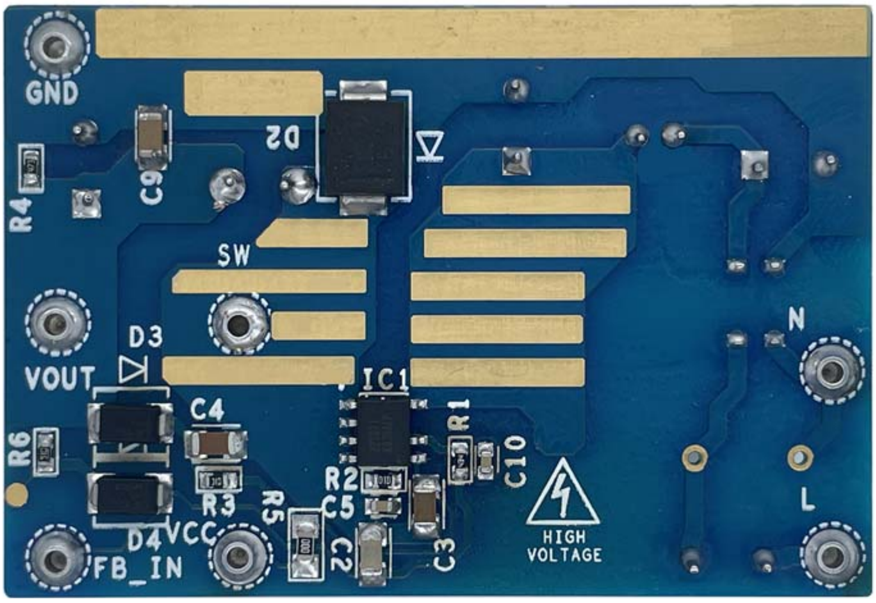

Figure 5. RTKA223021DE0000BU Evaluation Board (Bottom)

2.1 Layout Guidelines

Proper layout is important to ensure a stable operation, good thermal behavior, EMI performance and reliable operation for various operating environments. Please pay attention to the following layout recommendations.

- Leave proper spacing (minimum1.4mm) between high voltage (max 400V) traces and low voltage traces.
- Keep a small loop from input filter capacitor to IC, switching inductor, output capacitor and to the ground of input capacitor.
- Keep a small loop consisted of switching inductor, output capacitor and freewheeling diode.
- Keep a small loop consisted of input filter capacitor to IC and freewheeling diode.
- Keep sufficient copper area on the IC drain and/or source pin (not less than 140mm2 for 6-8W output power) for better thermal performance.
- Keep the switching inductor away from the input EMI inductor to avoid noise coupling, especially when an unshielded switching inductor is used.
- Keep a small loop from input filter capacitor to IC, sample hold circuit, output capacitor and to the ground of input capacitor.
- Place the V_{CC} decoupling cap and FB pin decoupling cap close to the pins.

