Fifth-generation fixed-frequency (FF) DIP-7 high-voltage (HV) buck design examples

ICE5BR4780BZ HV buck design examples

About this document

Scope and purpose

This application note describes a non-isolated high-voltage (HV) buck converter using the latest fifth-generation Infineon fixed-frequency (FF) CoolSET™ ICE5BR4780BZ. It contains the power supply specification, PCB layout, schematic, bill of materials (BOM) and performance data of some design examples. The information in the design examples can be used as reference for users who wish to see the performance of ICE5BR4780BZ under typical output voltage.

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.

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1 Introduction

This application note describes non-isolated HV buck converter power supply design examples using the fifth-generation FF CoolSET™ ICE5BR4780BZ. The design examples can be built using the **EVAL_5BR4780BZ_450mA1 evaluation board**, by adding or changing component values according to the typical output voltages of 12 V, 5 V and 3.3 V generally used to supply microcontrollers, small LCDs, motor controls, gate drivers and other digital/analog ICs. The target applications are auxiliary power supplies for major home appliances, small home appliances, smart metering, etc.

2 EVAL_5BR4780BZ_450mA1 evaluation board

This section covers the EVAL_5BR4780BZ_450mA1 15 V/450 mA evaluation board, PCB layout, schematic diagram and BOM. The different design examples will be based on this evaluation board. Refer to the separate engineering report [2] for the full test data and performance of this evaluation board.

