

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

EVAL_5BR3995BZ-1_BUCK1

About this document

Scope and purpose

This document describes a non-isolated 18 V/300 mA ultra-high-voltage buck converter using the CoolSET™ 5th Generation Fixed Frequency Plus switching controller from Infineon. The document contains power supply specifications, schematics, BOM, PCB layout, and performance data. The evaluation board is designed to evaluate the performance of CoolSET™ ICE5BR3995BZ-1 switching controller and its ease of use.

Intended audience

This document is intended for SMPS design/application engineers, students, etc., who wish to design low-cost and non-isolated buck converters, such as auxiliary power supplies for white goods, smart metering, etc.

CoolSET™

Infineon's CoolSET™ AC-DC integrated power stages in fixed-frequency switching scheme offers increased robustness and outstanding performance. This family offers superior energy efficiency, comprehensive protective features, and reduced system costs and is ideally suited for auxiliary power supply applications in a wide variety of potential applications such as:

- [SMPS](#)
- [Home appliances](#)
- [Server](#)
- [Telecom](#)

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1 Introduction

This document describes a 18 V/300 mA evaluation board designed in a buck converter topology using the CoolSET™ 5th Generation Fixed Frequency Plus switching controller. ICE5BR3995BZ-1 is targeted at auxiliary power supplies for white goods, PCs, servers, and TVs, or enclosed adapters for gaming consoles, smart metering, etc.

The CoolMOS™ 950 V SJ MOSFET integrated into this IC greatly simplifies the design and layout of the PCB. The new improved digital frequency reduction and frequency jitter feature offers lower EMI and higher efficiency. The enhanced active burst mode (ABM) power enables flexibility in standby power operation range selection. In addition, numerous adjustable protection functions have been implemented in ICE5BR3995BZ-1 to protect the system and customize the IC for the chosen application.

This document describes the list of features, the power supply specifications, schematics, BOM, and performance data. Typical operating characteristics such as performance curves and scope waveforms are provided at the end of the document.

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Evaluation board

2 Evaluation board



Figure 1 EVAL_5BR3995BZ-1_BUCK1

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1



EVAL_5BR3995BZ-1_BUCK1

Evaluation board specifications

3 Evaluation board specifications

Table 1 EVAL_5BR3995BZ-1_BUCK1 board specifications

Description	Symbol	Min	Typ	Max	Unit	Notes/conditions
Input						
Voltage	V_{IN}	85	–	460	V AC	Two-wire (no P.E)
Frequency	f_{LINE}	47	50/60	63	Hz	–
Output						
Voltage	V_{OUT}	18			V	–
Current	I_{OUT}	0.3			A	–
Output power	P_{OUT}	5.4			W	–
Output voltage accuracy	–	Less than $\pm 5\%$			–	–
Overcurrent protection	–	Less than 150% of rated current			A	–
Ripple and noise voltage	V_{pk-pk}	Less than 1% (20 MHz bandwidth)			mV	With 10 μ F E-cap and 0.1 μ F MLCC
Environmental						
Conducted EMI	–	6			dB	Margin, CISPR 22 Class B
Surge immunity						
Differential mode (DM)	–	± 1			kV	EN 61000-4-5
Ambient temperature	T_{amb}	–20	–	50	°C	Free convection, sea level
PCB form factor	–	70 × 35 × 23			mm	L × W × H

Note: Table 1 shows the minimum acceptable performance of the design; actual measurement results are listed in the [Test results](#) section. This evaluation board is designed to demonstrate the maximum output current only.

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Schematic

4 Schematic

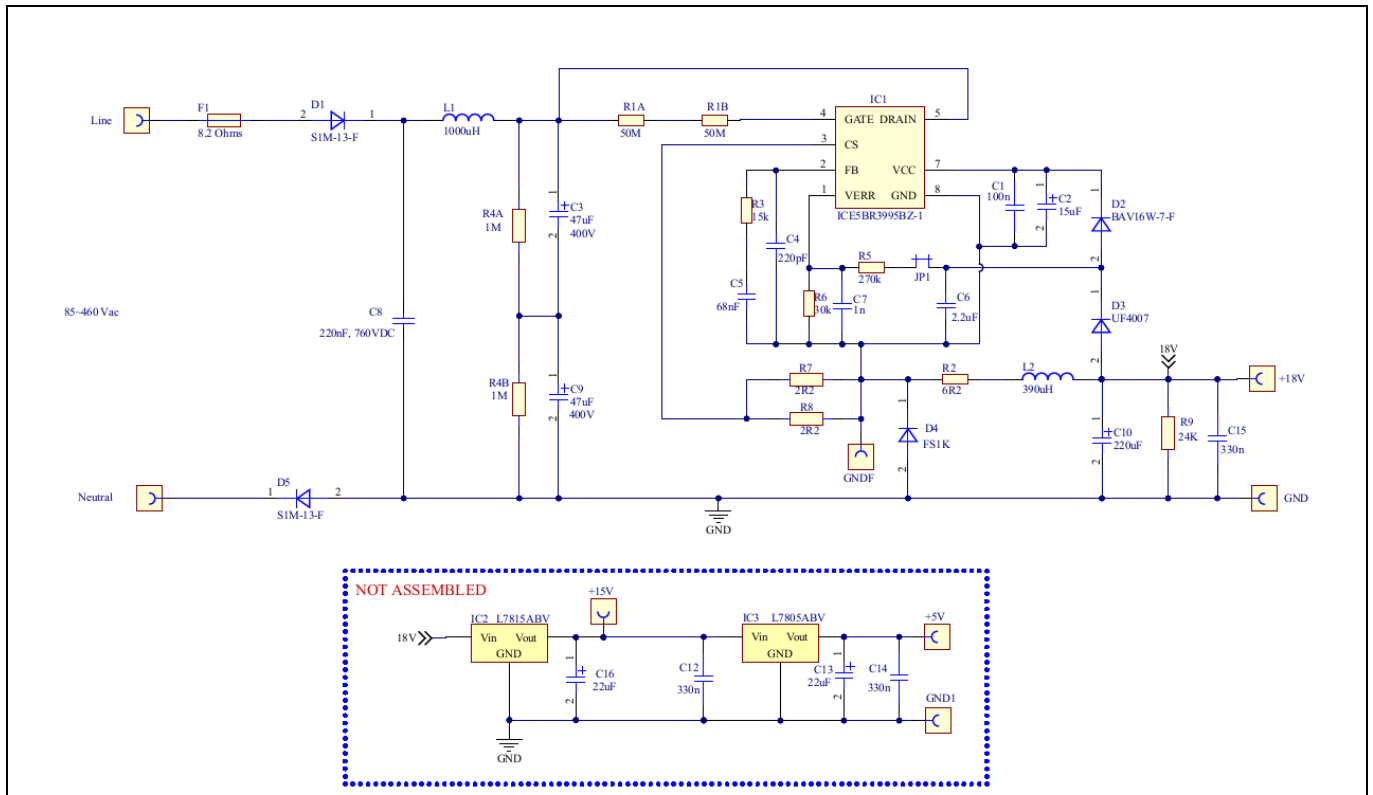


Figure 2 EVAL_5BR3995BZ-1_BUCK1

5 Circuit description

5.1 Line input

The AC line input stage comprises the following:

- Input fuse (F1)
- Rectifier diodes (D1 and D5)
- Capacitors (C8, C3, and C9)
- Inductor (L1)

The input fuse (F1) is a flameproof, fusible resistor that can act as an input fuse for overcurrent and limits the inrush current for rectifiers (D1 and D5). The X-capacitors (C8) and inductor (L1) act as EMI suppressors. A rectified DC voltage (120~650 V DC) is held by the bulk capacitor (C3 and C9) in series.

5.2 Startup

The CoolSET™ ICE5BR3995BZ-1 switching controller uses a cascode structure to fast-charge the V_{CC} capacitor. Pull-up resistors (R1A and R1B) connected to the GATE pin (pin 4) are used to initiate the start-up phase. When V_{VCC} reaches the turn-on voltage threshold (16 V), the IC begins with a soft start. The soft start implemented in ICE5BR3995BZ-1 is a digital time-based function. The preset soft-start time is 12 ms with four steps.

If not limited by other functions, the peak voltage on the CS pin will increase in increments from 0.3 V to 0.8 V. After the IC turn-on, the V_{CC} voltage is supplied by the output voltage. V_{CC} short-to-GND protection is implemented during the startup time.

5.3 Integrated MOSFET and PWM control

The CoolSET™ ICE5BR3995BZ-1 switching controller comprises a power MOSFET and a controller that simplify the circuit layout and reduce the PCB manufacturing cost. ICE5BR3995BZ-1 is placed at the high side of the converter with a floating ground at the cathode of the freewheeling diode (D4). Therefore, the output voltage is sensed only during the freewheeling diode conduction time.

5.4 Output stage

The maximum output voltage ripple is determined by the output capacitance and the equivalent series resistance (ESR) of the output capacitor. Selection of a low ESR capacitor helps reduce the ripple. The dummy load resistor (R9) helps in output voltage regulation at light-load conditions.

5.5 Feedback control

ICE5BR3995BZ-1 integrates a transconductance amplifier for feedback control. The output is sensed by the voltage divider (R5 and R6) and compared with an internal reference voltage at the VERR pin. An external compensation network (C4, C5, and R3) is recommended on the FB pin to control the output voltage.

5.6 Primary-side peak-current control

The MOSFET drain-source current is sensed via external resistors (R7 and R8). ICE5BR3995BZ-1 is a current mode controller that has a cycle-by-cycle primary current and FB voltage control, which ensure that the converter's maximum power is controlled in every switching cycle. To avoid mistrigging caused by the

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EVAL_5BR3995BZ-1_BUCK1

Circuit description

MOSFET switch-on transient voltage spikes, a leading-edge blanking (LEB) time (t_{CS_LEB}) is integrated in the current sensing (CS) path.

5.7 Frequency reduction

Frequency reduction is implemented in ICE5BR3995BZ-1 to achieve better efficiency during light load. At light-load conditions, the reduced switching frequency (F_{SW}) improves the efficiency by reducing the switching losses. When load decreases, V_{FB} decreases accordingly while F_{SW} decreases. To achieve better efficiency between light load and medium load, frequency reduction is implemented, with a reduction curve as shown in Figure 3.

V_{CS} is clamped by the current limit threshold or by the pulse-width modulation (PWM) opamp while the switching frequency is reduced. The minimum switching frequency possible is f_{OSC2_MIN} (28 kHz) under disabled burst mode setting. There is no further frequency reduction once the switching frequency reaches f_{OSC2_MIN} even if the load is further reduced.

