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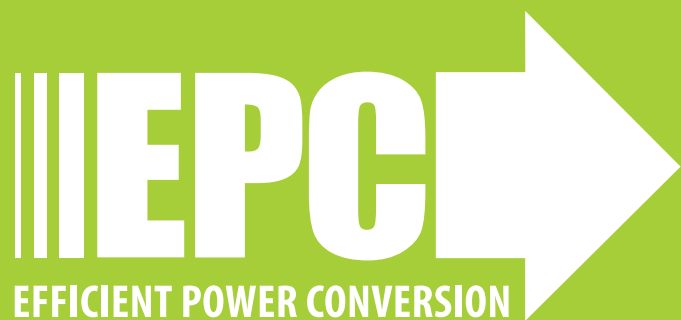
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Development Board EPC9204 Quick Start Guide

eGaN[®] IC Power Module, Using 30 V EPC2111

Revision 1.0



DESCRIPTION

The EPC9204 development board provides an eGaN IC based power module, featuring the EPC2111 eGaN® IC (Enhancement-mode Gallium Nitride Integrated Circuit). The purpose of this development board is to simplify the evaluation process of the EPC2111 eGaN IC by including all the critical components on a single board that can be easily connected into any existing converter.

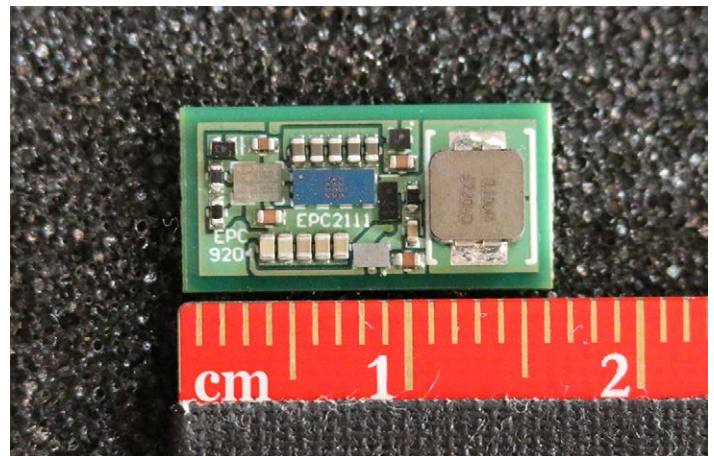
The ultra-low profile EPC9204 development board is 8 mm x 16 mm x 2 mm and contains an EPC2111 eGaN IC in combination with the Peregrine Semiconductor PE29102 gate driver. The board also contains all critical components and layout for optimal switching performance. A block diagram of the circuit is given in Figure 1.

For more information on the EPC2111 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

Development board EPC9204 is easy to set up to evaluate the performance of the EPC2111 eGaN IC. Refer to Figure 10 for pin descriptions, and follow the procedure below:

1. With power off, connect the input power supply bus to +V_{IN} and ground / return to PGND.
2. With power off, connect +V_{OUT} to your circuit as required.
3. With power off, connect the gate drive input to +V_{CC} and ground return to AGND.
4. With power off, connect the input PWM control signal to PWM and ground return to AGND.
5. Turn on the gate drive supply – make sure the supply is between 4.5 V and 5.5 V range.
6. Turn on the controller / PWM input source.
7. Turn on the bus voltage to the required value (do not exceed the absolute maximum voltage).
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.

