Development Board EPC9062 Quick Start Guide

100 V Half-bridge with Gate Drive, Using EPC2032

Revision 2.0

|||EPC

EFFICIENT POWER CONVERSION

DESCRIPTION

The EPC9062 development board is a 100 V maximum device voltage, 20 A maximum output current, half bridge with onboard gate drives, featuring the EPC2032 enhancement mode (eGaN®) field effect transistor (FET). The purpose of this development board is to simplify the evaluation process of the EPC2032 eGaN FET by including all the critical components on a single board that can be easily connected into the majority of existing converter topologies.

The EPC9062 development board measures 2" x 2" and contains two EPC2032 eGaN FETs in a half bridge configuration with the uPI Semiconductor uP1966A 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 EPC2032 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.

QUICK START PROCEDURE

The half bridge development board EPC9062 is easy to set up as buck or boost converter. Refer to figure 2 for buck converter configuration and measurement setup, and figure 3 for boost converter setup, and follow the procedure below:

Buck converter configuration

1. With power off, connect the input power supply bus to V_{IN} (J5, J6) and ground / return to GND (J7, J8).

2. With power off, connect the switch node (SW) of the half bridge (J3, J4) to your circuit as required (half bridge configuration). Or use the provided pads for inductor (L_1) and output capacitors (C_{out}), as shown in figure 2.

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 (J2, Pin-1) and ground return to any of GND J2 pins indicated on the bottom side of the board.

5. Turn on the gate drive supply – make sure the supply is between 7.5 V and 12 V.

6. Turn on the controller / PWM input source.

7. Making sure the intial 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.

Table 1: Performance Summary (T_A = 25°C) EPC9062

| Symbol	Parameter	Conditions	Min	Max	Units
V_{DD}	Gate Drive Input Supply Range		7.5	12	V
V_{IN}	Bus Input Voltage Range[1]			80	V
I_{OUT}	Switch Node Output Current [2]			20	A
V_{PWM}	PWM Logic Input Voltage Threshold	Input 'High' Input 'Low'	3.5 0	5.5 1.5	V V
	Minimum 'High' State Input Pulse Width	V_{PWM} rise and fall time < 10ns	50		ns
	Minimum 'Low' State Input Pulse Width [3]	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 100 V for EPC2032.
(2) Maximum current depends on die temperature – actual maximum current is affected by switching frequency, bus voltage and thermal cooling.
(3) Limited by time needed to 'refresh' high side bootstrap supply voltage.
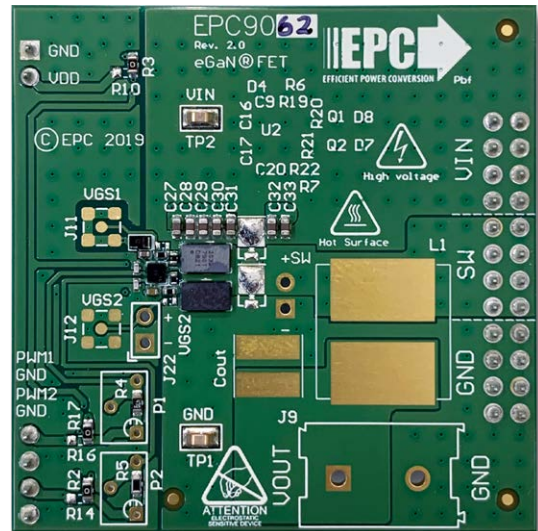
Front view
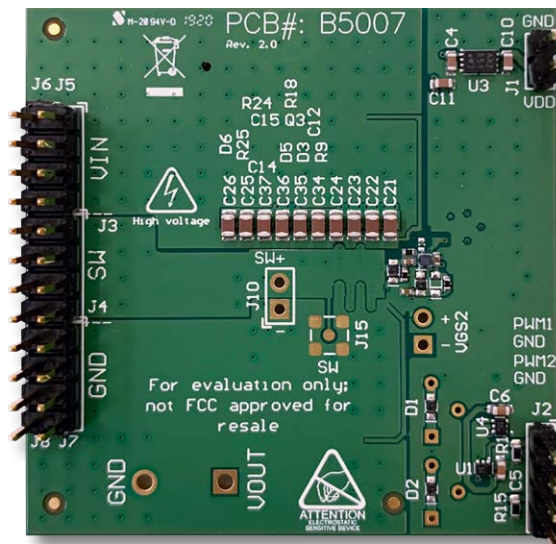
Back view