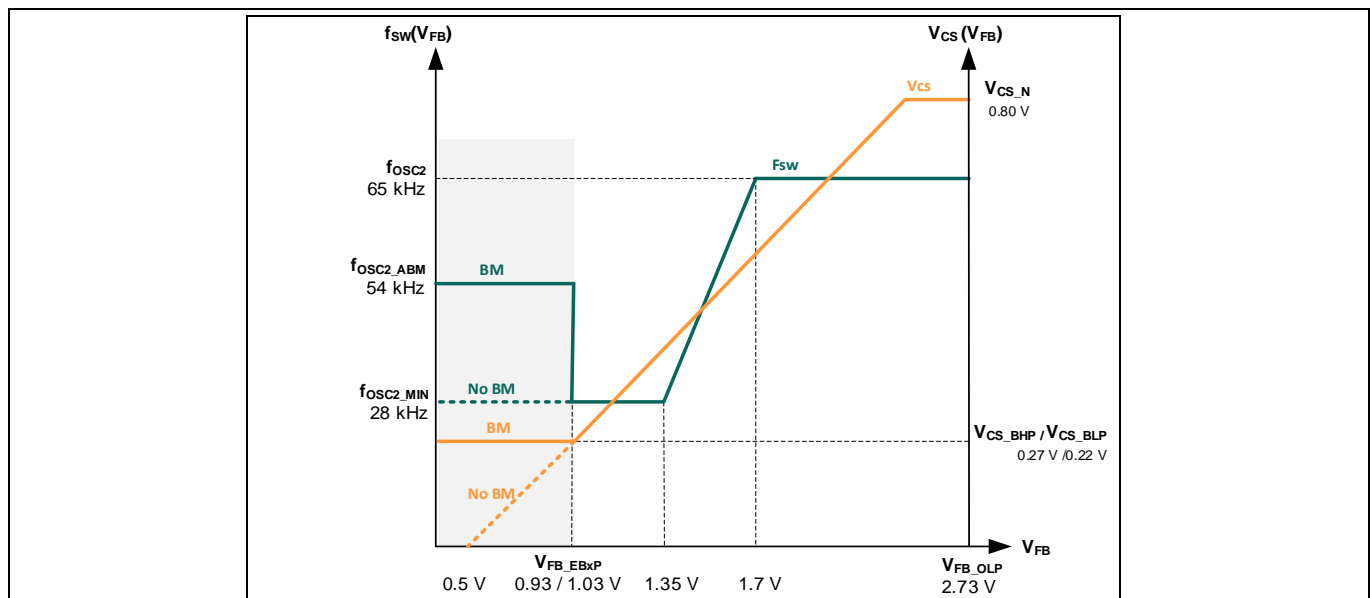


Figure 3 Frequency reduction curve

5.8 Active burst mode (ABM)

The ABM entry and exit power levels (two levels) can be selected in ICE5BR3995BZ-1. See the product datasheet [1] for more details. ABM power level 1 is used in this evaluation board.

5.9 Protection feature

ICE5BR3995BZ-1 provides comprehensive protection features to ensure a safe operation of the system. This includes faults like V_{CC} overvoltage, V_{CC} undervoltage, overload, overtemperature (controller junction), and V_{CC} short-to-GND. When those faults are detected, the system enters protection mode. Once the fault is removed, the system resumes normal operation. The following table lists the protection features and failure conditions.

Table 2 Protection features of ICE5BR3995BZ-1 switching controller

Protection function	Failure condition	Protection mode
V_{CC} overvoltage	$V_{VCC} \geq 30.5 \text{ V}$	Extended cycle skip auto-restart
V_{CC} undervoltage	$V_{VCC} \leq 10 \text{ V}$	Auto-restart
Overload	$V_{FB} \geq 2.73 \text{ V}$ and lasts for 54 ms	Extended cycle skip auto-restart
Overtemperature (junction temperature of controller chip only)	$T_J \geq 140^\circ\text{C}$	Non-switch auto-restart
V_{CC} short-to-GND ($V_{VCC} = 0 \text{ V}$, start-up = 50 M Ω and $V_{DRAIN} = 90 \text{ V}$)	$V_{VCC} \leq 1.1 \text{ V}$, $I_{VCC_charge1} \approx -0.2 \text{ mA}$	Cannot start up

6 PCB layout

6.1 Top side

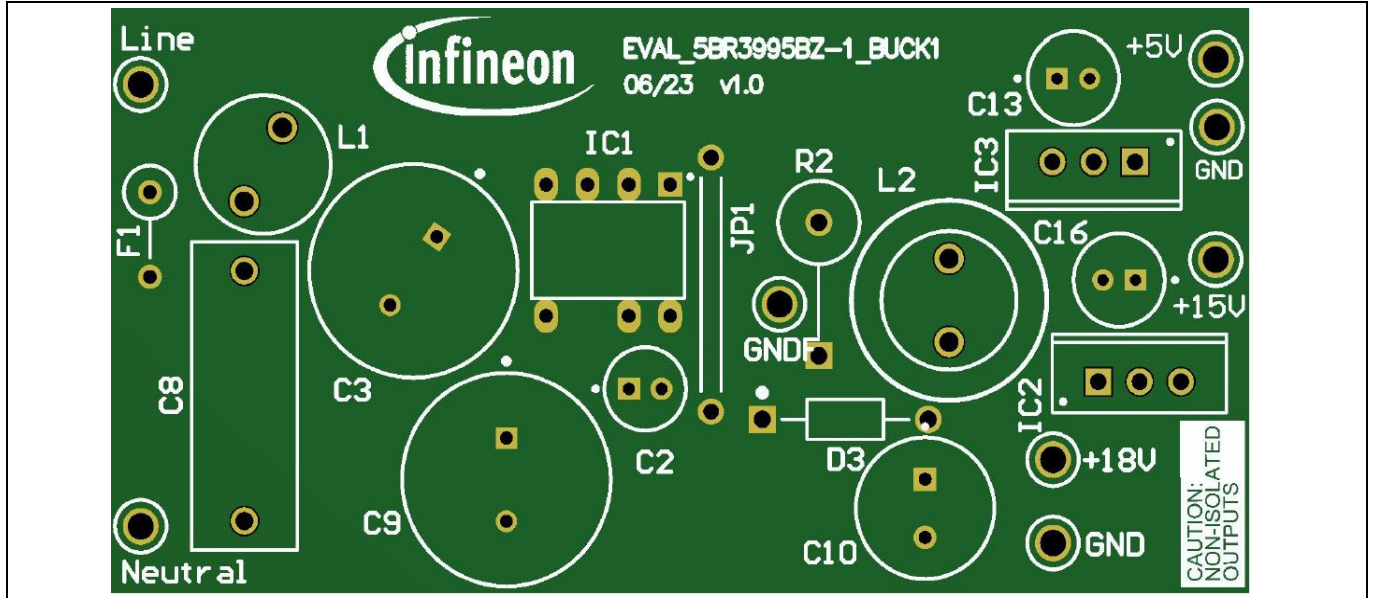


Figure 4 Top-side component legend

6.2 Bottom side

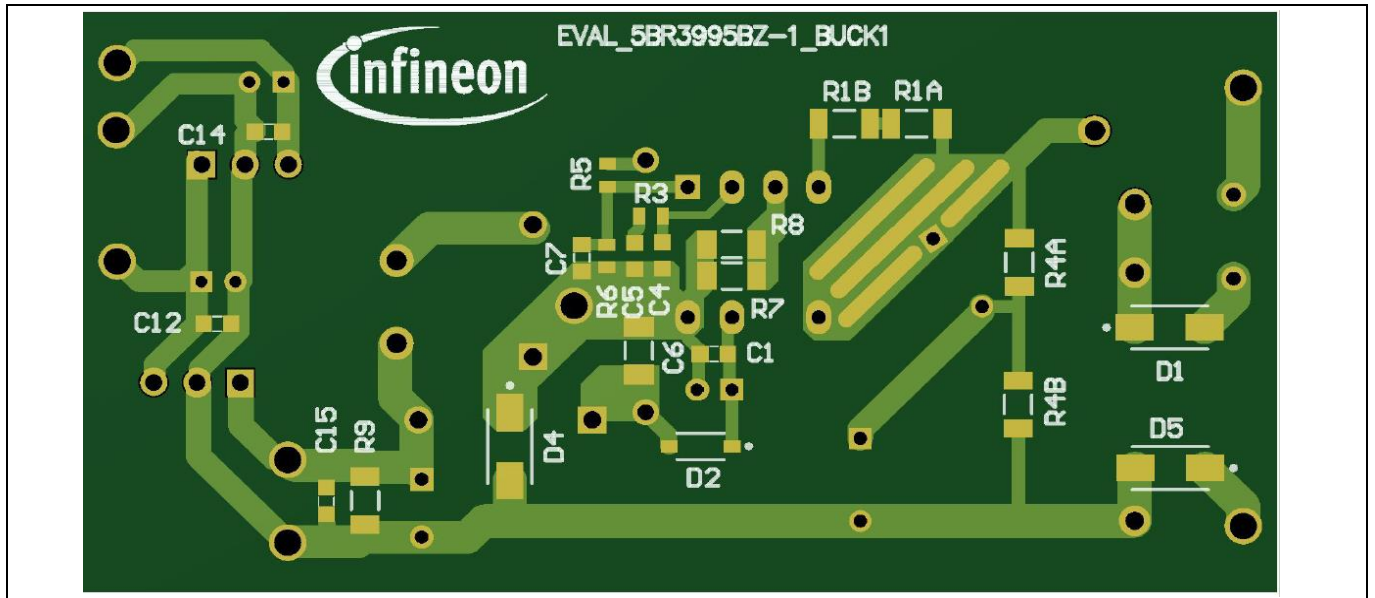


Figure 5 Bottom-side copper and component legend

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Bill of materials

7 Bill of materials

Table 3 BOM

No.	Designator	Description	Manufacturer	Part number	Qty
1	C2	Aluminum capacitor 15 μ F 20% 35 V radial	Nichicon	UVZ1V470MDD 1TA	1
2	C1	Ceramic capacitor 100 nF 50 V X7R 0603	–	–	1
3	C3, C9	Aluminum capacitor 47 μ F 20% 400 V radial	United Chemi-Con	EPAG401ELL47 0MK30S	2
4	C15	Ceramic capacitor 0.33 μ F 25 V X7R 0603	–	–	1
5	C4	Ceramic capacitor 220 pF 50 V X7R 0603	–	–	1
6	C5	Ceramic capacitor 0.068 μ F 50 V X7R 0603	–	–	1
7	C6	Ceramic capacitor 2.2 μ F 50 V X7R 1206	Murata	GCM31MR71E2 25KA57	1
8	C7	Ceramic capacitor 1 nF 50 V X7R 0603	–	–	1
9	C8	Film capacitor 0.22 μ F 20% 760 V DC radial	EPCOS/TDK	B32912B3224M	1
10	C10	Aluminum capacitor 220 μ F 20% 35 V radial	Rubycon	35ZLQ220MEFC 8X11.5	1
11	D2	General-purpose diode 100 V 150 mA SOD-123	Diodes Incorporated	BAV16W-7-F	1
12	D3	General-purpose diode 1 kV 1 A DO204AL	Vishay	UF4007-E3/73	1
13	D4	General-purpose diode 800 V 1 A SMA	Bourns	CD214A-FS1K	1
14	D1, D5	General-purpose diode 1 kV 1 A SMA	STMicroelectronics	S1M-13-F	2
15	F1	Resistor 8.2 Ω 2 W 5% axial, flameproof, fusible, safety wirewound	Yageo	FKN200JR-73-8R2	1
16	IC1	Fixed Frequency CoolSET™ DIP7	Infineon Technologies	ICE5BR3995BZ-1	1
17	JP1	Through-hole jumper, 15.24 mm pitch, 2 pins	3M	923345-06-C	1
18	R2	Resistor 5 W XSM M/OX 5% 6R2	TE Connectivity	ROX5SSJ6R2	1
19	R5	SMD resistor 270 k Ω 1% 1/10 W 0603	–	–	1
20	R6	SMD resistor 29.4 k Ω 1% 1/10 W 0603	–	–	1
21	R7, R8	SMD resistor 2.2 Ω 1% 1/2 W 1206	–	–	2
22	R4A, R4B	SMD resistor 1 m Ω 1% 1/4 W 1206	Vishay	RCV12061M00F KEA	2
23	R9	SMD resistor 24 k Ω 1% 1/4 W 1206	–	–	1
24	R1A, R1B	SMD resistor 50 M Ω 1% 1/4 W 1206	Vishay	CRHV1206AF50 M0FKET	2
25	R3	SMD resistor 15 k Ω 1% 1/10 W 0603	–	–	1
26	L2	Fixed inductor 390 μ H 1.25 A 0.6 Ω	Würth Elektronik	7447480391	1

