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Demonstration Board EPC9118 Quick Start Guide

EPC2001/EPC2021
48 V Buck Converter

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DESCRIPTION

The EPC9118 demonstration board is a 5 V output, 400 kHz buck converter with a 20 A maximum output current [25A with convection cooling] and 30 V to 60 V input voltage range (48 V nominal). The demonstration board features the EPC2001/EPC2021 enhancement mode (eGaN®) field effect transistors (FETs), as well as the LTC3891 Buck controller intended for use with MOSFETs.

The EPC9118 board contains the complete power stage (including eGaN FETs, driver, inductor and input/output caps) in a compact 1" x 1.3" layout to showcase the performance that can be achieved using the eGaN FETs and a traditional MOSFET controller together.

The EPC9118 demonstration board is 2 1/2" square and contains a fully closed-loop buck converter with optimized control loop.

There are also various probe points to facilitate efficiency calculation. A complete block diagram of the circuit is given in Figure 1. For more information on the EPC2001/EPC2021 eGaN FETs or LTC3891 controller, please refer to the datasheet available from EPC at www.epc-co.com and www.linear.com. These datasheets should be read in conjunction with this quick start guide.

Table 1: Performance Summary ($T_A = 25^\circ\text{C}$)

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Bus Input Voltage Range		30		60	V
V_{OUT}	Switch Node Output Voltage			5		V
I_{OUT}	Switch Node Output Current				20*	A
f_{SW}	Switching Frequency			400		kHz
UVLO	Under Voltage Lock-Out on V_{IN} Rising			29		V
	Peak Efficiency	48 V_{IN} , 13 A I_{OUT} , 200 LFM		92.8		%
	Full Load Efficiency	48 V_{IN} , 20 A I_{OUT} , 200 LFM		92.3		%

*Maximum limited by thermals

Demonstration Board Notification

EPC9118 boards are intended for product evaluation purposes only and are not intended for commercial use. As evaluation tools, they are 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. No Licenses are implied or granted under any patent right or other intellectual property whatsoever. EPC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.

EPC reserves the right at any time, without notice, to change said circuitry and specifications.

QUICK START PROCEDURE

Demonstration board EPC9118 is easy to set up to evaluate the performance of the EPC2001/EPC2021 eGaN FETs and directly driven 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 60 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 (20 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.

NOTE. 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 top pad and bottom pads of D2. See Figure 3 for proper scope probe technique. Measuring the switch node with a high bandwidth ($\geq 500\text{MHz}$) probe and high bandwidth scope ($\geq 1\text{GHz}$) is recommended.