EPC9062 development board

Boost Converter configuration

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

1. The inductor (L_1) and input capacitors (labeled as C_{out}) can either be soldered onto the board, as shown in figure 3, or provided off board. Anti-parallel diodes can also be installed using the additional pads on the right side of the EPC2032 FETs.

2. With power off, connect the input power supply bus to V_{OUT} (J9, Pin-1) and ground / return to GND (J9, Pin-2), or externally across the capacitor if the inductor L_1 and C_{out} are provided externally. Connect the output voltage (labeled as V_{IN}, J5, J6) to your circuit as required, e.g., resistive load.

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 (J2, Pin-1) and ground return to any of GND J2 pins indicated on the bottom side of the board. Note that the bottom FET gate drive signal is inverted with regard to PWM1. It is also possible to use separate input PWM signals by removing R2 and R17 and installing 0 Ω jumpers for R14 and R16.

5. Turn on the gate drive supply – make sure the supply is between 7.5 V 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.

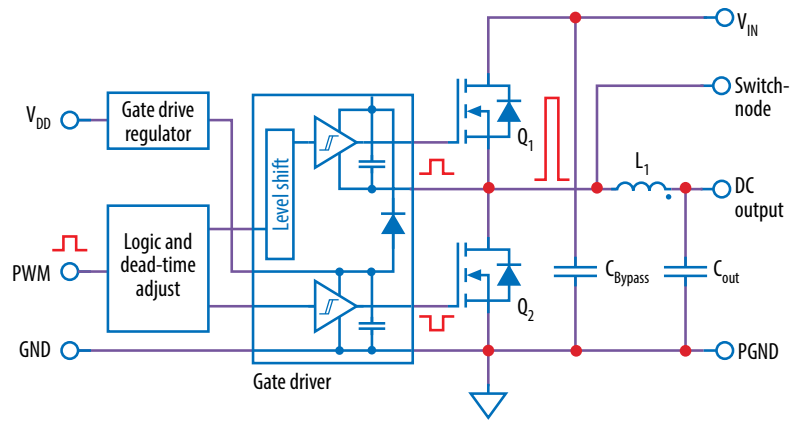9. For shutdown, please follow steps in reverse.