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EVAL_5BR3995BZ-1_BUCK1

Bill of materials

No.	Designator	Description	Manufacturer	Part number	Qty
27	L1	Fixed inductor 1 mH 500 mA 2.08 Ω THT	Würth Elektronik	768772102	1
28	Line, neutral, GND	PC test-point multipurpose THT, white	Keystone	5012	3
29	+18 V	PC test-point multipurpose THT, red	Keystone	5010	1
30	GND	PC test-point multipurpose THT, black	Keystone	5011	1

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1



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Test results

8 Test results

8.1 Efficiency

Table 4 Efficiency

Input (V AC/Hz)	Load percentage (%)	P _{IN} (W)	V _{OUT} (V DC)	I _{OUT} (A)	P _{OUT} (W)	Efficiency η (%)	Average efficiency η (%)
85 V AC/60 Hz	0	0.041	18.17	0	0		
	25	1.764	17.58	0.0746	1.312	74.35	72.1
	50	3.607	17.49	0.1495	2.615	72.52	
	75	5.476	17.44	0.2243	3.912	71.44	
	100	7.419	17.37	0.2992	5.198	70.07	
115 V AC/60 Hz	0	0.046	18.17	0	0		
	25	1.771	17.58	0.0746	1.312	74.08	72.53
	50	3.628	17.48	0.1495	2.613	72.03	
	75	5.411	17.42	0.2243	3.907	72.2	
	100	7.228	17.34	0.2993	5.19	71.8	
230 V AC/50 Hz	0	0.089	18.20	0	0		
	25	1.847	17.59	0.0746	1.312	71.05	72.19
	50	3.582	17.52	0.1495	2.62	73.15	
	75	5.379	17.44	0.2244	3.914	72.77	
	100	7.231	17.35	0.2993	5.191	71.79	
264 V AC/50 Hz	0	0.107	18.20	0	0		
	25	1.884	17.58	0.0747	1.313	69.68	71.34
	50	3.647	17.51	0.1496	2.62	71.83	
	75	5.395	17.44	0.2243	3.913	72.52	
	100	7.277	17.34	0.2992	5.189	71.31	
460 V AC/50 Hz	0	0.257	18.41	0	0		
	25	2.168	17.56	0.0747	1.311	60.47	64.9
	50	4.028	17.48	0.1495	2.613	64.88	
	75	5.848	17.4	0.2243	3.903	66.75	
	100	7.675	17.3	0.2993	5.179	67.48	

Note: A dummy load (R₉ = 24 kΩ) is placed on the board for output voltage regulation at no-load condition.

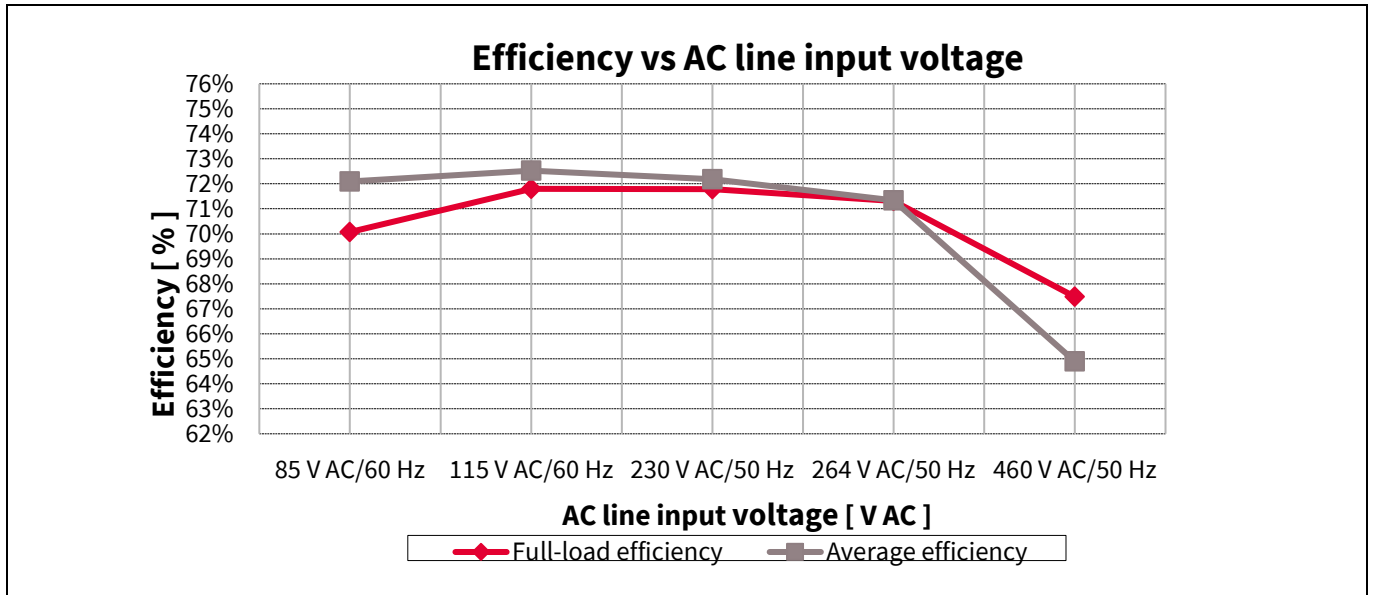


Figure 6 Efficiency vs AC line input voltage

8.2 Standby power

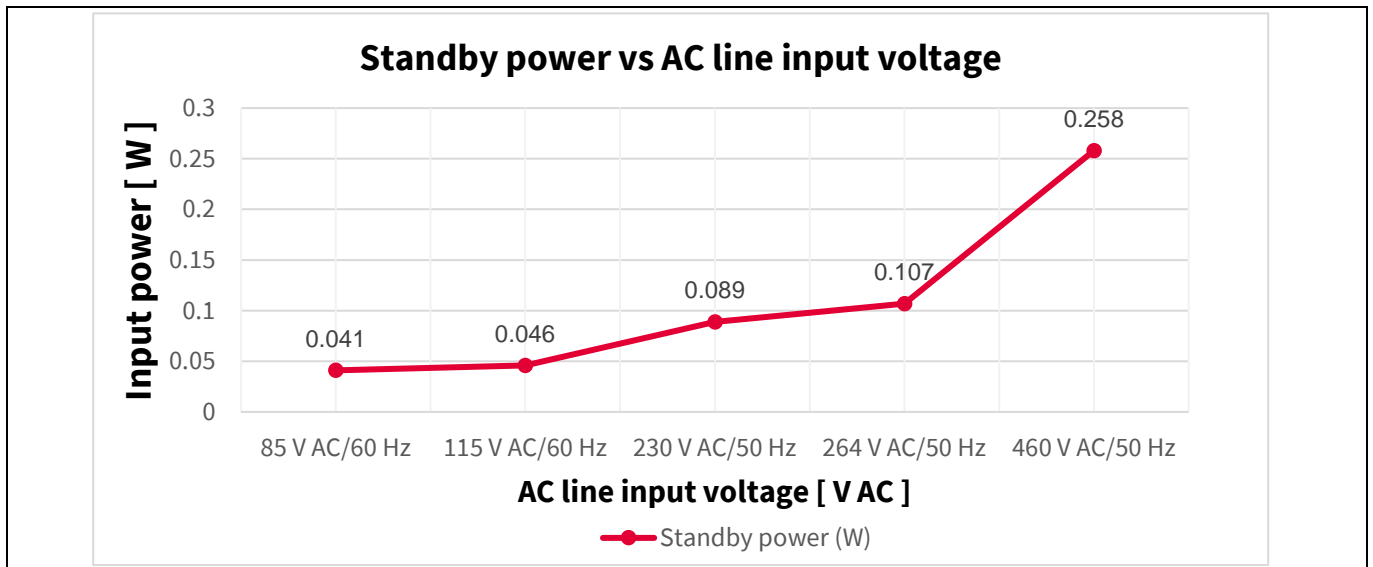


Figure 7 Standby power at no load vs AC line input voltage

8.3 Line regulation at full load

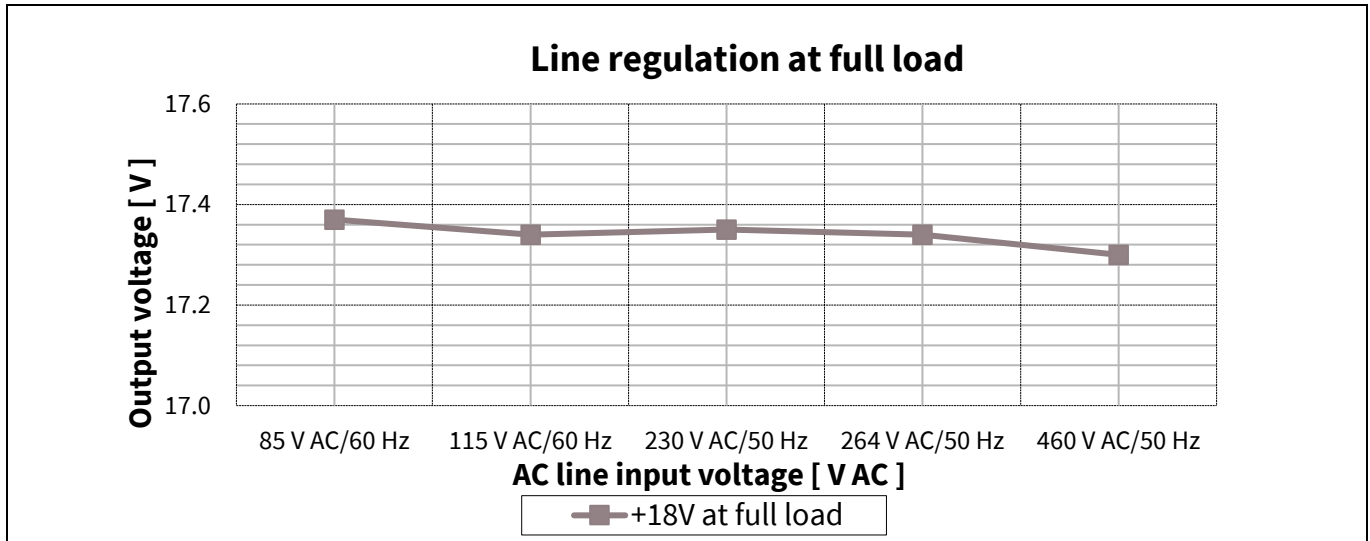


Figure 8 Line regulation V_{out} vs AC line input voltage

8.4 Load regulation

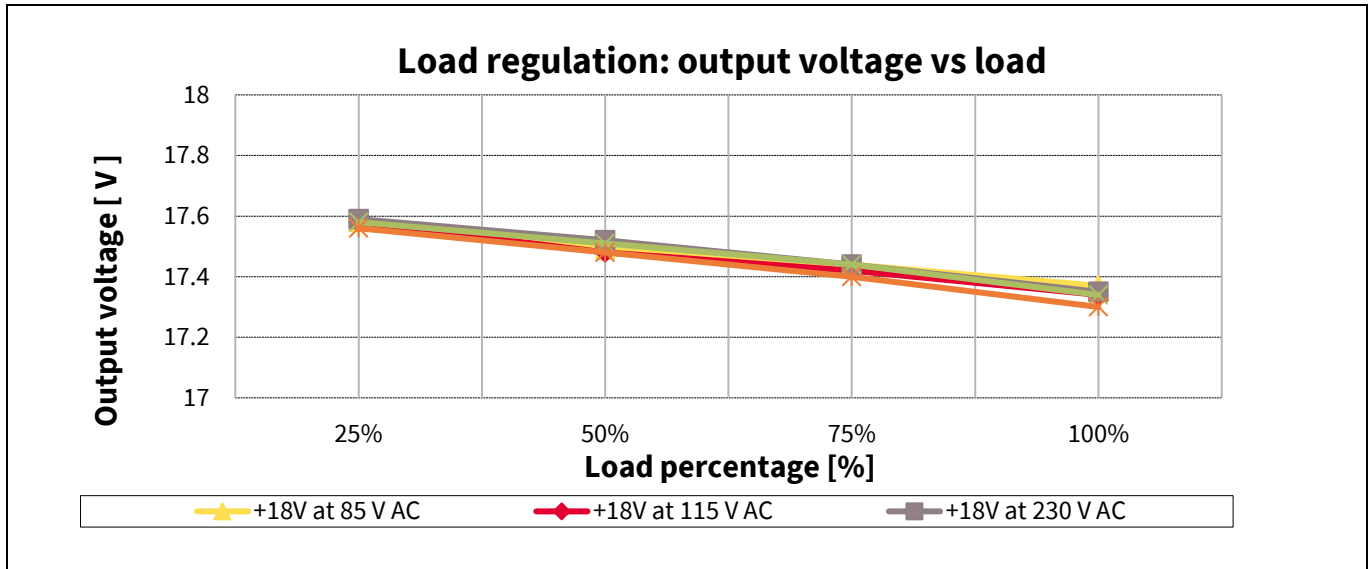


Figure 9 Load regulation V_{out} vs output power

8.5 Surge immunity (EN 61000-4-5)

This board passes the EN 61000-4-5 installation Class 3 (± 1 kV for line-to-line DM) test. A test failure is defined as a non-recoverable system auto-restart.