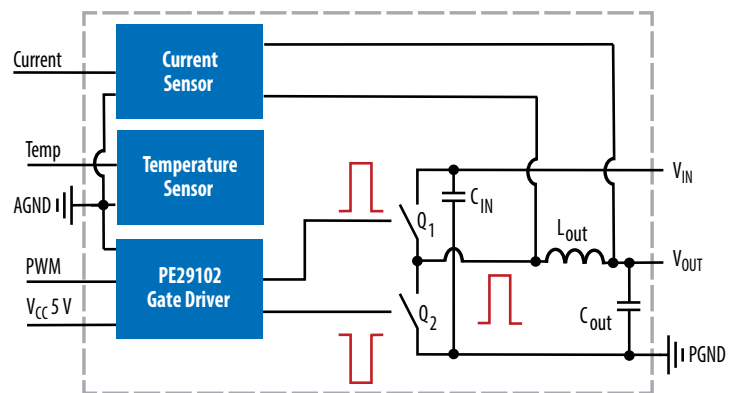


EPC9204 Top View

Table 1: Performance Summary (T_A = 25°C) EPC9204

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V _{CC}	Gate Drive Input Supply Range		4.5	5	5.5	V
V _{IN}	Bus Input Voltage Range (1)			12	20	V
I _{OUT}	Switch Node Output Current (2)			10		A
f _{sw}	Target Switching Frequency			5		MHz
V _{PWM}	PWM Logic Input Voltage Threshold	Input 'High' Input 'Low'	1.6 0		5 0.6	V V
	Minimum 'High' State Input Pulse Width	V _{PWM} rise and fall time < 10 ns	5			ns

(1) Maximum switch node ringing must be kept under 30 V for EPC2111.
 (2) Maximum current depends on die temperature – actual maximum current will be subject to switching frequency, bus voltage and thermal cooling.



Note: AGND and PGND are tied on the EPC9205 and do not need to be tied externally

Figure 1. Block Diagram of EPC9204 Development Board.

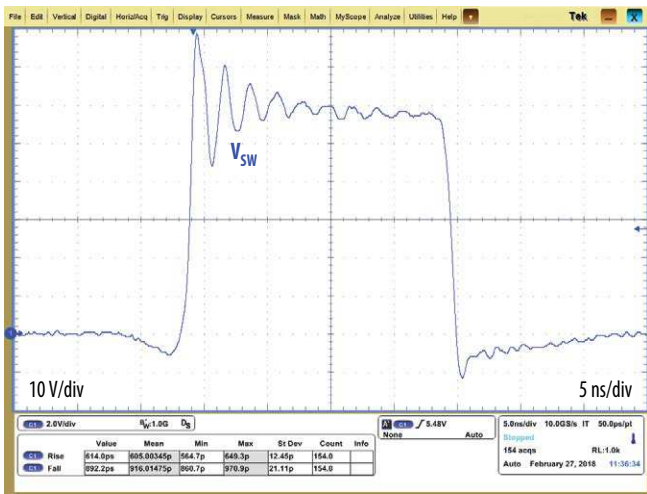
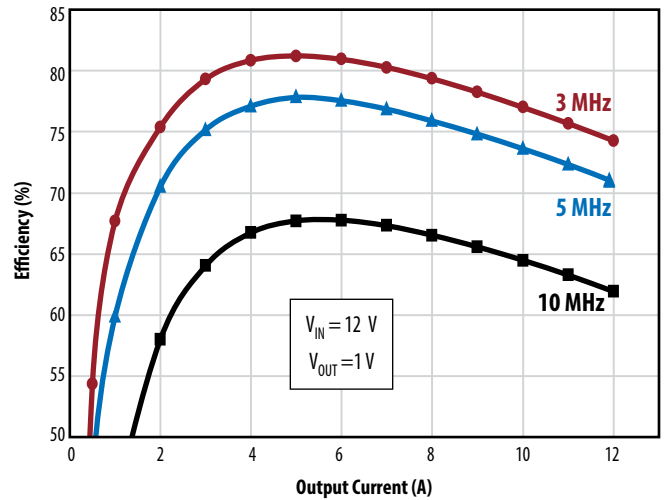


Figure 2: Typical Waveform for $V_{IN} = 12\text{ V}$ to 1 V_{OUT} , 10 A, 5 MHz Buck Converter



Note: Total system efficiency including power stage, inductor, driver, capacitors, and PCB losses.

