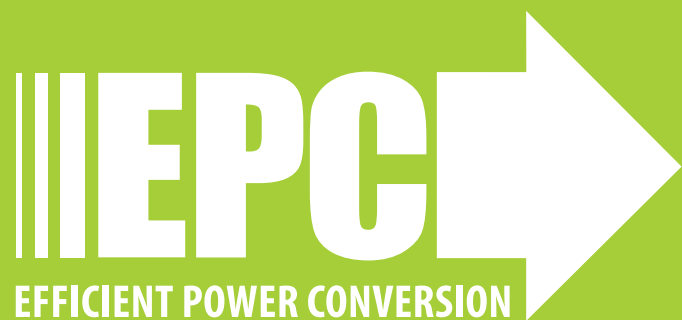


Development Board EPC90124 Quick Start Guide

200 V Half-bridge with Gate Drive, Using EPC2207

Revision 1.0



DESCRIPTION

The EPC90124 development board is a 200 V maximum device voltage, 8 A maximum output current, half bridge with onboard gate drives, featuring the EPC2207 GaN field effect transistor (FET). The purpose of this development board is to simplify the evaluation process of the EPC2207 by including all the critical components on a single board that can be easily connected into many existing converter topologies.

The EPC90124 development board measures 2" x 2" and contains two EPC2207 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 the EPC2207 please refer to the datasheet available from EPC at www.epc-co.com. The datasheet should be read in conjunction with this quick start guide.

Table 1: Performance Summary (T_A = 25°C) EPC90124

| Symbol | Parameter | Conditions | Min | Max | Units |
|------------------|--|--|-----|-----|-------|
| V _{DD} | Gate Drive Input Supply Range | | 7.5 | 12 | V |
| V _{IN} | Bus Input Voltage Range ⁽¹⁾ | | | 160 | V |
| I _{OUT} | Switch Node Output Current ⁽²⁾ | | | 8 | A |
| V _{SW} | Switch Node Voltage | | | 160 | V |
| V _{PWM} | PWM Logic Input Voltage Threshold ⁽³⁾ | Input 'High' | 3.5 | 5.5 | V |
| | | Input 'Low' | 0 | 1.5 | |
| | Minimum 'High' State Input Pulse Width | V _{PWM} rise and fall time < 10ns | 50 | | ns |
| | Minimum 'Low' State Input Pulse Width ⁽⁴⁾ | V _{PWM} rise and fall time < 10ns | 200 | | ns |

- (1) Maximum input voltage depends on inductive loading, maximum switch node ringing must be kept under 200 V for EPC2207.
- (2) Maximum current depends on die temperature – actual maximum current will be subject to 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.

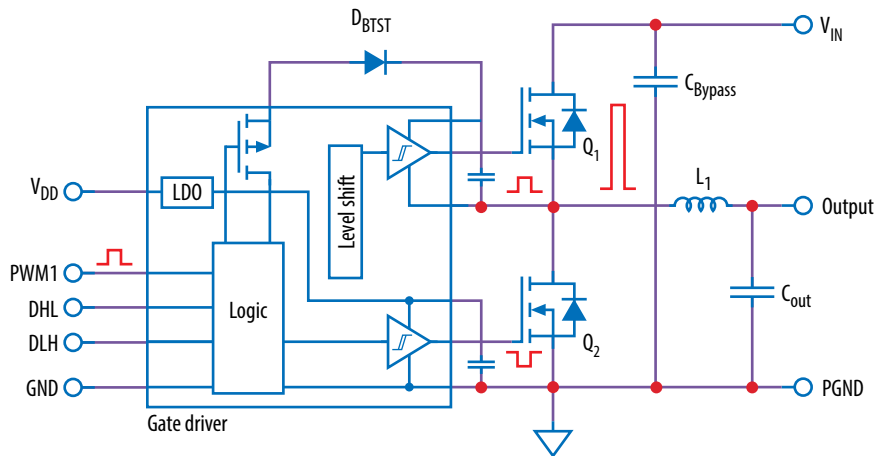
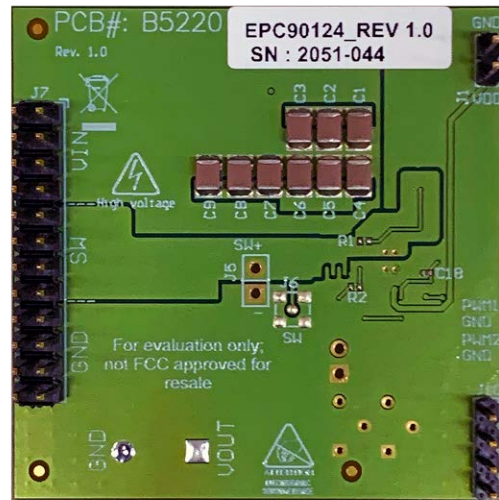


