

# Evaluation Board EPC9098 Quick Start Guide

*170 V Half-Bridge with Gate Drive using EPC2059*

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Version 2.0



## DESCRIPTION

The EPC9098 evaluation board is a 170 V maximum device voltage, 17 A maximum output current, half bridge with onboard gate drives, featuring the EPC2059 GaN field effect transistor (FET). The purpose of this evaluation board is to simplify the evaluation process of the EPC2059 by including all the critical components on a single board that can be easily connected into many existing converter topologies.

The EPC9098 evaluation board measures 2" x 2" and contains two EPC2059 GaN FETs in a half bridge configuration with the Texas Instruments LMG1210 gate driver. The board also contains all critical components and the layout supports optimal switching performance. There are also various probe points to facilitate simple waveform measurement and efficiency calculation. A block diagram of the circuit is given in figure 1.

For more information on [EPC2059](#) please refer to the datasheet available from EPC at [www.epc-co.com](http://www.epc-co.com). The datasheet should be read in conjunction with this quick start guide.

**Table 1: Performance Summary (T<sub>A</sub> = 25°C) EPC9098**

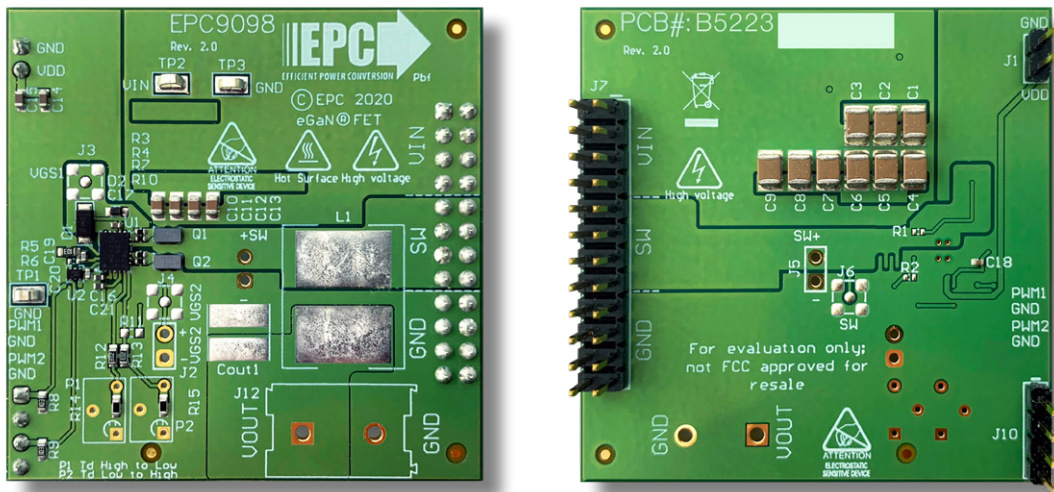
Symbol	Parameter	Conditions	Min	Nominal	Max	Units
V <sub>DD</sub>	Gate Drive Input Supply Range		7.5		12	V
V <sub>IN</sub>	Bus Input Voltage Range <sup>(1)</sup>				135	
I <sub>OUT</sub>	Switch Node Output Current <sup>(2)</sup>				17	A
V <sub>SW</sub>	Switch Node Voltage				170	
V <sub>PWM</sub>	PWM Logic Input Voltage Threshold <sup>(3)</sup>	Input 'High'	3.5		5.5	V
		Input 'Low'	0		1.5	
	Minimum 'High' State Input Pulse Width	V <sub>PWM</sub> rise and fall time < 10ns	50			ns
	Minimum 'Low' State Input Pulse Width <sup>(4)</sup>	V <sub>PWM</sub> rise and fall time < 10ns	200			

(1) Maximum input voltage depends on inductive loading, maximum switch node ringing must be kept under 170 V for EPC2059.

(2) Maximum current depends on die temperature – actual maximum current is affected by switching frequency, bus voltage and thermal cooling.

