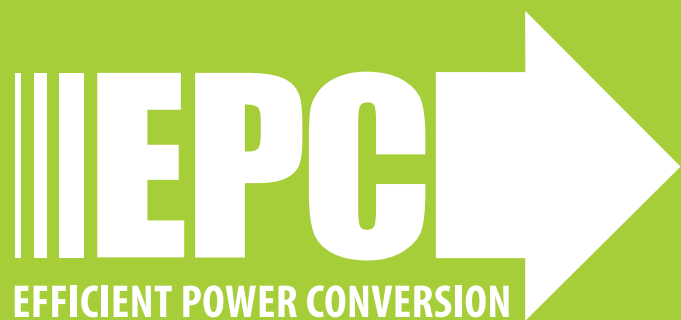


Evaluation Board EPC91132 Datasheet

*3-phase Inverter for Humanoid Robot Joints and Drone
Motors Featuring the EPC33110 3-phase ePower™ Stage*

May 26, 2026

Board EPC91132 Revision 1.1
Document Revision 1.0



FEATURED 3-Phase ePower™ Stage IC

The EPC91132 evaluation board features the EPC33110 3-Phase ePower™ Stage IC, which is a 100 V maximum voltage three-phase integrated power module shown in figure 2.

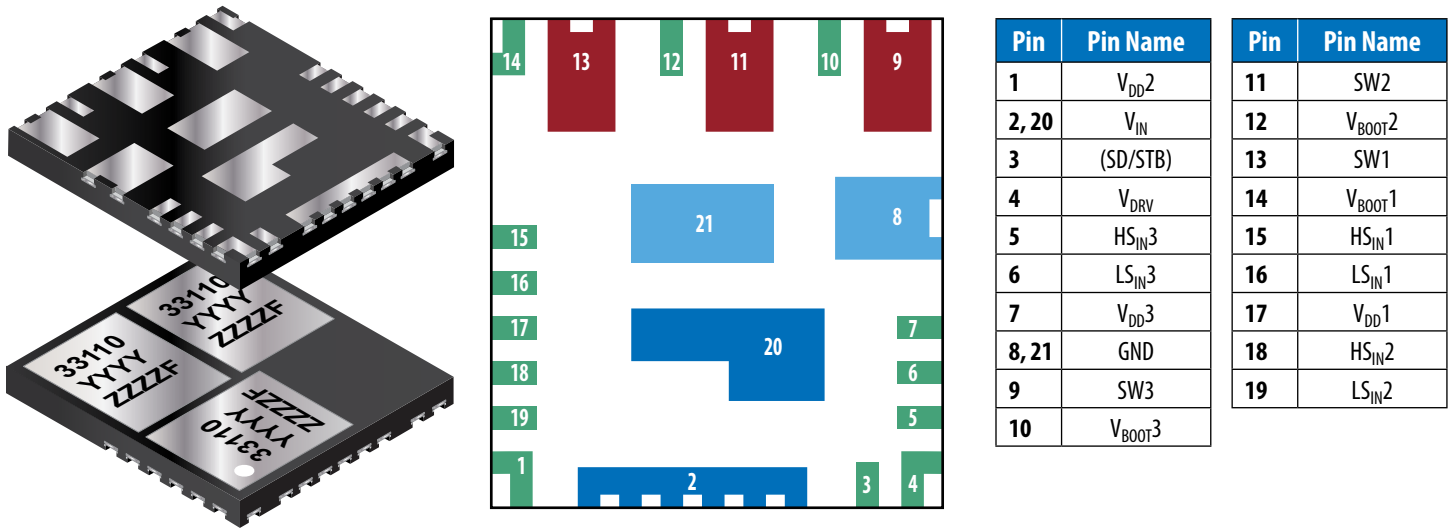


Figure 2: Pin assignments of the EPC33110

For additional details, refer to the [EPC33110 datasheet](http://www.epc-co.com) available at www.epc-co.com. The datasheet should be read in conjunction with this quick start guide.

OVERVIEW OF THE EPC91132 EVALUATION BOARD

Figure 3 shows an image of both sides of the EPC91132 evaluation board with the location of the various functional blocks highlighted.

