RTKA223181DE0010BU

The RTKA223181DE0010BU, featuring the RAA223181 900V regulator, is a dual output 5.7W universal input flyback evaluation board; it provides a low-cost high performance isolated AC/DC solution from a universal input of $85V_{AC}$ to $265V_{AC}$ to both a 13V output and a 5V output for smart meter applications.

The RTKA223181DE0010BU features proprietary cost savings such as the short-time heavy load operation that eliminates the need of transformer over-design for the heavy load in communication, and it features a single 400V electrolytic capacitor for input voltage up to $450V_{AC}$ that saves 3x capacitances when compared to the traditional two-cap solution. The board operates in DCM with constant frequency at 50kHz in normal operation and uses valley switching to reduce switching losses and EMI noises. The board has the built-in protections of overload, short-circuit, input brownout, V_{CC} UV, V_{CC} OV, V_{IN} UV, peak current limit, primary short, and over-temperature protections. With a low-cost input EMI filter, the board is pre-compliant with EN55022/CISPR 22 Class B conducted EMI limits, and it has the 4kV surge capability according to IEC61000-4-5 standard.

Features

- Fault tolerant input range up to $450V_{AC}$
- Short-time heavy load support
- Single bus capacitor design for input up to $450V_{AC}$
- Low BOM cost design
- EMI compliance for EN55022/CISPR22
- Surge test compliance to IEC61000-4-5 up to 4kV

Specifications

This board is optimized for the following operating conditions:

- Input voltage: $85V_{AC}$ ~ $265V_{AC}$
- Operating temperature: -40C ~ 95C
- Output: 13V/400mA; 5V/100mA
- Output power: 5.5W
- Max short-time load support (80ms):
  - 9.5W - $85V_{AC}$ ~ $265V_{AC}$ input
  - 12W - $120V_{AC}$ and $230V_{AC}$ input
- Efficiency: >75% at 100% load; >75% at 50% load
- Load regulation: 13V: <±2%; 5V: <±8%, 10% to 100% load
- Board dimension: 48mm x 29mm

Contents

1. Functional Description

The RTKA223181DE0010BU, featuring the RAA223181 900V regulator, is a dual output 5.7W universal input flyback demonstration board; it is designed to demonstrate a low-cost high performance isolated AC/DC solution from a universal input of $85V_{AC}$ to $265V_{AC}$ to either a 13V or a 5V output for smart meter applications.

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.
- A load resistor box with adjustable value of 32Ω and greater, or an electronics load that can emulate a resistor load or current load up to 400mA for a 13V output. A load resistor box with adjustable value of 50Ω and greater, or an electronics load that can emulate a resistor load or current load up to 100mA for a 5V output.
- Multimeters to measure the output voltage and current.
- Power meter to measure the AC input power.