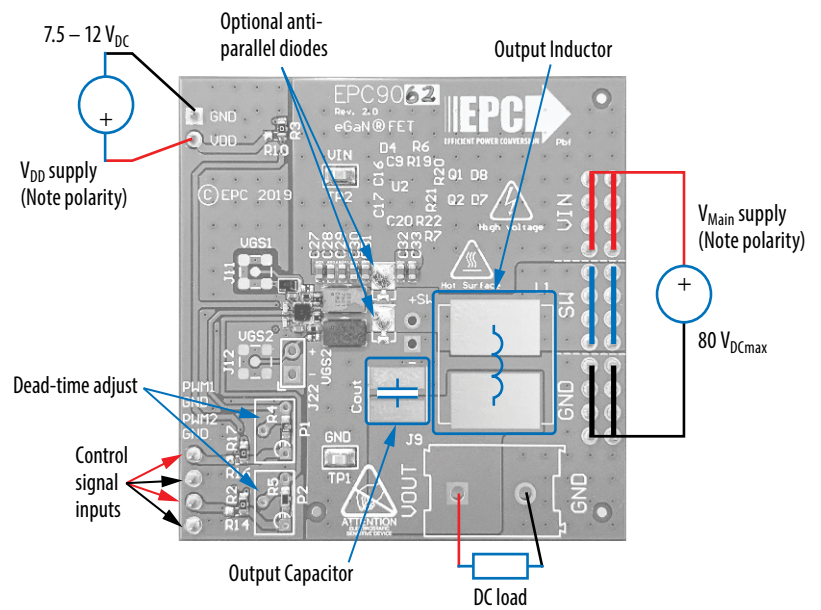Figure 1: Block diagram of EPC9062 development board
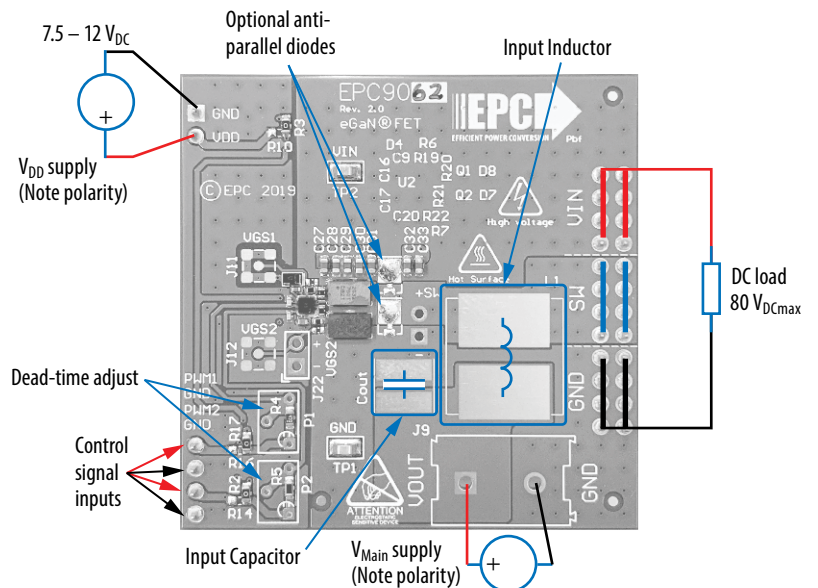

Figure 2: Buck configuration

Figure 3: Boost configuration

THERMAL CONSIDERATIONS

The EPC9062 development board showcases the EPC2032 eGaN FET. The EPC9062 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 EPC9062 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.
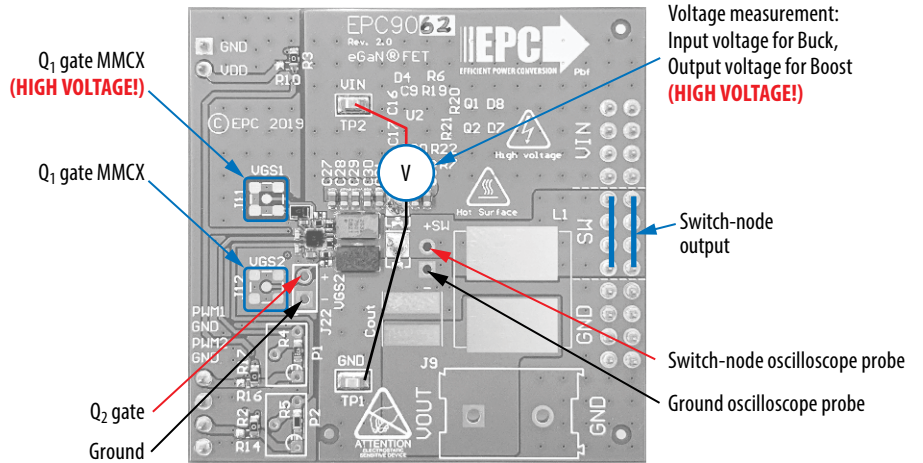
MEASUREMENT CONSIDERATIONS

When measuring the high frequency content switch node, care must be taken to provide an accurate high speed measurement. An optional two pin header (J10) is included for switch node measurement. MMCX connector footprint is also provided (J15 in figure 5) to measure switch node.