Table 5 Surge immunity test result

Description	Test	Level		Number of strikes				Test result
				0°	90°	180°	270°	
115/230 V AC, 300 mA	DM	+/- 1 kV	L → N	3	3	3	3	Pass

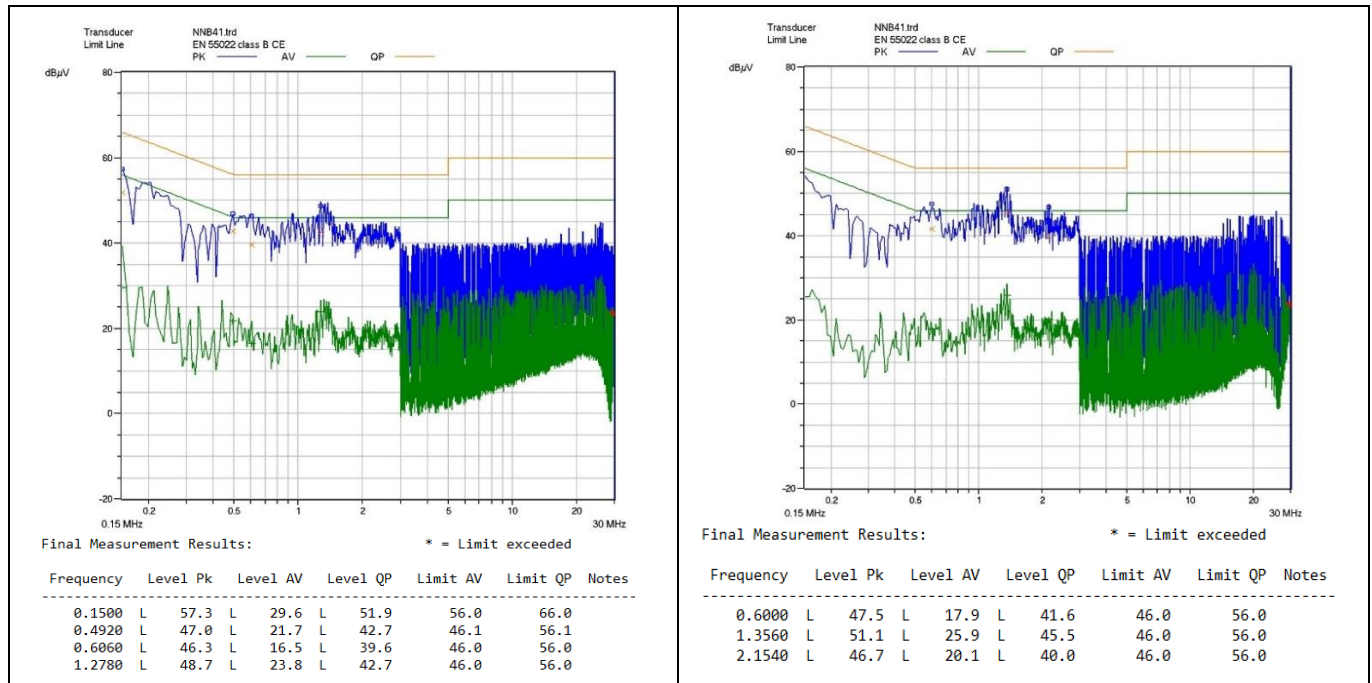
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Test results

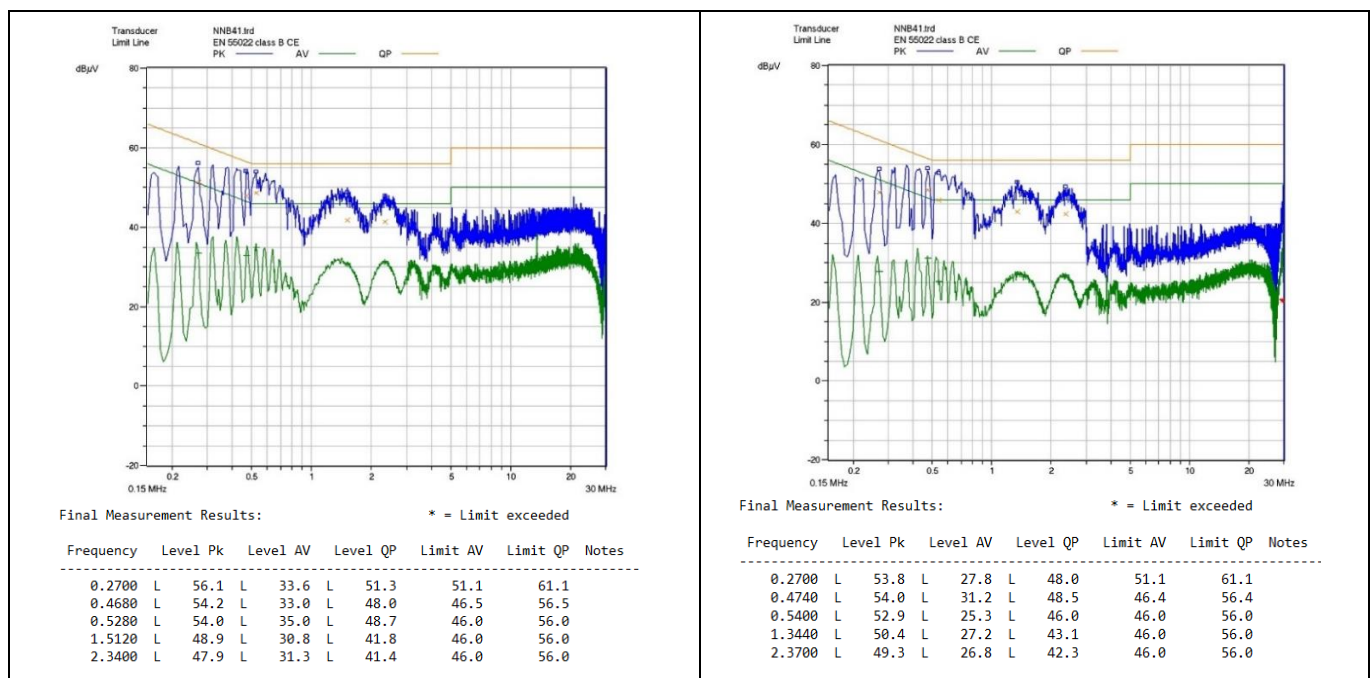
8.6 Conducted emissions (EN 55022 Class B)

Conducted EMI was measured by Schaffner SMR4503 EMI measuring receiver, and followed the test standard of EN 55022 (CISPR 22) Class B. The evaluation board is connected to a resistive load (300 mA) with an input voltage of 115 V AC and 230 V AC.



Passed with 10 dB margin for quasi-peak measurement at low-line (115 V AC)

Figure 10 Conducted emissions at 115 V AC with full load



Passed with 6 dB margin for quasi-peak measurement at high-line (230 V AC)

Figure 11 Conducted emissions at 230 V AC with full load

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Test results

8.7 Thermal measurement

The thermal testing of the open-frame evaluation board is done using an infrared thermography camera (FLIR-T62101) at an ambient temperature of 25°C. The measurements are taken after one hour running at full-load condition.

Table 6 Hottest components of the evaluation board

No.	Major component	85 V AC (°C)	460 V AC (°C)
1	IC1 (ICE5BR3995BZ-1)	51.7	69.8
2	Freewheeling diode (D4)	72	86.5
3	Inductor (L2)	50.6	74.5
4	Current sense resistor (R _{CS})	41.1	65.6
5	Anti-saturation resistor (R2*)	82.5	104

*R2 limits the current through the output inductor (L2) to avoid saturation during the start-up phase and output short condition.