Figure 1: Block diagram of EPC90124 development board



Front view



Back view

EPC90124 development board

QUICK START PROCEDURE

The EPC90124 development board is easy to set up as a buck or boost converter to evaluate the performance of two EPC2207 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 EPC90124 board can also operate in dual PWM input mode.

Single/dual PWM signal input settings

There are two PWM signal 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 2(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 2(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 include 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, dead-time settings and bypass configurations have been chosen and set then the board can be operated.

1. With power off, connect the input power supply bus to V_{IN} 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 V_{DD} (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 switch-node to see switching operation.

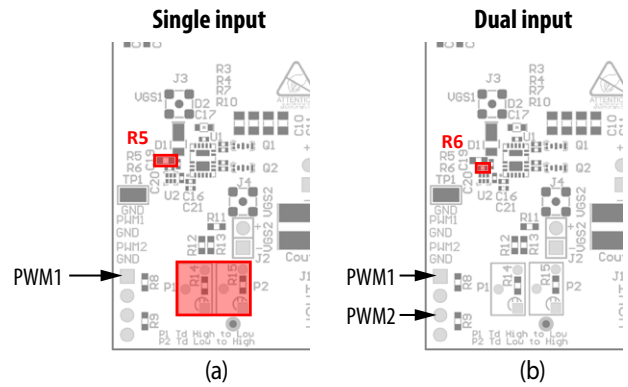


Figure 2: Input mode selection for the EPC90124

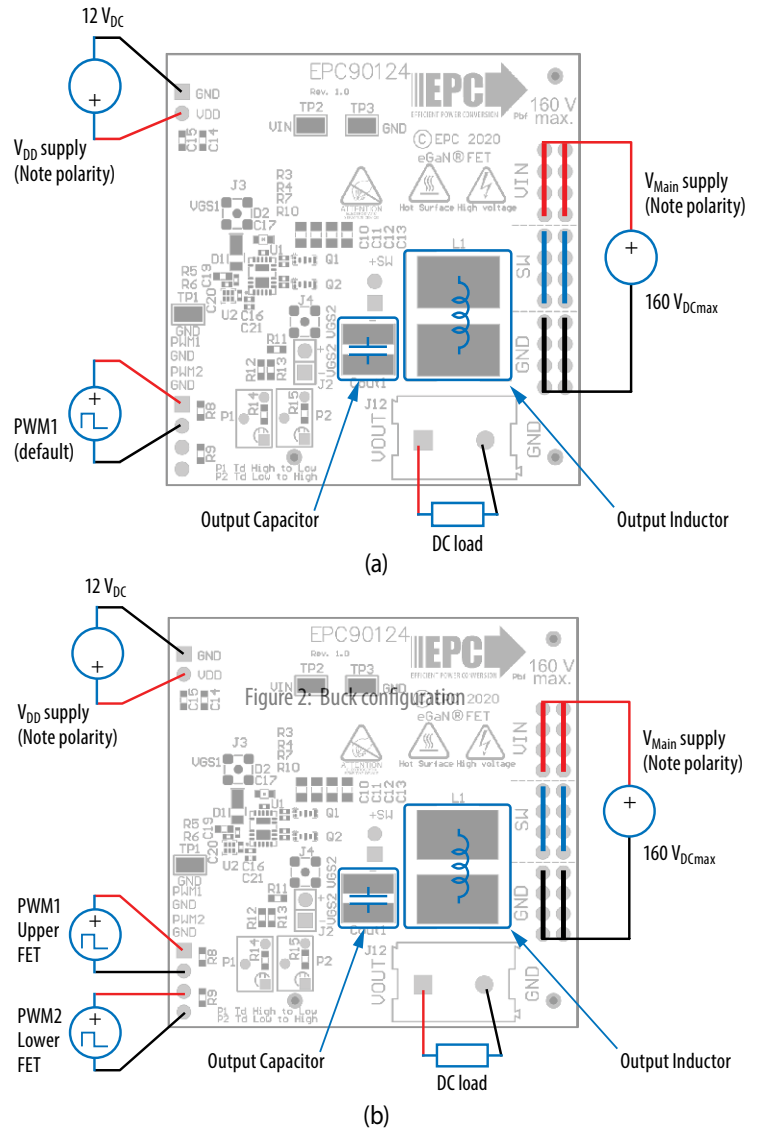


Figure 3: (a) Single-PWM input buck converter (b) Dual-PWM input buck converter configurations showing the supply, output capacitor, inductor, PWM, and load connections.