Low-side gate voltage (VGS2) can be measured at the two pin header (J22) or the MMCX (J12). Please refer to figure 4. R7 (0 Ohm resistor) will need to be installed.

High-side gate voltage (VGS1) can only be measured using the MMCX connector (J11). Please refer to figure 4. R6 (0 Ohm resistor) will need to be installed.

Differential probe is recommended for measuring high-side gate. IsoVu probes from Tektronix has mating MMCX connector.

For regulator passive voltage probes (e.g. TPP1000) measuring low-side gate or 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

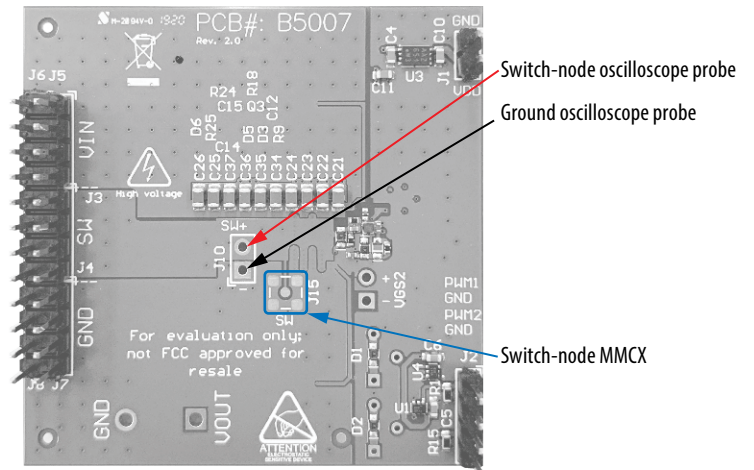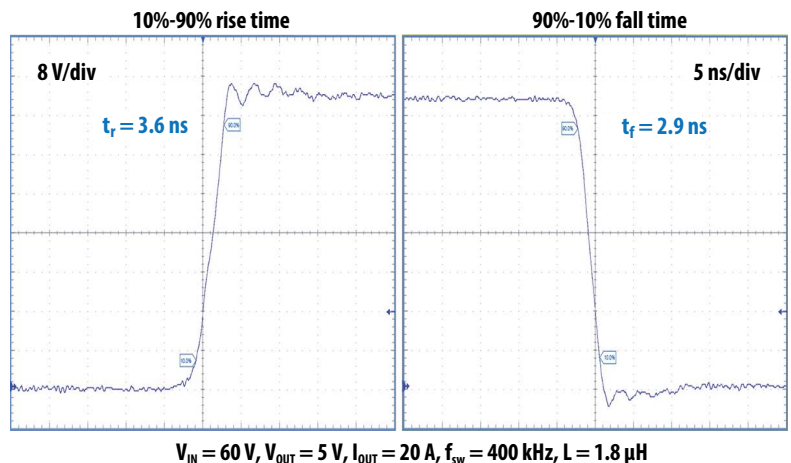Figure 4: Measurement top side

Figure 5: Measurement bottom side

$V_{IN} = 60$ V, $V_{OUT} = 5$ V, $I_{OUT} = 20$ A, $f_{sw} = 400$ kHz, L = 1.8 μH

