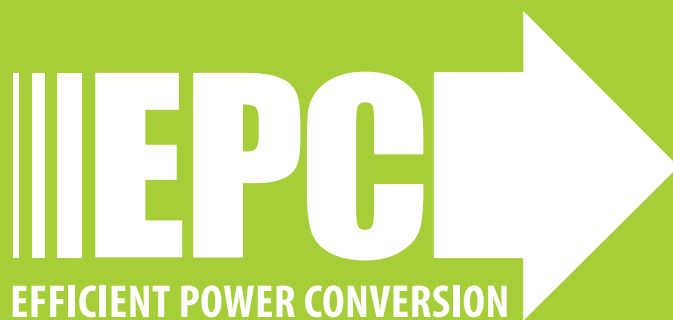


Development Board EPC9156 Quick Start Guide

EPC21603

40 V, 10 A High Current Pulsed Laser Diode Driver

Revision 1.0



DESCRIPTION

The EPC9156 development board is primarily intended to drive laser diodes with short, high current pulses. Capabilities include minimum pulse widths of < 2 ns, peak currents > 10 A, and bus voltage rating of 30 V. The board is shipped with an EPC21603 eGaN® IC. The EPC21603 monolithically integrates an ultrafast eGaN gate driver with and a 10 A, 40 V eGaN FET in one tiny 6-bump BGA IC. The EPC9156 ships with the EPC9989 interposer board. The EPC9989 is a collection of break-away 5 mm x 5 mm square interposer PCBs with footprints for different lasers, RF connectors, and a collection of other footprints designed for experimentation with different loads. The use of the interposers allows many different lasers or other loads to be mounted on the EPC9156. Laser diodes or other loads are not included, and must be supplied by the user.

The EPC9156 combines EPC21603 eGaN IC with a printed circuit board with inputs, outputs, and test points in order to evaluate and demonstrate the capabilities of the IC and connected load. The printed circuit board is designed to minimize the power loop inductance while maintaining mounting flexibility for the laser diode or other load. It includes multiple on-board passive probes for voltages and is equipped with MMCX connections for input and sensing. The EPC21603 IC requires a 5 V VDD supply, but is designed to interface with high-speed LVDS signals. Finally, the board can also be used for other applications requiring a ground-referenced eGaN FET, e.g. Class E amplifiers, boost converters, or similar. A complete block diagram of the circuit is given in Figure 1, and a detailed schematic in Figure 6.

For more information on the EPC21603 eGaN IC, 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.

SETUP AND OPERATION

Development board EPC9156 is easy to set up to evaluate the performance of the EPC21603 eGaN IC. Refer to Figure 2 for proper connect and measurement setup and follow the procedure below:

1. Review laser safety considerations. Observe all necessary laser safety requirements including the use of personal protection equipment (PPE) as required. Refer to qualified safety personnel as necessary.
2. With power off, install laser diode U2 or other load. The use of one of the interposers from the included EPC9989 may be used to mount the laser or other load, and this is discussed in the section **LASER DIODE AND LOAD CONSIDERATIONS** for further information.
3. With power off, connect the input power supply bus to +V_{BUS} (J8) and ground / return to -V_{BUS} (J8) or GND.
4. With power off, connect the logic supply (5.1-1.2 V_{DC}) to +V_{Logic} (J9) and ground return to -V_{Logic} (J9) or GND.
5. With power off, connect the signal pulse generator to the inputs J3 and J4, which are the IN+ and IN- inputs to the eGaN IC U2. J3 and J4 expect an LVDS input and have a differential termination of 100 Ω at the input of the EPC21603 IC (U2). If you are unfamiliar with LVDS signal levels, please refer to an appropriate reference, such as **LVDS Application and Data Handbook** published by Texas Instruments.
6. Connect the remaining measurement MMCX outputs to an oscilloscope, using 50 Ω cables and with the scope inputs set to 50 Ω impedance. See section **MEASUREMENT CONSIDERATIONS** for more information, including the attenuation values for each output. **Note that the current sensing output is not functional for this board revision.**
7. Turn on the logic supply voltage to a value within the specification.
8. Turn on the bus voltage to a value within the specification.