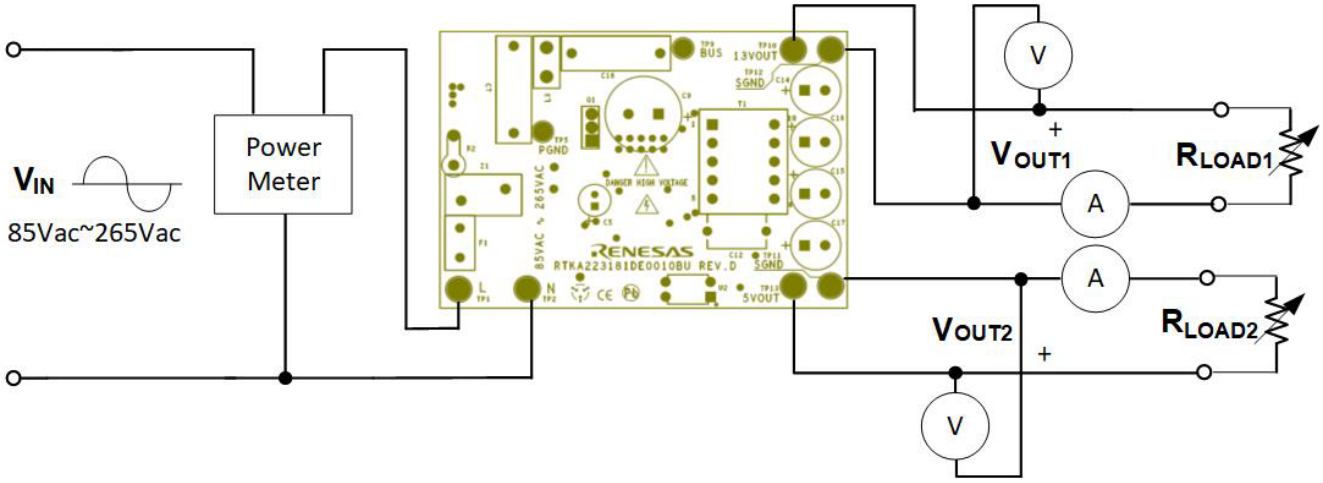

Figure 1. RTKA223181DE0010BU Connection Diagram

1.2 Quick Start Guide

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 RTKA223181DE0010BU. A optional power meter can be added in between AC power supply output and input of the board.
3. Connect the corresponding load to the output terminal $13V_{OUT}$ and GND and $5V_{OUT}$ and GND, respectively.
4. Connect a voltage meter to V_{OUT} and GND, and connect a current meter between the board outputs and the load.
5. Turn on the AC power supply.

2. Board Design

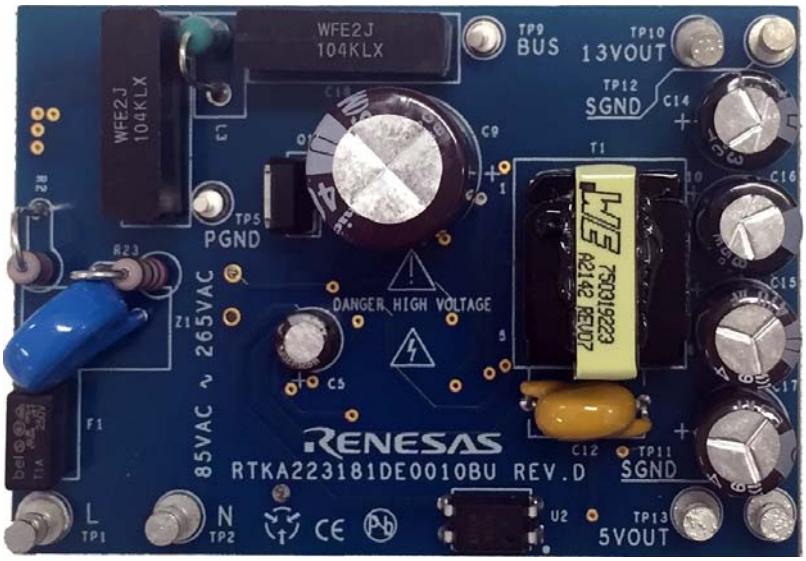

Figure 2. RTKA223181DE0010BU Evaluation Board (Top)

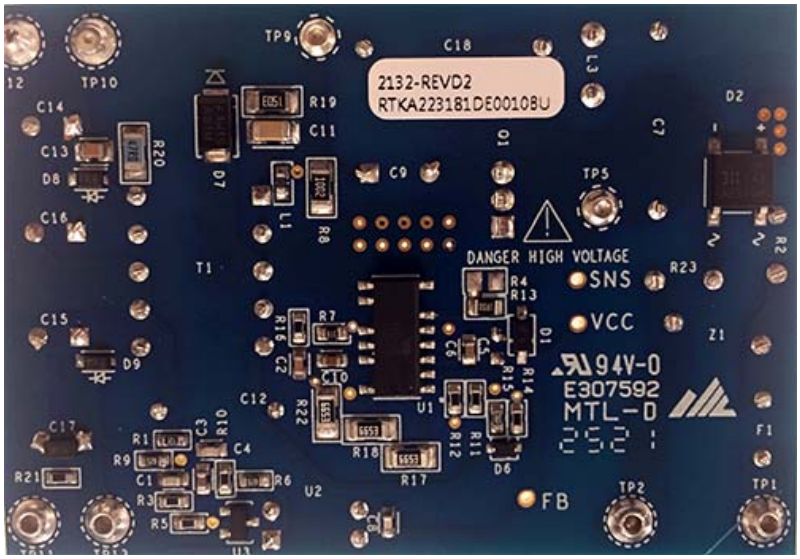

Figure 3. RTKA223181DE0010BU Evaluation Board (Bottom)