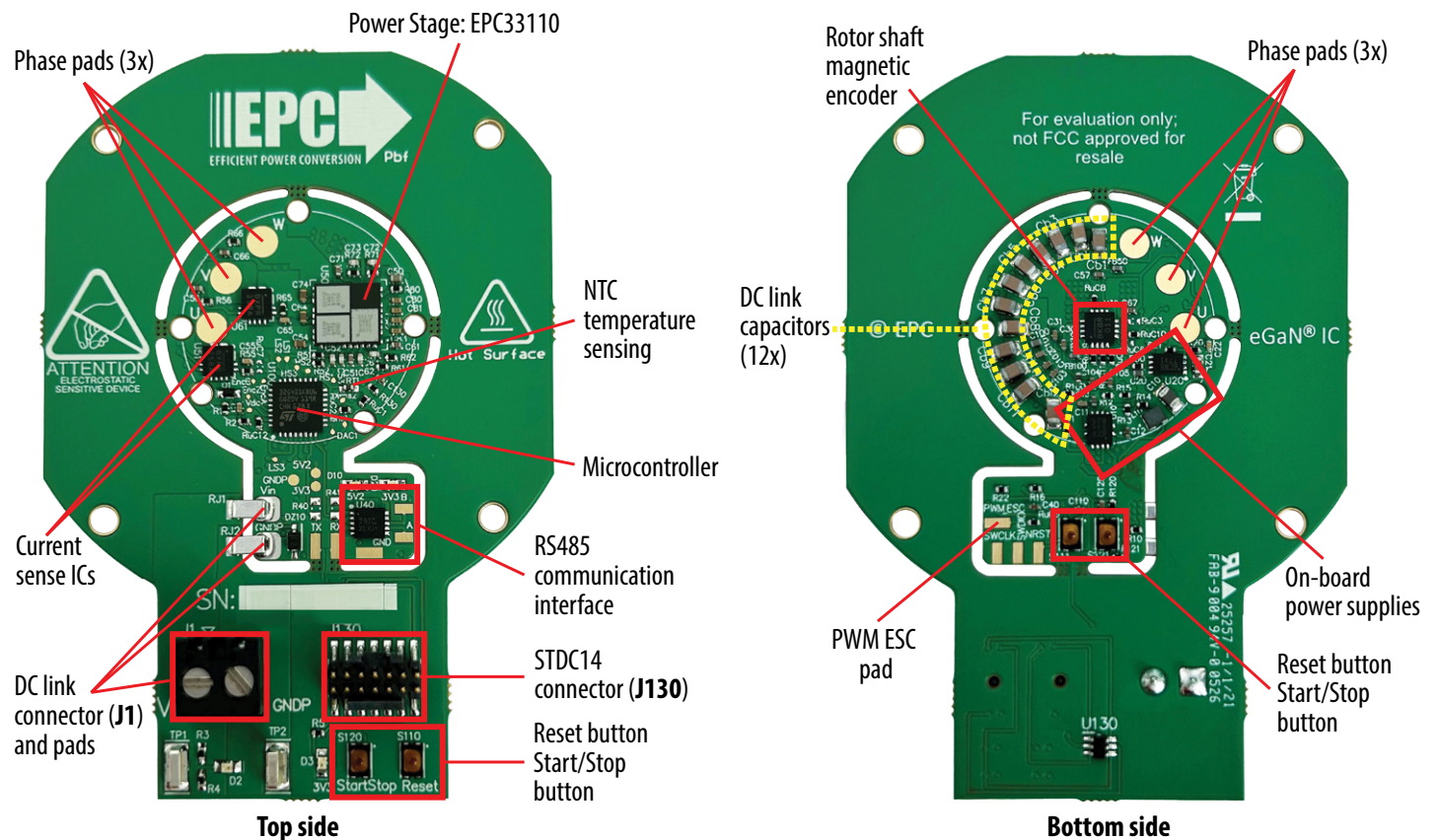
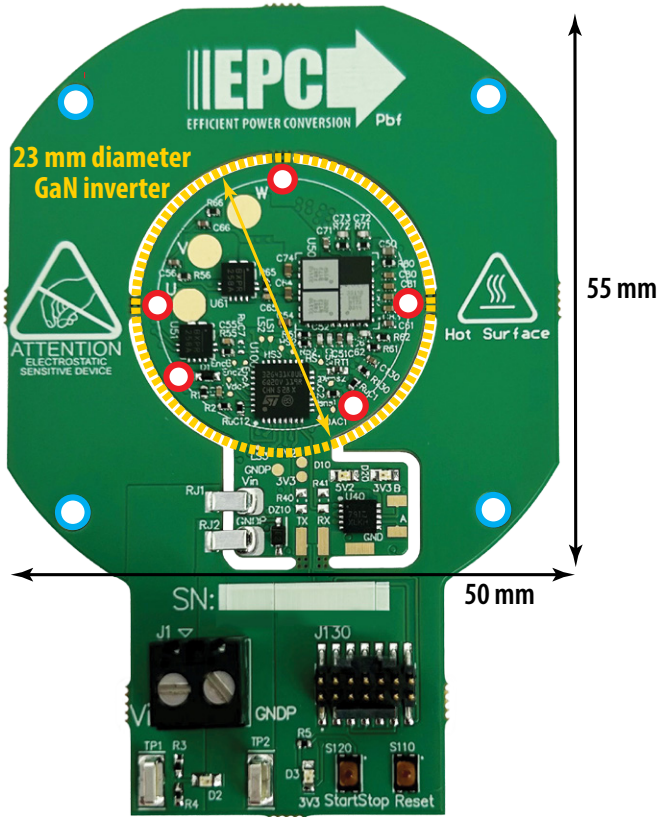