2.2 Schematic Diagrams

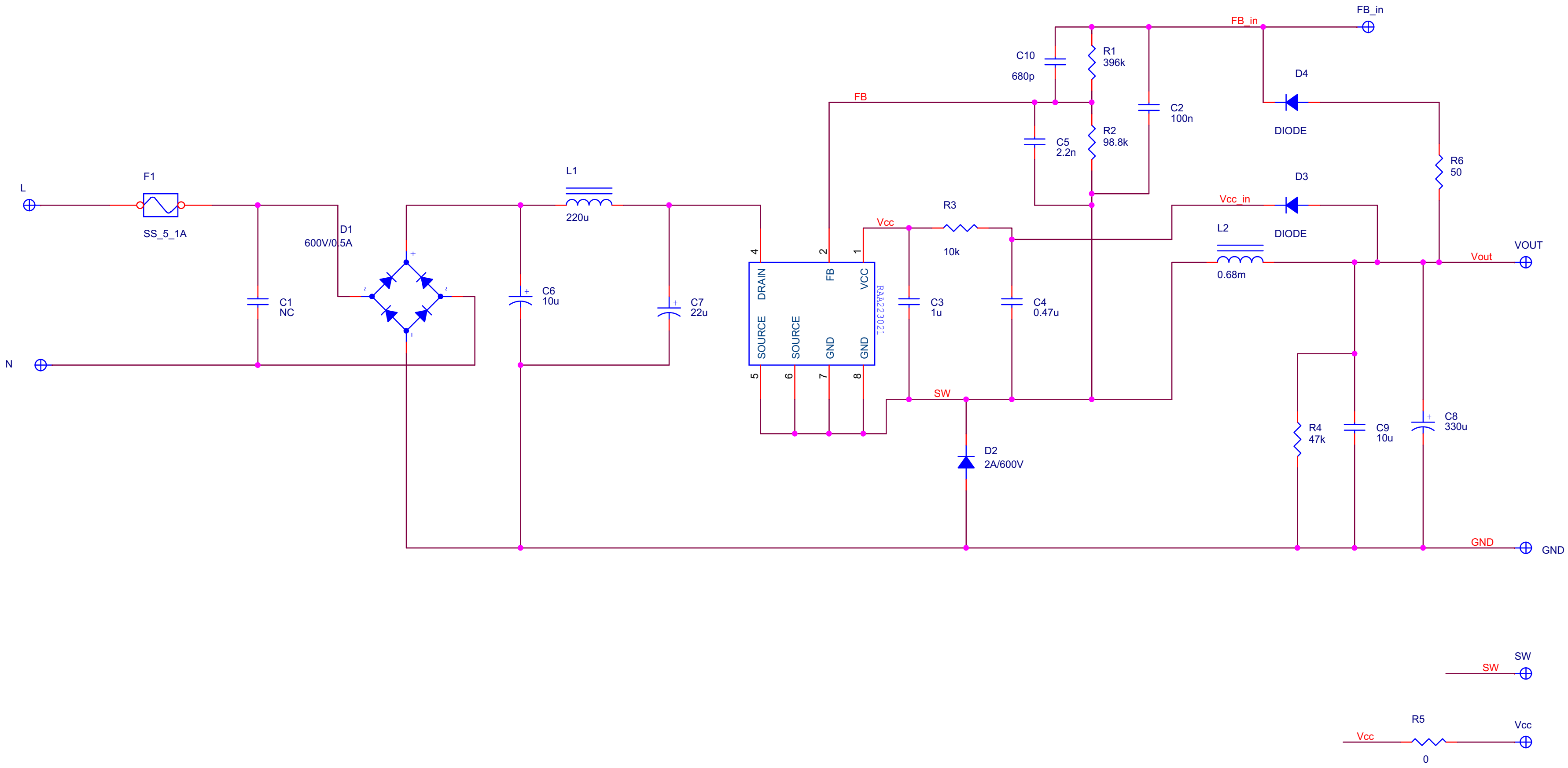

Figure 6. Schematic

2.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part
1	C2	CAP CER 0.1µF 50V C0G 1206	TDK	CGA5L2C0G1H104J160AA
1	C3	CAP CER 1µF 25V X7R 1206	TDK	CGJ5L2X7R1E105K160AA
1	C4	CAP CER 0.47µF 50V X7R 1206	TDK	C3216X7R1H474K160AA
1	C5	CAP CER 2200pF 50V X7R 0603	TDK	CGA3E2X7R1H222K080AA
2	C6	CAP ALUM 10µF 20% 400V RADIAL	WE	860021375011
	C7	CAP ALUM 10µF 20% 400V RADIAL	WE	860021375011
1	C8	CAP ALUM POLY 330µF 20% 35V T/H	Panasonic	35SEK330M
1	C9	CAP CER 10µF 25V X7R 1206	TDK	C3216X7R1E106K160AB
1	C10	CAP CER 680pF 50V C0G 0603	TDK	CGA3E2C0G1H681J080AA
1	D1	BRIDGE RECT 1P 600V 500mA MBM	N/A	MB6M
1	D2	DIODE GEN PURP 600V 2A SMC	ST	STTH2R06S
2	D3	DIODE GEN PURP 600V 1A SMA	ST	STTH1R06A
	D4	DIODE GEN PURP 600V 1A SMA	ST	STTH1R06A
1	F1	FUSE BOARD MNT 1A 250V_{AC} RADIAL	Eaton - Electronics Division	SS-5-1A
1	IC1	700V, 8W AC/DC Buck Regulator	Renesas	RAA223021
1	L1	FIXED IND 220µH 500MA 1.2Ω TH	WE	7447462221
1	L2	FIXED IND 680µH 900MA 790mΩ	WE	7447480681
1	R1	RES 397kΩ 1% 1/10W 0603	KOA	RN73H1JTTD3973F25
1	R2	RES 98.8kΩ 1% 1/10W 0603	KOA	RN73R1JTTD9882F25
1	R3	RES SMD 10kΩ 5% 1/10W 0603	Panasonic	ERJ-3GEYJ103V
1	R4	RES SMD 47kΩ 5% 1/10W 0603	Yageo	RC0603JR-0747KL
1	R5	RES 0 OHM JUMPER 1/4W 1206	Stackpole Electronics Inc	RMCF1206ZT0R00
1	R6	RES SMD 50Ω 0.1% 1/10W 0603	Yageo	RT0603BRE0750RL
7	TP	CONN-DBL TURRET, TH, 0.109LENGTH, BRASS/TIN, ROHS	Keystone Electronics	1514-2