Table 1: Performance Summary (T_A = 25°C) EPC9156

Symbol	Parameter	Conditions	Min	Nom	Max	Units
V _{Logic}	Gate drive and logic supply		5.5		12	V
V _{BUS}	Bus input voltage range		0		30*	
I _{LOAD}	Output load current				10**	A
Z _{IN}	Input impedance	J3 input		50		Ω
V _{INPUT}	Input pulse range	LVDS input required for proper operation	0		5	V
F _{INPUT}	Input pulse frequency		0	50	150***	MHz
T _{Pin}	Input pulse width		2		500	ns

* The voltage rating of the EPC21603 eGaN IC is 40 V. The extremely fast switching transitions may result in ringing. It is the responsibility of the user to ensure that the peak voltage does not exceed the rating.

** This is the EPC21603 rating, and does not account for heat generated by the load. It is the responsibility of the user to ensure that operating temperatures are within component specifications.

*** The EPC21603 is specified to have a 100 MHz maximum operating frequency, but in many cases can operate at a much higher frequency.

SAFETY WARNING: This board is capable of driving laser diodes to generate high power optical pulses. Such pulses are capable of causing **PERMANENT VISION DAMAGE AND BLINDNESS as well as additional injury or property damage**. Laser diodes may emit infrared (IR) light that is invisible to the user, but which can still cause **PERMANENT VISION DAMAGE AND BLINDNESS as well as additional injury or property damage**. User is fully responsible for following proper laser safety procedures to prevent injury or damage.

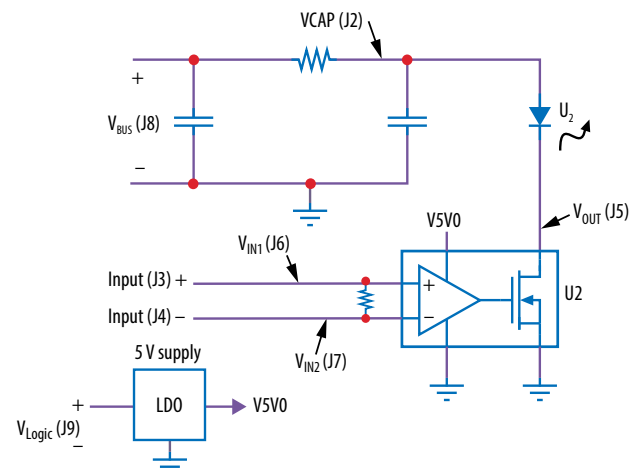


Figure 1: Block diagram of EPC9156 development board

9. Turn on the pulse source and observe switching operation via the outputs and any additional desired probing. Laser diode output may be observed with an appropriate electro-optical receiver.
10. Once operational, adjust the bus voltage, input pulse width, and pulse repetition frequency (PRF) as desired within the operating range and observe the system behavior.
11. For shutdown, please follow steps in reverse.

NOTE: This circuit contains nodes with very fast edges and with voltages one or two orders of magnitude higher than standard logic signals. Standard methods and probes for power circuits will normally not provide accurate results and may disrupt circuit operation. Please consider probe choice and use carefully. See **EPC measurement applications note**.

other load. The EPC9989 is updated as new lasers or loads become available, so Figure 4 may not show the latest board. Figure 5 shows an example of an Excelitas SMD laser diode mounted with one of the interposers.

Finally, a ground pad is made available for those who wish to use the board for alternative applications.

The recommended use of the interposer is the following:

1. Apply solder paste to the U1 pads on the EPC9156 PCB.
2. Apply solder paste to the appropriate pads on the top side of the interposer.
3. Place the desired interposer with the bottom side facing the top side of the EPC9156 on the U2 footprint, making sure the pads on the bottom of the interposer align with the footprint on top of the EPC9156 PCB.
4. Place the laser diode or desired load on the interposer, making sure the pads on the bottom of the laser or load align with the footprint on top of the interposer PCB.
5. Reflow the entire assembly with the recommended temperature profile for the solder used. The use of a reflow oven that can meet the recommended soldering specifications is highly recommended. Other reflow methods may also be used based on the experience of the user.

