Demonstration System EPC9157 Quick Start Guide

18–60 V Input, 12 V, 25 A Output
300 W $^{1}/_{16}^{th}$ Brick Evaluation Module

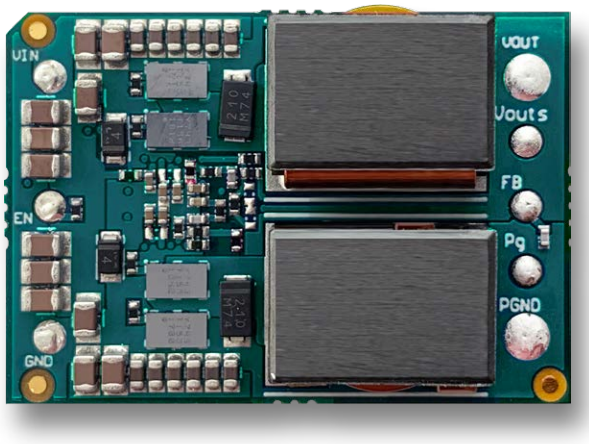
Revision 1.0

EFFICIENT POWER CONVERSION

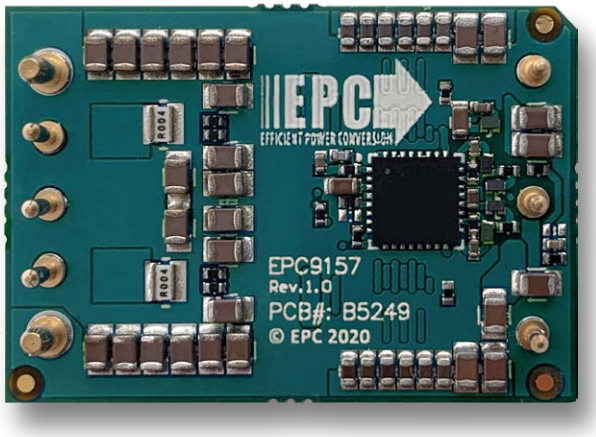
DESCRIPTION

The EPC9157 $^{1}/_{16}^{th}$ brick evaluation power module is designed for 48 V to 12 V DC-DC applications. It features the EPC2218 eGaN® FETGaN, and enhancement mode field effect transistors, as well as the Renesas ISL81806 80 V Dual Synchronous Buck Controller. Other features include:

- High efficiency: > 95% @ 12 V/25 A output
- Dimension: 33 mm x 22.9 mm x 9 mm (1.30 in. x 0.90 in. x 0.35 in.)
- Industry standard footprint and pinout
- Positive logic on/off
- Power good output
- Constant switching frequency: 500 kHz
- Remote output voltage sense
- Fault protection:
  - o Output over-current/ over-voltage
  - o Over temperature protection



EPC9157 top view



EPC9157 bottom view

REGULATORY INFORMATION

This power module is for evaluation purposes only. It is not a full-featured power module and cannot be used in final products. No EMI test was conducted. It is not FCC approved.

Table 1: Maximum Ratings

Symbol	Parameter	Conditions	Min	Max	Units
V_{IN}	Input voltage			65	V
I_{OUT}	Output current	With Sufficient Cooling		25	A
T_C	Operating temperature	Measured at FET case as indicated in thermal measurement figure, airflow 1700 LFM		100	°C

Table 2: Electrical Characteristics (T_A = 25°C unless specified otherwise)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IN}	Input Voltage		18	48	60	V
$V_{IN,on}$	Input UVLO turn on voltage			18.5		
$V_{IN,off}$	Input UVLO turn off voltage			17		
V_{OUT}	Output voltage		11.8	12	12.1	
C_{OUT}	External capacitance load		200			µF
$t_{OUT,rise}$	Output Voltage Rise Time			12		ms
ΔV_{OUT}	Output Voltage Ripple	I_{OUT} = 25 A, mounted in EPC9534 test fixture		40		mV
I_{OUT}	Output Current	1700 LFM airflow	0		25	A
$I_{OUT,limit}$	Overcurrent Limit Threshold	Each phase		20	26	
f_s	Switching Frequency			500		kHz
On/off control input logic						
V_{on}	Logic low (Module Off)				0.9	V
V_{off}	Logic high (Module On)		1.83		5.25	
I_{off}	Current sink for disable				0.15	mA
Power good output logic						
P_{good}	Logic high (in regulation)	Internal 100 kΩ pull-up resistor		5	5.25	V
P_{good}	Logic low (not regulated)		0		0.35	
I_{Pgood}	Sink current capability of P_{good}				2	mA

