Demonstration System EPC9514 Quick Start Guide

6.78 MHz, 27 W, 19 V Regulated Wireless Power Receiver using EPC2016C

Revision 1.0

EFFICIENT POWER CONVERSION

DESCRIPTION

The EPC9514 demonstration board is a 6.78 MHz (Lowest ISM band) highly resonant wireless power receiver capable of delivering up to 27 W as a 19 V regulated output when operating to the AirFuel™ standard (excluding the BLE communications). This board is intended to power products such as small laptops when used in a wireless power system.

The EPC9514 includes a Category 5 AirFuel Alliance compliant device coil and circuit with high frequency Schottky diode based full bridge rectifier, DC smoothing capacitor and 19 V regulator. The regulator is based on a SEPIC converter that features a 100 V EPC2016C eGaN® FET. The power circuit is attached to the coil. A photo of the EPC9514 is shown in figure 1.

For more information on the EPC2016C eGaN FETs, 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) EPC9514

Symbol	Parameter	Conditions	Min	Max	Units
V_{Unreg}	Un-regulated output voltage		12.5	48	V
I_{Unreg}	Un-regulated output current			1.4*	A
V_{Unreg_UVLOR}	UVLO Enable	Un-regulated voltage rising		25	V
V_{Unreg_UVLOF}	UVLO Disable	Un-regulated voltage falling	12.5		V
V_{OUT}	Output Voltage Range	V_{Unreg_min} = 8.3 V	18.75	19.25	V
I_{OUT}	Output Current Range	V_{Unreg_min} = 8.3 V	0	1.4*	A

** Actual maximum current subject to operation temperature limits.*

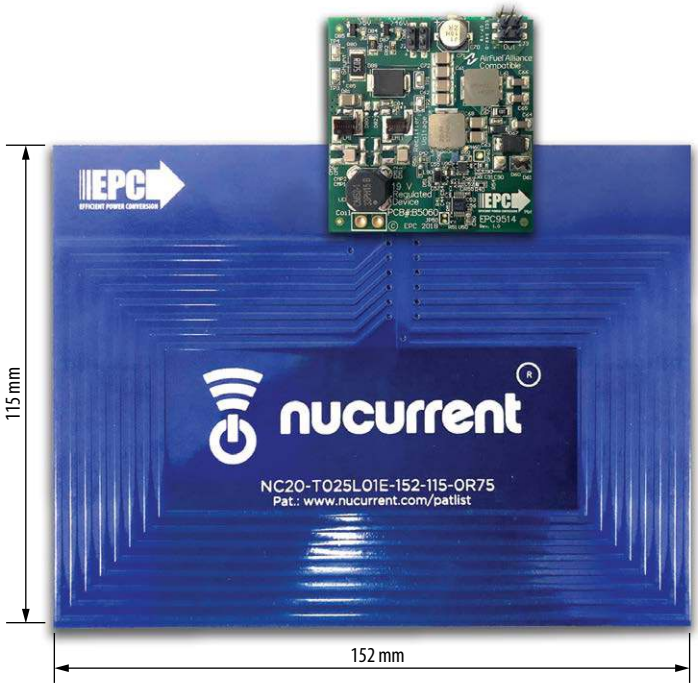

Figure 1: EPC9514 demonstration system.

DETAILED DESCRIPTION

The schematic diagram of the EPC9514 is shown in Figure 2 and comprises a tuning circuit for the device coil with a common-mode choke for EMI suppression, a high frequency rectifier and SEPIC based output regulator. The EPC9514 is powered using a Category 5 AirFuel compliant device coil and by default is tuned to 6.78 MHz for the specific coil provided with it. The tuning circuit comprises both parallel and series tuning which is also differential to allow balanced connection and voltage reduction for the capacitors.

Two LEDs have been provided to indicate that the board is receiving power with an un-regulated voltage greater than 4 V (green LED) and the red LED will illuminate when the un-regulated voltage exceeds 44 V.

The EPC9514 has limited over-voltage protection using a TVS diode that clamps the un-regulated voltage to 46 V. This can occur when the receive coil is placed above a high power transmitter with insufficient distance to the transmit coil and there is little or no load connected. During an over-voltage event, the TVS diode will dissipate a large amount of power and the red LED will illuminate indicating an over-voltage. The receiver should removed from the transmitter as soon as possible to prevent the TVS diode from over-heating.

