Development Board EPC9141 Quick Start Guide

48 V – 12 V, 10 A Synchronous Buck Converter using EPC2045 controlled by LTC7800

Revision 2.0

DESCRIPTION

The EPC9141 demonstration board is a 12 V output, 400 kHz buck converter with a 10 A maximum output current and 30 V to 54 V input voltage range (48 V nominal). The demonstration board features the EPC2045 enhancement mode (eGaN®) field effect transistors (FETs), as well as the LTC7800 Buck controller.

The EPC9141 board contains the complete power stage (including eGaN FETs, controller, inductor and input/output caps) in a compact 25 mm x 33 mm layout to showcase the performance that can be achieved using the eGaN FETs and a traditional MOSFET controller together.

The EPC9141 demonstration board is 2.5 inch (64 mm) square and contains a fully closed-loop buck converter with optimized control loop.

There are also various probe points to facilitate efficiency measurement. A complete block diagram of the circuit is given in figure 1. For more information on the EPC2045 eGaN FETs or LTC7800 controller, please refer to the datasheet available from EPC at **www.epc-co.com** and **www.analog.com**. These datasheets should be read in conjunction with this quick start guide.

QUICK START PROCEDURE

Demonstration board EPC9141 is easy to set up to evaluate the performance of the EPC2045 eGaN FETs and directly drive from the controller IC. Refer to figure 2 for proper connect and measurement setup and follow the procedure below:

1. With power off, connect the input power supply bus between V_{IN} and GND banana jacks as shown.
2. With power off, connect the active (constant current) load as desired between V_{OUT} and GND banana jacks as shown.
3. Turn on the supply voltage beyond UVLO to the required value (do not exceed the absolute maximum voltage of 54 V on V_{IN}).
4. Measure the output voltage to make sure the board is fully functional and operating no-load.
5. Turn on active load to the desired load current while staying below the maximum current (10 A)
6. Once operational, adjust the bus voltage and load current within the allowed operating range and observe the output switching behavior, efficiency and other parameters.
7. For shutdown, please follow steps in reverse.

Precautions

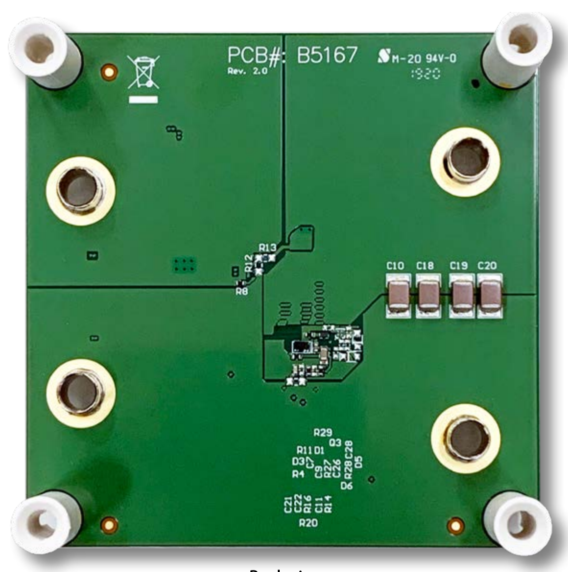
1. When measuring the high frequency content switch node, care must be taken to avoid long ground leads. Measure the switch node by placing the oscilloscope probe tip on the inductor pad and bottom pad of D2 as shown in figure 3. Measuring the switch node with a high bandwidth (≥ 500 MHz) probe and high bandwidth scope (≥ 1 GHz) is recommended.
2. The EPC9141 demonstration board does not have any thermal protection on board.

Table 1: Performance Summary (T_A = 25°C) EPC9141

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{IN}	Bus input voltage range		30		54	V
V_{OUT}	Switch node output voltage			12		V
I_{OUT}	Switch node output current				10[1]	A
f_{SW}	Switching frequency			400		kHz
UVLO	Under voltage lockout on V_{IN}, rising			28		V

(1) Maximum limited by thermals

Front view



Back view

EPC9141 development board

CIRCUIT PERFORMANCE

The EPC9141 demonstration circuit was designed to showcase the size and performance that can readily be achieved at 400 kHz operation using eGaN FETs for supply voltages up to 48 V or more. Since a closed loop controller is included on board, the associated losses must also be lumped into any efficiency measurement that is performed. In an effort to mitigate these losses and focus on the efficiency of the power stage, the controller is powered directly from the output. Thus the controller and gate drive losses are still included, but the associated conversion loss from the input supply is improved.