ELECTRICAL PERFORMANCE

Typical efficiency and power loss

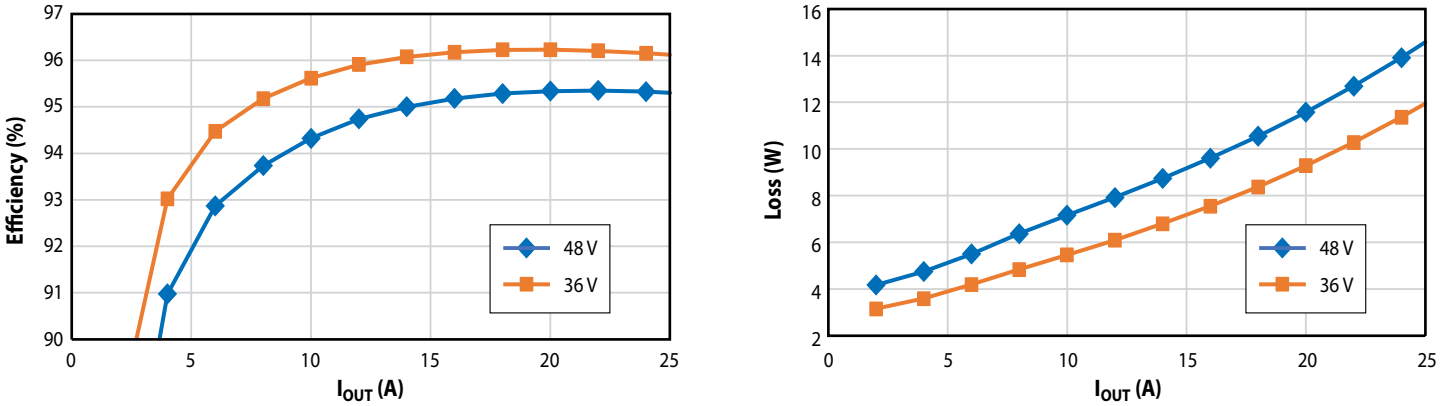


Figure 1. 12 V output, various input voltages

Typical output voltage ripple

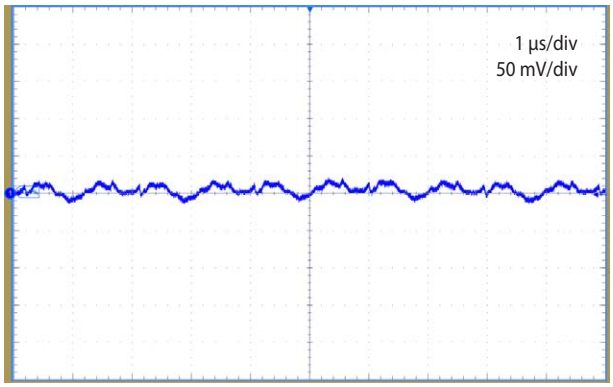


Figure 2. 48 V input, 12 V 25 A output

Typical transient response

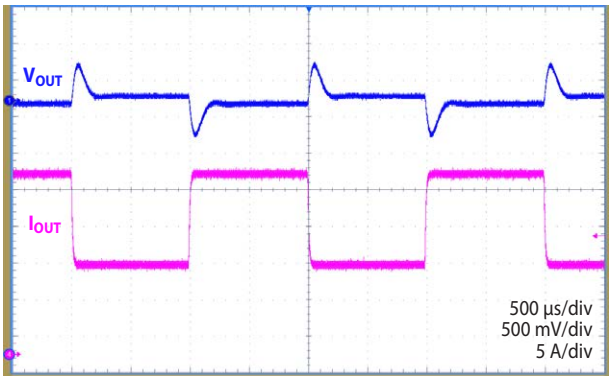


Figure 3. V_{IN} = 48 V, V_{OUT} = 12 V, 50% (12.5 A) to 100% (25 A) at 500 Hz repetition rate output current transitions