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.

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: *In boost mode, the PWM polarity is inverted.*

Note: It is important to provide the correct PWM signals that include 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, dead-time settings and bypass configurations have been chosen and set then the board 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 VOUT 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 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 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 switch-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.

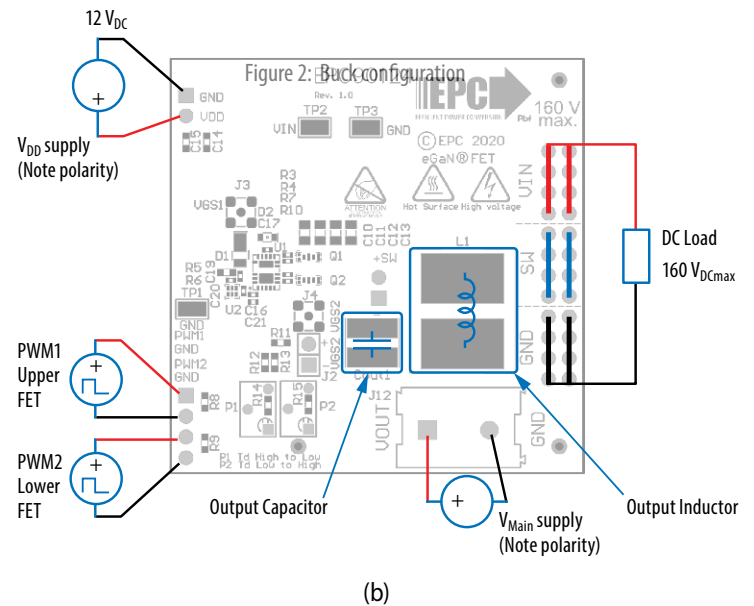
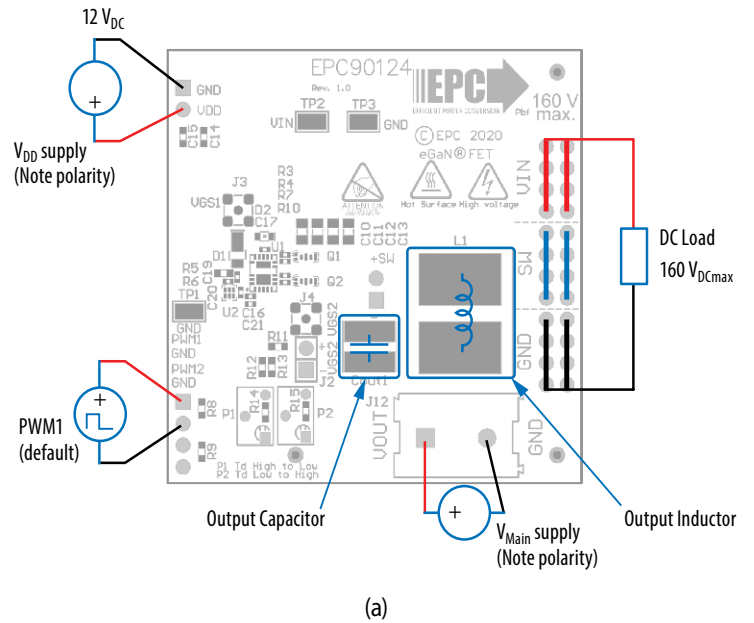


Figure 4: (a) Single-PWM input boost converter (b) Dual-PWM input boost converter configurations showing the supply, inductor, output capacitor, PWM, and load connections.

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 have 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 EPC90124 development board showcases the EPC2207 eGaN FET. The EPC90124 is intended for bench evaluation with room 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 EPC90124 development 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.