2.1 Schematic Diagram

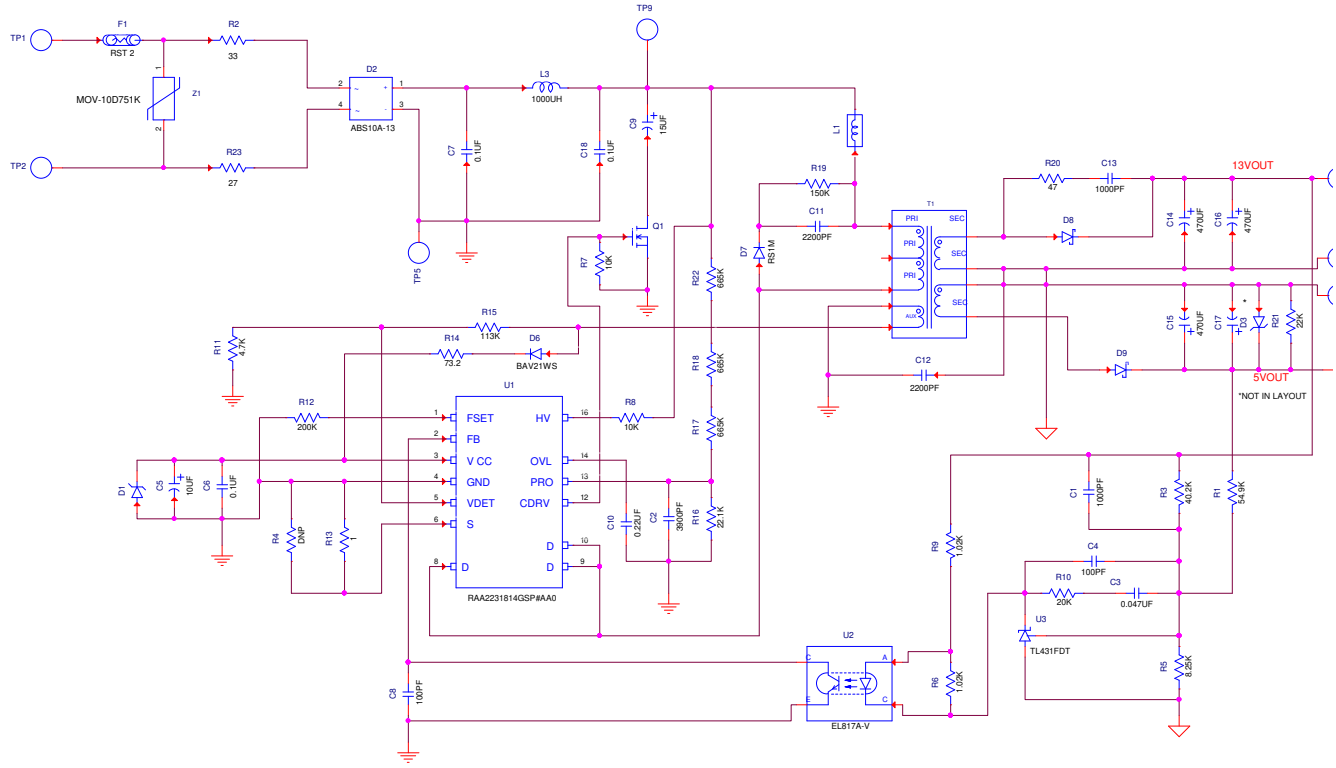

Figure 4. RTKA223181DE0010BU Schematic

2.2 Bill of Materials

Qty	Reference Designator	Description	Value	Manufacturer	Manufacturer Part Number
1	F1	Fuse	2A, 250V_{AC}, Radial	Bel Fuse	RST 2
1	D2	1A 1000V Bridge Rectifier	1A, 1000V, ABS	Diodes Inc	ABS10A-13
1	D1	Zener Diode	20V, 6%, 500mW, SOD-123	Micro commercial	BZT52C20-TP
1	D3	Zener Diode	5.6V, 500mW, SOD-123	Micro commercial	BZT52C5V6-TP
1	D6	General Purpose Diode	0.2A, 200V, SOD-323	Micro commercial	BAV21WS-TP
1	D7	Fast Recovery Diode	1A, 1kV, SMA	Onsemi	RS1M
2	D8, D9	Schottky Rectifier	2A, 120V, DO-219AD	Vishay	V2PM12
1	L1	Ferrite Bead, SMD	60Ω at 100MHz, 0603	Murata	BLM18PG600SN1D
1	L3	Fixed Inductor	1mH, 5%, 0.1A, Axial	TDK Bourns	B78108S1105J000 77F102J-TR-RC
1	C1	Multilayer Ceramic Cap	1000pF, 10%, 50V, 0603	Various	Generic
1	C2	Multilayer Ceramic Cap	3900pF, 10%, 50V, 0603	Various	Generic
1	C3	Multilayer Ceramic Cap	47nF, 10%, 50V, 0603	Various	Generic
1	C4	Multilayer Ceramic Cap	100pF, 10%, 50V, 0603	Various	Generic