Startup

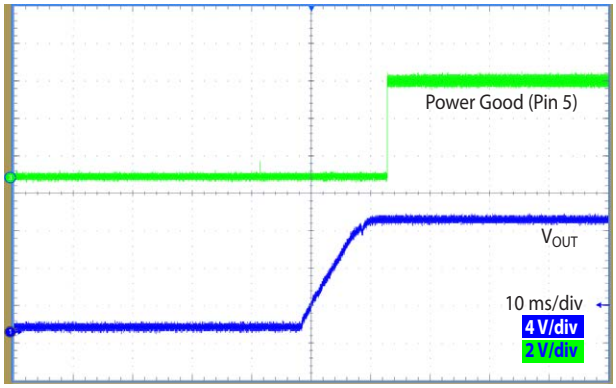


Figure 4. 48 V input, EN floating

ELECTRICAL PERFORMANCE *(continued)*

Typical load regulation

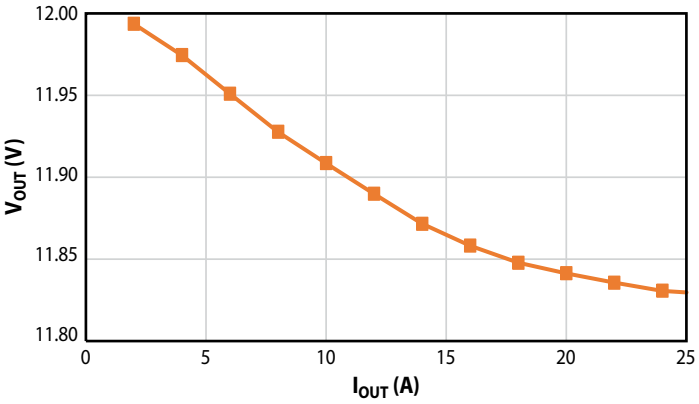


Figure 5. V_{IN} = 48 V, V_{OUT} = 12 V

Temperature vs. output current

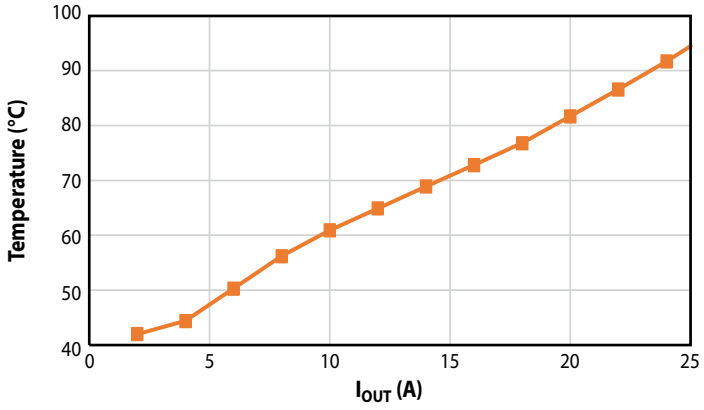


Figure 6. V_{IN} = 48 V, V_{OUT} = 12 V, 1700 LFM forced air cooling

OPERATING CONSIDERATIONS

Output capacitance

Minimum external output capacitance of 200 µF is recommended for stability. The EPC9534 16th brick motherboard includes this extra capacitance and is used for testing. The measured voltage loop phase and gain margin with EPC9534 are 80° and 19 dB, respectively.