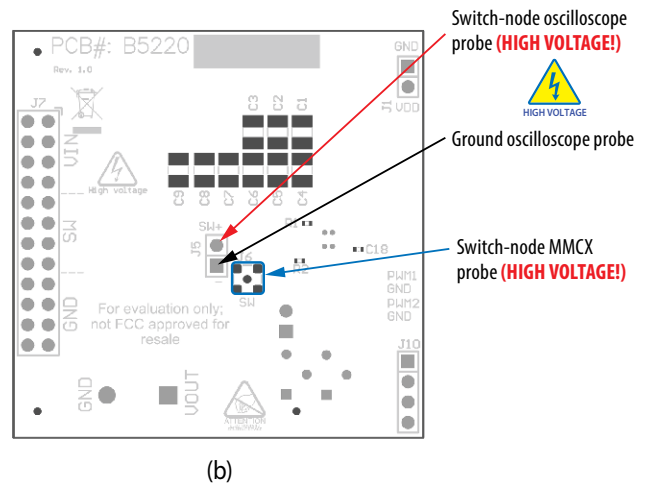
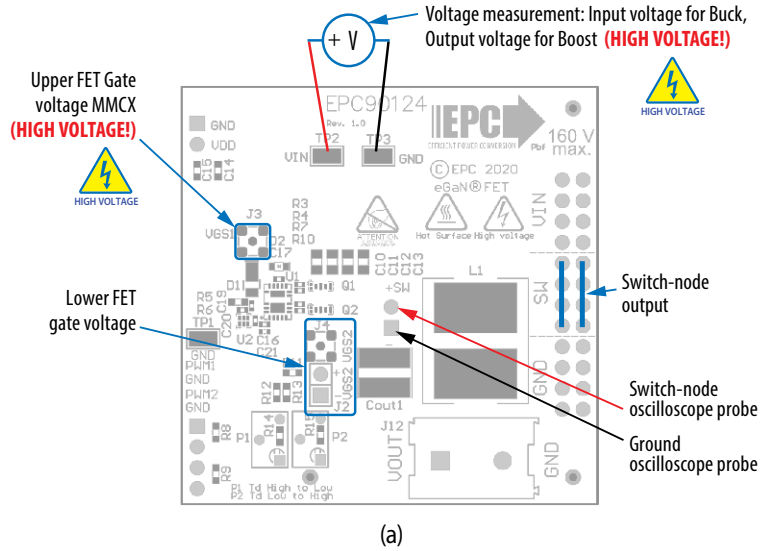


Figure 5: Measurement points front side (a) and back side (b)