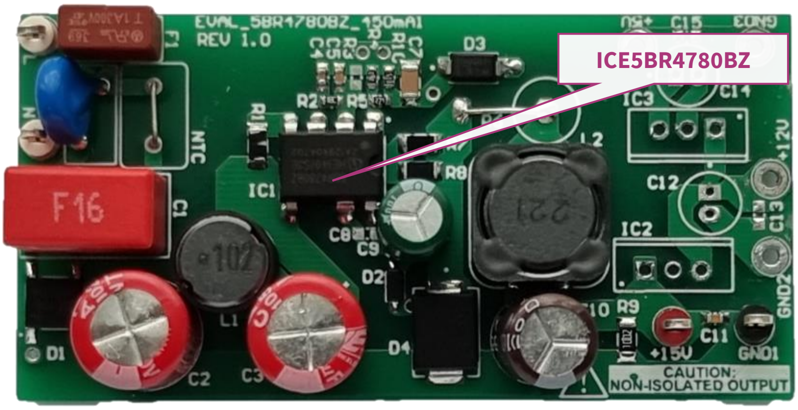

Figure 1 EVAL_5BR4780BZ_450mA1

2.1 PCB layout

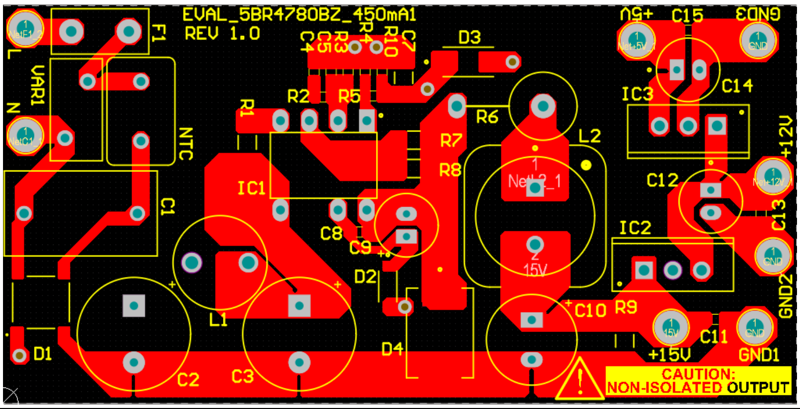

Figure 2 Top-side copper and component legend

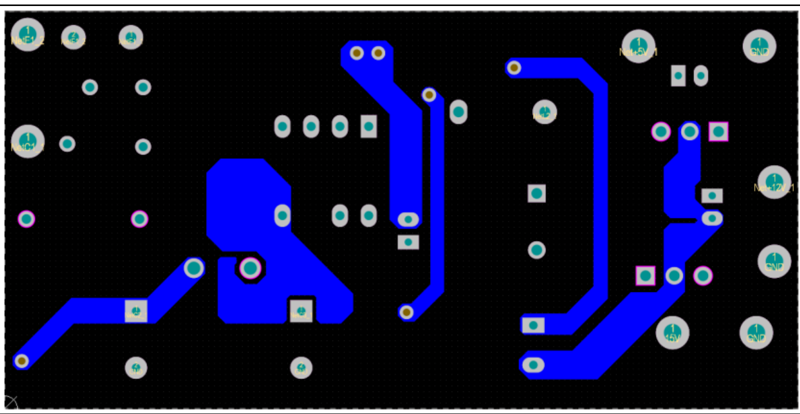

Figure 3 Bottom-side copper

2.2 Schematic diagram

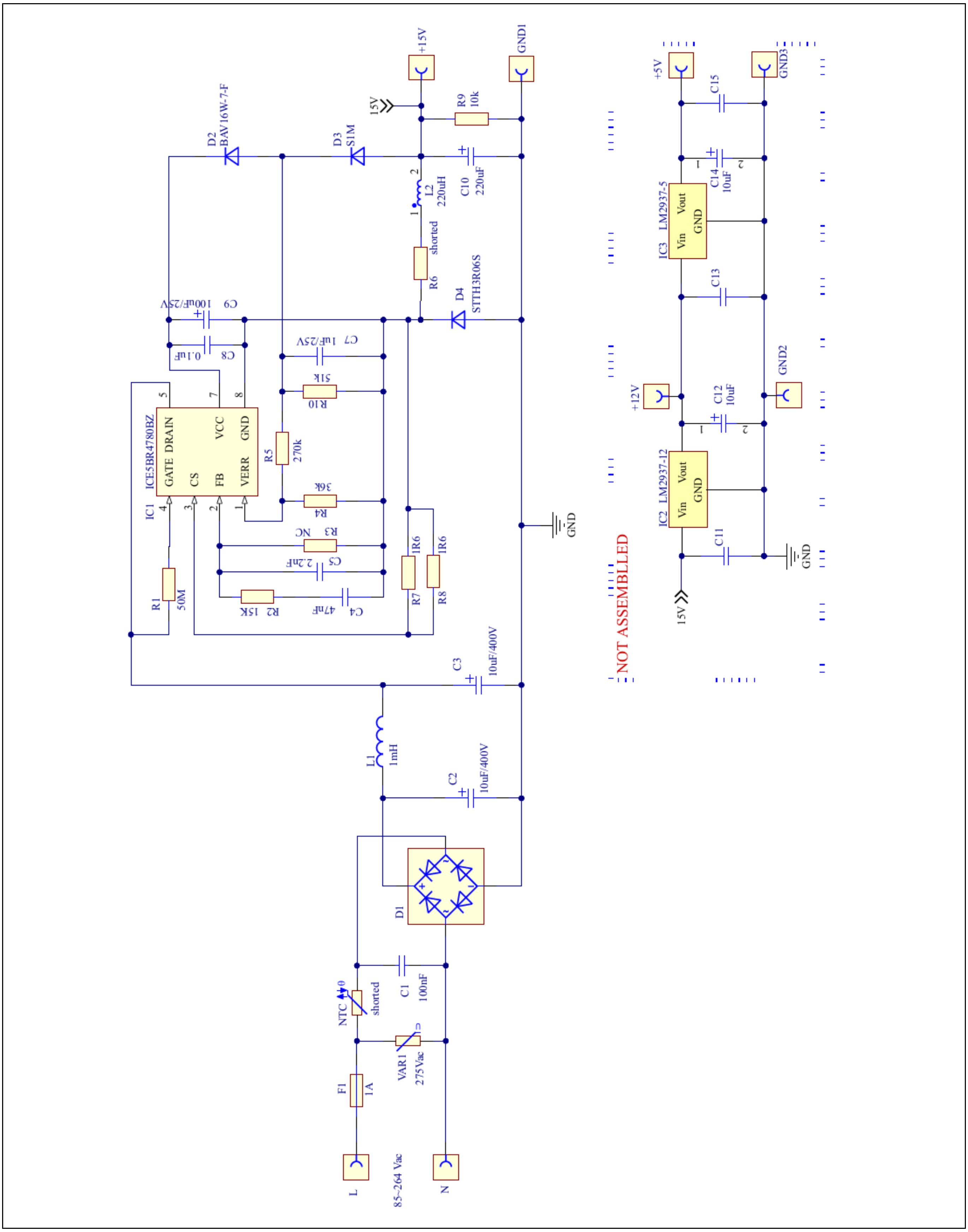

Figure 4 EVAL_5BR4780BZ_450mA1 schematic diagram

2.3 Bill of materials

Table 1 BOM

No.	Designator	Description	Part number	Manufacturer	Quantity
1	C1	Film capacitor 0.1 µF 10% 310 V AC radial	890334023023	Würth Elektronik	1
2	C2, C3	Aluminum capacitor 10 µF 20% 450 V radial	450BXF10M10X16	Rubycon	2
3	C4	Ceramic capacitor 47 nF 25 V X7R 0603			1
4	C5	Ceramic capacitor 2.2 nF 25 V X7R 0603			1
5	C7	Ceramic capacitor 1 µF 25 V X7R 1206			1
6	C8	Ceramic capacitor 0.1 µF 50 V X7R 0603			Open
7	C9	Aluminum capacitor 100 µF 20% 50 V radial			1
8	C10	Aluminum capacitor 220 µF 20% 25 V radial	860160474017	Würth Elektronik	1
9	C11, C13, C15	Ceramic capacitor 0.1 µF 50 V X7R 0603			Open
10	C12, C14	Aluminum capacitor 10 µF 20% 50 V radial	50PX10MEFC5X11	Rubycon	Open
11	D1	Bridge rectifier single-phase 1 kV 1 A 4-SOPA	ABS10A-13	Diodes Incorporated	1
12	D2	General-purpose diode 100 V 150 mA SOD-123	BAV16W-7-F	Diodes Incorporated	1
13	D3	General-purpose diode 1 kV 1 A SMA DO-214AC	S1M		1
14	D4	Surface-mount ultrafast power rectifier	STTH3R06S		1