The power loop inductance, including that of the laser diode, is a primary factor that determines the shape of the laser pulse. Considerable effort has been made to minimize power loop inductance while maximizing the choice of laser diode and its orientation. The discharge caps, laser diode or other load, and the eGaN FET must all be mounted in close proximity to each other in order to minimize inductance. As a result, the user must take care not to damage any components when mounting the laser or changing other components in the power loop.

The EPC9156 is capable of driving laser diodes with current pulses can result in peak powers of several tens of watts of optical power. Laser diodes for lidar applications are designed with this in mind, but thermal limitations of the laser package mean that pulse widths, duty cycles, and pulse repetition frequency limitations must be observed. Read laser diode data sheets carefully and follow any manufacturers' recommendations.

MEASUREMENT CONSIDERATIONS

MMCX jacks are provided to measure several voltages in the circuit, including EPC21603 IC input (J6) and output (J5) voltages, and the charge voltage of the energy storage cap (J2). All measurement points are designed to be terminated in 50 Ω, hence when viewing waveforms, the oscilloscope inputs should be set to a 50 Ω input. Ideally, unused inputs should be also terminated with a 50 Ω load to prevent the probes from creating additional resonances. The output voltage and the discharge cap sense voltage have on-board terminations to greatly reduce this effect, and in practice, the remaining resonances are small enough to ignore in most applications. It is recommended that the user verify this for their own requirements.

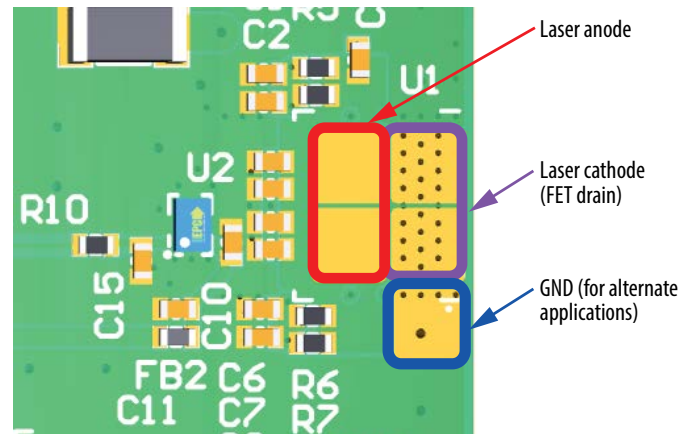


Figure 3: Output terminals of the EPC9156

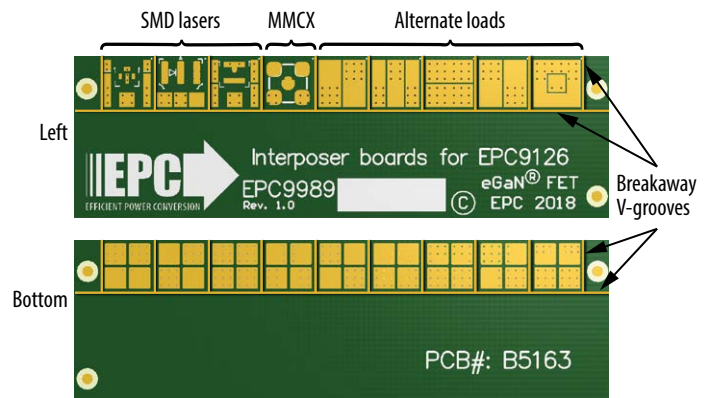


Figure 4: EPC9989 interposer. Note that this board is revised as needed to accommodate new lasers and other loads as needed, so the picture may not show the latest revision.