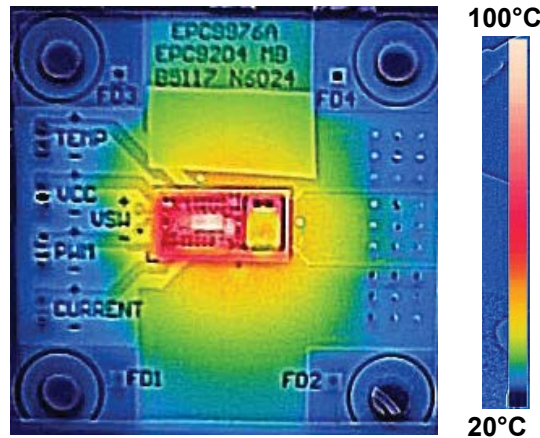
Figure 3: Typical System Efficiency for $V_{IN} = 12\text{ V}$ to 1 V_{OUT} Buck Converter

THERMAL CONSIDERATIONS

The EPC9204 development board showcases the EPC2111 eGaN IC. The EPC9204 is intended for bench evaluation. 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. An example thermal image is shown in Figure 4 for typical operating conditions.

For more information regarding the thermal performance of EPC eGaN FETs and ICs, 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.



Note: Max eGaN FET case temperature = 98°C

Figure 4: Thermal image for $V_{IN} = 12\text{ V}$ to 1 V_{OUT} , 10 A, 5 MHz, 300 LFM airflow.

CURRENT & TEMPERATURE SENSING

The EPC9204 includes on-board output current and temperature sensing, using the Maxim MAX9929 current-sense amplifier and TI LMT70 precision analog temperature sensor, respectively. The output voltage characteristics of these two sensors on the EPC9204 are shown in Figure 5 and Figure 6.

Note: The on-board temperature sensor reflects the temperature of the PCB. The relationship between sensor output voltage and eGaN FET temperature may vary with operating conditions and thermal design, and it should be calibrated for a given test setup. Figure 6 shows an example of this calibration curve in one test case.

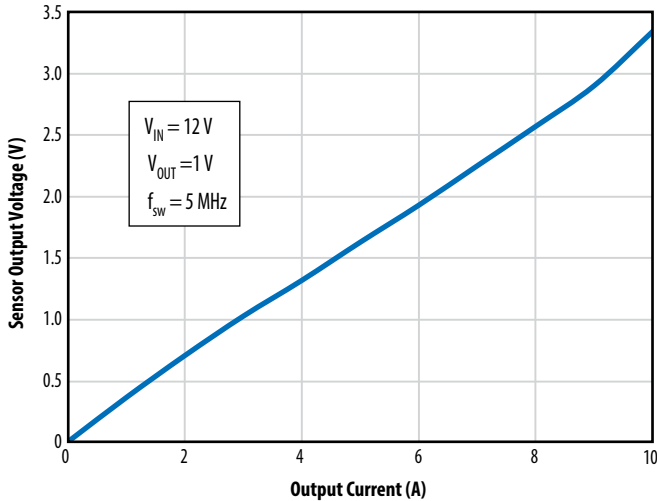


Figure 5: Typical Current Sensor Output Curve for EPC9204 Development Board with $V_{IN} = 12\text{ V}$ to 1 V_{OUT} , 5 MHz

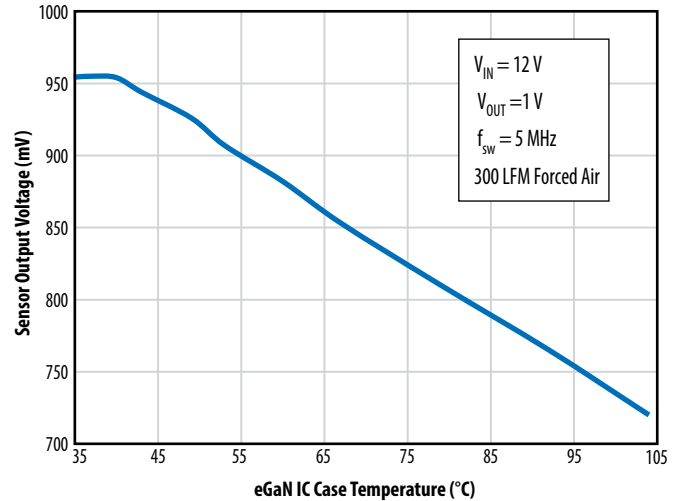


Figure 6: Example Temperature Sensor Output Curve for EPC9204 Development Board with $V_{IN} = 12\text{ V}$ to 1 V_{OUT} , 5 MHz, 300 LFM Forced Air Cooling