1	C5	Multilayer Ceramic Cap, X7R	0.1µF, 10%, 50V, 0603	Various	Generic
1	C6	Aluminum Cap, radial	10µF, 20%, 25V, 0603	Nichicon	UMV1E100MFD1TP
1	C8	Multilayer Ceramic Cap	100pF, 10%, 50V, 0603	Various	Generic
1	C9	Aluminum Electrolytic 105C rated 10khrs	15µF, 20%, 400V, Radial	Nichicon	UCS2G150MHD
1	C10	Multilayer Ceramic Cap	0.22µF, 10%, 25V, 0603	Various	Generic
1	C11	Multilayer Ceramic Cap	2.2nF, 10%, 630V, 1206	MuRata	GRM31BR72J222KW01L
1	C12	AC Rated Class Y1 Ceramic Disk Capacitor	2200pF, 20%, 500V_{AC}	Vishay	VY1222M37Y5VQ63V0
1	C13	Multilayer Ceramic Cap	1nF, 10%, 200V, 0805	Various	Generic
2	C7, C18	Film Cap, Radial	0.1µF, 10%, 630V, Radial	Panasonic	ECW-FE2J104KA
2	C14, C16	Aluminum Electrolytic 105C rated 8khrs	470µF, 20%, 16V, Radial	Rubycon	16ZLH470MEFCT78X11.5
2	C15, C17	Aluminum Electrolytic 105C rated 6khrs	470µF, 20%, 10V, Radial	Rubycon	10YXF470MEFCT78X11.5
1	R1	Thick Film Chip Resistor	54.9k, 1%, 1/16W, 0603	Various	Generic
2	R2	Wirewound Resistors	33, 5%, 1W, Axial	Yageo	KNP100JR-73-33R
1	R3	Thick Film Chip Resistor	40.2k, 1%, 1/16W, 0603	Various	Generic
0	R4	Thick Film Chip Resistor	DNP	Various	Generic
1	R5	Thick Film Chip Resistor	8.25k, 1%, 1/16W, 0603	Various	Generic
2	R6, R9	Thick Film Chip Resistor	1.02k, 1%, 1/16W, 0603	Various	Generic
1	R7	Thick Film Chip Resistor	10k, 1%, 1/16W, 0603	Various	Generic
1	R8	Thick Film Chip Resistor	10k, 1%, 1/4W, 1206	Various	Generic
1	R10	Thick Film Chip Resistor	20k, 1%, 1/16W, 0603	Various	Generic
1	R11	Thick Film Chip Resistor	4.7k, 1%, 1/16W, 0603	Various	Generic
1	R12	Thick Film Chip Resistor	200k, 1%, 1/16W, 0603	Various	Generic
1	R13	Thick Film Chip Resistor	1, 1%, 1/8W, 0805	Various	Bourns
1	R14	Thick Film Chip Resistor	73.2, 1%, 1/16W, 0603	Bourns	Generic
1	R15	Thick Film Chip Resistor	113k, 1%, 1/16W, 0603	Various	Generic
1	R16	Thick Film Chip Resistor	22.1k, 1%, 1/16W, 0603	Various	Generic
3	R17, R18, R22	Thick Film Chip Resistor	665k 1%, 1/8W, 1206	Various	Generic
1	R19	Thick Film Chip Resistor	150k, 1%, 1/8W, 1206	Various	Generic
1	R20	Thick Film Chip Resistor	47, 5%, 1/8W, 1206	Various	Generic
1	R23	Wirewound Resistors	27, 5%, 1W, Axial	Yageo	KNP100JR-73-27R
1	Q1	N-Channel MOSFET	650V, 4.3A, TO-251	Infineon	IPS65R1K0CE
1	T1	Transformer	1.5mH, 10%, EE16, PTH	Wurth	750319223 REV07
1	U1	900V, Offline Flyback Regulator	RAA223181, SO16-13	Renesas	RAA223181
1	U2	Opto-coupler	CTR: 80-160, PTH	Lite-On	LTV-817-A