2.4 Board Layout

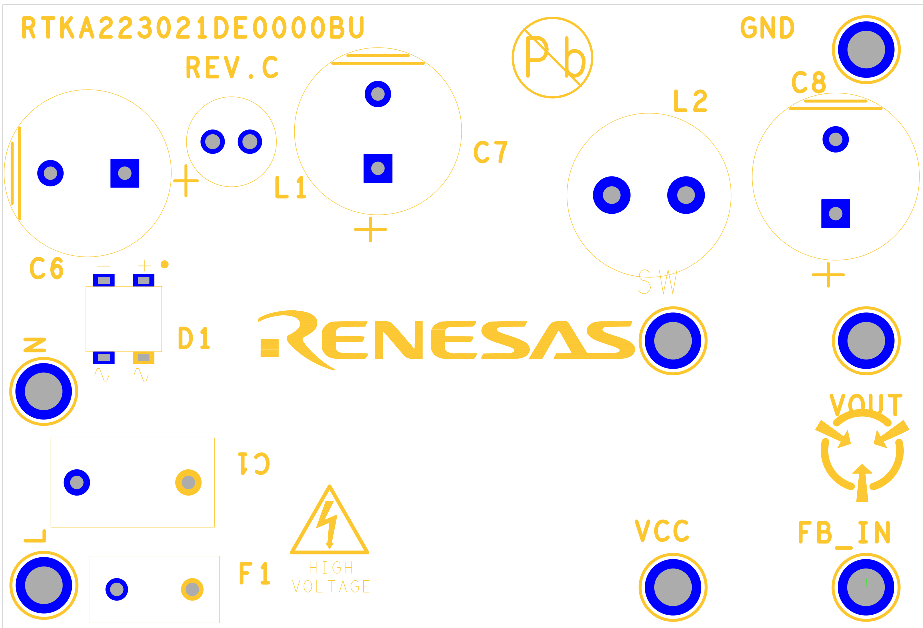

Figure 7. Top Layer

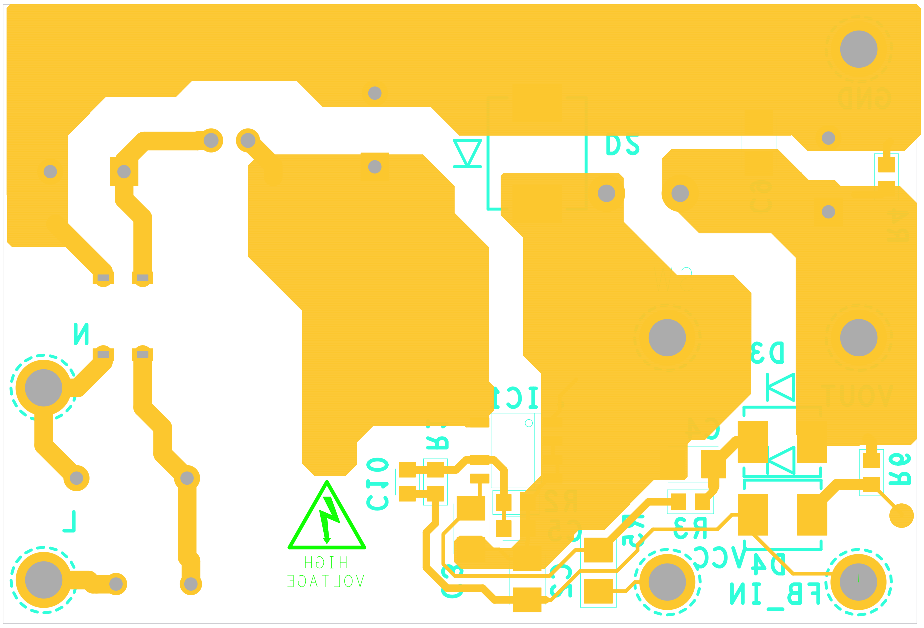

Figure 8. Bottom Layer

3. Typical Performance Graphs

V_{OUT} = 12V, unless otherwise noted.