(3) When using the on board logic buffers, refer to the LMG1210 datasheet when bypassing the logic buffers.

(4) Limited by time needed to 'refresh' high side bootstrap supply voltage.



Front view

EPC9098 evaluation board

Back view

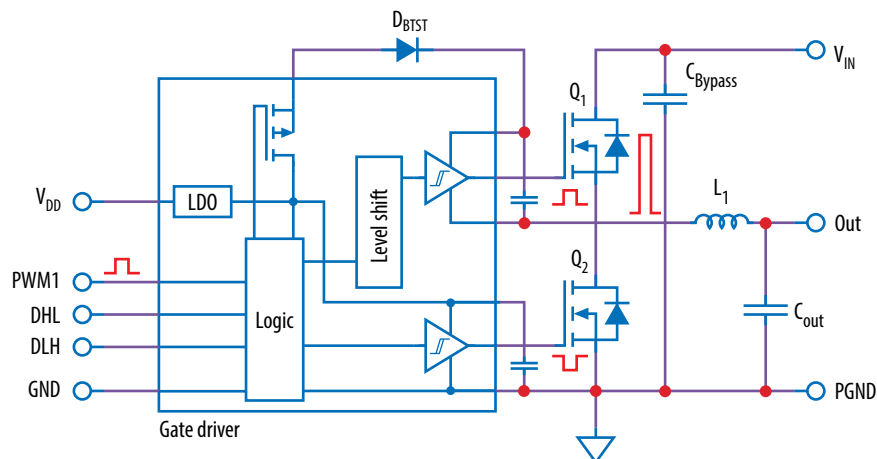


Figure 1: Block diagram of EPC9098 evaluation board

### QUICK START PROCEDURE

The EPC9098 evaluation board is easy to set up as a buck or boost converter to evaluate the performance of two EPC2059 eGaN® FETs. It can operate in single PWM mode with on board dead time, defined as the delay from when the gate signal of one FET is commanded to turn off, to when the gate signal of the other FET is commanded to turn on. The EPC9098 board can also operate in dual PWM input mode.

#### Single/dual PWM signal input settings

There are two PWM input ports on the board, PWM1 and PWM2. Both input ports are used as inputs in dual-input mode where PWM1 connects to the upper FET and PWM2 connects to the lower FET. The PWM1 input port is used as the input in single-input mode where the circuit will generate the required complementary PWM with preset dead time of 10 ns for the FETs as shown in figure 3(a). This is the default configuration. Refer to the LMG1210 datasheet for details on how to adjust the dead time setting using P1 and P2 or R14 and R15.

To select dual input mode, the zero-ohm resistor in position R5 needs to be removed and a zero-ohm resistor must be installed in position R6 as shown in figure 3(b).

**Note:** In dual mode there is no shoot-through protection as both gate signals can be set high at the same time.

#### Buck converter configuration

To operate the board as a buck converter, either a single or dual PWM input can be chosen. Figure 3(a) shows the connection setup for single PWM input mode and figure 3(b) for the dual PWM input mode.

**Note:** It is important to provide the correct PWM signals that includes dead-time and polarity when operating in dual PWM input mode and not making use of the gate driver dead time function.

Once the input source and dead-time settings have been chosen and set, then the board can be operated.

1. With power off, connect the input power supply bus to VIN and ground/return to GND.
2. With power off, connect the switch node (SW) of the half bridge to your circuit as required (half bridge configuration). Or use the provided pads for inductor (L1) and output capacitors (Cout), as shown in figure 3.
3. With power off, connect the gate drive supply to VDD (J1, Pin-1) and ground return to GND (J1, Pin-2 indicated on the bottom side of the board).
4. With power off, connect the input PWM control signal to PWM1 and/or PWM2 according to the input mode setting chosen and ground return to any of GND J10 pins indicated on the bottom side of the board.
5. Turn on the gate drive supply – make sure the supply is between 7.5 and 12 V.
6. Turn on the controller / PWM input source.
7. Making sure the initial input supply voltage is 0 V, turn on the power and slowly increase the voltage to the required value (**do not exceed the absolute maximum voltage**). Probe switching node to see switching operation.
8. Once operational, adjust the PWM control, bus voltage, and load within the operating range and observe the output switching behavior, efficiency, and other parameters.
9. For shutdown, please follow steps in reverse.