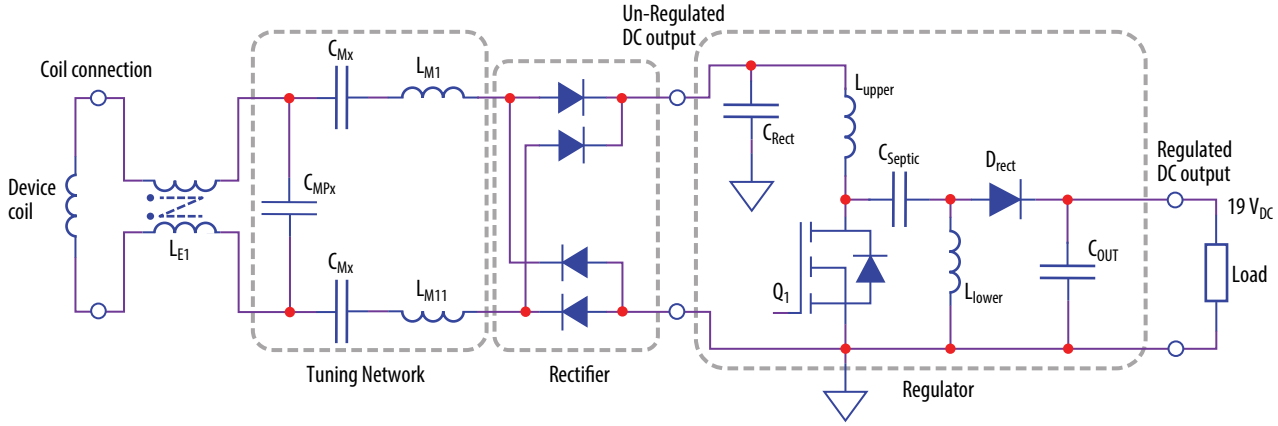

Figure 2: Schematic diagram of the EPC9514 demo board.

DETAILED DESCRIPTION (continued)

The EPC9514 can be operated with or without the regulator. The regulator can be disabled by inserting a jumper into position JP50 and connecting the load directly to the unregulated output terminals. In regulated mode, the design of the EPC9514 controller will ensure stable operation in a wireless power system. The regulator operates at 300 kHz and the controller features over current protection that limits the current drawn by the regulator to 2 A.

The EPC9514 device boards come equipped with kelvin connections for easy and accurate measurement of the un-regulated and regulated output voltages. The rectified voltage current can also be measured using the included shunt resistor. In addition, the EPC9514 has been provided with a switch-node measurement connection for low inductance connection to an oscilloscope probe that yield reliable waveforms.

The EPC9514 is designed to operate in conjunction with EPC9120 and EPC9129 (33 W EPC9512) transmitter units.

Figure 3 shows the proper connection method to the EPC9514.

QUICK START PROCEDURE

The EPC9514 demonstration system is easy to set up and evaluate the performance of the eGaN FET in a wireless power transfer application. Refer to Figure 3 for proper connection and measurement setup before following the testing procedures.

The EPC9514 can be operated using any one of two alternative methods:

a. Using the regulator

b. Bypassing the regulator

a. Operation using the regulator

In this mode, the regulator is used to provide a fixed output voltage of 19 V for the wireless power receiver and will limit the output current to 1.4 A.

1. Make sure the entire system is fully assembled (this includes the wireless power transmitter) prior to making electrical connections and make sure jumper JP50 is NOT installed. Connect the load to the regulated output and connect all required instrumentation according to figure 3.
2. Power up the wireless power transmitter and observe that the EPC9514 receives power via the green LED, un-regulated voltage and output voltage.
3. Once operation has been confirmed, observe the output voltage and other parameters on the device board.
4. For shutdown, please follow steps in the reverse order.

b. Bypassing the regulator

In this mode, the regulator is disabled and the load connected directly to the un-regulated output of the board. There is no protection against over-current in this mode.

1. Make sure the entire system is fully assembled (this includes the wireless power transmitter) prior to making electrical connections and make sure jumper JP50 is installed. Connect the load to the un-regulated output and connect all required instrumentation according to figure 3.
2. Power up the wireless power transmitter and observe that the EPC9514 receives power via the green LED, un-regulated voltage and output voltage.
3. Once operation has been confirmed, observe the output voltage and other parameters on the device board.
4. For shutdown, please follow steps in the reverse order.