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	3	C4, C10, C11	Capacitor, 1 µF, 10%, 25 V, X7R	TDK	C1608X7R1E105K
2	2	C5, C6	Capacitor, 0.1 µF, 10%, 25 V, X7R	TDK	C1608X7R1E104K
3	1	C9	Capacitor, 0.1 µF, 10%, 25 V, X7R	Yageo	CC0402KRX7R8BB104
4	2	C12, C14	Capacitor, 0.1 µF, 10%, 16 V, X7R	Murata	GRM155R71C104KA88D
5	1	C15	Capacitor, 0.022 µF, 10%, 25 V, X7R	TDK	C1005X7R1E223K050BB
6	2	C16, C17	Capacitor, 100 pF, 10%, 50 V, X7R	Yegeo	CC0402KRX7R9BB101
7	1	C20	Capacitor, 4.7 µF, 10%, 10 V, X5R	TDK	C1005X5R1A475K050BC
8	10	C21, C22, C23, C24, C25, C26, C34, C35, C36, C37	Capacitor, 1 µF 100 V 20% X7S	TDK	C2012X7S2A105M125AB
9	7	C27, C28, C29, C30, C31, C32, C33	Capacitor, 0.22 µF, 10%, 100 V, X7S	Taiyo Yuden	HMK107C7224
10	4	D1, D2, D5, D6	Schottky Diode, 30 V, 30 mA	Diodes Inc.	SDM03U40
11	1	D4	Zeer Diode, 5.1 V, 150 mW	Bournes	CD0603-Z5V1
12	2	Q1, Q2	eGaN FET, 100 V, 48 A, 4 mΩ	EPC	EPC2032
13	1	Q3	eGaN FET, 100 V, 0.5 A, 3300 mΩ	EPC	EPC2038
14	1	U1	IC GATE NAND 1CH 2-INP 6MICROPAK	Fairchild	NC7SZ00L6X
15	1	U2	100 V eGaN Driver	uPI	uP1966A
16	1	U3	Linear Voltage Regulator IC P, 5 V, 250 mA	Microchip	MCP1703T-5002E/MC
17	1	U4	IC GATE AND 1CH 2-INP 6-MICROPAK	Fairchild	NC7SZ08L6X
18	2	R1, R15	Resistor, 10.0 k, 5%, 1/10 W	Yageo	RC0603JR-0710KL
19	3	R2, R3, R17	Resistor, 0 Ω, 1/10 W	Stackpole	RMCF0603ZT0R00
20	1	R4	Resistor, 47 Ω, 1%	Stackpole	RMCF0603FT47R0
21	1	R5	Resistor, 100 Ω, 1%	Stackpole	RMCF0603FT100R
22	1	R9	RES SMD 0.0 Ω Jumper 1/16 W	Stackpole	RMCF0402ZT0R00
23	2	R19, R21	Resistor, 2.7 Ω, 5%, 1/10 W	Panasonic	ERJ-2GEJ2R7X
24	2	R20, R22	Resistor, 500 mΩ, 1%, 1/8 W	Yageo	PT0402FR-7W0R5L
25	1	R24	Resistor, 27 kΩ, 5%, 1/10 W	Panasonic	ERJ-2GEJ273X
26	1	R25	Resistor, 20 Ω, 5%, 1/16 W	Stackpole	RMCF0402JT20R0
27	2	J1, J22	Connector, .1" Male Vert.	Würth	61300211121
28	7	J2, J3, J4, J5, J6, J7, J8	Connector, .1" Male Vert.	Tyco	4-103185-0-04
29	2	TP1, TP2	SMT test point	Keystone	5015