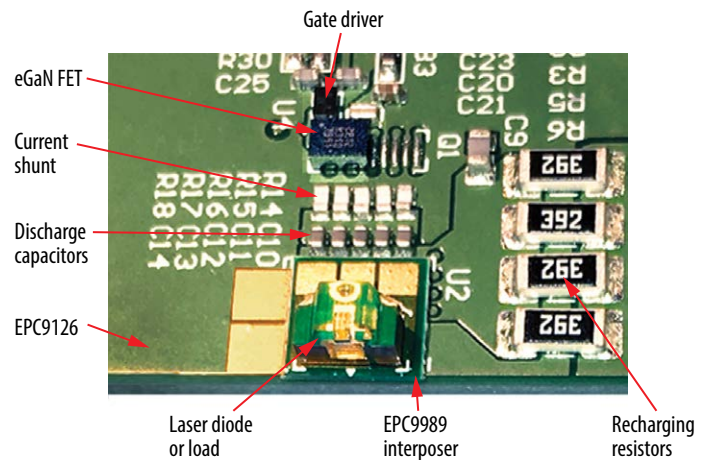


Figure 5: Laser diode mounting on output terminals with interposer. Please note that the photograph is of the EPC9126 demo board, but the same interposers and footprints apply to the EPC9156.

All sense measurement MMCXs, except for the shunt measurement (J1), use the transmission line probe principle to obtain waveform fidelity at sub-ns time scales. They have been verified to produce near-identical results to a Tektronix P9158 3 GHz transmission line probe. As a result of their design, they have a built-in attenuation factor. The impedance of the probes at the measurement node is relatively small (~ 1 kΩ). In order to minimize the effects of the low probe impedance on the operation of the demo board, the output voltage (J5) and capacitor voltage (J2) probes have DC blocking capacitors. As a result, measured pulse waveforms will exhibit droop as pulse widths are increased. The user should keep these factors in mind if accustomed to more conventional oscilloscope probes.

Rev. 1 of the EPC9156 does not include a current shunt, therefore the current shunt output J1 is not used at this time. A future revision may include this functionality.

Table 2 summarizes the properties of the MMCX test points for ease of reference.

NOTE. The EPC9156 demonstration board does not have any thermal protection on board.

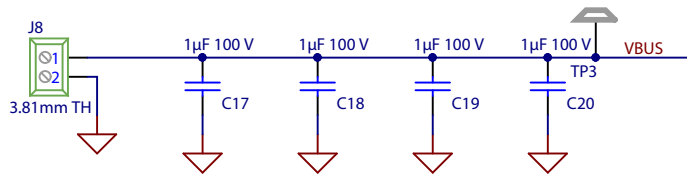
Table 2: Key properties of the MMCX test points for ease of reference

Designator	PCB label	Description	Attenuation factor	Internal 50 Ω termination	Attenuation factor
J2	CAP	Bus capacitor voltage (VCHARGE on schematic)	41 V/V	YES	YES
J1	SHUNT	Not used	Not used	Not used	Not used
J5	V _{OUT}	U2 output voltage	41 V/V	YES	YES
J6	V _{IN1}	U2 input voltage IN+	20 V/V	NO	NO
J7	V _{IN2}	U2 input voltage IN-	20 V/V	NO	NO