15	F1	Fuse board mount 1 A 300 V AC radial			1
16	IC1	Fifth-generation FF CoolSET™ DIP-7	ICE5BR4780BZ	Infineon Technologies	1
17	IC2	IC linear regulator 12 V 1.5 A TO-220AB	L7812CV		Open
18	IC3	IC linear regulator 5 V 1.5 A TO-220AB	L7805CV		Open
19	L1	Fixed inductor 1000 µH 0.6 A 1.27 Ω	7447452102	Würth Elektronik	1
20	L2	Fixed inductor 220 µH 1.7 A	SRR1210-221M	Bourns	1
21	NTC	ICL 5 Ω 20% 4.2 A 9.5 mm	B57235S0509M000	TDK	Short
22	R1	Resistor 50 MΩ 300 mW 1206	CRHA1206AF50M0FKEF		1
23	R2	SMD resistor 15 kΩ 1% 1/10 W 0603			1
24	R4	SMD resistor 36 kΩ 1% 1/10 W 0603			1
25	R5	SMD resistor 270 kΩ 1% 1/10 W 0603			1
26	R6	Resistor 3 Ω 3 W TH	MCKNP03UJ020JB00		Short
27	R7	SMD resistor 1.6 Ω 1% 1/2 W 1206			1
28	R8	SMD resistor 1.6 Ω 1% 1/2 W 1206			1
29	R9	SMD resistor 10 kΩ 1% 1/4 W 1206			1
30	R10	SMD resistor 51 kΩ 1% 1/10 W 0603			1
31	VAR1	S07K275E2/275 V AC/10%	B72207S2271K101	Epcos	1
32	Line, neutral	Multipurpose PC test point THT, white	5012	Keystone	2
33	GND1, GND2, GND3	Multipurpose PC test point THT, black	5011	Keystone	3
34	+5 V, +12 V, +15 V	Multipurpose PC test point THT, red	5010	Keystone	3

3 Circuit description

3.1 Line input

The AC-line input stage comprises the input fuse F1, varistor VAR1, X-capacitor C1, rectifier diode bridge D1, capacitors C2 and C3, and inductor L1. The X-capacitor C1 and π-filter C2, L1 and C3 act as EMI suppressors.