DESIGN CONSIDERATIONS

To improve the electrical and thermal performance of the EPC9204 development board, some design considerations are recommended:

1. Large copper planes should be connected to the development board to improve thermal performance as shown in Figures 7 and 8. If filled vias are used in the board design, thermal vias should be placed under the device to better distribute heat through buried inner layers. For a design without filled vias, thermal vias should be located outside of the development board.
2. The gate return ground connection (pin 2 in mechanical drawings), is connected on the EPC9204 board and should be isolated from the power ground connection (pins 8, 11, 14, 17, 20 in mechanical drawings).
3. If additional input filter capacitance is required, it can be placed outside the module. Due to the internal on-board input capacitance, minimizing the distance of the additional input capacitors to the development board, while preferred, is not a design requirement.

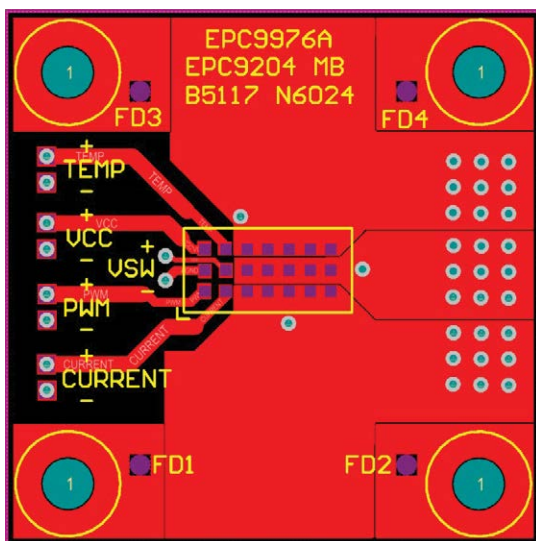


Figure 7: Top layer without filled thermal vias.

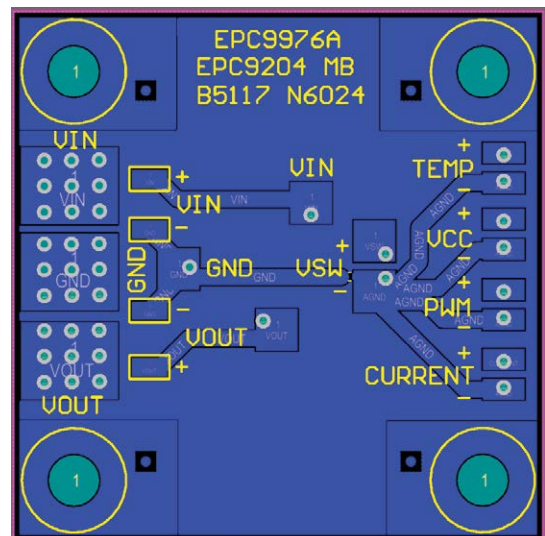
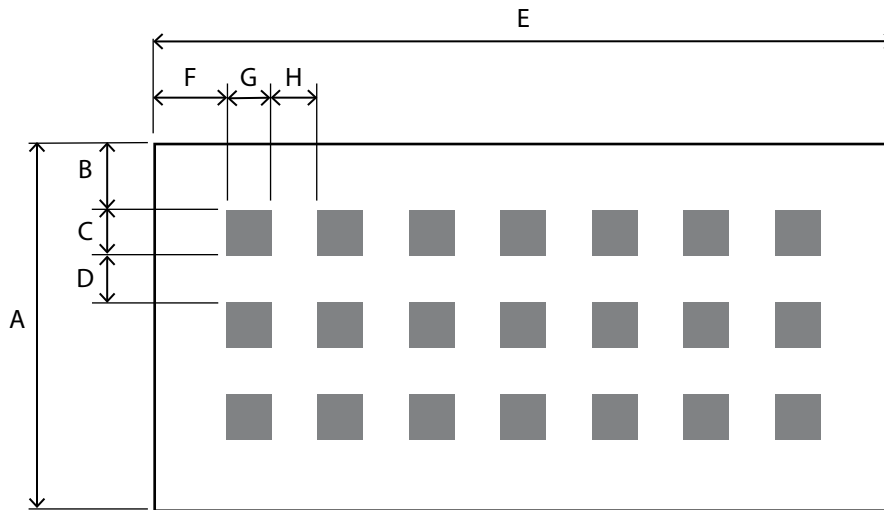