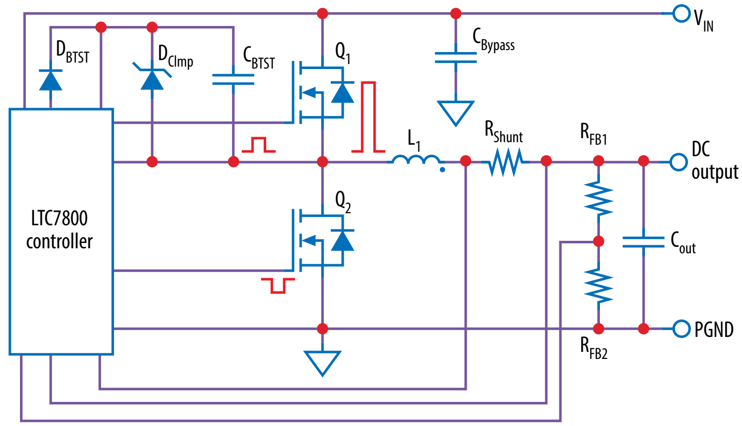


Figure 1: Block diagram of demonstration board

THERMAL CONSIDERATIONS

The EPC9141 demonstration board thermal image for steady state full load operation is shown in figure 6. The EPC9141 is intended for bench evaluation with low ambient temperature and convection cooling. The addition of heat-sinking and forced air cooling could increase the current capability of the demonstration circuit, but care must be taken to not exceed the absolute maximum die temperature of 150°C and stay within the constraints of the other components within the circuit, most notably the saturation of the output inductor.

NOTE. The EPC9141 development board does not have any thermal protection on board. For more information regarding the thermal performance of EPC eGaN FETs, please consult:
D. Reusch and J. Glaser, *DC-DC Converter Handbook*, a supplement to *GaN Transistors for Efficient Power Conversion*, First Edition, Power Conversion Publications, 2015.