3.2 Start-up

ICE5BR4780BZ uses a cascode structure to fast-charge the V_{CC} capacitor. Pull-up resistor R1 connected to the GATE pin (pin 4) is 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 ICE5BR4780BZ 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 1 V. After IC turn-on, the V_{CC} voltage is supplied by output voltage. V_{CC} short-to-GND protection is implemented during the start-up time.

3.3 Integrated MOSFET and PWM control

ICE5BR4780BZ comprises a power MOSFET and the controller, which simplifies the circuit layout and reduces the cost of PCB manufacture. The controller together with the MOSFET is placed at the high-side of the converter with a floating ground at the cathode of freewheeling diode D4. An ultra-fast recovery diode D4 is used to allow the inductor demagnetizing current to flow through it and limit the spike current through the power MOSFET, especially when the buck converter operates in CCM mode. Thus, output voltage is sensed only during the freewheeling diode conduction time.

3.4 Output stage

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

3.5 Feedback control

ICE5BR4780BZ integrates a transconductance amplifier for feedback (FB) control. The output is sensed by the voltage divider (R4 and R5) and compared with an internal reference voltage at the VERR pin. An external compensation network (C4, C5 and R2) is recommended on the FB pin to control output voltage.

3.6 Primary-side peak-current control

The MOSFET drain-source current is sensed via external resistors R7 and R8. ICE5BR4780BZ is a current mode controller that has a cycle-by-cycle primary current and FB voltage control, which ensures the converter's maximum power is controlled in every switching cycle. To avoid mis-triggering caused by MOSFET switch-on transient voltage spikes, a leading-edge blanking time (t_{CS_LEB}) is integrated into the current sensing path.

3.7 Frequency reduction

Frequency reduction is implemented in ICE5BR4780BZ to achieve better efficiency during light load. At light load, the reduced switching frequency F_{SW} improves efficiency by reducing the switching losses. When load decreases, V_{FB} decreases accordingly, as well as F_{SW}. Typically, F_{SW} at high load is 65 kHz and starts to decrease at V_{FB} = 1.7 V. There is no further frequency reduction once it reaches the f_{OSCx_MIN} even if the load is further reduced.

3.8 Active burst mode

Active burst mode (ABM) entry and exit power (two levels) can be selected in ICE5BR4780BZ. Details are illustrated in the product datasheet. ABM power level 1 is used in this evaluation board (R3 = open).

3.9 Protection features

ICE5BR4780BZ provides comprehensive protection to ensure the safe operation of the system. This includes V_{CC} overvoltage and undervoltage, overload, output overvoltage, overtemperature (controller junction) and V_{CC} short-to-GND. When those faults are found, the system will enter protection mode. Once the fault is removed, the system resumes normal operation.

To protect ICE5BR4780BZ from thermal stress during auto restart protection, a 100 µF V_{CC} capacitor C9 is used to extend the total auto restart off-time.

4 Design examples

The following design examples can be obtained by reworking the EVAL_5BR4780BZ_450mA1 evaluation board. The board can be reworked by changing the components based on the optimized values in **Table 2** for different output specifications. Buck converter output is set to 12 V. Lower output voltage (e.g., 5 V or 3.3 V) is achieved by connecting low dropout (LDO) regulators to the buck converter output.

Multiple outputs are also possible with the evaluation board. Select a design example with an output current greater than or equal to the sum of all the output currents. Following are example scenarios and solutions.

- A 12 V/200 mA first output and 5 V/250 mA second output (450 mA total output current) can be achieved by design example 3 by taking the 12 V directly from the buck converter output and taking 5 V from the LDO output.
- A 12 V/150 mA first output and 3.3 V/150 mA second output (300 mA total output current) can be achieved by design example 6 by taking the 12 V directly from the buck converter output and taking 3.3 V from the LDO output.