Figure 3: Top and bottom views of EPC91132

MECHANICAL OVERVIEW

Figure 4 shows the inverter located in a 23 mm diameter circle. The external PCB ring is meant for mechanical reasons to install the board into a specific humanoid joint motor and to place the connectors J130 and J1, which result useful for debugging the firmware and to do lab tests.

The EPC91132 is preprogrammed to operate the humanoid joint motor at 100 kHz, 20 ns, running at 100 rpm on the outer rotor, but different speed conditions can be set either by connecting to the real time GUI through the JTAG connector or by programming the microcontroller to communicate through the RS485 port.



- Screw holes (5x) for connecting the board to the drone motor chassis
- Screw holes (4x) for connecting the board to the humanoid joint motor chassis

Figure 4: Mechanical details of EPC91132

The EPC91132 board was shaped both a specific humanoid joint motor and a drone motor. The whole inverter is disposed in the 23 mm inner circle, while the external frame can be adjusted to fit in different motors. The design files are available on request from EPC website. Figure 5.a shows the EPC91132 inverter board mounted inside the stator of the humanoid joint motor, while figure 5.b shows the EPC91132 inverter board without outer PCB ring mounted in the drone motor.



Figure 5a: EPC91132 with outer PCB ring mounted in a humanoid joint motor

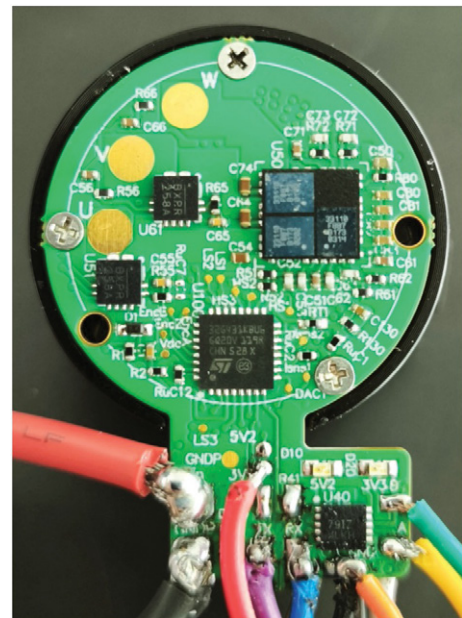


Figure 5b: EPC91132 mounted in a drone motor

HIGHLIGHTED PARTS OF THE EPC91132 CIRCUIT

Power Stage

The EPC91132 features the 3-phase module EPC33110. For more information on the EPC33110 please refer to the [datasheet available from EPC at \[www.epc-co.com\]\(http://www.epc-co.com\)](#). The datasheet of EPC33110 should be read in conjunction with this document.

Onboard Power Supply

The EPC91132 board includes house-keeping power supplies that are powered from the main input supply voltage to the inverter board. The 5.2 V supply is generated by a small DC-DC converter to supply the GaN FET ICs and LDO, which generates a 3.3 V that supplies the microcontroller, the current sensors, the magnetic encoder and RS485 interface chip.

A green LED is powered by the 5 V supply, a yellow LED is powered by the 3.3 V supply, and a red LED is powered by the main input supply voltage.

Current and Voltage Sense

The EPC91132 inverter is equipped with current sense for phases U and V and voltage sense for the DC input.