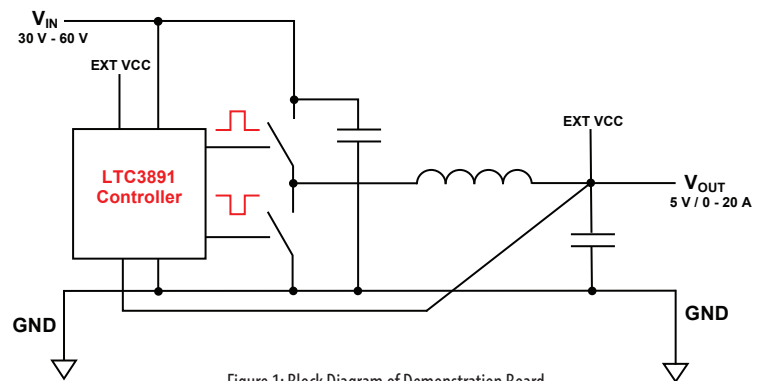


Figure 1: Block Diagram of Demonstration Board

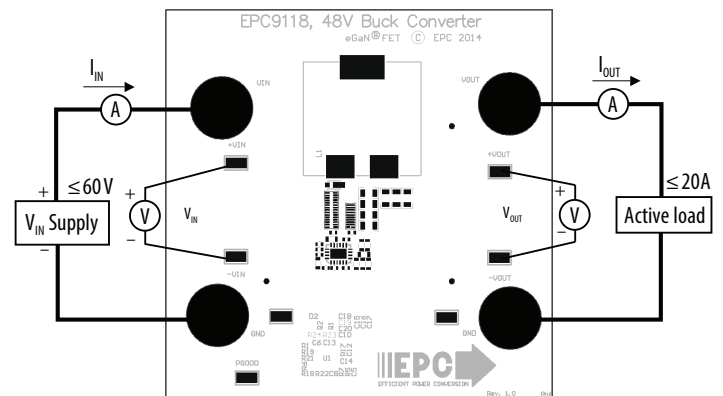


Figure 2: Proper Connection and Measurement Setup

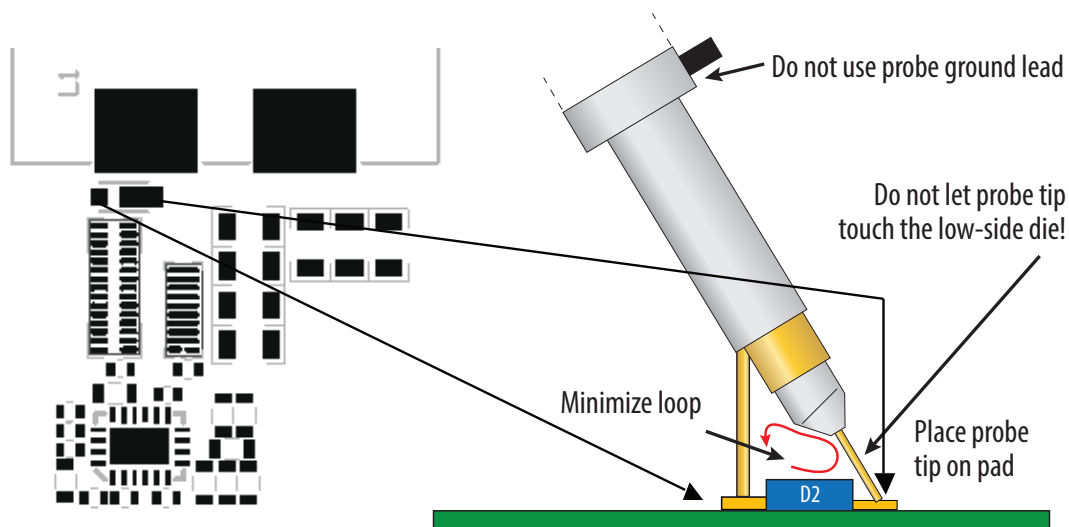


Figure 3: Proper Measurement of Switch Node

QUICK START PROCEDURE



Figure 4: Typical Waveforms for 48 V to 5 V / 20 A (400 kHz) CH4: Switch Node Voltage

CIRCUIT PERFORMANCE

The EPC9118 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.

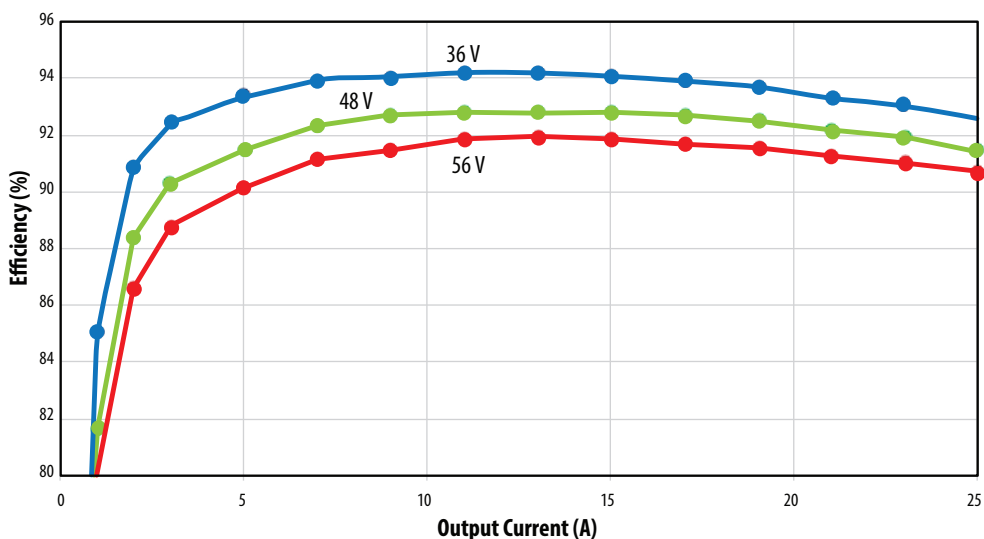


Figure 5: Typical Efficiency Curves for 36 V, 48 V and 56 V Input Short Term Operation Above 20 A

THERMAL CONSIDERATIONS

The EPC9118 demonstration board thermal image for steady state full load operation is shown in Figure 6. The EPC9118 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 125°C and stay within the constraints of the other components within the circuit, most notably the saturation of the output inductor.

NOTE: The EPC9118 demonstration board does not have any thermal protection on board.