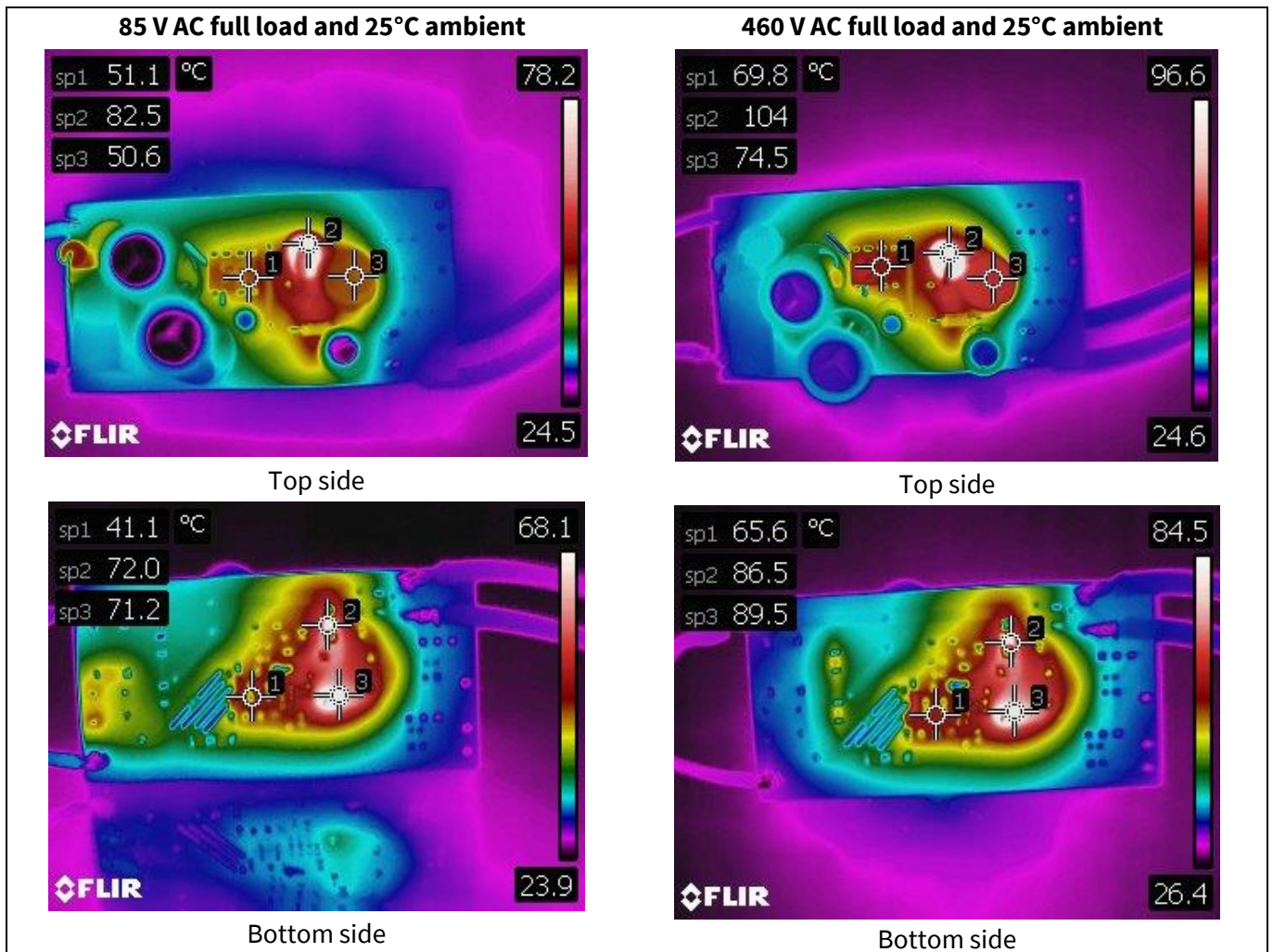


Figure 12 Infrared thermal image of EVAL_5BR3995BZ-1_BUCK1

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Waveforms and scope plots

9 Waveforms and scope plots

9.1 Start-up with maximum load

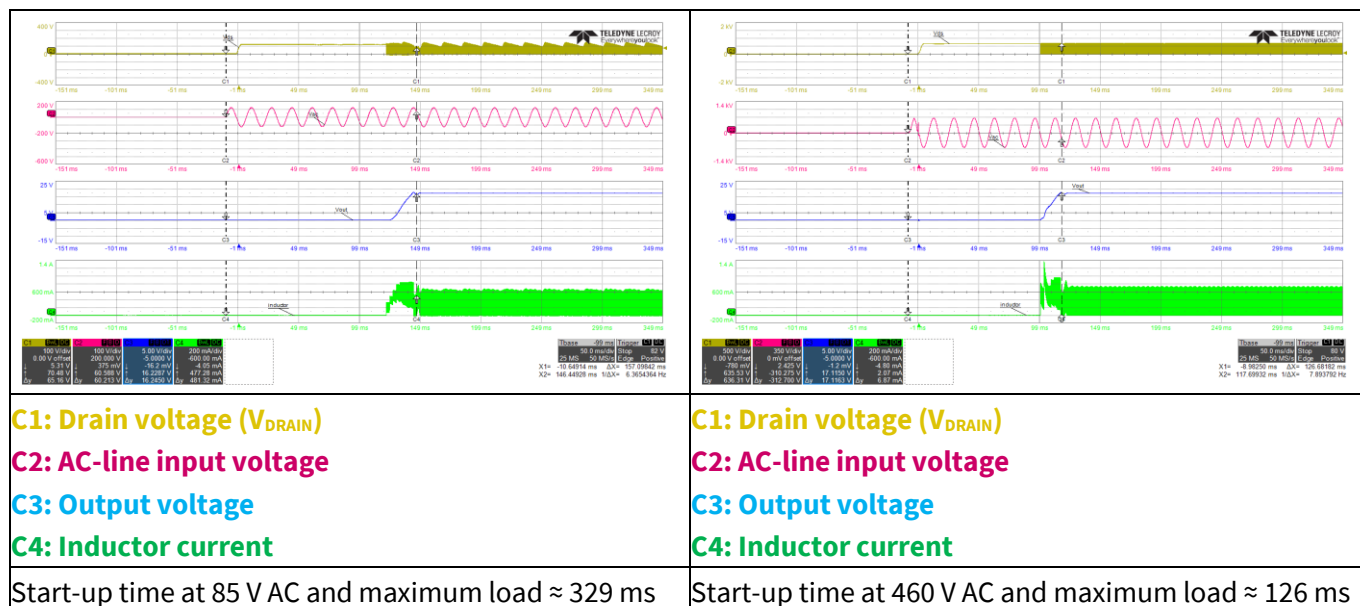


Figure 13 Start-up

9.2 Soft-start

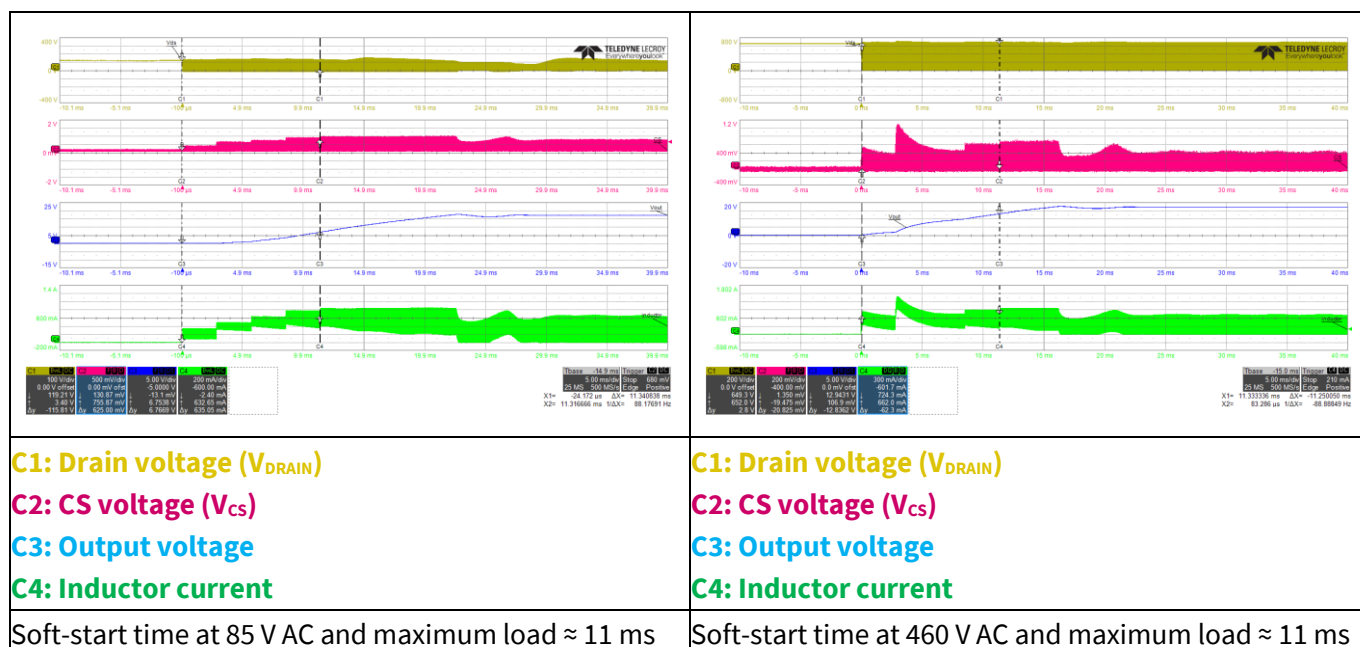


Figure 14 Soft-start

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Waveforms and scope plots

9.3 Drain voltage and current at maximum load

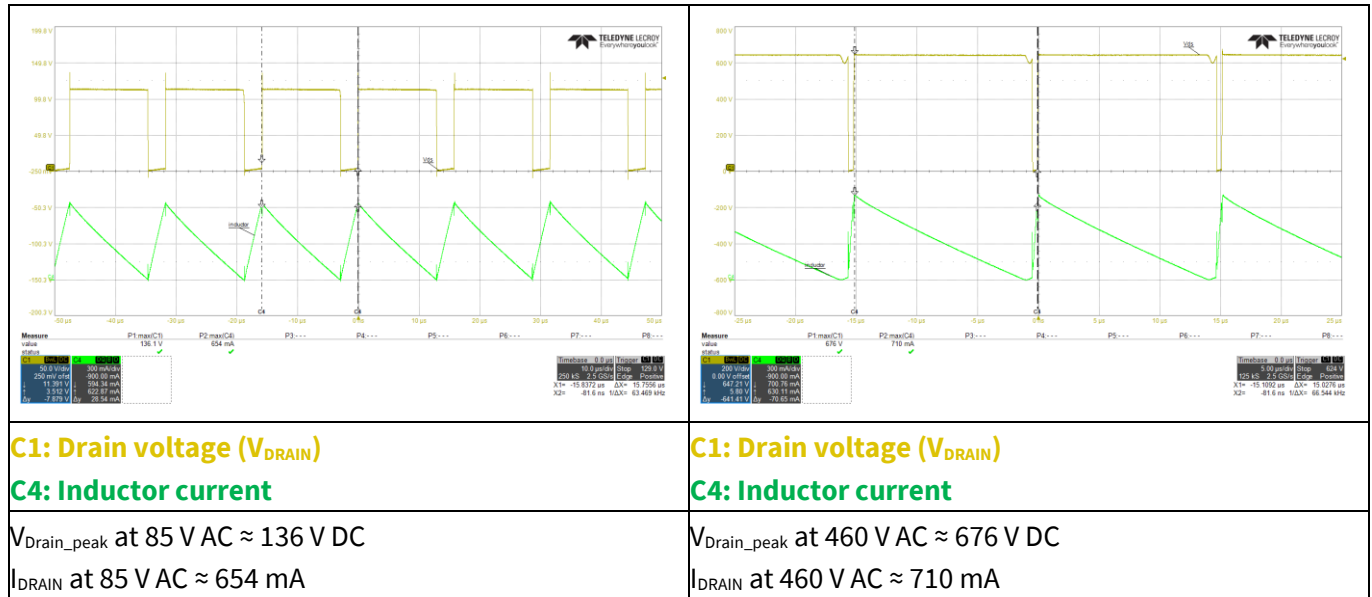


Figure 15 Drain and CS voltage at maximum load

9.4 Output ripple voltage at maximum load

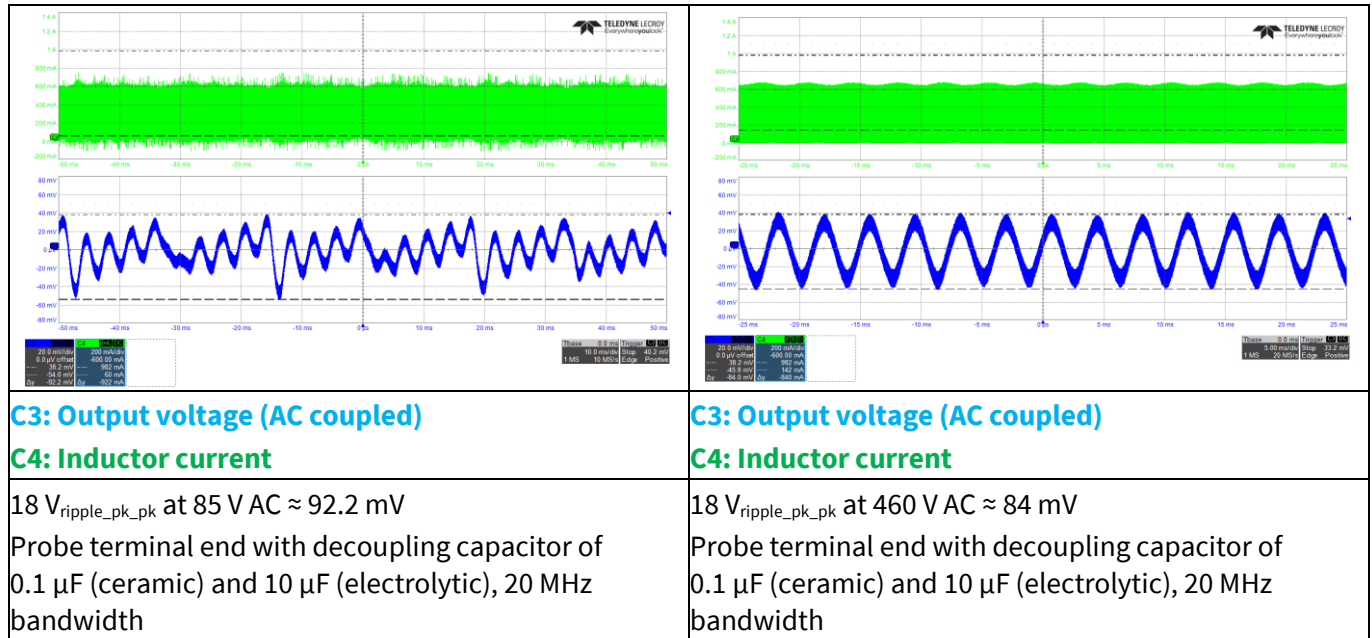


Figure 16 Output ripple voltage at maximum load

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Waveforms and scope plots

9.5 ABM operation

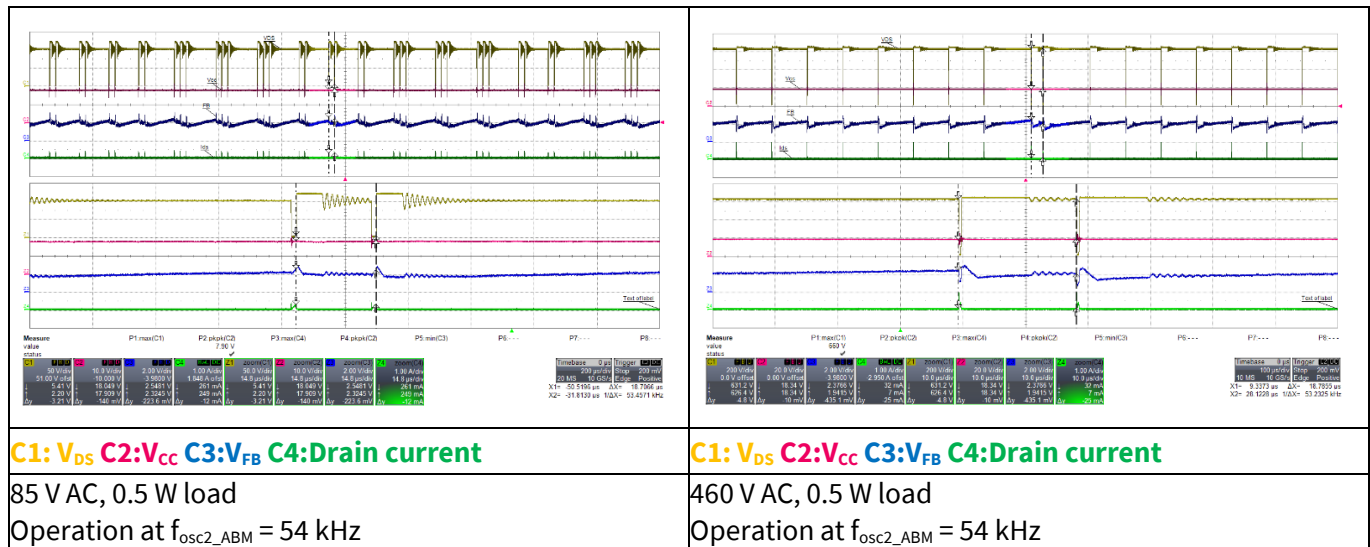


Figure 17 ABM operation

9.6 Overload protection

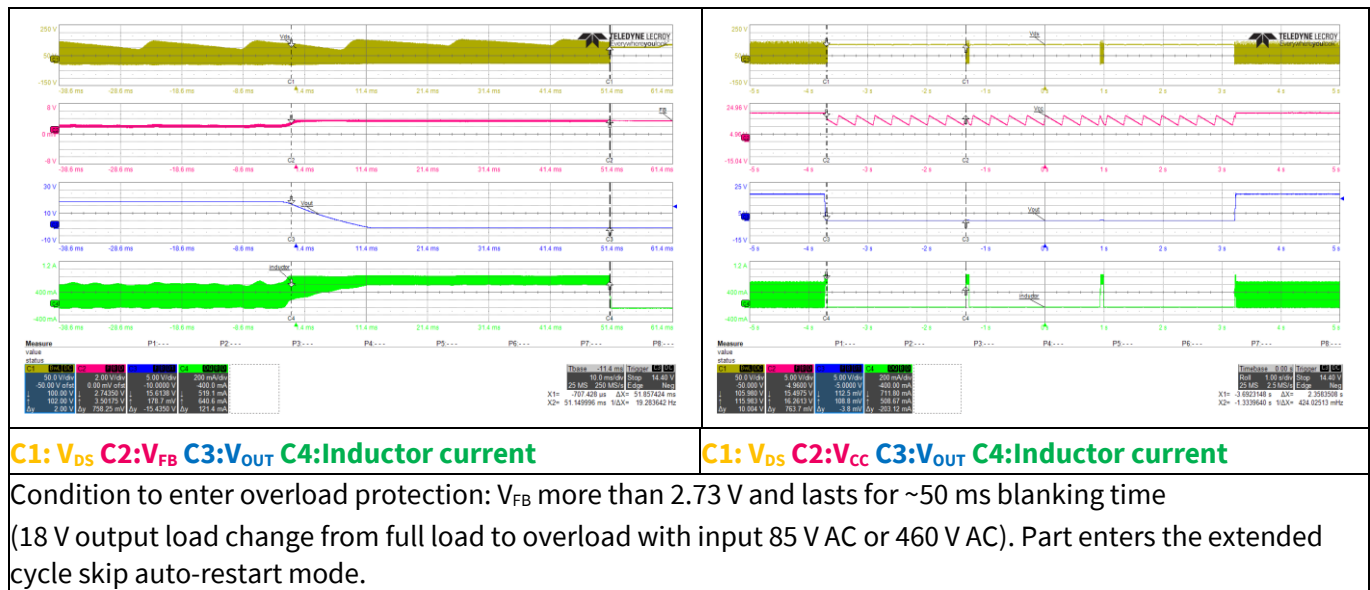


Figure 18 Overload protection

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Waveforms and scope plots

9.7 Output short test

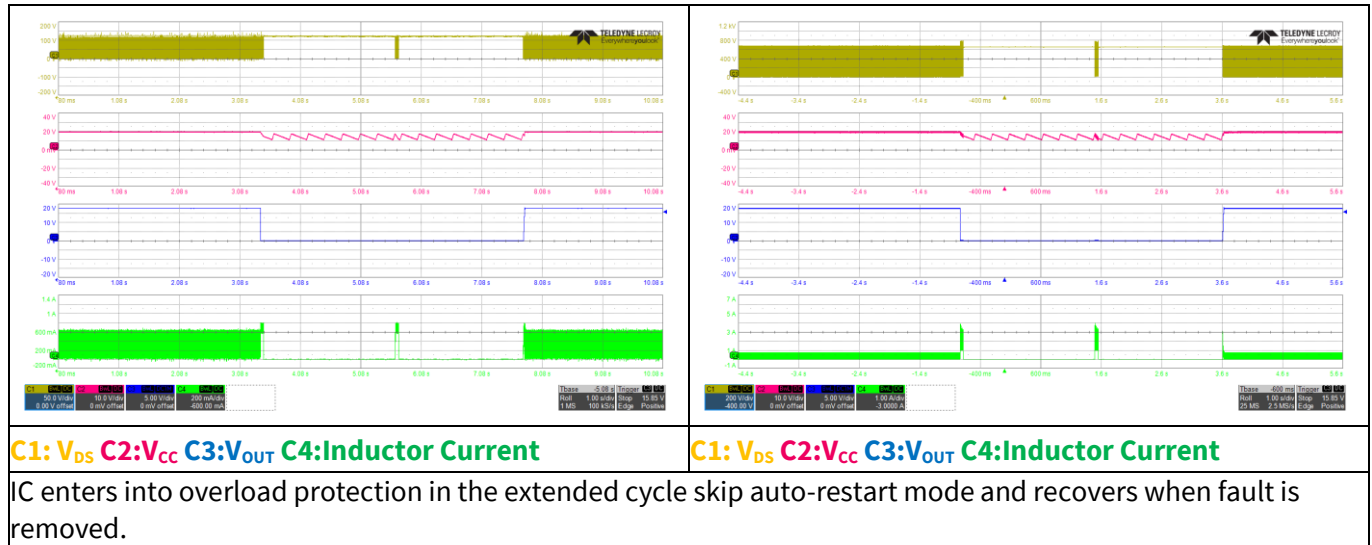


Figure 19 Output short test

300 mA non-isolated ultra high-voltage buck evaluation board using CoolSET™ ICE5BR3995BZ-1

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Design example A