The output current of phases U and V is measured using the current sense IC MCS1823-330BRN, that has a sensitivity of 44 mV/A. The two sensors also feature an overcurrent detection circuit ($\pm 30A$) that are pulled up and connected to the microcontroller in a wired-OR configuration.

The main input DC supply voltage is measured using a resistor divider network that yields a total gain of 50.87 mV/V.

DC Link Capacitors

The entire DC link is made of MLCC capacitors and are dimensioned on the maximum RMS phase current that can be delivered by the board.

Rotor Shaft Magnetic Encoder

An encoder located in the center of the board detects the position of the magnet placed at the end of the rotor shaft. The encoder has a resolution of 1024 PPR (Pulses Per Revolution) and the Z index pin, if it is used as an incremental encoder with ABZ signals. The sensor can also be employed through an SPI port for configuring it or for directly reading the absolute position angle. By default, the incremental ABZ interface is configured in both hardware and firmware. For using the SPI interface, the motor control firmware must be adapted, and it is needed to mount RuC3 and RuC6 while RuC2 and RuC5 must be removed.

Microcontroller

The microcontroller provided on the board is the small 5x5 mm UFQFPN32 STM32G431KBU6. For deeper information on its complete functions, please visit ST microelectronics website. (www.st.com).

STDC14 Connector

The board doesn't include on-board programmer, for this reason an external programmer is needed available at these links:

- [STLINK-V3SET | Tool - STMicroelectronics](#)
- [STLINK-V3MINIE | Tool - STMicroelectronics](#)

The programmer can be connected to 14-pin connector on the board, so that the microcontroller can be programmed via SWD protocol. A serial communication is included on the connector. Via the STLINKV3 which acts as a USB-USART bridge, this communication is used to interface with Motor Pilot software.

RS485 Interface

The inverter is equipped with an RS485 port to meet the typical communication interface of humanoid robot motors. By default, USART communication is set, to use the RS485 interface it is needed to mount resistors R40 and R41, and the Hardware Flow Control (RS485) must be enabled during the microcontroller's configuration.

HARDWARE INFORMATION

Electrical Specifications

Table 1: Electrical specifications

Symbol	Parameter	Conditions	Min	Nom	Max	Units
V_{IN}	Input supply voltage		10	48	60	V
V_{IN_uvlo}	Input under voltage lockout voltage			4		
I_s	Standby current		23	33	46	mA
I_{Phase}	EPC91132 RMS phase current ⁽¹⁾			11	15	A_{RMS}
f_{sw}	Switching frequency		60	100	150	kHz
V_{Isns_range}	Phase current sense voltage dynamic range	-Imax to Imax	0		3.3	V
I_{sns_range}	Phase current sense dynamic range	Current sense IC gain: 44 mV/A	-37.5		37.5	A
I_{ovc}	Positive over-current threshold	Over-current circuits detects both positive and negative OVC		30		
V_{Isns_offset}	Amplified current sense signal offset voltage			1.65		V
G_{Isns}	Amplified current sense gain	Current sense IC MCS1823GQTE-330BRN		44		mV/A
G_{Vsns}	Phase and DC voltage sense gain ⁽²⁾			50.87		mV/V
SD_{Pull}	SDn pin Internal pull-up resistance ⁽³⁾	Pulled-up to V_{DRV}		50		k Ω
OCD_{Pull}	Current sensor overcurrent signal ⁽⁴⁾ OCDn pull-up resistance	External pull-up resistance to 3.3 V		100		
ENC_res	Encoder default resolution			1024		PRR

⁽¹⁾ Maximum current depends on die temperature – actual maximum current is affected by switching frequency, bus voltage and thermal cooling. Refer to thermal performance section in this guide and to EPC33110 data sheet for details.

⁽²⁾ **Maximum dynamic voltage range is 0 V to 65 V which exceeds maximum recommended input voltage of the 5.2 V housekeeping power supply**