Input capacitance

To minimize the impact from the input voltage feeding line, low ESR capacitors should be located at the input to the module. It is recommended that a 33 µF - 100 µF input capacitor be placed near the module.

Over-current protection

As described in "Output Average Current Monitoring and Regulation Loops" section in the ISL81806 datasheet, the over-current protection can be set to either constant current output when triggered, or hiccup type of protection. In this module, the protection is set to hiccup type--after the average current is higher than the set point for 32 consecutive switching cycles, the converter turns off for 50 ms before a restart is issued.

Remote On/Off

This module has positive on/off logic: the module is turned on during a logic high and off during a logic low. Remote on/off can be controlled by an external switch between the on/off pin and the Vin- (GND) pin as shown in figure 7. The switch can be an open collector or open drain. If the remote on/ off feature is not used, leave the on/ off pin floating.

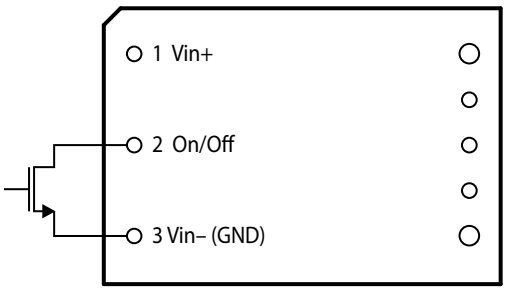


Figure 7. Adding an external MOSFET for remote enable/disable

Remote output voltage sense

Remote sense can compensate for output voltage distribution drop by sensing the actual output voltage at the point of load. The maximum voltage allowed between the output and sense pins is 5% of the output voltage (0.6 V for 12 V output). If the remote sense feature is not used, the pin can be either left floating or connected to Vout+.

Power good

This module features a power good signal with 5 V logic. The output is open-drain with an onboard 100 kΩ pull-up resistor. This signal will be logic high when the output voltage is regulated to +/- 11% of the setpoint, and logic low for all other conditions. If the power good feature is not used, the pin should be left floating.

Output voltage trim (adjustment)

The output voltage of this module can be trimmed (adjusted) by connecting an external resistor between the Trim pin and Vout- (GND) pin as shown in figure 8.

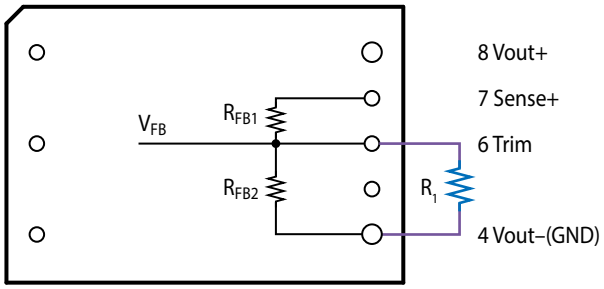


Figure 8. External resistor connection for output voltage trim adjust

The new output voltage can be calculated as follows:

$$V_{OUT} = V_{FB} R_{FB1} \left(\frac{1}{R_{FB2}} + \frac{1}{R_1} \right) + V_{FB}$$

For this design, V_{FB} is 0.8 V, R_{FB1} is 48.7 kΩ, R_{FB2} is 3.48 kΩ, therefore

$$V_{OUT} = 12 + \frac{39}{R_1\,[k\Omega]}$$

The maximum trim voltage is 1 V using this method.

QUICK START PROCEDURE

The EPC9157 1/16th brick module is best tested plugged into EPC9534 motherboard. The EPC9534 QSG provides detailed operating procedure instructions. See **EPC9534 QSG**.