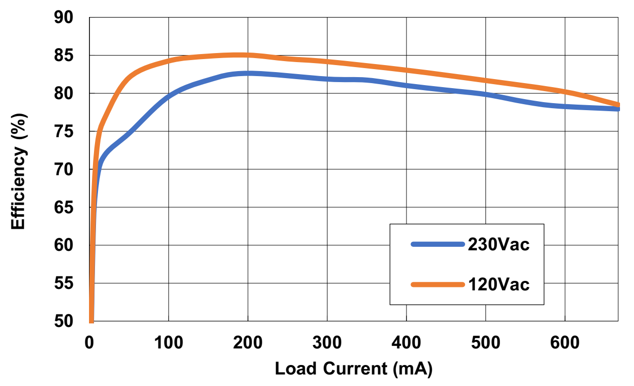

Figure 9. Efficiency

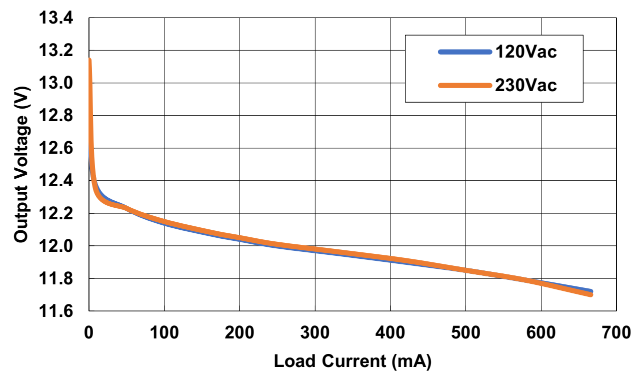

Figure 10. Load Regulation

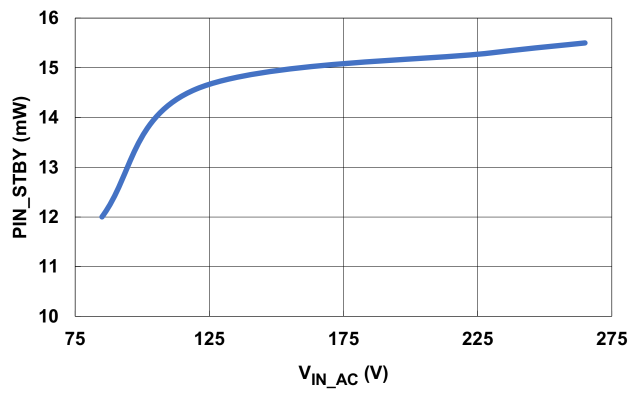

Figure 11. No Load Power Loss

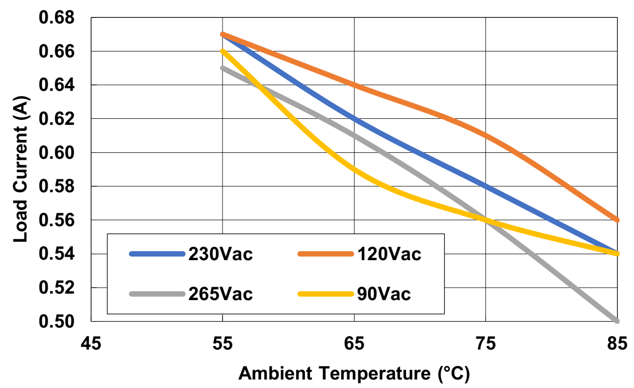

Figure 12. 12V Output Power Derating

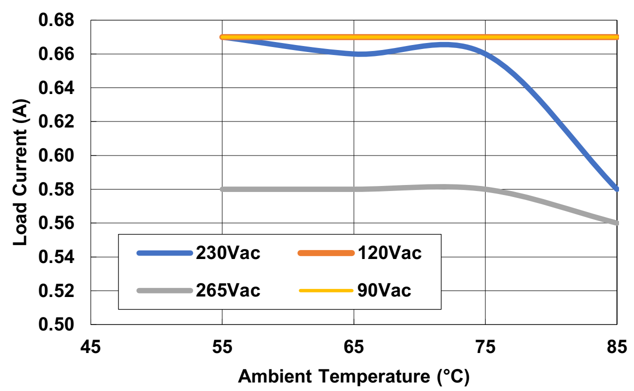

Figure 13. 3.3V Output Power Derating

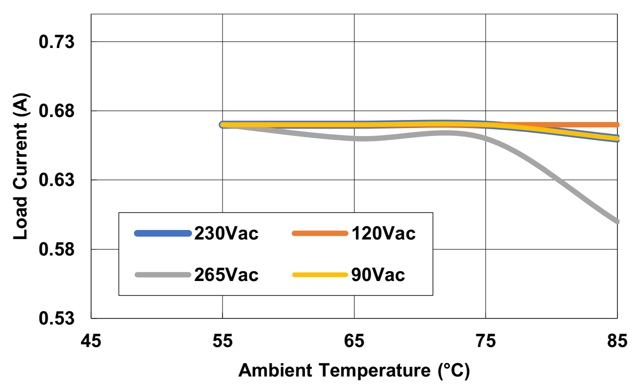

Figure 14. 5V Output Power Derating

V_{OUT} = 12V, unless otherwise noted. (Cont.)