10 Design example A

In this design example, two linear regulators are placed in series on the board. The main output is still 18 V. The 15 V output that is capable of supplying up to 200 mA is obtained from the main output through IC2. The 5 V output that is capable of supplying up to 100 mA is obtained from the 15 V output through IC3. The additional circuit is shown in the following figure.

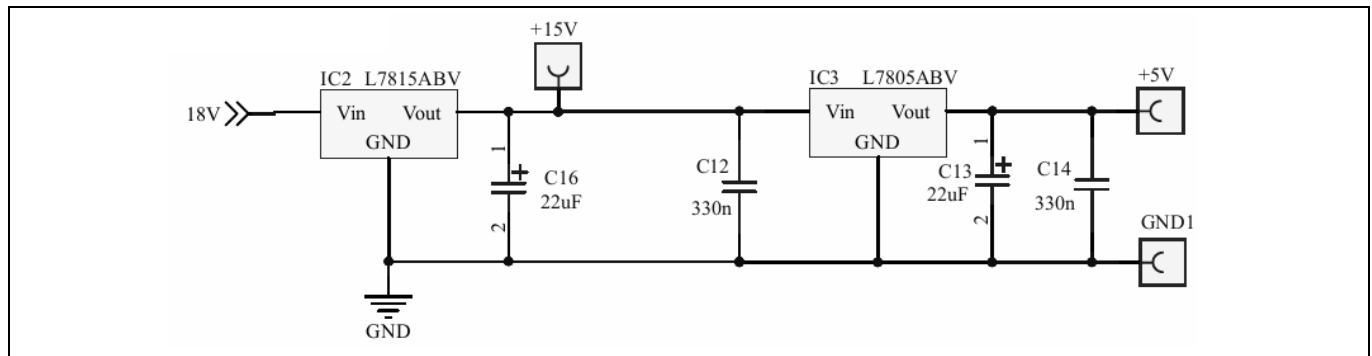


Figure 20 Additional circuit for design example A

Note: Components in the additional circuit shown in [Figure 20](#) are not mounted on the actual evaluation board.

10.1 Specification of design example A

Because the 12 V output and 5 V output are subordinated to the main output (18 V), the total output current must not exceed the maximum capacity of the main output current. The specification of this design example is shown in Table 7.

Table 7 Specification of design example A

Description	Symbol	Value	Comments
Output voltage 1	V_{o1}	18 V	Main output
Max. output current 1	I_{o1}	0.1 A	–
Output voltage 2 (via LDO)	V_{o2}	15 V	Derived from 18 V output
Max. output current 2	I_{o2}	0.1 A	–
Output voltage 3 (via LDO)	V_{o3}	5 V	Derived from 15 V output
Max. output current 3	I_{o3}	0.1 A	–

10.2 Full-load efficiency

Additional power loss caused by LDO circuits reduces the overall efficiency.