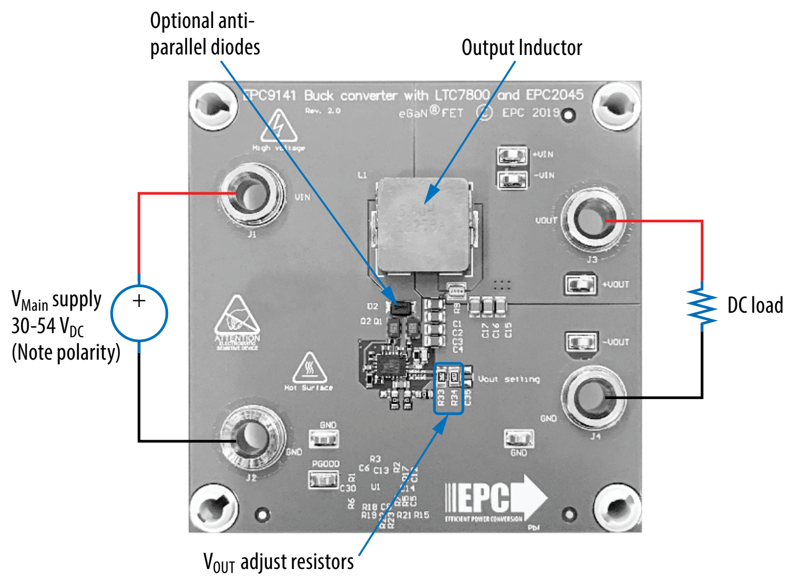


Figure 2: Proper connection setup

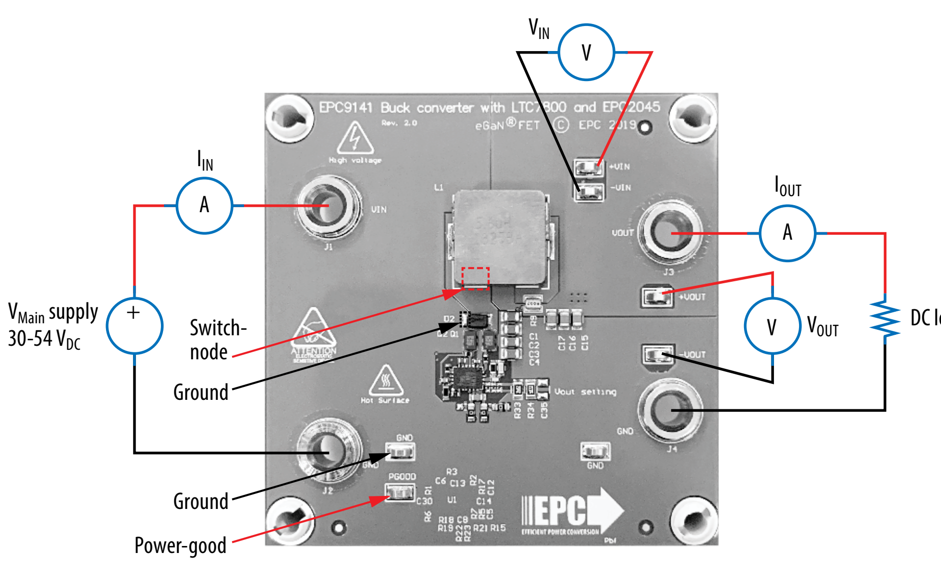


Figure 3: Proper measurement setup

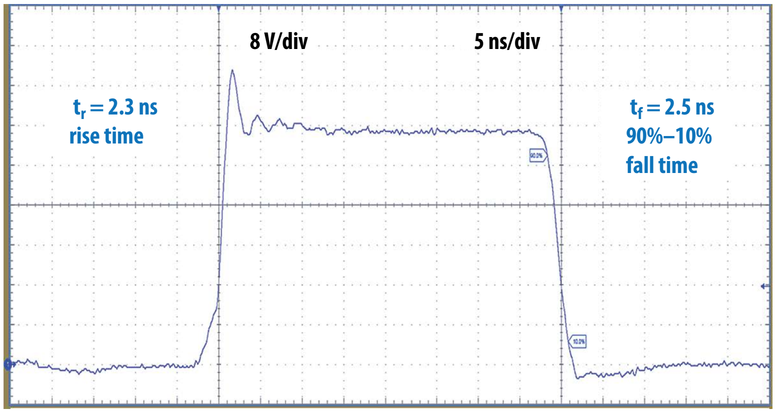


Figure 4: Typical waveforms for V_{IN} = 48 V, V_{OUT} = 12 V, I_{OUT} = 10 A, f_{sw} = 400 kHz, L = 5.6 µH
(On period of waveform truncated to show details.)

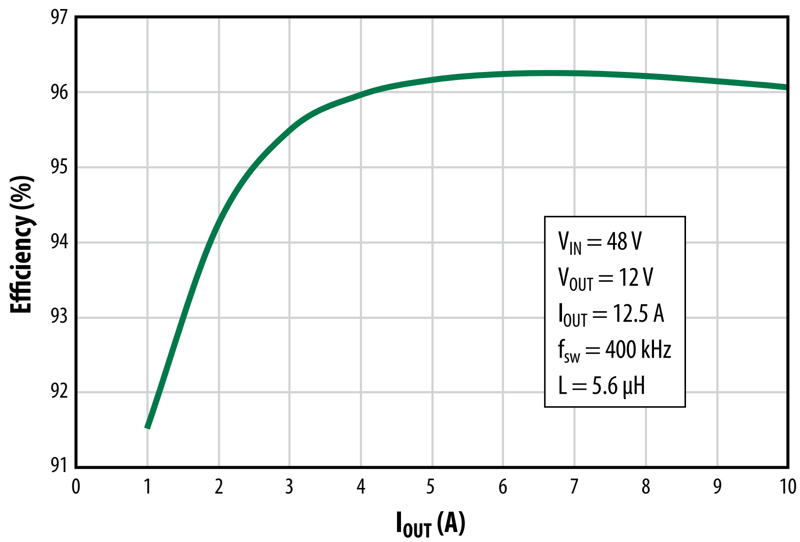


Figure 5: Typical efficiency curves for 48 V input short term operation above 10 A

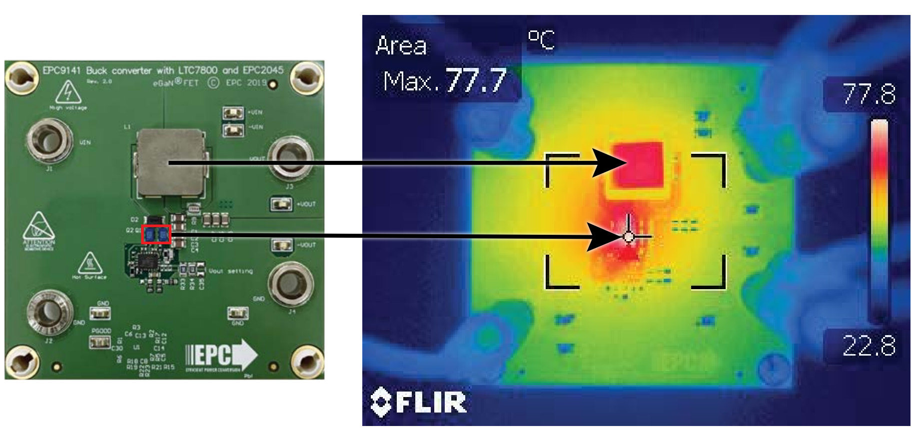


Figure 6: Thermal image of EPC9141 under full load operation: V_{IN} = 48 V, V_{OUT} = 12 V, I_{OUT} = 10 A, 200 LFM airflow