Table 3: Bill of Materials - EPC9156

Item	Quantity	Reference	Part Description	Manufacturer	Manufacturer Part #
1	1		PCB		
2	13	C1, C2, C3, C4, C6, C7, C8, C9, C10, C11, C12, C13, C16	CAP CER 0.1 μ F 50 V X7R 0402	TDK	C1005X7R1H104K050BB
3	3	C5, C14, C15	CAP CER 5 pF 50 V C0G 0402	TDK	C1005C0G1H050C050BA
4	4	C17, C18, C19, C20	CAP CER 1 μ F 100 V X7S 0805	TDK	CGA4J3X7S2A105K125AB
5	2	C21, C26	CAP CER 4.7 μ F 25 V X5R 0603	TDK	C1608X5R1E475K080AC
6	5	C22, C23, C24, C25, C27	CAP CER 1 μ F 50 V X7R 0603	Taiyo Yuden	UMK107AB7105KA-T
7	2	D1, D2	DIODE SCHOTTKY 100 V 200 mA SOD523	ST Microelectronics	BAT41KFILM
8	1	FB1	FERRITE BEAD 50 Ω 1206 12A 1LN	Murata	BLM315N500SN1L
9	1	FB2	FERRITE BEAD 330 Ω 0402 0.7 A 280 m Ω	TDK	MPZ1005S331ET000
10	7	J1, J2, J3, J4, J5, J6, J7		Molex	734152063
11	2	J8, J9	3.81 mm 2 pos. Euro Block	Tyco	1776113-2
12	8	MB1, MB2, MB3, MB4, MB5, MB6, MB7, MB8	5 hole Mouse Bites	N/A	N/A
13	1	Q1	100 V 73 m Ω 1.7 A	EPC	
14	1	R2	RES SMD 49.9 Ω 1% 1/10 W 0402	Panasonic	ERJ-2RKF49R9X
15	1	R3	RES SMD 0 Ω JUMPER 1/20 W 0201	Panasonic	ERJ-1GE0R00C
16	4	R4, R5, R6, R7	RES SMD 1 Ω 1% 1/5 W 0402	Vishay Dale	CRCW04021R00FKEDHP
17	2	R8, R15	RES SMD 1K Ω 1% 1/10 W 0402	Panasonic	ERJ-2RKF1001X
18	2	R9, R13	RES SMD 0 Ω JUMPER 1/16 W 0402	Yageo	RC0402JR-070RL
19	1	R10	RES SMD 1.8K Ω 1% 1/10 W 0402	Panasonic	ERJ-2RKF1801X
20	2	R11, R16	RES SMD 49.9 Ω 1% 1/20 W 0201	Yageo	RC0201FR-0749R9L
21	1	R12	RES SMD 100 Ω 1% 1/10 W 0402	Yageo	RC0402FR-07100RL
22	3	R14, R23, R24	RES SMD 1K Ω 1% 1/10 W 0402, RES SMD 0 Ω JUMPER 1/10 W 0402	Panasonic	ERJ-2RKF1001X, ERJ-2GE0R00X
23	2	R17, R18	RES SMD 953 Ω 1% 1/10 W 0402	Panasonic	ERJ-2RKF9530X
24	6	TP1, TP2, TP3, TP4, TP5, TP6		Keystone	5015
25	1	U2	40 V 10 A 60 m Ω FET with integrated driver, 5 V VDD LVDS logic in	EPC	EPC21603
26	1	U3	5.0 V 250 mA DFN	MicroChip	MCP1703T-5002E/MC
27	1	U4	Linear Regulator 3v3 500 mA 6-WSON (2x2)	Texas Instruments	TLV755XXPDRVR

Main Supply Input



Logic Supply

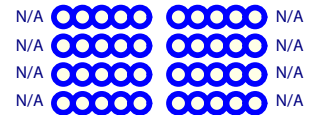
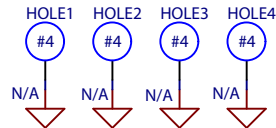
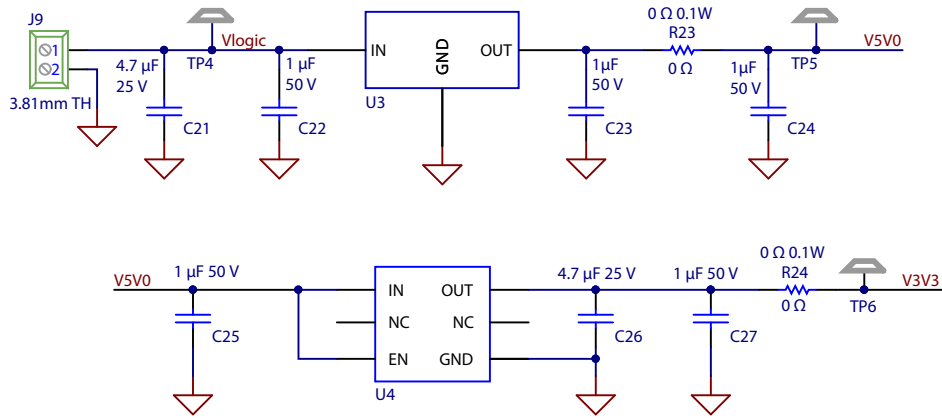


Figure 6: Schematic EPC9156 (part1)