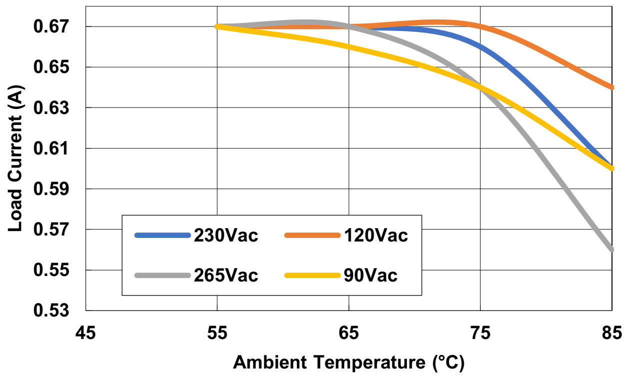

Figure 15. 9V Output Power Derating

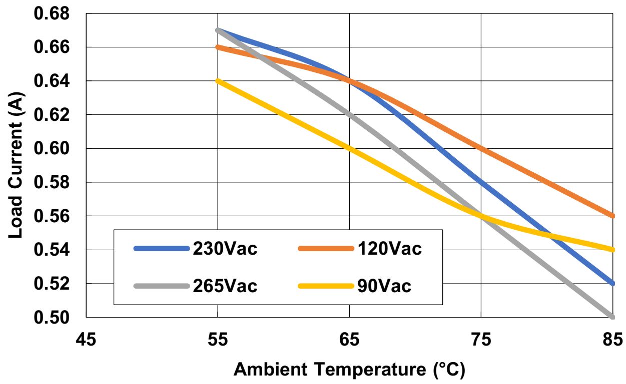

Figure 16. 15V Output Power Derating

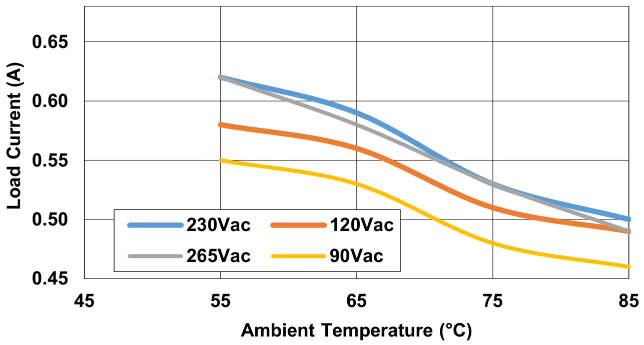

Figure 17. 24V Output Power Derating

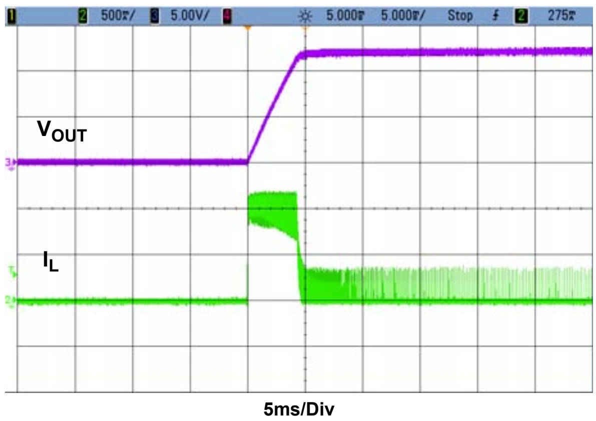

Figure 18. V_{IN} = 230V_{AC}, I_{OUT} = 0A

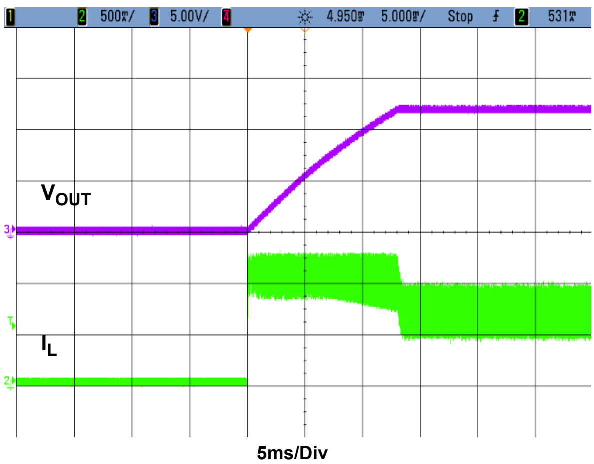

Figure 19. V_{IN} = 230V_{AC}, I_{OUT} = 0.667A

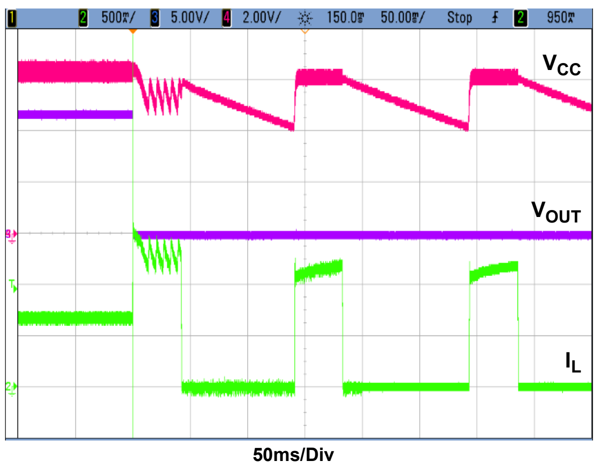

Figure 20. V_{IN} = 230V_{AC}, I_{OUT} = 0.667A to short

4. EMI Test Result