⁽³⁾ SD signal is Active Low

⁽⁴⁾ OCD signal is Active Low

Microcontroller Pin Assignment

Table 2: EPC91132 controller pin map

Pin #	Function Name	Pin Name	Description	Type	Input/Output
1	3V3	VDD	Input supply voltage	Power	Input
2	PWML3	PF0-OSC_IN	Phase W low PWM signal	Digital	Output
3	Vdc	PF1-OSC_OUT	Vdc sense signal	Analog	Input
4	NRST	PG10-NRST	Reset pin	Digital	Input
5	Temp	PA0	NTC sense signal	Analog	Input
6	USART_DE	PA1	Driver Enable (DE) signal for RS485 communication	Digital	Output
7	USART_TX	PA2	Transmitter (TX) signal for USART/RS485 communication	Digital	Output
8	USART_RX	PA3	Receiver (RX) signal for USART/RS485 communication	Digital	Input
9	DAC_CH1	PA4	DAC Channel 1	Analog	Output
10	Isns1	PA5	Phase U current sense signal	Analog	Input
11 ^a	ODCn	PA6	Overcurrent detection signal	Digital	Input
11 ^b	SPI_MISO	PA6	SPI MISO signal	Digital	Input/Output
12	SPI_MOSI	PA7	SPI MOSI signal	Digital	Input/Output
13	Isns2	PB0	Phase V current sense signal	Analog	Input
14	GND	VSSA	Input analog supply voltage	Power	Input
15	3V3A	VDDA	Analog ground	Power	Input
16	GNDP	VSS_1	Power ground	Power	Input
17	3V3	VDD_2	Input supply voltage	Power	Input
18	PWMH1	PA8	Phase U high PWM signal	Digital	Output
19	PWMH2	PA9	Phase V high PWM signal	Digital	Output
20	PWMH3	PA10	Phase W high PWM signal	Digital	Output
21	PWML1	PA11	Phase U low PWM signal	Digital	Output
22	PWML2	PA12	Phase V low PWM signal	Digital	Output
23	SWDIO	PA13	SWD input/output signal	Digital	Input/Output
24	SWCLK	PA14	SWD clock signal	Digital	Input
25 ^a	PWM_ESC	PA15	PWM ESC control signal	Digital	Input
25 ^b	SPI_NSS	PA15	SPI NSS signal	Digital	Input/Output
25 ^c	OCDn	PA15	Overcurrent detection signal	Digital	Input
26	SPI_SCK	PB3	SPI clock signal	Digital	Input/Output
27	EncA	PB4	Encoder A signal	Digital	Input
28	EncB	PB5	Encoder B signal	Digital	Input
29	StartStop	PB6	Start/Stop button signal	Digital	Input
30	EncZ	PB7	Encoder Z signal	Digital	Input
31	BOOT0	PB8-BOOT0	GPIO pin/BOOT function	Digital	Input
32	GNDP	VSS_2	Power ground	Power	Input

11^a) default pin configuration; RuC2 mounted, RuC3 not mounted;

11^b) alternative pin configuration; RuC2 not mounted, RuC3 mounted; needed for SPI communication with the encoder

25^a) default pin configuration; RuC5 mounted, RuC6 not mounted; RuC7 not mounted; needed for PWM ESC control

25^b) alternative pin configuration; RuC5 not mounted, RuC6 mounted; RuC7 not mounted; needed for SPI communication with the encoder

25^c) alternative pin configuration; RuC5 not mounted, RuC6 not mounted; RuC7 mounted; needed for Overcurrent detection when 11^b) is used