Optional Components

| Item	Qty	Reference	Part Description	Manufacturer	Part Number
1	1	Cout	TBD	Generic	Generic
2	1	L1	TBD	Generic	Generic
3	3	R10, R14, R16	Resistor, 0 Ω, 1/10 W	Stackpole	RMCF0603ZT0R00
4	2	R6, R7	Resistor, 0.0 Ω, 1/16 W	Stackpole	RMCF0402ZT0R00
5	1	R18	Resistor, 4.7 Ω, 5%, 1/10 W	Panasonic	ERJ-2GEJ4R7X
6	3	J11, J12, J15	MMCX Connector Jack	Molex	734152063
7	1	J9	7.62 mm Euro Term.	Würth	691216410002
8	2	P1, P2	Trimmer, 1 kΩ, 1/4 W	Murata	PV37W102C01B00
9	1	D3	Schottky Diode, 40 V, 300 mA	ST	BAT54KFILM
10	2	D7, D8	Schottky Diode, 100 V, 2 A	Vishay	SS2PH10-M3
11	1	J10	Connector, .1" Male Vert.	Würth	61300211121
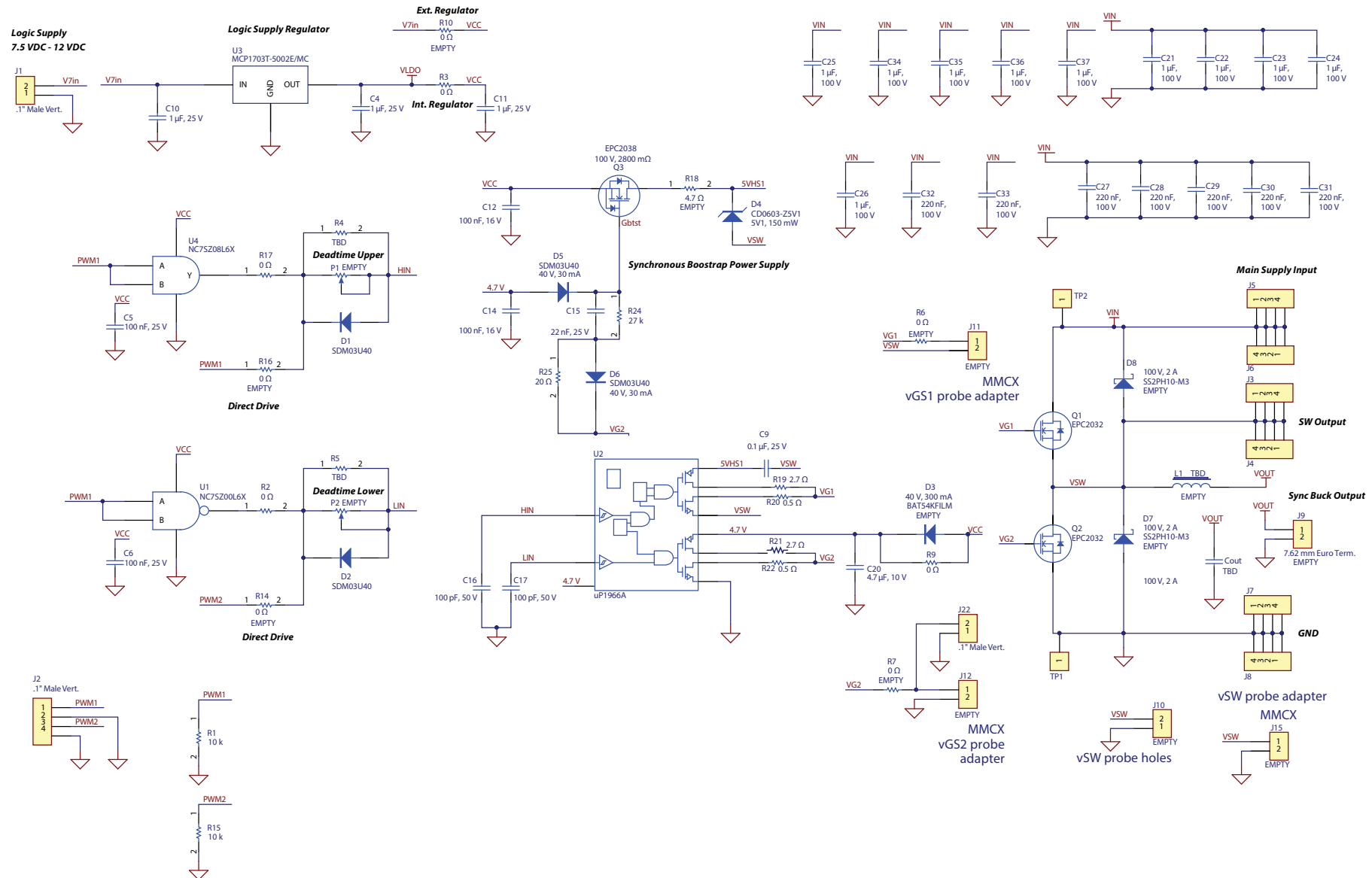
Figure 7: EPC9062 schematic

For More Information:

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