Table 2: Bill of Materials

Item	Qty	Reference	Part Description	Manufacturer	Part Number
1	4	C1, C2, C3, C4	1 µF, 100 V, 0805	TDK	C2012X7S2A105M125AB
2	1	C6	2.2 µF, 25 V, 0402	Murata	GRM155R61E225ME15D
3	3	C7, C13, C30	100 nF, 25 V, 0402	Murata	GRM155R61E104KA87D
4	1	C8	10 nF, 50 V, 0603	TDK	CGA3E2X7R1H103K080AA
5	1	C9	100 nF, 100 V, 0603	Murata	GRM188R72A104MA35D
6	4	C10, C18, C19, C20	4.7 µF, 100 V, 1210	TDK	CGA6M3X7S2A475K200AB
7	1	C12	4.7 nF, 50 V, 0603	Murata	GRM1885C1H472JA01D
8	1	C14	100 pF, 50 V, 0402	Murata	GRM1555C1H101JA01J
9	3	C15, C16, C17	22 µF, 25 V, 0805	Murata	GRT21BR61E226ME13L
10	1	C21	1 nF, 25 V, 0402	TDK	CGJ2B2X7R1E102K050BA
11	1	D1	100 V, 215 mA	Nexperia	BAS16L,315
12	1	D2	100 V, 2 A	Diodes	DFLS2100
13	1	D3	5.1 V, 150 mW	Bournes	CD0603-Z5V1
14	4	J1, J2, J3, J4	Non-Insulated Std. Banana PCB socket	Keystone	575-4
15	1	L1	5.6 µH	Vishay	IHLP5050FDER5R6M01
16	2	Q1, Q2	100 V, 25 A, 9 mΩ	EPC	EPC2045
17	1	Q3	100 V, 2800 mΩ	EPC	EPC2038
18	1	R1	2.2 Ω	Panasonic	ERJ-2GEJ2R2X
19	2	R2, R3	1 Ω	Yageo	RC0402FR-071RL
20	1	R4	100 kΩ	Panasonic	ERJ-2RKF1003X
21	1	R6	28.7 kΩ	Panasonic	ERA-3AEB2872V
22	2	R8, R18	0 Ω, 0402	Stackpole	RMCF0402ZT0R00
23	1	R9	2 mΩ, 1%	Susumu	KRL2012E-M-R002-G-T5
24	2	R11, R12	10 Ω	Panasonic	ERJ-2RKF10R0X
25	1	R14	470 kΩ	Panasonic	ERJ-2RKF4703X
26	3	R15, R22, R23	0 Ω, 0603	Stackpole	RMCF0603ZT0R00
27	1	R16	20 kΩ	Panasonic	ERJ-2RKF2002X
28	1	R17	3.32 kΩ	Panasonic	ERJ-3EKF3321V
29	1	R33	34.8 kΩ	Panasonic	ERJ-PB6D3482V
30	1	R34	487 kΩ	Panasonic	ERJ-PB6D4873V
31	7	TP1, TP2, TP3, TP6, TP7, TP9, TP10	SMD probe loop	Keystone	5015
32	1	U1	Synchronous step-down controller	Analog Devices	LTC7800

Optional Components

Item	Qty	Reference	Part Description	Manufacturer	Part Number
1	3	C5, C11, C35	10 pF, 0402	Generic	Generic
2	1	C22	1 nF, 25 V, 0402	TDK	CGJ2B2X7R1E102K050BA
3	1	C26	22 nF, 25 V, 0402	TDK	C1005X7R1E223K050BB
4	1	C28	100 nF, 16 V, 0402	Murata	GRM155R71C104KA88D
5	1	R27	20 Ω	Stackpole	RMCF0402JT20R0
6	1	R28	27 kΩ	Panasonic	ERJ-2GEJ273X
7	1	R29	4.7 Ω	Panasonic	ERJ-2GEJ4R7X
8	2	D5, D6	40 V 30 mA	Diodes Inc.	SDM03U40
9	1	R5	487 kΩ	Panasonic	ERJ-2RKF4873X
10	1	R7	34.8 kΩ	Panasonic	ERJ-2RKF3482X
11	1	R13	6.98k	Yageo	RC0603FR-076K98L
12	2	R19, R21	0 Ω, 0603	Stackpole	RMCF0603ZT0R00
13	1	R20	3 k	Panasonic	ERJ-3EKF3001V