Connection Information

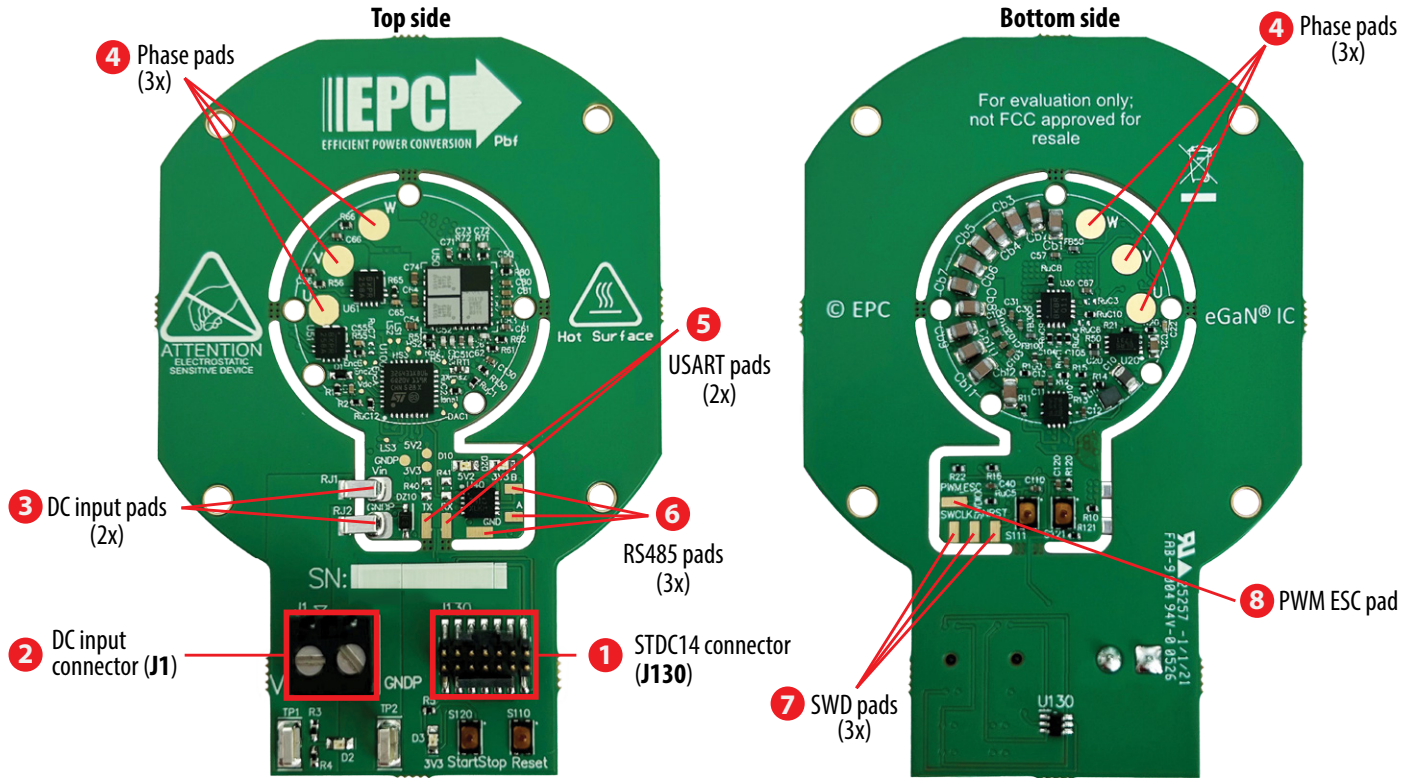


Figure 6: Connectors overview of EPC91132

1 STDC14 connector

J130 is a 14-pin connector of SAMTEC (PN: FTSH-107-01-L-DV-K-A-P) to interface STLINKV3 programmer to the microcontroller, for programming it via SWD protocol and for communicating with it through the USART interface.

2 DC input connector

The DC link connector J1 is a 2 position PCB terminal block, Header, Wire-to-Board, Through Hole (PN: 1776113-2) of TE Connectivity.

3 DC input Pads

The DC link can be interfaced through V_{IN} and GND pads directly soldering the wires for the DC input.

4 Phase Pads

The phase connections are made of U, V, W pads on the board where the connections can be soldered for the motor windings.

5 USART Pads

The USART communication with the microcontroller can be directly accessed through RX TX pads. **To use USART communication interface R40 and R41 must not be placed, but the RS485 communication will not be available**

6 RS485 Pads

The RS485 transceiver is interfaced through A, B, G pads. **To use RS485 communication interface mount R40 and R41, but the USART communication will not be available**

7 SWD Pads

The microcontroller can be directly programmed using SWDIO, SWCLK, NRST (optional) pads, especially when the EPC91132 inverter board is used without the outer PCB ring.

8 PWM ESC Pad

The PWM ESC pad can be used for sending to the microcontroller a PWM signal to set the motor speed, which is the standard method to control an ESC in drone applications.

PERFORMANCE

The EPC91132 motor drive inverter was tested in a steady state condition. This analysis was performed to outline the thermal performance of the board at different RMS phase currents delivered. The tests were carried out using a 24-48 V_{DC} supply voltage while switching at 60 kHz, 80 kHz, and 100 kHz, 20 ns dead-time setting and powering a 3 kW servo motor at 100 rpm.

Steady State Thermal Performance

The steady state thermal performance summary of the EPC91132 board is shown in Figure 7 and Figure 8. When operated on a motor bench at ambient temperature of 24°C, 100 kHz, 80 kHz and 60 kHz PWM frequency, 24 V_{DC} supply and natural convection cooling, the EPC91132 can deliver 7 A_{RMS} per phase without a heatsink with temperature increase below 80 °C from eGaN IC case to ambient. At the same condition EPC91132 can deliver 11 A_{RMS} per phase with the humanoid joint motor casing acting as a heatsink, in which the ICs were covered using a 1 mm-thick electrically non-conductive thermal interface material (PN: TG-A1780-20-20-1.0), keeping the temperature rise below 80°C from eGaN IC case to ambient.