Conducted EMI compliance for EN55022/CISPR22 (12V/600mA output)

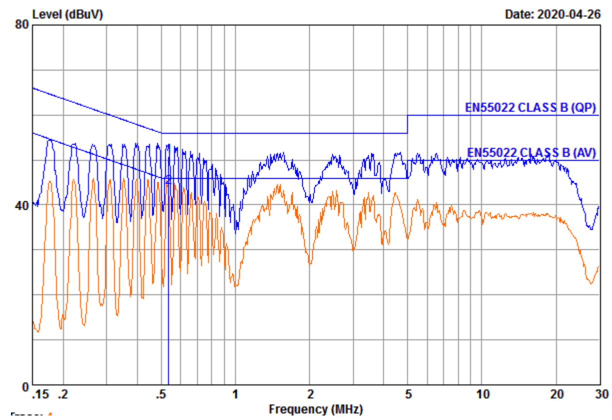

Figure 21. Line, 230V_{AC}

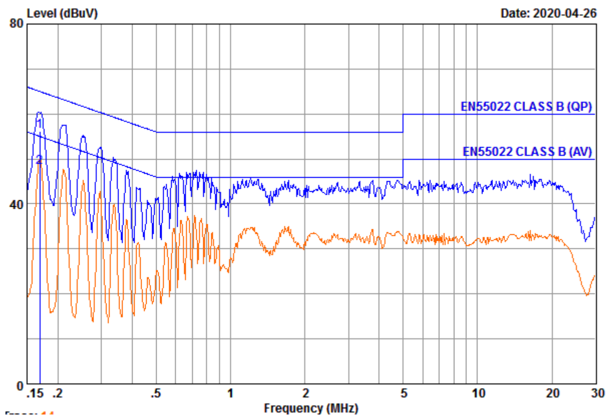

Figure 22. Line, 120V_{AC}

5. Ordering Information

Part Number	Description
RTKA223021DE0000BU	High Voltage BUCK Converter Evaluation Board

6. Revision History

Revision	Date	Description
1.1	May 26, 2021	Updated Table 1 and 2 with 24V output. Added 24V Figure 17 and 18.
1.0	Mar 26, 2021	Initial release

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