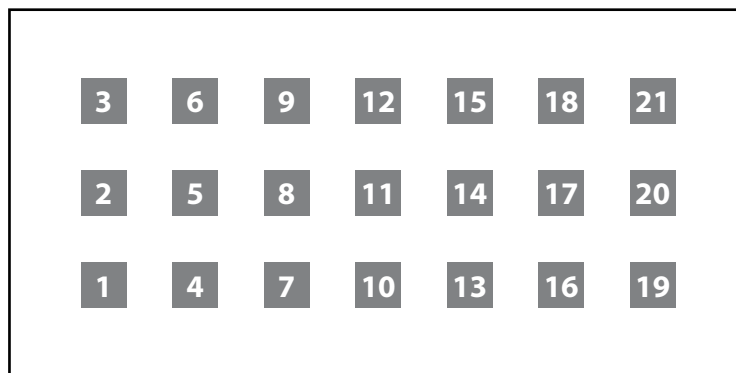
Figure 8: Bottom layer layout.

MECHANICAL DATA



Symbol	Dimension
A	8 mm
B	1.5 mm
C	1 mm
D	1 mm
E	16 mm
F	1.5 mm
G	1 mm
H	1 mm

Figure 9: Footprint mechanical outline and pin numbering. (Top view)



Pin	Type
1	PWM
2	AGND
3	V _{CC}
4	Current
5	NC – Leave open
6	Temp
8, 11, 14, 17, 20	PGND
7, 10, 13, 16, 19	V _{OUT}
9, 12, 15, 18, 21	V _{IN}

Figure 10: Pin Descriptions. (Top view)

Table 2: Bill of Materials

Item	Qty	Reference	Part Description	Manufacturer	Part #
1	5	CIN1, CIN2, CIN3, CIN4, CIN5	Cap, ceramic, 2.2 µF, 25 V, X5R, 0402	TDK	C1005X5R1E225M050BC
2	1	QHB	eGaN half bridge IC, 30 V	EPC	EPC2111
3	1	CB	Cap, ceramic, 0.1 µF, 25 V, X5R, 0402	TDK	C1005X5R1E104K050BC
4	3	CD, CDT, CDCS	Cap, ceramic, 1 µF, 25 V, X5R, 0402	TDK	C1005X5R1E105K050BC
5	1	U1	Gate Drive IC, half bridge	Peregrine	PE29102
6	5	COUT1, COUT2, COUT3, COUT4, COUT5	Cap, ceramic, 22 µF, 6.3 V, X5R, 0402	Samsung	CL05A226MQ5QUNC
7	1	D1	Diode, Schottky, 40 V, 200 mA	Diodes Inc	BAS40LP-7
8	1	L1	Inductor, 0.1 µH, 20%, 11.5 A	Vishay	IHLP1616ABERR10M01
9	1	U3	Current sense amplifier IC	Maxim	MAX9929FABT+T
10	1	U2	Temperature sensor IC, analog	TI	LMT70YFQT
11	1	R4	Res, 59 k, 1%, 1/10 W, 0402	Panasonic	ERJ-2RKF5902X
12	1	R5	Res, 35.7 k, 1%, 1/16 W, 0402	Stackpole	RMCF0402FT35K7
13	1	DQA	Diode, Schottky, 30 V, 2 A	Diodes Inc	SDM2U30CSP-7
14	1	CS	Cap, ceramic, 10 nF, 16 V, X7R, 0402	AVX	0402YC103JAT2A
15	1	RS	Res, 1.65 k, 0.1%, 1/16 W, 0402	Panasonic	ERA-2AEB1651X