Table 2 Component changes on EVAL_5BR4780BZ_450mA1 under different design examples

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
1	12	450	n.a.	n.a.	180 µH (MSS1278H-184KED Coilcraft)	1.6 Ω (1206)	1.5 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)
2	5	450	5 V LDO (L7805CV)	10 µF/25 V					
3	3.3	450	3.3 V LDO (MIC29150-3.3WT)						
4	12	300	n.a.	n.a.	270 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	2.2 Ω (1206)		
5	5	300	5 V LDO (L7805CV)	10 µF/25 V					
6	3.3	300	3.3 V LDO (MIC29150-3.3WT)						
7	12	250	n.a.	n.a.	330 µH (MSS1278H-334KED Coilcraft)	2.4 Ω (1206)	3.0 Ω (1206)		
8	5	250	5 V LDO (L7805CV)	10 µF/25 V					
9	3.3	250	3.3 V LDO (MIC29150-3.3WT)						
10	12	350	n.a.	n.a.	220 µH (MSS1278H-224KED Coilcraft)	2.0 Ω (1206)	1.8 Ω (1206)		
11	5	350	5 V LDO (L7805CV)	10 µF/25 V					
12	3.3	350	3.3 V LDO (MIC29150-3.3WT)						

Note: Design examples 10 to 12 were derived using calculation tools without actual test verification. The LDO should be mounted on a heatsink to protect the device from thermal runaway.

4.1 Design example 1 (12 V, 450 mA)

Electrical test data of design example 1 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below.

Table 3 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
1	12	450	n.a.	n.a.	180 µH (MSS1278H-184KED Coilcraft)	1.6 Ω (1206)	1.5 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

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 η (%)
85 V AC/ 60 Hz	No load	0.043	12.909	0.000			
	10% load	0.715	12.180	0.045	0.55	76.66%	
	25% load	1.693	12.045	0.112	1.35	79.90%	80.64%
	50% load	3.330	11.970	0.225	2.69	80.81%	
	75% load	4.965	11.934	0.337	4.03	81.07%	
	100% load	6.623	11.900	0.450	5.35	80.78%	
115 V AC/ 60 Hz	No load	0.044	12.911	0.000			
	10% load	0.723	12.183	0.045	0.55	75.83%	
	25% load	1.702	12.058	0.112	1.35	79.56%	80.67%
	50% load	3.339	11.990	0.225	2.70	80.72%	
	75% load	4.966	11.954	0.337	4.03	81.19%	
	100% load	6.595	11.913	0.450	5.36	81.21%	
230 V AC/ 50 Hz	No load	0.047	12.980	0.000			
	10% load	0.763	12.171	0.045	0.55	71.78%	
	25% load	1.754	12.040	0.112	1.35	77.09%	78.90%
	50% load	3.420	11.975	0.225	2.69	78.71%	
	75% load	5.063	11.943	0.337	4.03	79.56%	
	100% load	6.674	11.912	0.450	5.36	80.25%	
264 V AC/ 50 Hz	No load	0.048	13.045	0.000			
	10% load	0.764	12.137	0.045	0.55	71.49%	
	25% load	1.773	12.037	0.112	1.35	76.24%	78.18%
	50% load	3.452	11.968	0.225	2.69	77.94%	
	75% load	5.104	11.935	0.337	4.03	78.87%	
	100% load	6.717	11.905	0.450	5.35	79.69%	

4.2 Design example 2 (5 V, 450 mA)

Electrical test data of design example 2 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 5 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
2	5	450	5 V LDO (L7805CV)	10 µF/25 V	180 µH (MSS1278H-184KED Coilcraft)	1.6 Ω (1206)	1.5 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 6 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.110	5.055	0.000	0
	6.686	5.047	0.450	2.27
115 V AC/60 Hz	0.112	5.055	0.000	0
	6.664	5.047	0.450	2.27
230 V AC/50 Hz	0.116	5.055	0.000	0
	6.738	5.047	0.450	2.27
264 V AC/50 Hz	0.120	5.055	0.000	0
	6.779	5.047	0.450	2.27

4.3 Design example 3 (3.3 V, 450 mA)

Electrical test data of design example 3 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 7 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
3	3.3	450	3.3 V LDO (MIC29150-3.3WT)	10 µF/25 V	180 µH (MSS1278H-184KED Coilcraft)	1.6 Ω (1206)	1.5 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 8 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.048	3.332	0.000	0
	6.680	3.303	0.450	1.49
115 V AC/60 Hz	0.049	3.332	0.000	0
	6.646	3.303	0.450	1.49
230 V AC/50 Hz	0.051	3.332	0.000	0
	6.713	3.303	0.450	1.49
264 V AC/50 Hz	0.054	3.332	0.000	0
	6.751	3.303	0.450	1.49

4.4 Design example 4 (12 V, 300 mA)

Electrical test data of design example 4 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below.