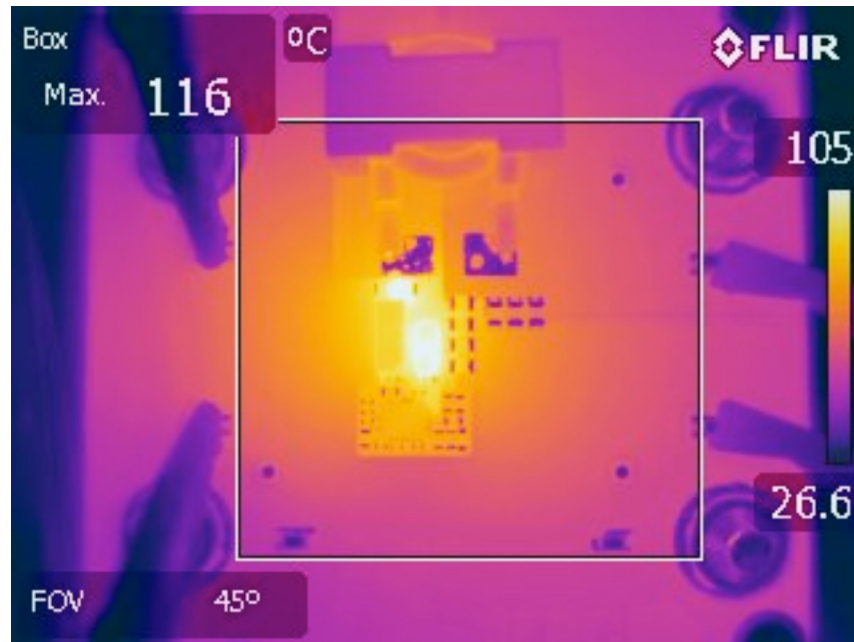
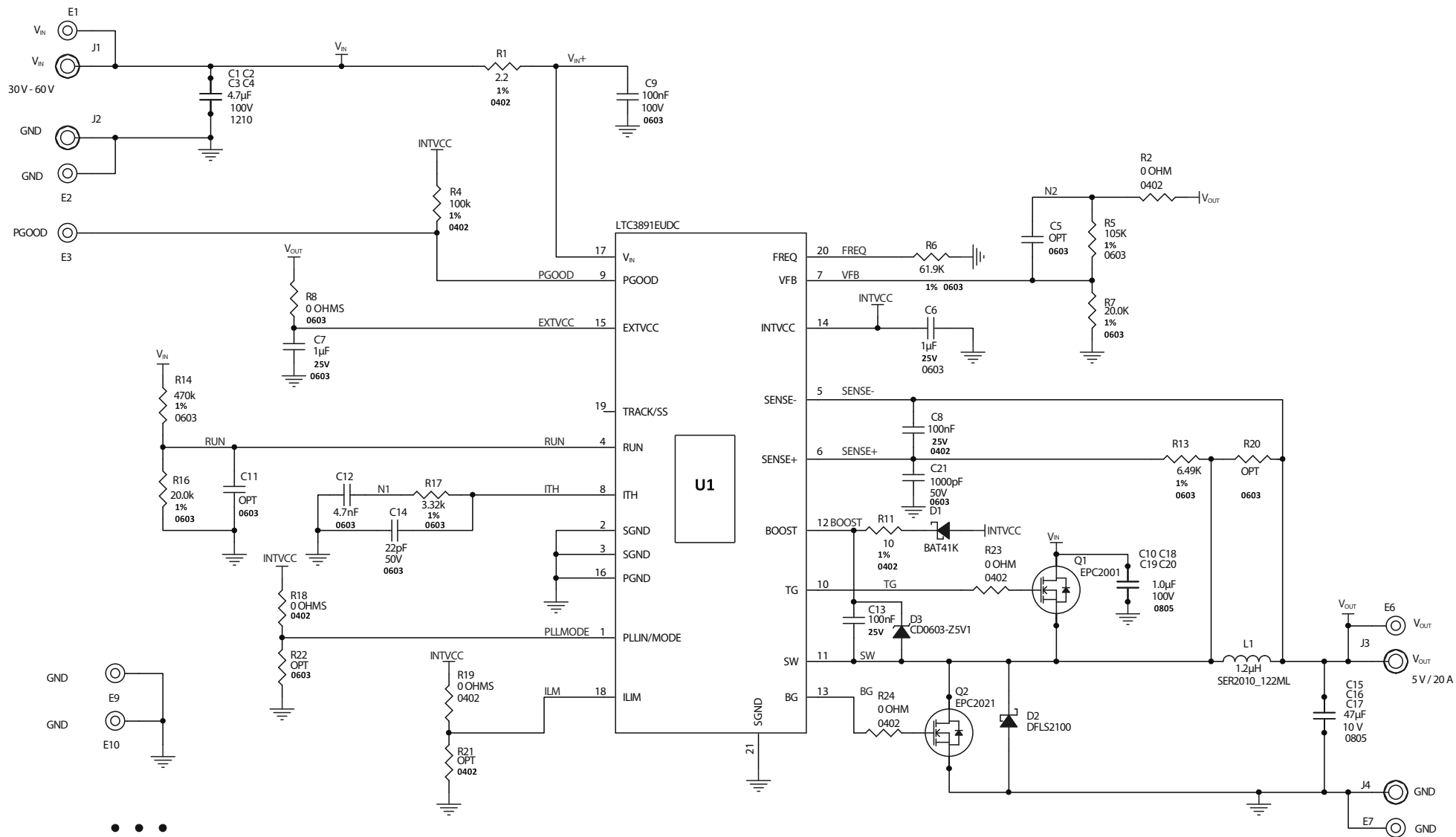