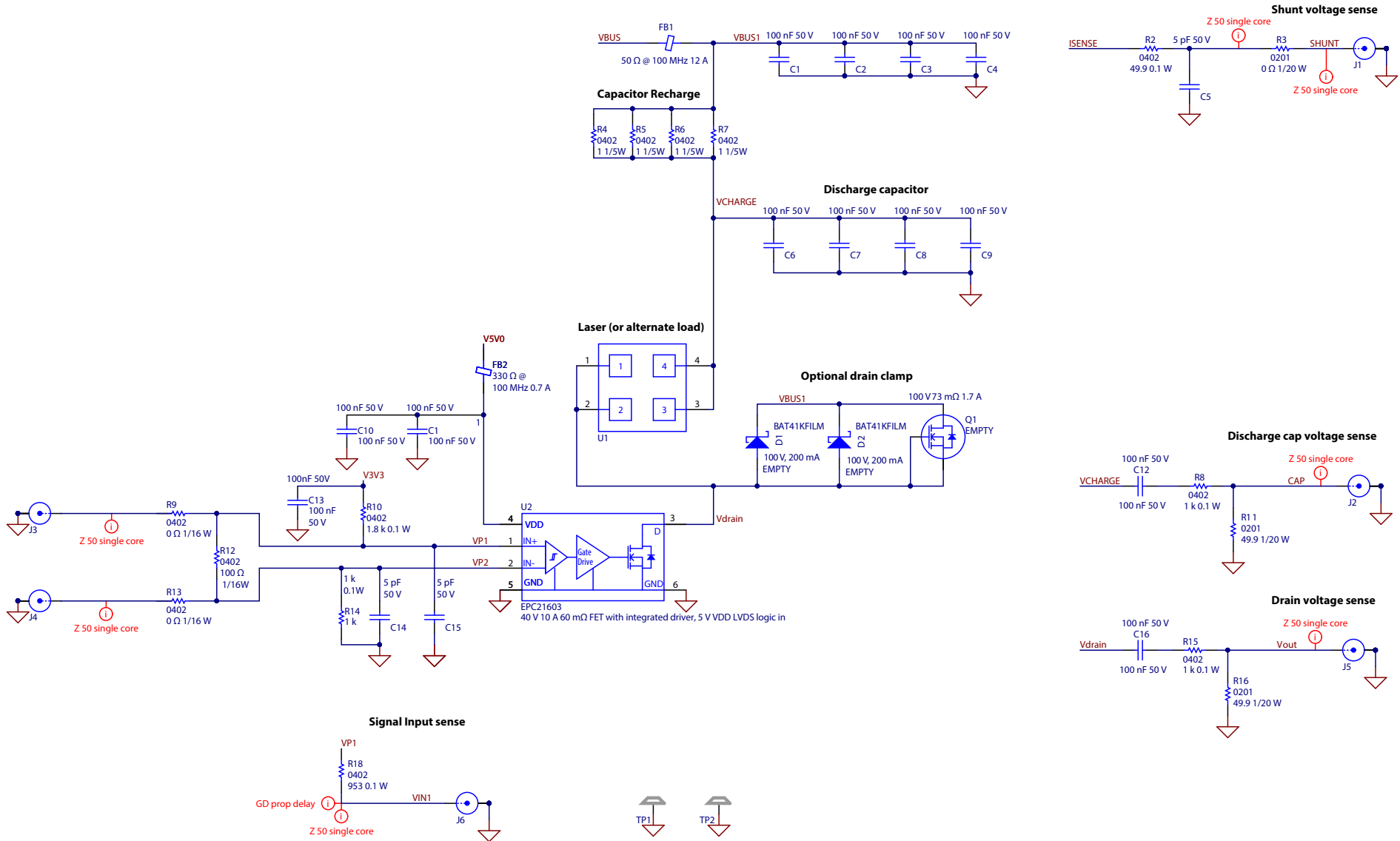


Figure 7: Schematic EPC9156 (part 2)

For More Information:

Please contact info@epc-co.com
or your local sales representative

Visit our website:
www.epc-co.com

Sign-up to receive
EPC updates at
bit.ly/EPCupdates
or text EPC to 22828



EPC Products are distributed through Digi-Key.
www.digikey.com

Demonstration Board Notification

The EPC9156 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.

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.

The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this Quick Start Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved.

Disclaimer: EPC reserves the right at any time, without notice, to make changes to any products described herein to improve reliability, function, or design. EPC does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, or other intellectual property whatsoever, nor the rights of others.