1	U3	Shunt Regulator	TL431, SOT23	Nexperia	TL431FDT
1	Z1	Varistor	750V 2.5KA PTH	Bourns	MOV-10D751K

2.3 Board Layout

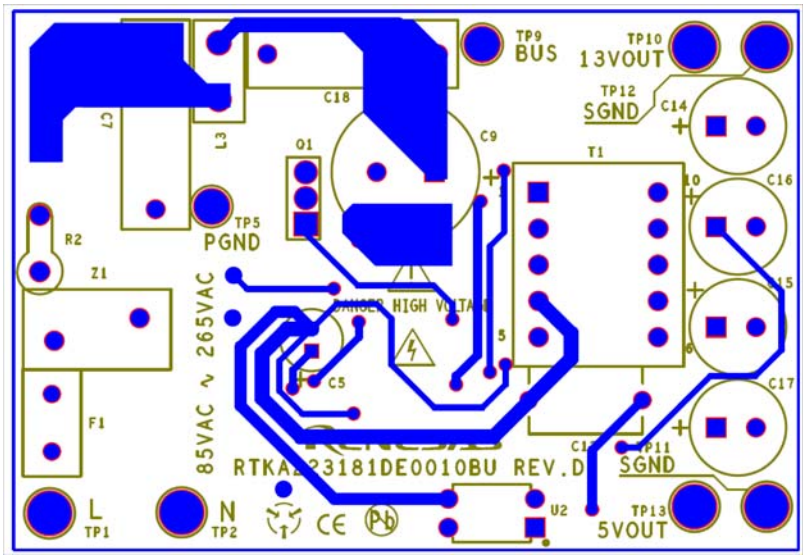

Figure 5. RTKA223181DE0010BU Evaluation Board (Top)

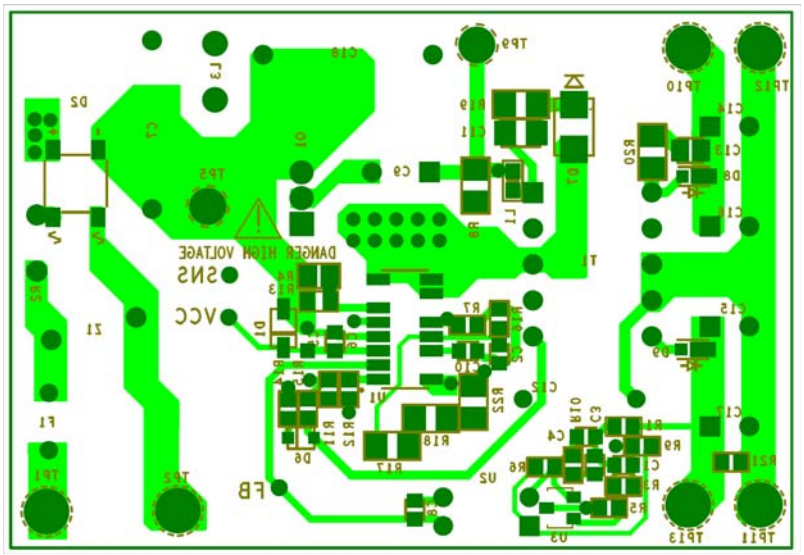

Figure 6. RTKA223181DE0010BU Evaluation Board (Top)

3. Typical Performance Graphs

V_{IN} = 85V_{AC} ~ 265V_{AC}, VO1 = 13V, I_{OUT}= 450mA (max), V_{OUT} = 5V, I_{OUT}= 100mA (max), T_A = +25°C