MECHNICAL SPECIFICATIONS

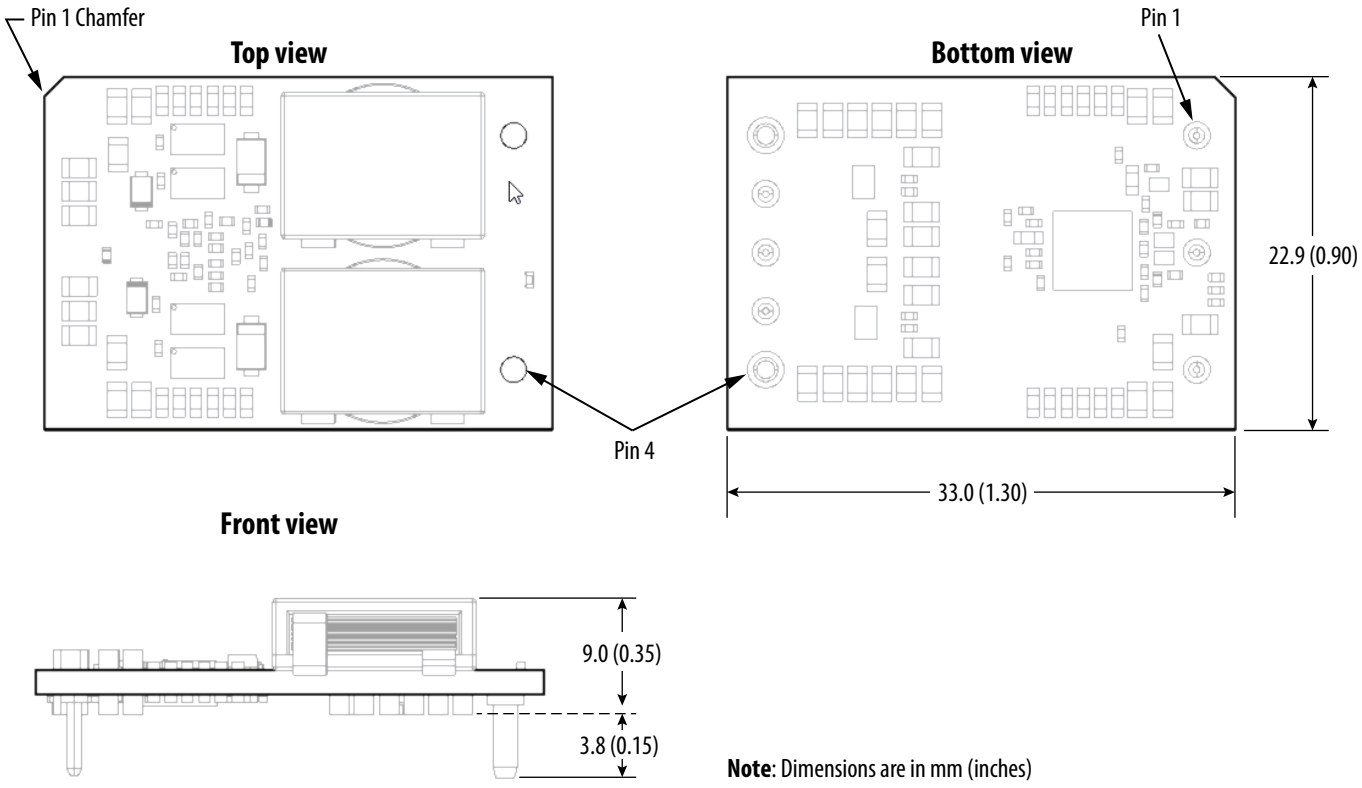


Figure 9. EPC9157 mechanical dimensions

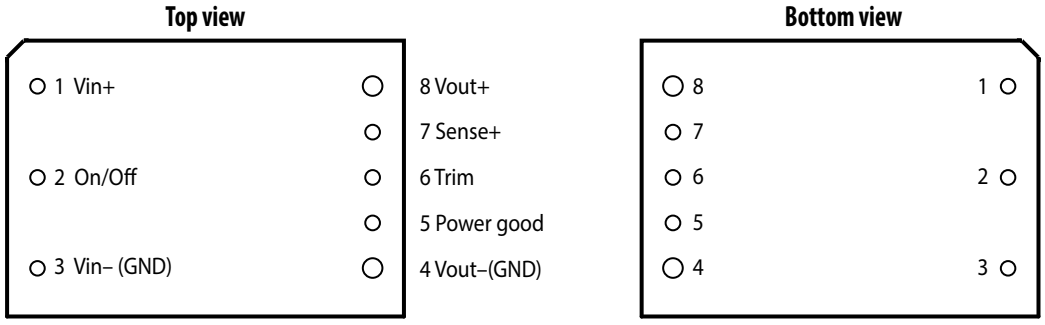


Figure 10. Pin assignment

THERMAL MANAGEMENT

Thermal management is very important to ensure proper and reliable operation. Sufficient cooling is required for this module to operate in the full specified output current range. Forced air of 1700 LFM is used for specification testing. Heatsink or heat spreader can also be used. The hot spots are the control FETs of the buck converter (Q1 and Q3) as shown in figure 11.

Thermal derating

Without sufficient cooling, the output current capability is reduced. The module temperature should be monitored to ensure the maximum temperature does not exceed the rating. Especially when the input voltage is higher than 48 V, the maximum output current is reduced.