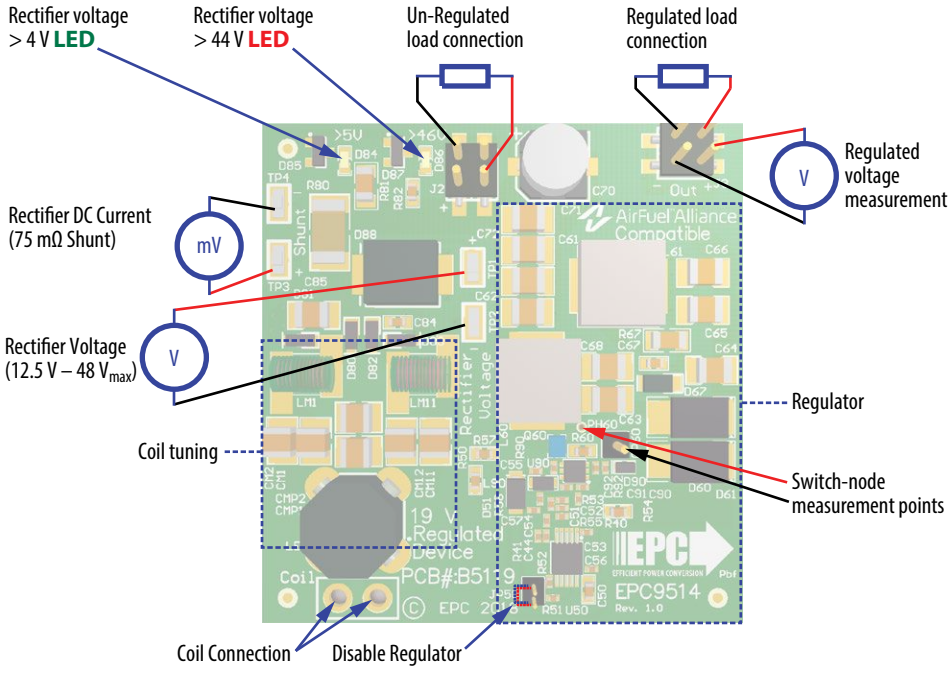

Figure 3: Proper connection and measurement setup for the receiver board.

MEASUREMENT NOTES

When measuring the high frequency content such as the switch-node, care must be taken to avoid long ground leads. An oscilloscope probe connection (preferred method) has been built into the board to simplify the measurement of the switch-node voltage (shown in Figure 3).

PRE-CAUTIONS

The EPC9514 demonstration system has limited enhanced protection systems (thermal and electrical) and therefore should be operated with caution. Some specific precautions are:

1. Never operate the EPC9514 receiver with a transmitter that is AirFuel compliant as this system does not communicate with the source to correctly setup the required operating conditions and doing so may lead to the failure. Please contact EPC at info@epc-co.com should operating the system with an AirFuel compliant device be required to obtain instructions on how to do this.
2. There is no heat-sink on the devices and during experimental evaluation it is possible present conditions to the regulator that may cause the device to overheat. Always check operating conditions and monitor the temperature of the EPC devices using an IR camera.
3. Never connect the EPC9514 device board into your VNA in an attempt to measure the input impedance. Doing so can severely damage the VNA.
4. Exercise caution when handling the coil while in operation as high RF voltages are present and can lead to RF burns.
5. Please contact EPC at info@epc-co.com should the tuning of the coil be required to change to suite specific conditions so that it can be correctly adjusted for use with this board.

THERMAL CONSIDERATIONS

The EPC9514 demonstration system showcases the EPC2016C eGaN FETs in a wireless energy transfer application. Although the electrical performance surpasses that of traditional silicon devices, their relatively smaller size does magnify the thermal management requirements. The operator must observe the temperature of the gate driver and eGaN FET to ensure that both are operating within the thermal limits as per the datasheets.