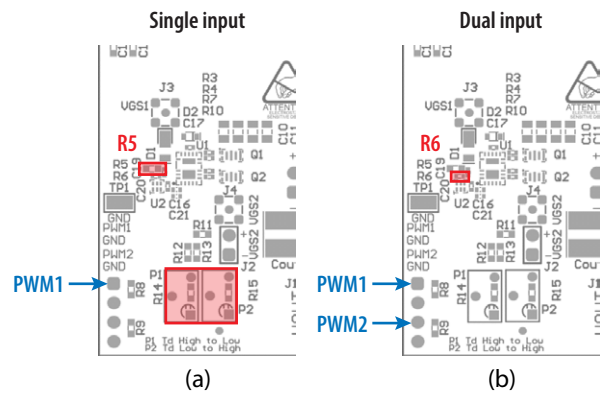


Figure 2: Input mode selection

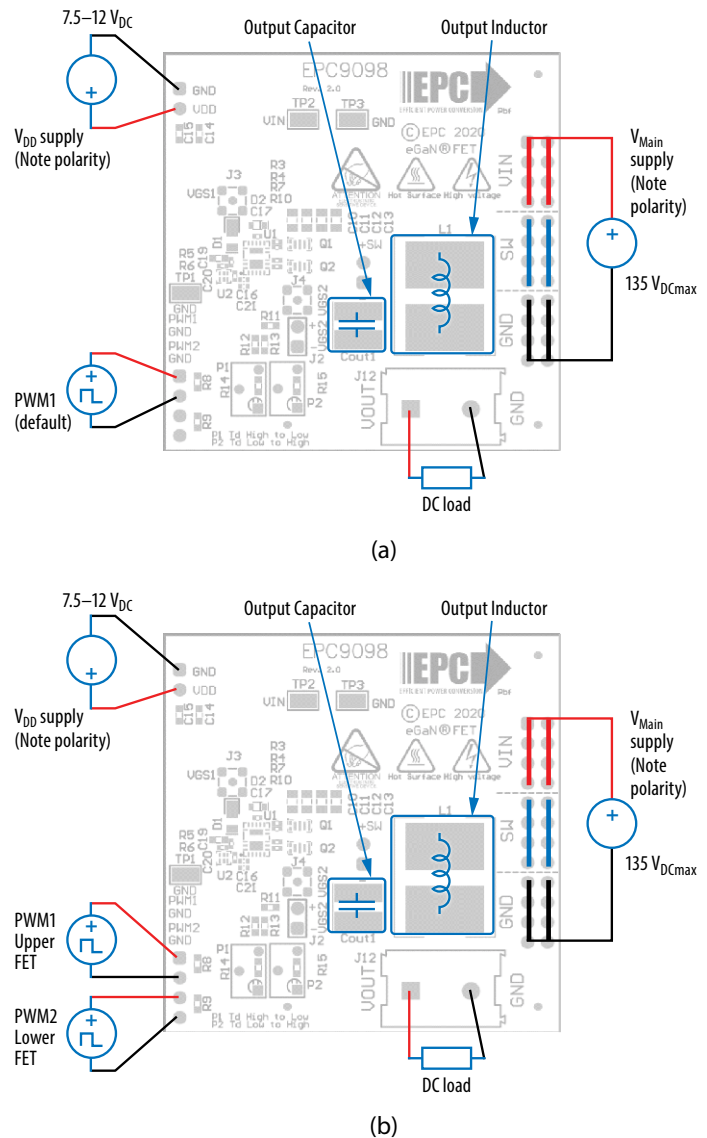


Figure 3: (a) Single-PWM input buck converter (b) Dual-PWM input buck converter configurations showing the supply, output capacitor, inductor, PWM, and load connections.