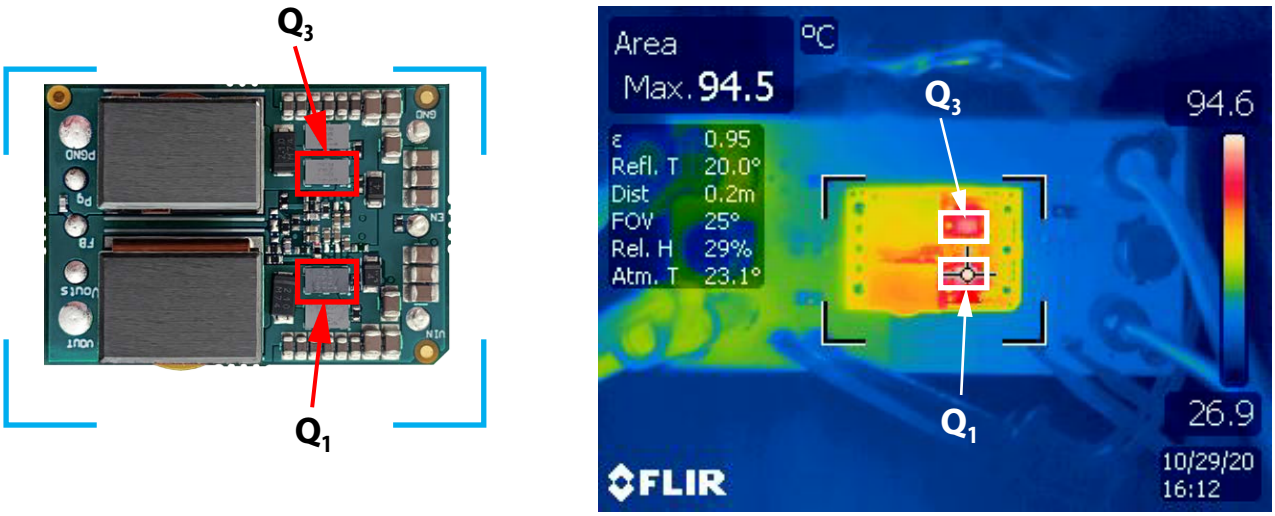


Figure 11. V_{IN} = 48 V, V_{OUT} = 12 V, 1700 LFM forced air cooling

Table 3: Bill of Materials

Item	Qty	Reference	Part Description	Manufacturer	Part #
1	20	C1, C2, C3, C19, C21, C35, C71, C72, C73, C74, C75, C76, C77, C78, C80, C81, C83, C84, C85, C86	1 µF, 100 V	TDK	C2012X7S2A105M125AB
2	20	C5, C6, C7, C8, C10, C27, C28, C29, C30, C37, C63, C64, C65, C66, C67, C68, C69, C70, C79, C82	22 µF, 25 V	Murata	GRT21BR61E226ME13L
3	24	C14, C20, C23, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C54, C55, C56, C57, C58, C59, C60, C61, C62	220 nF, 100 V	Taiyo Yuden	HMK107C7224
4	2	C15, C32	10 µF 25 V	Murata	GRM188R61E106MA73J
5	2	C9, C11	56 nF, 50 V	Murata	GRM155R71H563KE14D
6	1	C12	1 nF, 50 V	Samsung	CL05B102KB5NNNC
7	1	C13	2.2 µF, 25 V	Murata	GRM155R61E225ME15D
8	1	C16	2.2 nF, 50 V	Murata	GCM155R71H222KA37D
9	1	C17	390 pF, 50 V	Murata	GRM1555C1H391JA01D
10	3	C18, C31, C34	100 nF, 25 V	Murata	GRM155R61E104KA87D
11	1	C24	1 nF, 50 V	Murata	GRM1555C1H102JA01D
12	1	C25	1 nF, 50 V	Yageo	CC0402KRX7R9BB102
13	1	C33	100 nF, 100 V	Murata	GRM155R62A104KE14D
14	4	C50, C51, C52, C53	10 nF, 50 V X7R	Murata	GRM155R71H103KA88D
15	1	C87	100 pF	Murata	GRM1555C1H101JA01D
16	4	Q1, Q2, Q3, Q4	100 V, 3.2 mΩ	EPC	EPC2218
17	1	R1	5.11 k	Yageo	RC0402FR-075K11L