Figure 6: Thermal Image of EPC9118 Under Full Load Condition: 48 V_{in}, 20 A_{out} with Minimal Airflow

Table 2: Bill of Materials				
Item	Qty	Reference	Part Description	Manufacturer/Part#
1	4	C1, C2, C3, C4	Capacitor, 4.7 μ F, 100V, \pm 10 %, X7S	TDK, CGA6M3X7S2A475K200AB
2	2	C6, C7	Capacitor, 1 μ F, 25V \pm 10%, X5R	Murata, GRM188R61E105KA12D
3	1	C9	Capacitor, 100 nF, 100V, \pm 10 %, X7R	Murata, GRM188R72A104KA35D
4	1	C12	Capacitor, 4.7 nF, 10%, 50V, X7R	Murata, GRM1885C1H472JA01D
5	1	C14	Capacitor, 22 pF, 5%, 50V, NPO	Murata, GRM1885C1H220JA01D
6	1	C21	Capacitor, 1000 pF, 5%, 50V, NPO	Murata, GRM1885C1H102JA01D
7	4	C10, C18, C19, C20	Capacitor, 1 μ F, 100V, 10%, X7S	TDK, CGA4J3X7S2A105K125AE
8	2	C8, C13	Capacitor, 100 nF, 25V, \pm 10 %, X5R	TDK, C1005X5R1E104K
9	3	C15, C16, C17	Capacitor, 47 μ F, 10V, \pm 20%, X5R	TDK, C2012X5R1A476M125AC
10	1	D1	Schottky Diode, 100 V, 200 mA	STMicroelectronics, BAT41KFILM
11	1	D2	Schottky Diode, 100V, 2A	Diodes Inc., DFSL2100
12	1	D3	Zener, 5.1V, 150 mW	Bourns Inc., CD0603-Z5V1
13	7	E1, E2, E3, E6, E7, E9, E10	Test Point	Keystone, 5015
14	4	J1, J2, J3, J4	Banana Jacks, Female	Keystone, 575-4
15	1	L1	Inductor, 1.2 μ H, \pm 20%, 36A	Coilcraft, SER2010-122MLB
16	1	Q1	eGaN [®] FET	EPC, EPC2001
17	1	Q2	eGaN [®] FET	EPC, EPC2021
18	1	R1	Resistor, 2.2 OHMS, 1% 1/16W	Yageo, RC0402FR-072R2L
19	5	R2, R18, R19, R23, R24	Resistor, 0 OHMS, 1/16W	Stackpole, RMCF0402ZT0R00
20	1	R4	Resistor, 100K, 1%, 1/16W	Stackpole, RMCF0402FT100K
21	1	R14	Resistor, 470K, 1%,1/10W	Stackpole, RMCF0603FT470K
22	1	R17	Resistor, 3.32K, 1%,1/10W	Stackpole, RMCF0603FT3K32
23	1	R5	Resistor, 105K, 1%, 1/10W	Stackpole, RMCF0603FT105K
24	1	R6	Resistor, 61.9K, 1%, 1/10W	Stackpole, RMCF0603FT61K9
25	2	R7, R16	Resistor, 20K, 1%,1/10W	Stackpole, RMCF0603FT20K0
26	1	R8	Resistor, 0 OHMS, 1/10W	Stackpole, RMCF0603ZT0R00
27	1	R11	Resistor, 10 OHMS, 1%, 1/16W	Stackpole, RMCF0402FT10R0
28	1	R13	Resistor, 6.49K, 0.1%, 1/10W	Stackpole, RMCF0603FT6K49
29	1	U1	PWM buck controller	Linear Technology, LTC3891EUDC
30	0	C5, C11	Optional	
31	0	R20, R21, R22	Optional	



**Development Board Schematic
EPC9118**