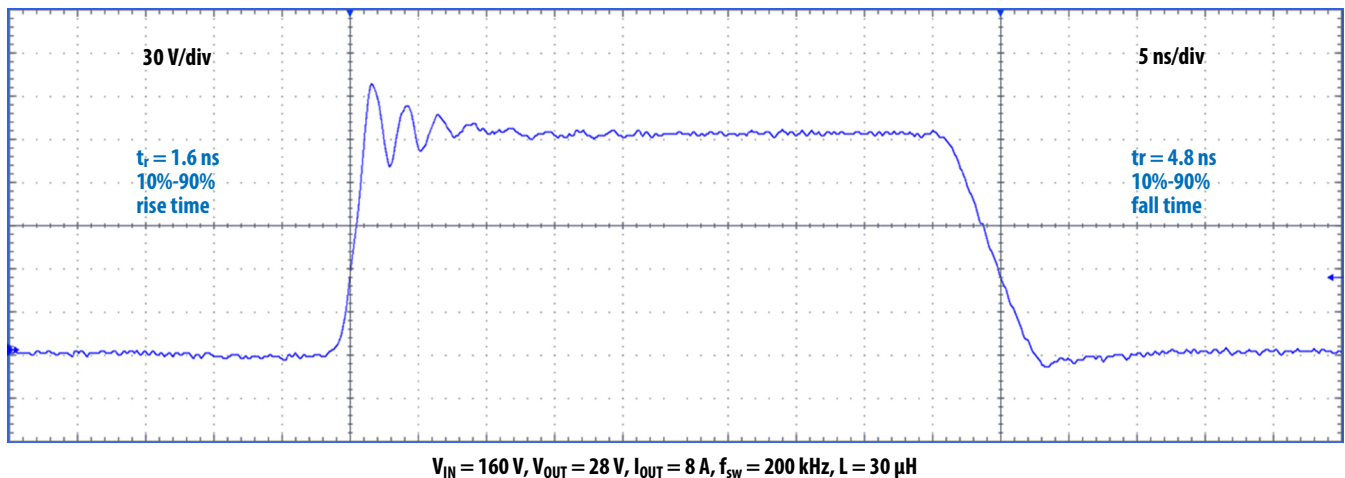


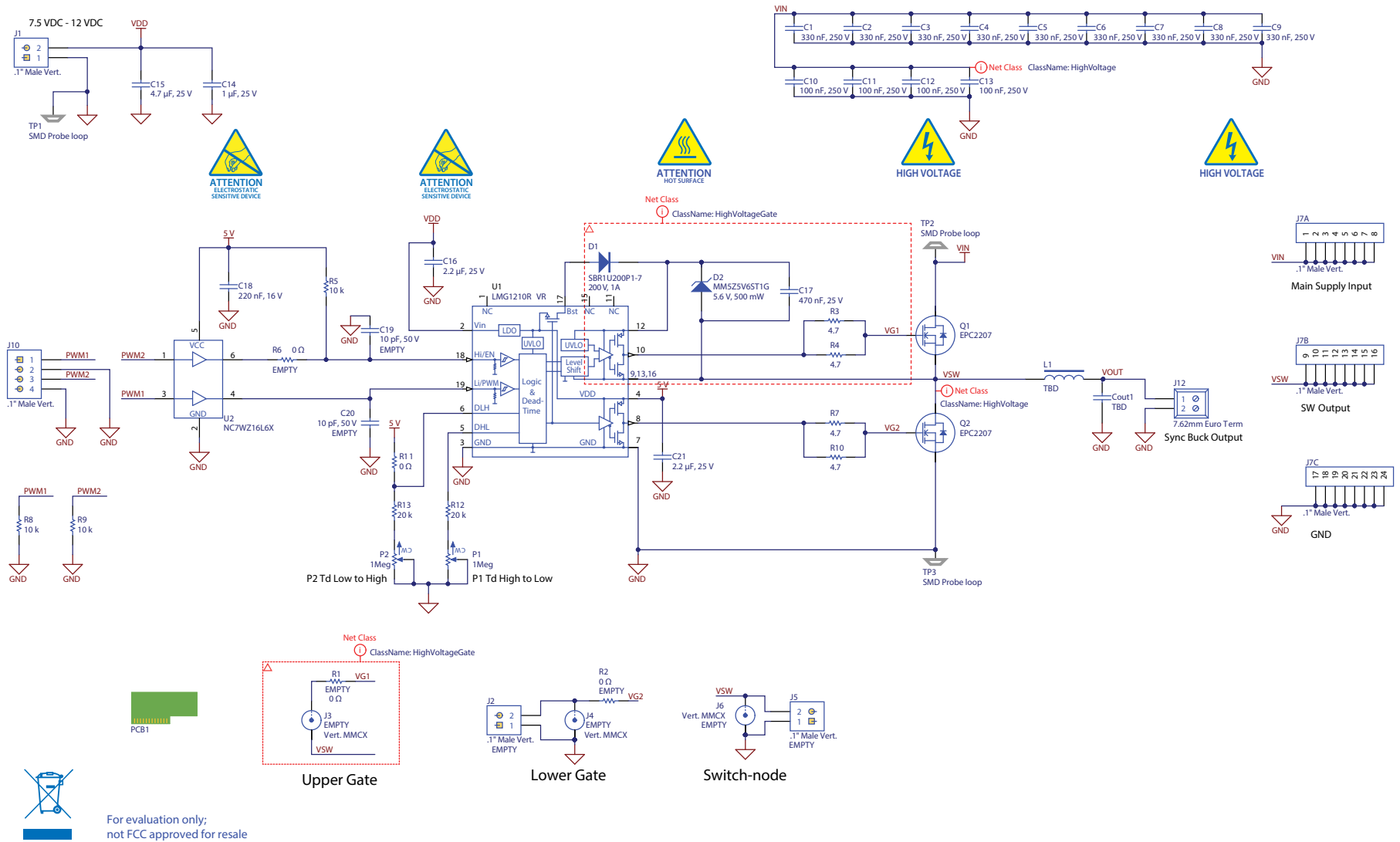
Figure 6: Typical switch-node waveform when operated as a buck converter