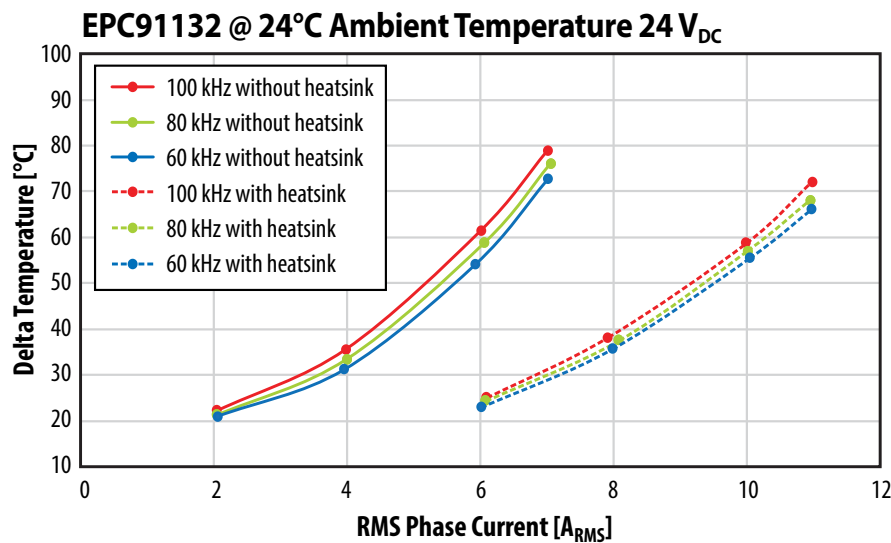


Figure 7: 24 V_{DC} EPC91132 eGaN IC temperature increase vs. the ambient temperature (24°C)

When operated on a motor bench at ambient temperature of 24°C, 100 kHz, 80 kHz, and 60 kHz PWM frequency, 48 V_{DC} supply and natural convection cooling, the EPC91132 can deliver 6 A_{RMS} per phase without a heatsink with temperature increase below 70 °C from eGaN IC case to ambient. At the same condition EPC91132 can deliver 10 A_{RMS} per phase with the humanoid joint motor casing acting as a heatsink, in which the ICs were covered using a 1 mm-thick electrically non-conductive thermal interface material (PN: TG-A1780-20-20-1.0), keeping the temperature rise below 70°C from eGaN IC case to ambient.

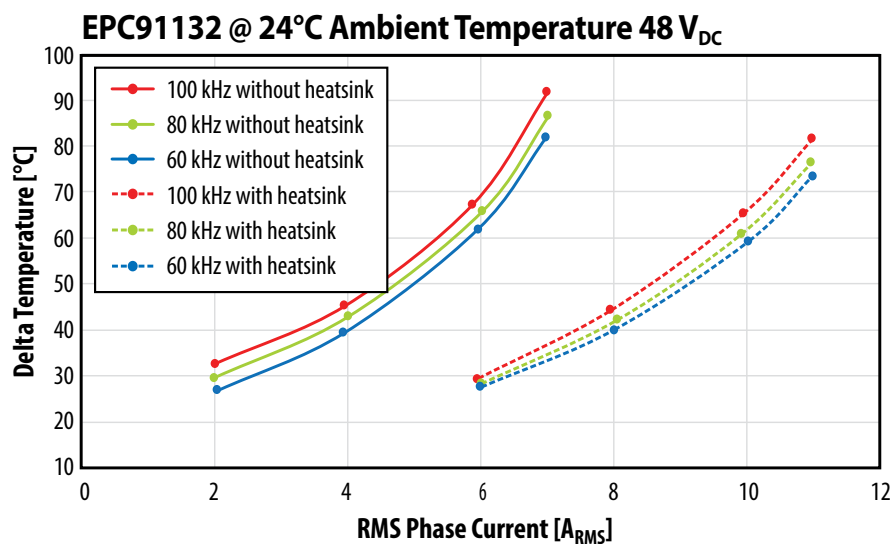


Figure 8: 48 V_{DC} EPC91132 eGaN IC temperature increase vs. the ambient temperature (24°C)

Figure 9 shows two examples of the thermal transient measured using a thermocouple in contact with the exposed top side of the EPC33110 during the steady state tests. It can be observed that after 10 minutes, the temperature becomes stable in both configurations, with and without the humanoid joint motor casing acting as a heatsink.