Table 8 Full-load efficiency – example A

Input (V AC/Hz)	P_{IN} (W)	V_{o1} (V DC)	I_{o1} (A)	V_{o2} (V DC)	I_{o2} (A)	V_{o3} (V DC)	I_{o3} (A)	P_{OUT} (W)	Efficiency η
85 V AC/60 Hz	7.80	17.843	0.1	14.942	0.1	5.075	0.1	3.786	49%
115 V AC/60 Hz	7.64	17.843	0.1	14.942	0.1	5.075	0.1	3.786	50%

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Design example A

Input (V AC/Hz)	P _{IN} (W)	V _{o1} (V DC)	I _{o1} (A)	V _{o2} (V DC)	I _{o2} (A)	V _{o3} (V DC)	I _{o3} (A)	P _{OUT} (W)	Efficiency η
230 V AC/60 Hz	7.62	17.875	0.1	14.942	0.1	5.087	0.1	3.790	50%
264 V AC/60 Hz	7.69	17.875	0.1	14.942	0.1	5.087	0.1	3.790	49%
460 V AC/60 Hz	8.21	17.859	0.1	14.942	0.1	5.087	0.1	3.789	46%

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Design example B

11 Design example B

Design example B shows a universal input voltage buck converter with ICE5BR3995BZ-1 in a single output of +15 V/550 mA. You can achieve such a design through a simple modification on the EVAL_5BR3995BZ-1_BUCK1 board with the following schematic and BOM.

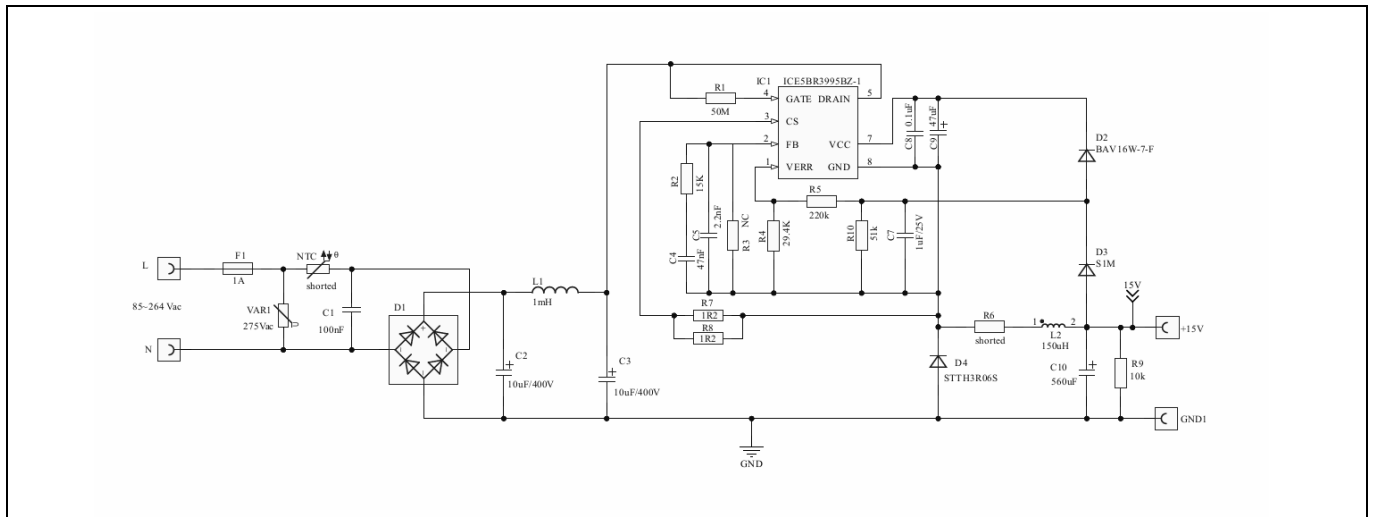


Figure 21 Circuit diagram of design example B

11.1 Specification of design example B

Table 9 Specification of design example B

Description	Symbol	Value	Comments
Input voltage	V_{IN}	85~264 V AC	–
Output voltage	V_{OUT}	15 V	Less than $\pm 5\%$ of rated voltage
Max. output current	I_{OUT}	0.55 A	–
Ripple and noise voltage	V_{rpp}	150 mV	Less than 1% of rated voltage
Output power	P_{OUT}	8.25 W	–
Efficiency	η_{avg}	No less than 80 %	–
Ambient temperature	T_{amb}	50°C	Free convention

11.2 Bill of materials of design example B

Table 10 BOM of design example B

No.	Designator	Description	Manufacturer	Part number	Qty
1	C1	Film capacitor 0.1 µF 10% 310 V AC radial	–	–	1
2	C2, C3	Aluminum capacitor 10 µF 20% 450 V radial	–	–	2
3	C4	Ceramic capacitor 47 nF 25 V X7R 0603	–	–	1

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Design example B

No.	Designator	Description	Manufacturer	Part number	Qty
4	C5	Ceramic capacitor 2.2 nF 25 V X7R 0603	–	–	1
5	C7	Ceramic capacitor 1 µF 25 V X7R 1206	–	–	1
6	C9	Aluminum capacitor 47 µF 20% 50 V radial	–	–	1
7	C10	Aluminum capacitor 220 µF 20% 25 V radial	–	–	1
8	C11, C13, C15	Ceramic capacitor 0.1 µF 50 V X7R 0603	–	–	3
9	C12, C14	Aluminum capacitor 10 µF 20% 50 V radial	–	–	2
10	D1	Bridge rectifier 1-phase 1 kV 1 A 4SOPA	Diodes	ABS10A-13	1
11	D2	General-purpose diode 100 V 150 mA SOD-123	Diodes	BAV16W-7-F	1
12	D3	General-purpose diode 1 kV 1 A SMA DO-214AC	–	S1M	1
13	D4	Ultrafast power rectifier	STMicroelectronics	STTH3R06S	1
14	F1	Mounted fuse board 1 A 300 V AC radial	–	–	1
15	IC1	CoolSET™ DIP7	Infineon Technologies	ICE5BR3995BZ-1	1
16	L1	Fixed inductor 1000 µH 0.6 A 1.27 Ω	Würth Elektronik	7447452102	1
17	L2	Fixed inductor 150 µH 2 A	Würth Elektronik	7447480151	1
18	R1	Resistor 50 mΩ 300 mW 1206	Vishay	CRHA1206AF50M 0FKEF	1
19	R2	SMD resistor 15 kΩ 1% 1/10 W 0603	–	–	1
20	R4	SMD resistor 29.4 kΩ 1% 1/10 W 0603	–	–	1
21	R5	SMD resistor 220 kΩ 1% 1/10 W 0603	–	–	1
22	R7, R8	SMD resistor 1.2 Ω 1% 1/2 W 1206	–	–	2
23	R9	SMD resistor 10 kΩ 1% 1/4 W 1206	–	–	1
24	R10	SMD resistor 51 kΩ 1% 1/10 W 0603	–	–	1
25	VAR1	S07K275E2/275 V AC/10%	EPCOS/TDK	B72207S2271K10 1	1
26	Line, neutral	PC test-point multipurpose THT, white	Keystone	5012	2
27	GND1	PC test-point multipurpose THT, black	Keystone	5011	1
28	+15 V	PC test-point multipurpose THT, red	Keystone	5010	1

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Design example B

11.3 Test results of design example B

11.3.1 Efficiency and standby power

Table 11 Efficiency and standby power – design example B

Input (V AC/Hz)	Load percentage (%)	P _{IN} (W)	V _{OUT} (V DC)	I _{OUT} (A)	P _{OUT} (W)	Efficiency η (%)	Average efficiency η (%)
85 V AC/60 Hz	0	0.055	15.796	0.000			82.77
	25	2.432	15.046	0.134	2.021	83.09	
	50	4.977	14.984	0.276	4.130	82.97	
	75	7.475	14.953	0.414	6.191	82.82	
	100	9.868	14.906	0.544	8.113	82.22	
115 V AC/60 Hz	0	0.056	15.765	0.000			83.50
	25	2.421	15.046	0.134	2.021	83.46	
	50	4.934	14.984	0.276	4.130	83.70	
	75	7.413	14.953	0.414	6.191	83.51	
	100	9.745	14.921	0.544	8.122	83.34	
230 V AC/50 Hz	0	0.058	15.797	0.000			83.23
	25	2.468	15.093	0.134	2.027	82.13	
	50	4.982	15.046	0.276	4.147	83.23	
	75	7.428	15.015	0.414	6.216	83.69	
	100	9.716	14.968	0.544	8.147	83.85	
264 V AC/50 Hz	0	0.059	15.796	0.000			82.74
	25	2.488	15.093	0.134	2.027	81.47	
	50	5.016	15.046	0.276	4.147	82.67	
	75	7.462	15.015	0.414	6.216	83.30	
	100	9.753	14.968	0.544	8.147	83.53	