**Boost Converter configuration**

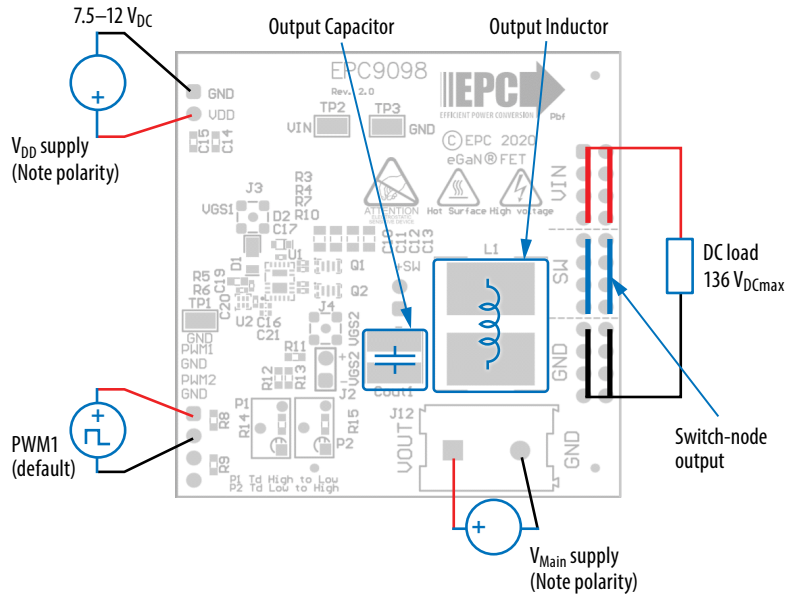
**Warning:** Never operate the boost converter mode without a load as the output voltage can increase beyond the maximum ratings.

To operate the board as a boost converter, either a single or dual PWM input can be chosen. Figure 4(a) shows the connection setup for single PWM input mode and figure 4(b) for the dual PWM input mode. **Note that in boost mode, the PWM polarity is inverted.**

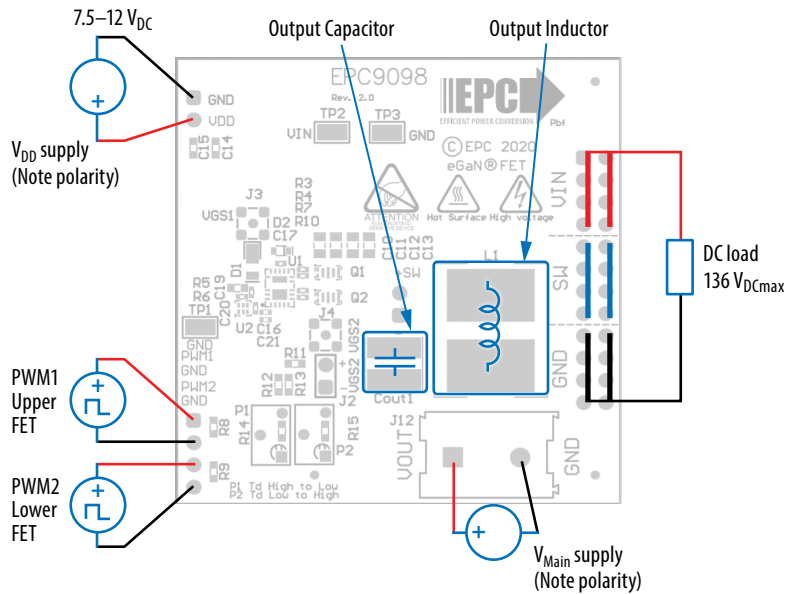
**Notes:** It is important to provide the correct PWM signals that includes dead-time and polarity when operating in dual PWM input mode and not making use of the gate driver dead time function.