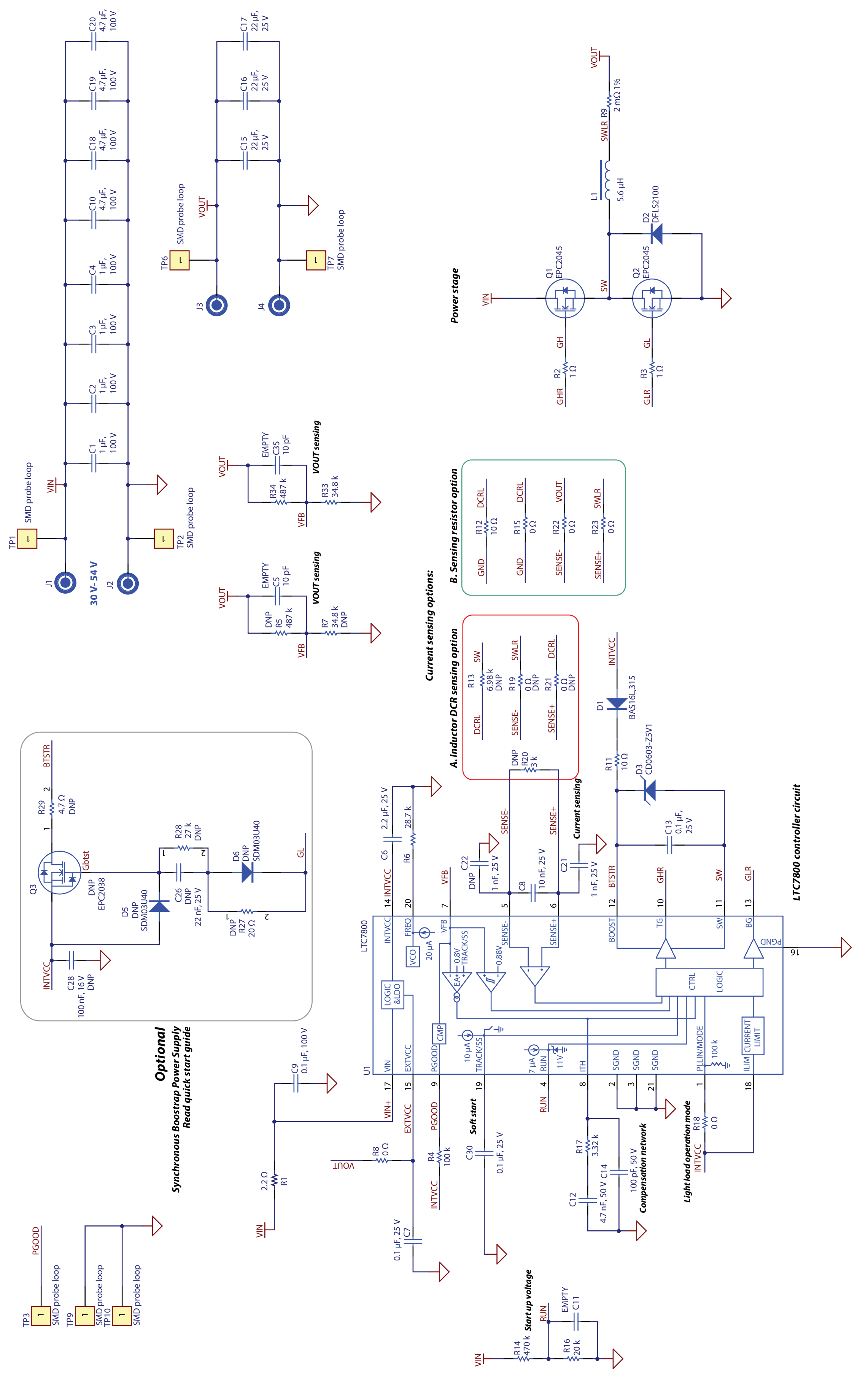


Figure 7: EPC9141 schematic

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Demonstration Board Notification

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As an evaluation tool, this board is not designed for compliance with the European Union directive on electromagnetic compatibility or any other such directives or regulations. As board builds are at times subject to product availability, it is possible that boards may contain components or assembly materials that are not RoHS compliant. Efficient Power Conversion Corporation (EPC) makes no guarantee that the purchased board is 100% RoHS compliant.

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