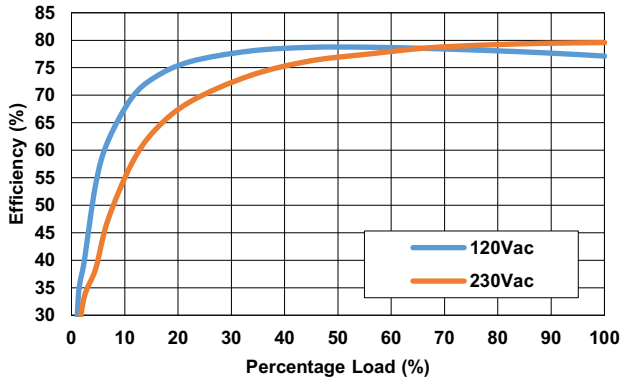

Figure 7. Efficiency Overload Range

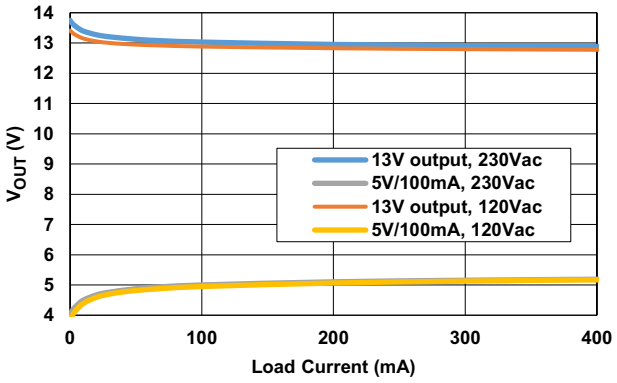

Figure 8. Load Regulation with 13V Load Sweep

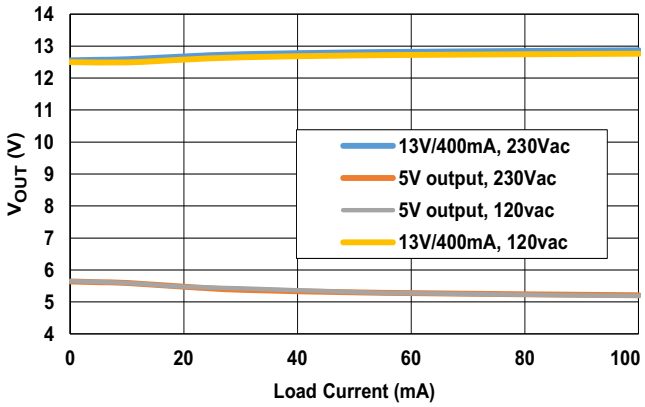

Figure 9. Load Regulation with 5V Load Sweep

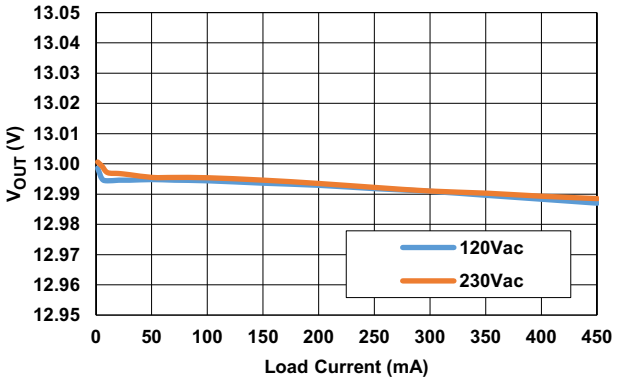

Figure 10. Load Regulation with Single Output (R5 = 9.31k, R1: Not Install)

Table 1. Typical No-Load Power Consumption (25°C Ambient)

Input Voltage	Standby Power
120V_{AC}/60Hz	205mW
230V_{AC}/50Hz	487mW

3.1 EMI

RTKA223181DE0010BU is compliant to the conducted EMI requirements of FCC Part 15 and CISPR22 Class B.