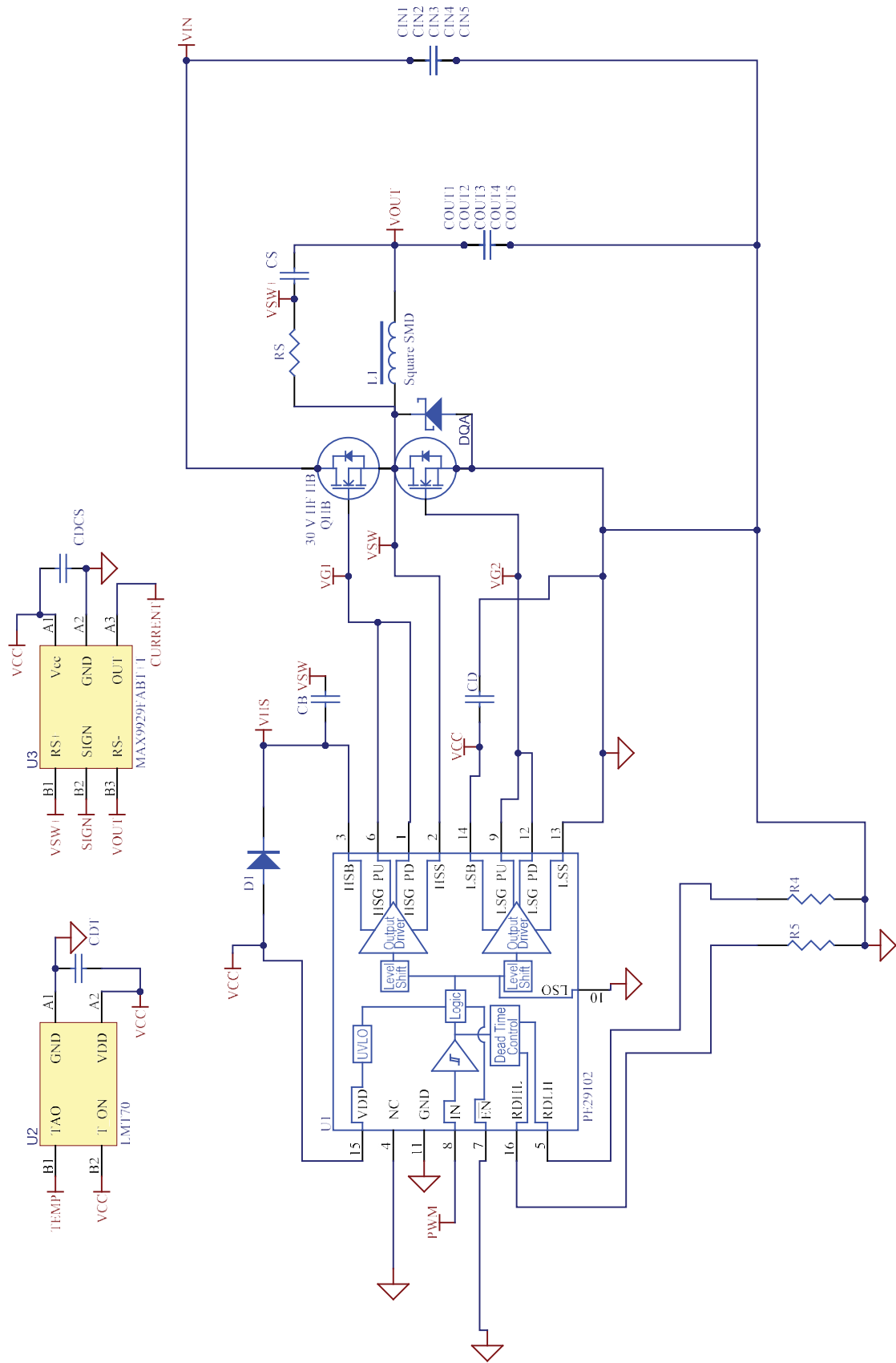


Figure 11: EPC9204 schematic

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The EPC9204 board is intended for product evaluation purposes only and is not intended for commercial use. 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.

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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