Table 9 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
4	12	300	n.a.	n.a.	270 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	2.2 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 10 Efficiency

Input (V AC/Hz)	Load percentage (%)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)	Efficiency η (%)	Average η (%)
85 V AC/ 60 Hz	No load	0.043	12.652	0.000			
	10% load	0.485	12.106	0.030	0.36	74.88%	
	25% load	1.123	11.982	0.075	0.90	80.02%	81.40%
	50% load	2.193	11.910	0.150	1.79	81.46%	
	75% load	3.257	11.867	0.225	2.67	81.98%	
	100% load	4.323	11.834	0.300	3.55	82.12%	
115 V AC/ 60 Hz	No load	0.044	12.654	0.000			
	10% load	0.492	12.105	0.030	0.36	73.81%	
	25% load	1.133	11.985	0.075	0.90	79.34%	81.00%
	50% load	2.209	11.920	0.150	1.79	80.94%	
	75% load	3.274	11.881	0.225	2.67	81.65%	
	100% load	4.329	11.845	0.300	3.55	82.09%	
230 V AC/ 50 Hz	No load	0.047	12.723	0.000			
	10% load	0.518	12.063	0.030	0.36	69.86%	
	25% load	1.182	11.966	0.075	0.90	75.93%	78.32%
	50% load	2.287	11.901	0.150	1.79	78.06%	
	75% load	3.372	11.866	0.225	2.67	79.18%	
	100% load	4.432	11.835	0.300	3.55	80.11%	
264 V AC/ 50 Hz	No load	0.050	12.806	0.000			
	10% load	0.538	12.061	0.030	0.36	67.25%	
	25% load	1.217	11.967	0.075	0.90	73.75%	76.78%
	50% load	2.334	11.894	0.150	1.78	76.44%	
	75% load	3.424	11.857	0.225	2.67	77.92%	
	100% load	4.490	11.827	0.300	3.55	79.02%	

4.5 Design example 5 (5 V, 300 mA)

Electrical test data of design example 5 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 11 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
5	5	300	5 V LDO (L7805CV)	10 µF/25 V	270 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	2.2 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 12 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.110	5.058	0.000	0
	4.393	5.052	0.300	1.52
115 V AC/60 Hz	0.114	5.058	0.000	0
	4.400	5.052	0.300	1.52
230 V AC/50 Hz	0.120	5.058	0.000	0
	4.501	5.052	0.300	1.52
264 V AC/50 Hz	0.124	5.058	0.000	0
	4.546	5.052	0.300	1.52

4.6 Design example 6 (3.3 V, 300 mA)

Electrical test data of design example 6 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 13 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
6	3.3	300	3.3 V LDO (MIC29150-3.3WT)	10 µF/25 V	270 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	2.2 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 14 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.047	3.331	0.000	
	4.345	3.303	0.300	0.99
115 V AC/60 Hz	0.048	3.331	0.000	
	4.353	3.303	0.300	0.99
230 V AC/50 Hz	0.055	3.331	0.000	
	4.465	3.303	0.300	0.99
264 V AC/50 Hz	0.059	3.331	0.000	
	4.505	3.303	0.300	0.99

4.7 Design example 7 (12 V, 250 mA)

Electrical test data of design example 7 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below.

Table 15 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
7	12	250	n.a.	n.a.	330 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	3.0 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 16 Efficiency