Table 2: Bill of Materials

| Item | Qty | Reference | Part Description | Manufacturer | Part Number |
|------|-----|------------------------------------|--|-------------------|----------------------|
| 1 | 9 | C1, C2, C3, C4, C5, C6, C7, C8, C9 | Capacitor, 0.33 μ f, 10%, 250 V, X7T | TDK | CGA6M3X7T2E334K200AA |
| 2 | 4 | C10, C11, C12, C13 | Capacitor, 0.1 μ f, 10%, 250 V, X7T | TDK | CGA4J3X7T2E104K125AA |
| 3 | 1 | C14 | Capacitor, 1 μ f, 10%, 25 V, X7R | TDK | C1608X7R1E105K |
| 4 | 1 | C15 | Capacitor, 4.7 μ f, 10%, 25 V, X5R | TDK | C1608X5R1E475K080AC |
| 5 | 2 | C16, C21 | Capacitor, 2.2 μ f, 10%, 16 V, X5R | TDK | C1005X5R1C225K050BC |
| 6 | 1 | C17 | Capacitor, 0.47 μ f, 10%, 25 V, X5R | TDK | C1005X5R1E474K050BB |
| 7 | 1 | C18 | Capacitor, 0.22 μ f, 10%, 16 V, X7R | TDK | C1005X7R1C224K050BC |
| 8 | 2 | C19, C20 | Capacitor, 10 pf, 10%, 25 V, C0G/NP0 | Murata | GRM1555C1E100JA01D |
| 9 | 1 | D1 | Diode Super Barrier, 200 V, 1A | Diodes | SBR1U200P1Q |
| 10 | 1 | D2 | Zener Diode, 5.61 V, 500 mW | On Semiconductor | MM5Z5V6ST1G |
| 11 | 1 | J1 | Connector, .1" Male Vert | Würth | 61300211121 |
| 12 | 1 | J7 | Connector, .1" Male Vert | Tyco | 4-103185-0-04 |
| 13 | 1 | J10 | Connector, .1" Male Vert | Tyco | 4-103185-0-04 |
| 14 | 2 | R14, R15 | 30k Ohm 1% 1/10 W | Panasonic | ERJ-3EKF3002V |
| 15 | 2 | Q1, Q2 | eGaN FET, 200 V, 22 m Ω | EPC | EPC2207 |
| 16 | 4 | R3, R4, R7, R10 | Resistor, 4.7 Ω , 5%, 1/10 W, 0402 | Panasonic | ERJ-2GEJ4R7X |
| 17 | 3 | R5, R8, R9 | Resistor, 10 k Ω , 5%, 1/10 W, 0603 | Yageo | RC0603JR-0710KL |
| 18 | 2 | R12, R13 | Resistor, 20 k Ω , 5%, 1/10 W, 0604 | Stackpole | RNCF0603BTE20K0 |
| 19 | 3 | TP1, TP2, TP3 | Test point, miniature SMT | Keystone | 5015 |
| 20 | 1 | U1 | 200 V HB Gate Driver | Texas Instruments | LMG1210RVR |
| 21 | 1 | U2 | IC BUFF NONINVERT 5.5V 6MICROPAK | Fairchild | NC7WZ16L6X |

Optional Components

| Item | Qty | Reference | Part Description | Manufacturer | Part Number |
|------|-----|------------|--|--------------|----------------|
| 1 | 1 | Cout1 | TBD | Generic | Generic |
| 2 | 3 | J3, J4, J6 | MMCX Connector Jack | Molex | 734152063 |
| 3 | 1 | J12 | 7.62 mm Euro Term. | Würth | 691216410002 |
| 4 | 1 | L1 | TBD | Generic | Generic |
| 5 | 3 | R1, R2, R6 | Resistor, 0 Ω jumper, 1/16 W, 0402 | Stackpole | RMCF0402ZT0R00 |
| 6 | 1 | R11 | Resistor, 0 Ω jumper, 1/10 W, 0603 | Stackpole | RMCF0603ZT0R00 |
| 7 | 2 | P1, P2 | Potentiometer, 1 M Ω , through-hole, for dead time adjustment | Murata | PV37W105C01B00 |



For evaluation only; not FCC approved for resale

Figure 7: EPC90124 - Schematic

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