Table 2: Rev 1.0 Bill of Materials

Item	Qty	Reference	Part Description	Manufacturer	Part #
1	1	C44	100 pF, 25 V	Würth	885012205038
2	1	C50	100 nF, 100 V	Murata	GRM188R72A104KA35D
3	4	C51, C56, C57, C91	100 nF, 16 V	Würth	885012205037
4	1	C53	220 pF, 50 V	Murata	GRM155R71H221KA01D
5	2	C55, C90	1 µF, 25 V	TDK	C1005X5R1E105M050BC
6	6	C61, C62, C63, C68, C71, C72	10 µF, 50 V	Taiyo Yuden	UMK325BJ106MM-T
7	3	C64, C65, C66	22 µF, 35 V	TDK	C3216JB1V226M160AC
8	1	C67	10nF, 200 V	Kemet	C0603C103K2RACTU
9	1	C70	10 µF, 50 V	Nichicon	UZR1H100MCL1GB
10	1	C84	100 nF, 50 V	Murata	GRM188R71H104KA93D
11	1	C85	10 µF, 50 V	Taiyo Yuden	UMK325BJ106MM-T
12	1	C92	22 pF, 50 V	Würth	885012005057
13	2	CM1, CM11	390 pF	Vishay	VJ1111D391KXLAJ
14	1	Coil	Receive Coil	NuCurrent	NC20-T025L01E-152-115-0R75
15	1	D51	30 V, 500 mA	ST	STPS0530Z
16	1	D60	100 V, 5 A	Diodes	PDS5100-13
17	1	D67	200 V, 1 A	Diodes Inc.	DFLS1200
18	4	D80, D81, D82, D83	60 V 1 A	Diodes Inc.	PD3S160-7
19	1	D84	LED 0603 Green	Lite-On	LTST-C193KGKT-5A
20	1	D85	2.7 V, 250 mW	Nexperia	BZX84-C2V7,215
21	1	D86	LED 0603 Red	Lite-On	LTST-C193KRKT-5A
22	1	D87	43 V, 250 mW	Nexperia	BZX84-C43,215
23	1	D88	44 V, 51.6 A	Littelfuse	SMDJ36A
24	1	GP60	.1" Male Vert.	Würth	61300111121
25	2	J2, J3	.1" Male Vert.	Amphenol FCI	95278-101A04LF

(continued on next page)

Table 2: Rev 1.0 Bill of Materials (continued)

Item	Qty	Reference	Part Description	Manufacturer	Part #
26	1	JP50	.05" 2 pos Male Vert	Sullins	GRPB021VWVN-RC
27	2	L60, L61	22 µH, 4.3A	Vishay Dale	IHLP3232DZER220M11
28	1	L90	10 µH, 150 mA	Taiyo Yuden	LBR2012T100K
29	1	LE1	25 µH, 5.3 A	Eaton	CMS2-1-R
30	2	LM1, LM11	82 nH	Würth	744912182
31	1	Q60	100 V, 11 A, 16 mΩ	EPC	EPC2016C
32	1	R40	84.5 kΩ 1%	Panasonic	ERJ-3EKF8452V
33	1	R41	6.04 kΩ	Panasonic	ERJ-2RKF6041X
34	1	R50	10 Ω	Panasonic	ERJ-3EKF10R0V
35	1	R51	124 kΩ 1%	Panasonic	ERJ-2RKF1243X
36	1	R52	56.2 kΩ 1%	Yageo	RC0402FR-0756K2L
37	1	R53	2.32 kΩ	Yageo	RC0402FR-072K32L
38	1	R54	300 Ω	Yageo	RC0402JR-07300RL
39	1	R57	2.49 MΩ 1%	Yageo	RC0603FR-072M49L
40	1	R58	150 kΩ 1%	Panasonic	ERJ-2RKF1503X
41	1	R60	22 mΩ, 0.4 W	Vishay Dale	WSLP0603R0220FEB
42	1	R67	10 kΩ, 5% 2/3 W	Panasonic	ERJ-P08J103V
43	1	R80	75 mΩ, 1 W	Stackpole	CSRN2512FK75L0
44	1	R81	4.7 kΩ	Stackpole	RMCF1206FT4K70
45	1	R82	422 Ω	Yageo	RMCF0603FT422R
46	1	R90	2 .2 Ω	Yageo	RC0402JR-072R2L
47	1	R92	20 Ω	Stackpole	RMCF0402JT20R0
48	4	TP1, TP2, TP3, TP4	SMD probe loop	Keystone	5015
49	1	U50	Boost Controller	Texas Instruments	LM3481MM/NOPB
50	1	U90	Gate Driver with LDO	Texas Instruments	UCC27611DRV