Input (V AC/Hz)	Load percentage (%)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)	Efficiency η (%)	Average η (%)
85 V AC/ 60 Hz	No load	0.046	12.673	0.000			
	10% load	0.422	12.156	0.025	0.30	72.01%	
	25% load	0.971	12.032	0.063	0.76	78.07%	79.99%
	50% load	1.871	11.962	0.125	1.50	79.92%	
	75% load	2.776	11.920	0.188	2.24	80.73%	
	100% load	3.657	11.883	0.250	2.97	81.23%	
115 V AC/ 60 Hz	No load	0.047	12.670	0.000			
	10% load	0.430	12.151	0.025	0.30	70.65%	
	25% load	0.983	12.032	0.063	0.76	77.11%	79.32%
	50% load	1.889	11.965	0.125	1.50	79.18%	
	75% load	2.796	11.927	0.188	2.24	80.20%	
	100% load	3.679	11.890	0.250	2.97	80.80%	
230 V AC/ 50 Hz	No load	0.052	12.747	0.000			
	10% load	0.461	12.111	0.025	0.30	65.68%	
	25% load	1.042	12.013	0.063	0.76	72.63%	75.80%
	50% load	1.981	11.943	0.125	1.49	75.36%	
	75% load	2.897	11.873	0.188	2.23	77.05%	
	100% load	3.797	11.870	0.250	2.97	78.15%	
264 V AC/ 50 Hz	No load	0.055	12.820	0.000			
	10% load	0.464	12.108	0.025	0.30	65.24%	
	25% load	1.061	12.007	0.063	0.76	71.30%	74.56%
	50% load	2.013	11.934	0.125	1.49	74.11%	
	75% load	2.956	11.895	0.188	2.24	75.65%	
	100% load	3.843	11.865	0.250	2.97	77.19%	

4.8 Design example 8 (5 V, 250 mA)

Electrical test data of design example 8 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 17 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
8	5	250	5 V LDO (L7805CV)	10 µF/25 V	330 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	3.0 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 18 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.110	5.058	0.000	0
	4.393	5.052	0.300	1.52
115 V AC/60 Hz	0.114	5.058	0.000	0
	4.400	5.052	0.300	1.52
230 V AC/50 Hz	0.120	5.058	0.000	0
	4.501	5.052	0.300	1.52
264 V AC/50 Hz	0.124	5.058	0.000	0
	4.546	5.052	0.300	1.52

4.9 Design example 9 (3.3 V, 250 mA)

Electrical test data of design example 9 and the rework done on the EVAL_5BR4780BZ_450mA1 evaluation board are listed below. Additional power loss from the LDO increases the no-load input power and reduces the system efficiency. The LDO is mounted on an Aavid 513002B02500G heatsink to protect the device from thermal runaway.

Table 19 Rework done on EVAL_5BR4780BZ_450mA1 evaluation board

Design example	V_{OUT} (V)	I_{OUT} (mA)	IC2	C12	L2	R7	R8	R4	R5
9	3.3	250	3.3 V LDO (MIC29150-3.3WT)	10 µF/25 V	330 µH (MSS1278H-274KED Coilcraft)	2.4 Ω (1206)	3.0 Ω (1206)	47 kΩ (0603)	270 kΩ (0603)

Table 20 No-load and full-load input power

Input (V AC/Hz)	P_{IN} (W)	V_{OUT} (V DC)	I_{OUT} (A)	P_{OUT} (W)
85 V AC/60 Hz	0.047	3.331	0.000	
	4.345	3.303	0.300	0.99
115 V AC/60 Hz	0.048	3.331	0.000	
	4.353	3.303	0.300	0.99
230 V AC/50 Hz	0.055	3.331	0.000	
	4.465	3.303	0.300	0.99
264 V AC/50 Hz	0.059	3.331	0.000	
	4.505	3.303	0.300	0.99

References

[1] Infineon Technologies AG: Fixed-frequency 800 V / 950 V CoolSET™ (V 1.0); 2022-02-22; **ICE5BR4780BZ Datasheet**

[2] Infineon Technologies AG: 450 mA non-isolated high-voltage buck evaluation board using ICE5BR4780BZ (V 1.0); 2022-06-15; **EVAL_5BR4780BZ_450mA1 Engineering Report**

[3] Infineon Technologies AG: Calculation tool for fixed-frequency HV buck converter using Gen5 CoolSET™ (Version 1.0); **Fifth-generation HV buck calculation tool**

[4] Infineon Technologies AG: Fifth-generation CoolSET™ high-voltage buck design guide (V 1.0); 2022-06-15; **Fifth-generation CoolSET™ high-voltage buck design guide**

Revision history

Document version	Date of release	Description of changes
V 1.0	2022-08-11	First release

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