18	1	R3	20 Ω	Yageo	RC0402FR-0720RL
19	4	R4, R5, R25, R29	2.4 Ω	Yageo	RC0402JR-072R4L
20	3	R6, R11, R12	51 k 5%	Yageo	RC0402JR-0751KL
21	1	R7	2.2 k 1%	Yageo	RC0402FR-072K2L
22	1	R8	48.7 k	Panasonic	ERA-2AEB4872X
23	1	R9	3.48 k	Panasonic	ERA-2AEB3481X
24	1	R10	64.9 k	Yageo	RC0402FR-0764K9L
25	1	R13	36 k	Yageo	RC0402JR-0736KL
26	1	R14	19.1 k	Yageo	RC0402FR-0719K1L
27	2	R15, R27	100 k 5%	Yageo	RC0402JR-07100KL
28	1	R16	487 k	Yageo	RC0402FR-07487KL
29	2	R17, R32	4 mΩ	Susumu	KRL2012E-M-R004-F-T5
30	4	R18, R19, R33, R34	1 Ω	Yageo	RC0402FR-071RL
31	2	R20, R21	10 Ω	Yageo	RC0402FR-0710RL
32	1	R22	5.1 Ω	Yageo	RC0402JR-075R1L
33	2	R23, R26	0 Ω	Yageo	RC0402JR-070RL
34	2	R24, R28	20 k	Yageo	RC0402JR-0720KL
35	1	R30	5.6 k	Yageo	RC0402FR-075K6L
36	1	R35	1 k 5% 1/16 W	Yageo	RC0402JR-071KL
37	1	R36	820 Ω	Yageo	RC0402JR-07820RL
38	3	D1, D2, D5	100 V, 215 mA	Nexperia	BAS16L,315
39	2	D3, D4	5 V 1, 250 mW	Diodes	BZT52C5V1LP-7
40	2	D6, D7	100 V, 700 mA	Rohm	RB578VAM100TR
41	6	J1, J2, TP1, TP2, TP9, TP10	.040 dia pin	Mill-Max	3102-1-00-21-00-00-08-0
42	2	J4, J5	.062 dia pin	Mill-Max	3144-1-00-15-00-00-08-0
43	2	L1, L2	2.4 µH	TDK	B82559A0242A013
44	1	U1	2-phase controller	Renesas	ISL81806

Table 4. Optional Components

Item	Qty	Reference	Part Description	Manufacturer	Part Number
1	2	D9, D10	100 V, 700 mA	Rohm	RB578VAM100TR