Once the input source and dead-time settings have been chosen and set, then the boards can be operated.

1. The inductor (L1) and input capacitors (labeled as Cout) can either be soldered onto the board, as shown in figure 4, or provided off board.
2. With power off, connect the input power supply bus to V<sub>OUT</sub> and ground / return to GND, or externally across the capacitor if the inductor L1 and Cout are provided externally. Connect the output voltage (labeled as VIN) to your circuit as required, e.g., resistive load.
3. With power off, connect the gate drive supply to V<sub>DD</sub> (J1, Pin-1) and ground return to GND (J1, Pin-2 indicated on the bottom side of the board).
4. With power off, connect the input PWM control signal to PWM1 and/or PWM2 according to the input mode setting chosen and ground return to any of GND J10 pins indicated on the bottom side of the board.
5. Turn on the gate drive supply – make sure the supply is between 7.5 and 12 V.
6. Turn on the controller / PWM input source.
7. **Making sure the output is not open circuit**, and the input supply voltage is initially 0 V, turn on the power and slowly increase the voltage to the required value (**do not exceed the absolute maximum voltage**). Probe switching node to see switching operation.
8. Once operational, adjust the PWM control, bus voltage, and load within the operating range and observe the output switching behavior, efficiency, and other parameters. Observe device temperature for operational limits.
9. For shutdown, please follow steps in reverse.



(a)



(b)

Figure 4: (a) Single-PWM input boost converter (b) Dual-PWM input boost converter configurations showing the supply, inductor, output capacitor, PWM, and load connections.

### MEASUREMENT CONSIDERATIONS

Measurement connections are shown in figure 5. Figure 6 shows an actual switch-node voltage measurement when operating the board as a buck converter.

When measuring the switch node voltage containing high-frequency content, care must be taken to provide an accurate high-speed measurement. An optional two pin header (J5) and an MMCX connector (J6) are provided for switch-node measurement.

A differential probe is recommended for measuring the high-side bootstrap voltage. IsoVu probes from Tektronix has a mating MMCX connector.

For regular passive voltage probes (e.g. TPP1000) measuring switch node using MMCX connector, probe adaptor is available. PN: 206-0663-xx.

**NOTE.** For information about measurement techniques, the EPC website offers: “AN023 Accurately Measuring High Speed GaN Transistors” and the How to GaN educational video series, including: HTG09-Measurement

### THERMAL CONSIDERATIONS

The EPC9098 evaluation board showcases the EPC2059 eGaN FET. The EPC9098 is intended for bench evaluation with low ambient temperature and convection cooling. The addition of heat-sinking and forced air cooling can significantly increase the current rating of these devices, but care must be taken to not exceed the absolute maximum die temperature of 150°C.

**NOTE.** The EPC9098 evaluation board does not have any current or 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.

For support files including schematic, Bill of Materials (BOM), and gerber files please visit the EPC9098 landing page at: <https://epc-co.com/epc/products/demo-boards/epc9098>