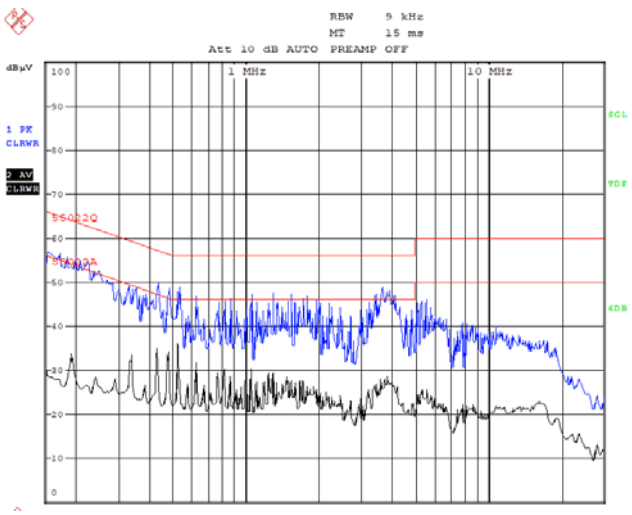

Figure 11. 120V_{AC}, Line

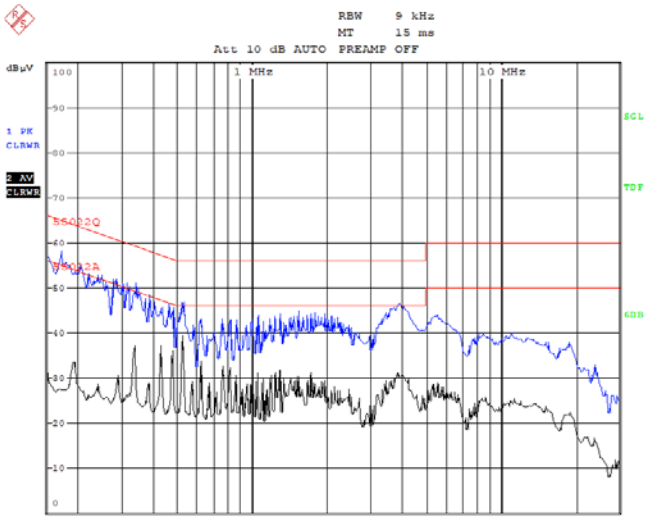

Figure 12. 120V_{AC}, Neutral

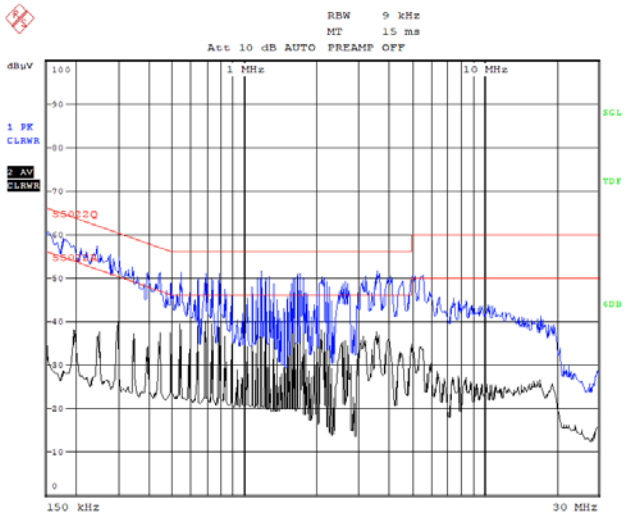

Figure 13. 230V_{AC}, Line

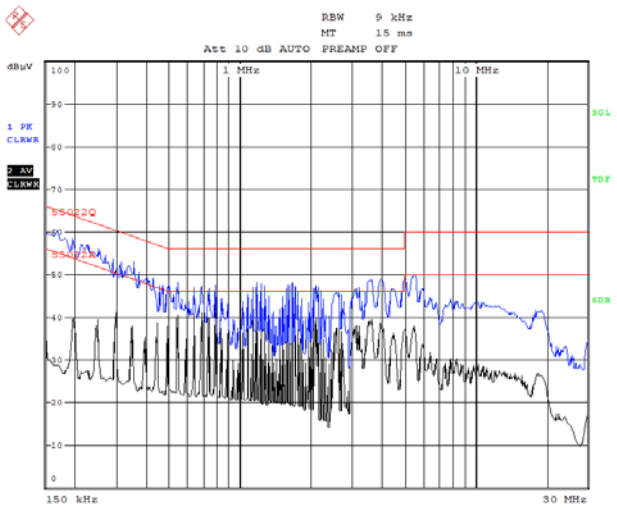

Figure 14. 230V_{AC}, Neutral

4. Ordering Information

Part Number	Description
RTKA223181DE0010BU	RAA223181 Evaluation Board

5. Revision History

Revision	Date	Description
1.02	Dec 7, 2021	Updated the Bill of Materials and the schematic, Figure 4.
1.01	Nov 29, 2021	Updated the schematic, Figure 4.
1.00	Nov 5, 2021	Initial release

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