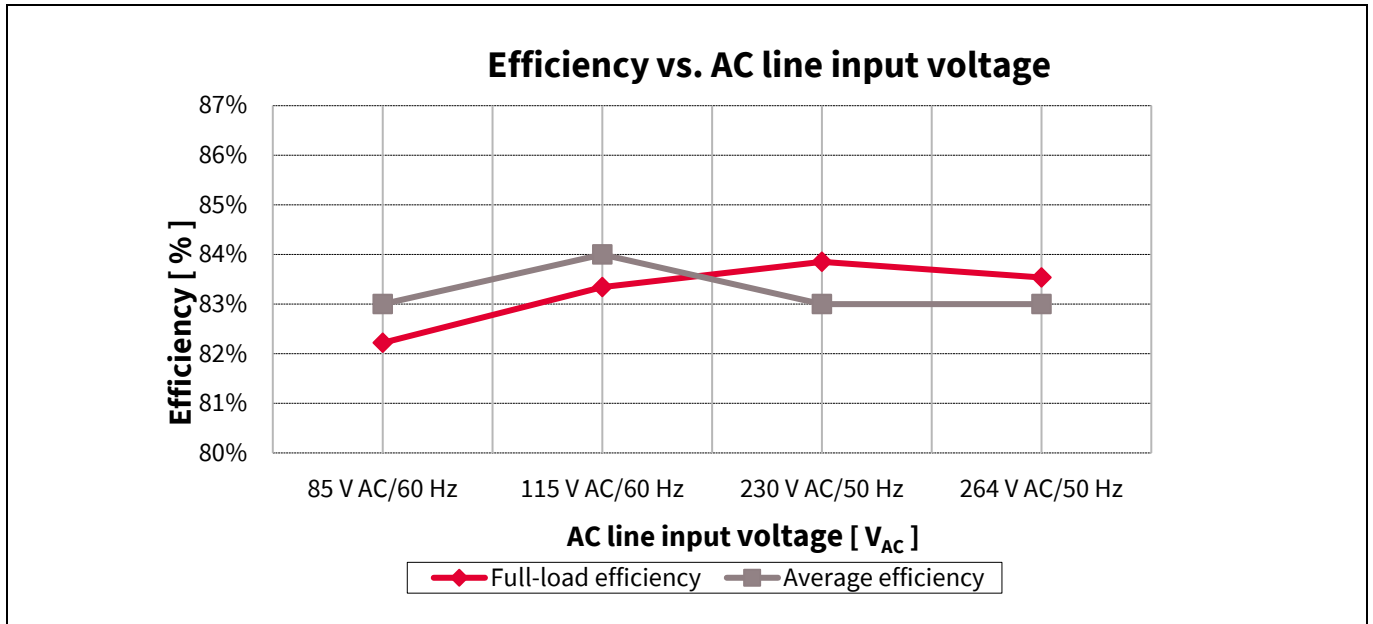


Figure 22 Efficiency vs AC line input voltage – design example B

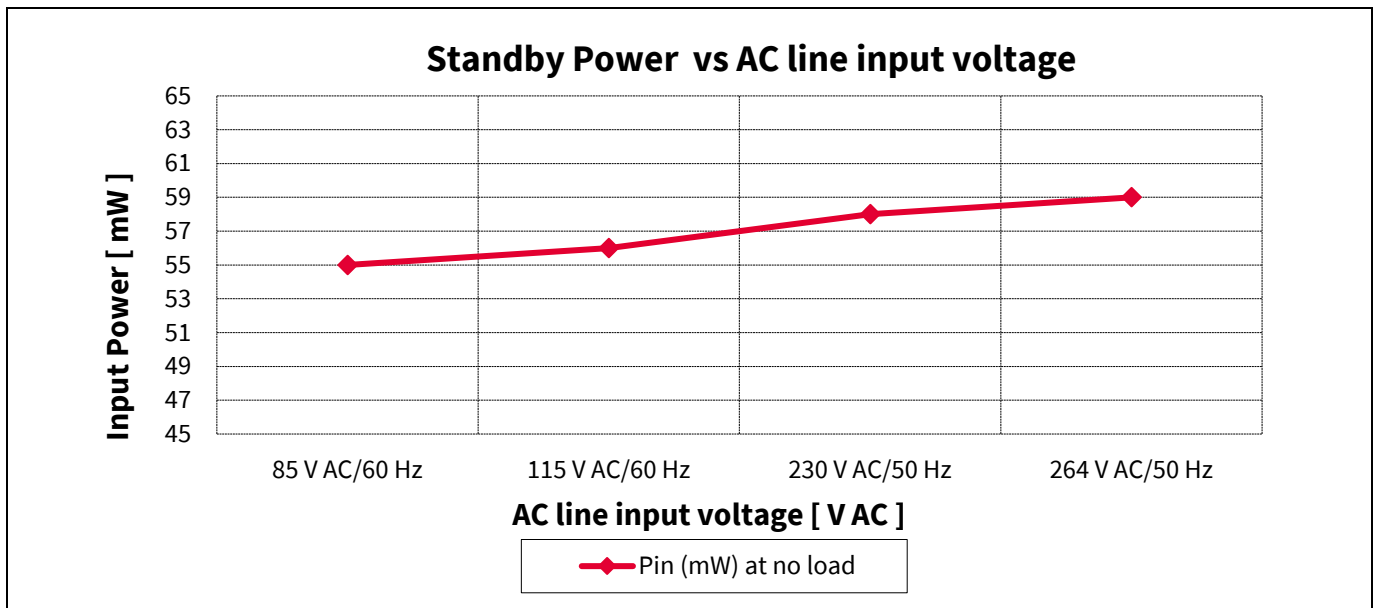


Figure 23 Standby power vs AC line input voltage – design example B

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Design example B

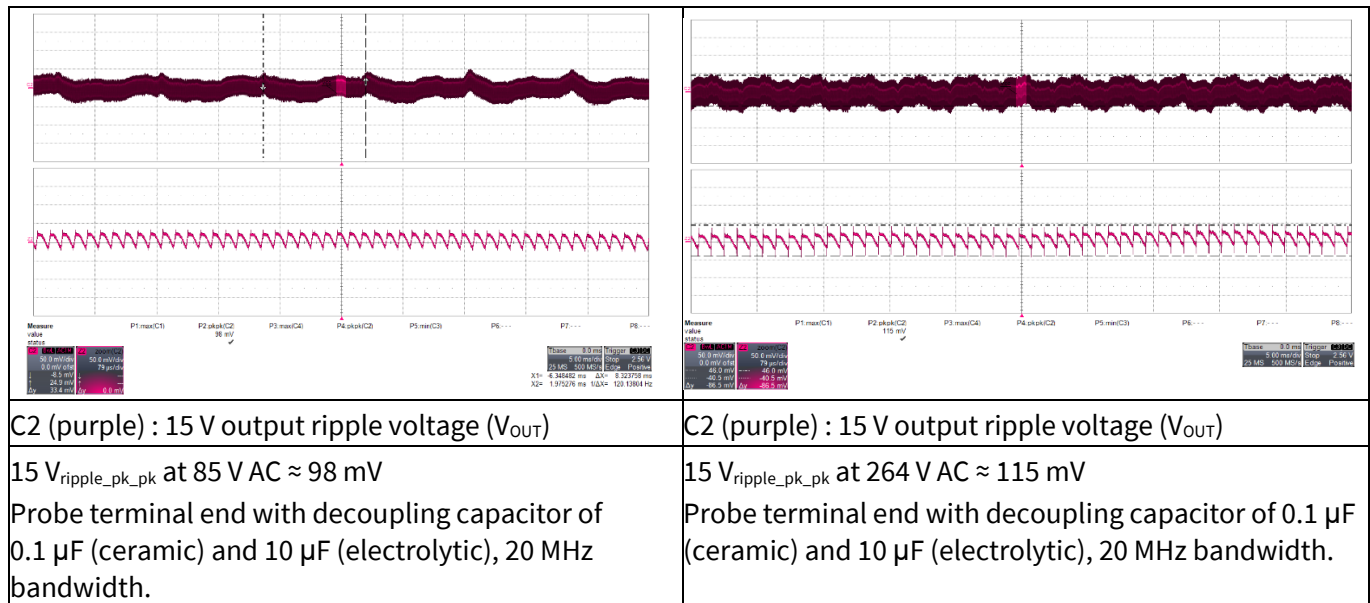


Figure 24 Output ripple voltage at maximum load – design example B

11.3.2 Output voltage regulation – design example B

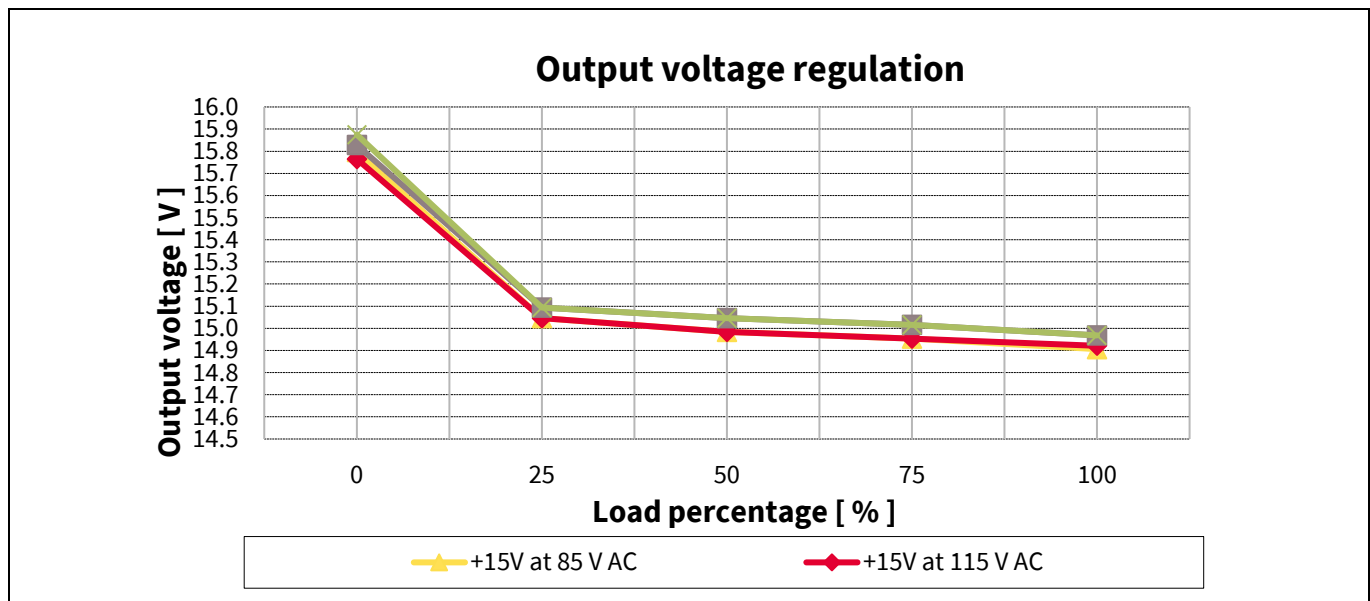


Figure 25 Output voltage regulation – design example B

11.4 Thermal measurement – design example B

The thermal testing of the open-frame evaluation board is done using an infrared thermography camera (FLIR-T62101) at an ambient temperature of 25°C. The measurements are taken after one hour running at full load (550 mA) condition.

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Design example B

Table 12 Hottest temperature of design example B

No.	Major component	85 V AC (°C)	264 V AC (°C)
1	IC1 (ICE5BR3995BZ-1)	67.3	56.8
2	Freewheeling diode (D4)	67.3	68.6
3	Inductor (L2)	55.0	68.5
4	Ambient	24.6	24.9

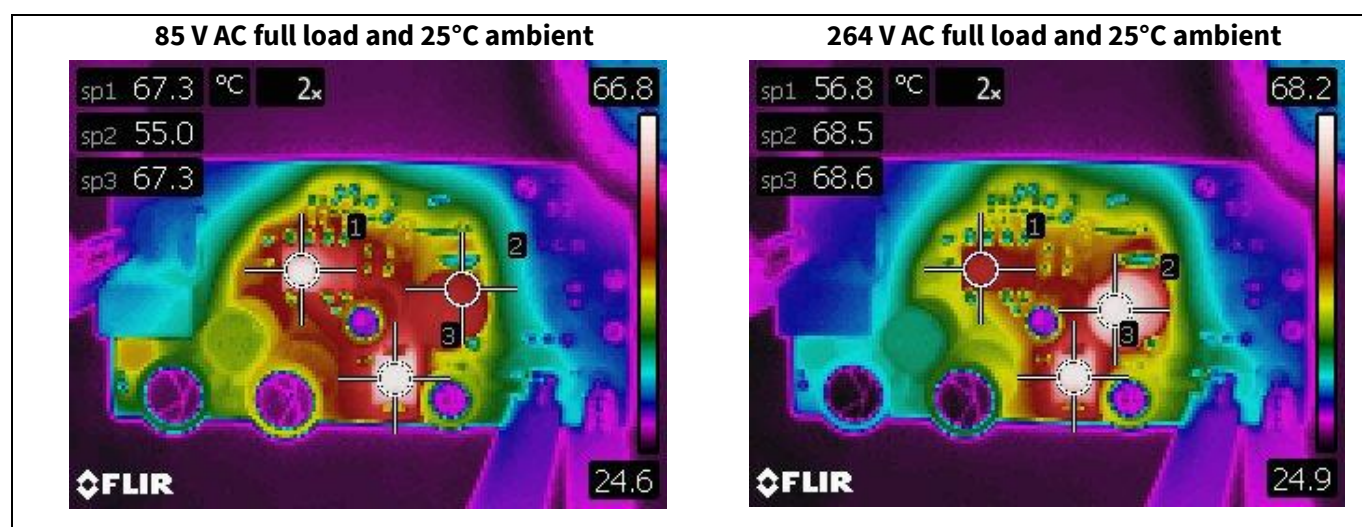


Figure 26 Infrared thermal image of design example B

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References

References

- [1] Infineon Technologies AG: *ICE5xRxxxxxBZx - 1 datasheet*; [Available online](#)
- [2] Infineon Technologies AG: *CoolSET™ 5th Generation Fixed Frequency buck design guide*; [Available online](#)
- [3] Infineon Technologies AG: *CoolSET™ 5th Generation Fixed Frequency Calculation tool for buck*; [Available online](#)

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Revision history

Revision history

Document revision	Date	Description of changes
V 1.0	2024-08-23	Initial release

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Edition 2024-08-23

Published by

Infineon Technologies AG

81726 Munich, Germany

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AN075135

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