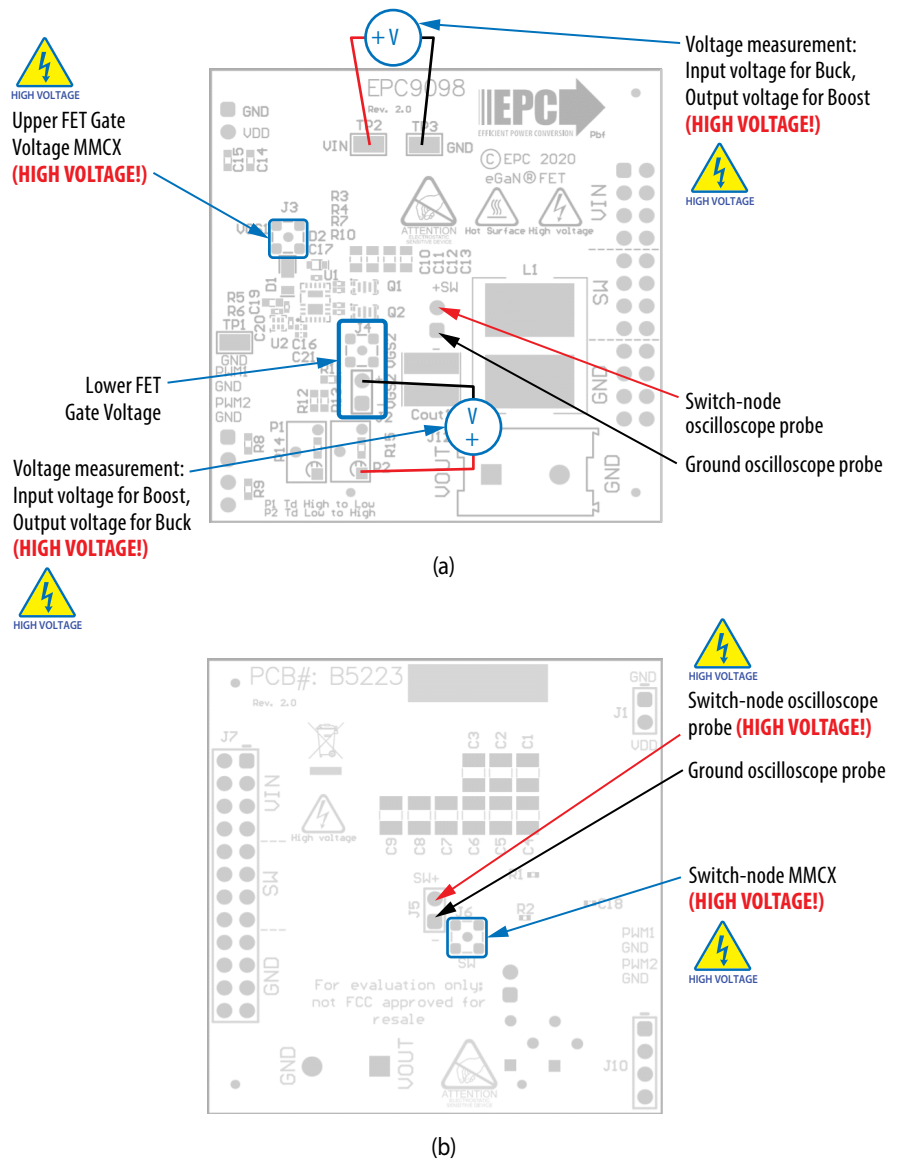


Figure 5 Measurement points (a) front side, (b) Back side

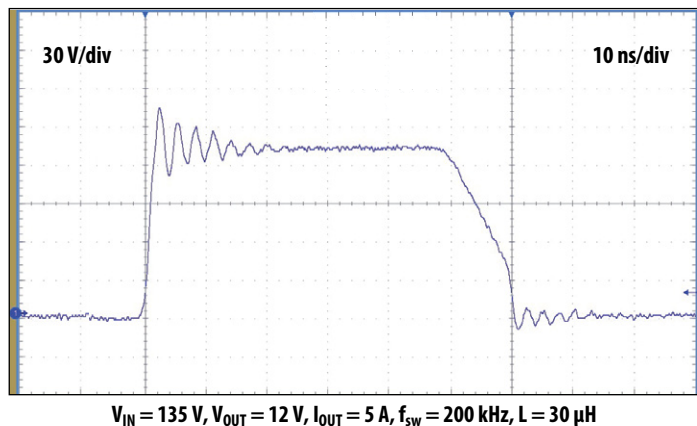


Figure 6: Typical switch-node waveform when operated as a buck converter

## For More Information:

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**The EPC9098 board is intended for product evaluation purposes only. It is not intended for commercial use nor is it FCC approved for resale.** Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Quick Start Guide. Contact an authorized EPC representative with any questions. This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk.

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