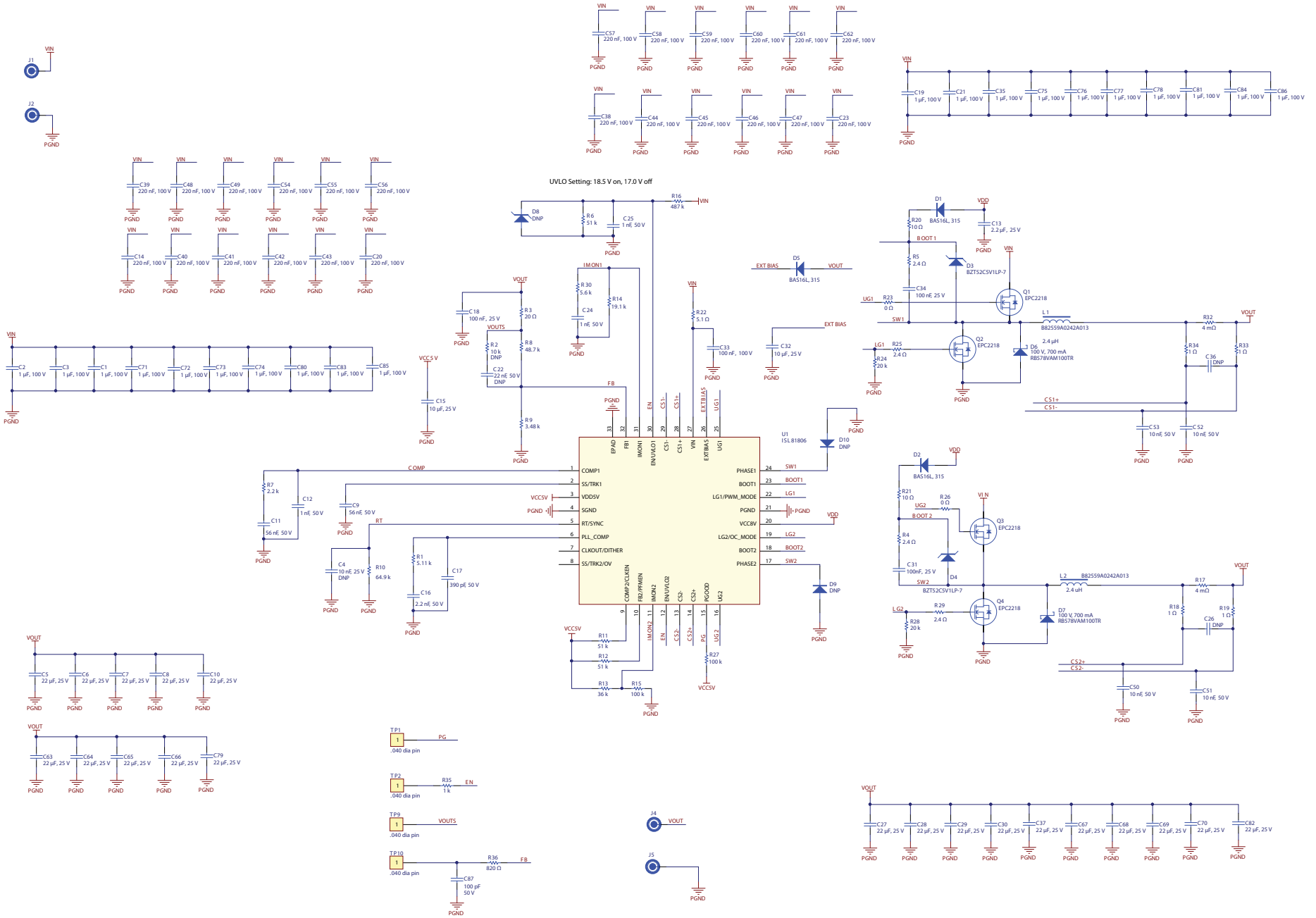


Figure 12: EPC9157 schematic

EPC would like to acknowledge Renesas Electronics Corporation (www.renesas.com) for their support of this project.

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The EPC9157 system features the Renesas ISL81806 80 V Dual Synchronous Buck Controller.

Learn more at www.renesas.com.

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