Table 3: Optional Components

Item	Qty	Reference	Part Description	Footprint
1	1	D61	100 V 5 A Diode	PowerDI5 / SMB

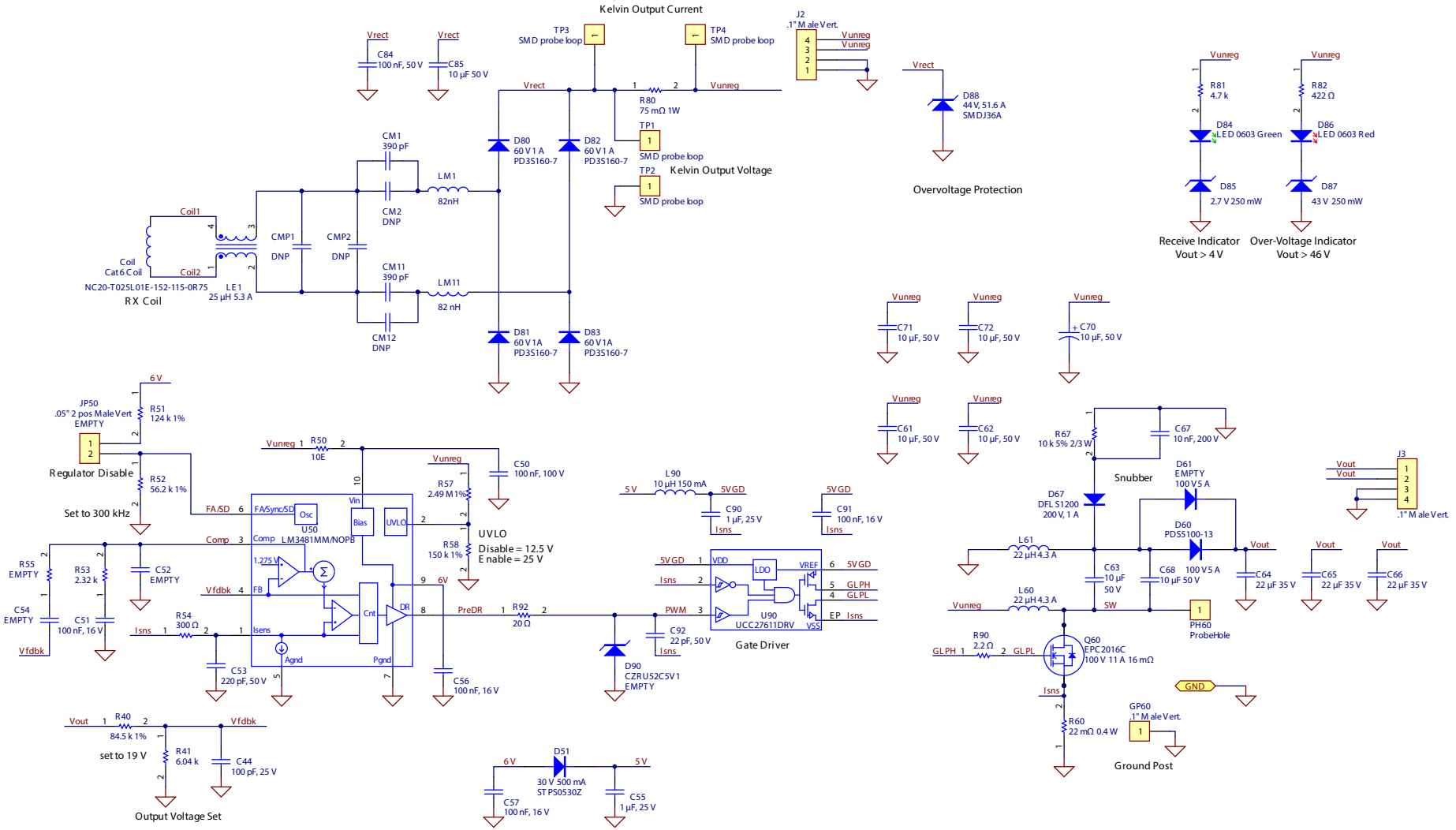

Figure 4: EPC9514 Receiver schematic.

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The EPC9514 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.

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