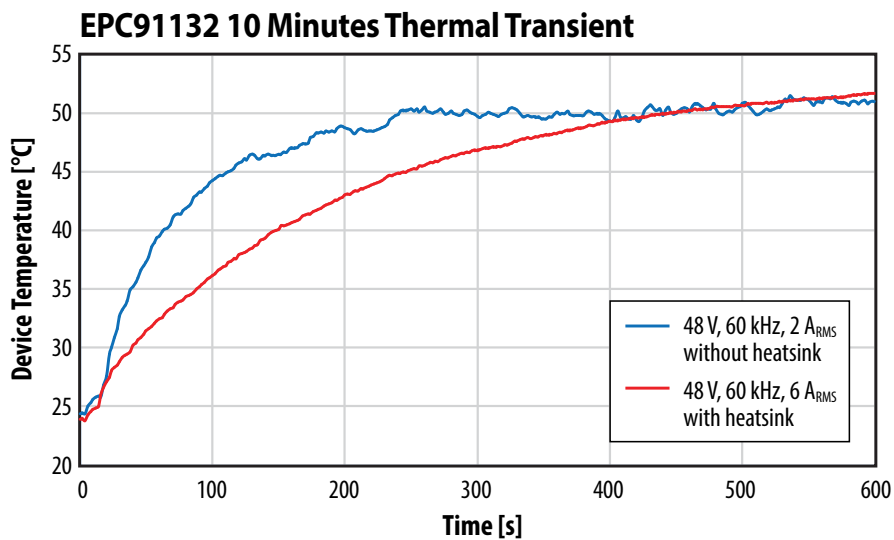


Figure 9: 48 V_{DC} EPC91132 eGaN IC thermal transient starting from 24°C ambient temperature

Pulsed Torque Operation

The pulsed torque tests were performed to emulate the performance of EPC91132 in applications subject to a dynamic operation. The tests were carried out connecting the humanoid motor to a hysteresis brake, which was controlled to generate load pulses with a period of 5 s. During these pulses, the phase current delivered by the EPC91132 reaches 15 A_{RMS}.

Similar to the steady state tests, the board was tested without a heatsink, but also using the humanoid joint motor casing as a heatsink. The thermal performance summary of the EPC91132 board during pulsed torque operation is shown in Figure 10, where it can be observed that the EPC33110 temperature rise mimics the steady-state traces.

An example of phase current waveforms is shown in Figure 11, which is referred to as a pulsed torque test at 20% pulse duty, with the humanoid joint motor casing acting as a heatsink.

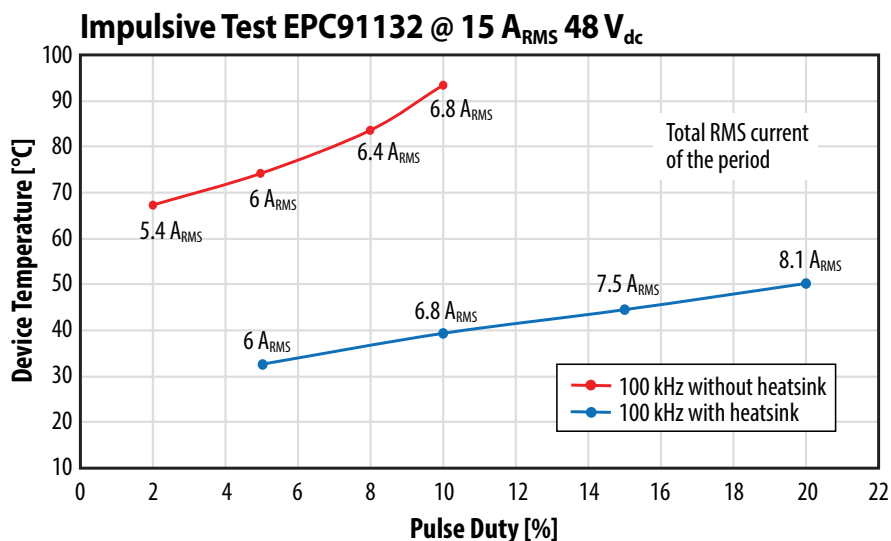


Figure 10: 48 V_{DC} EPC91132 eGaN IC temperature increase vs. the ambient temperature (24°C) during pulsed torque tests

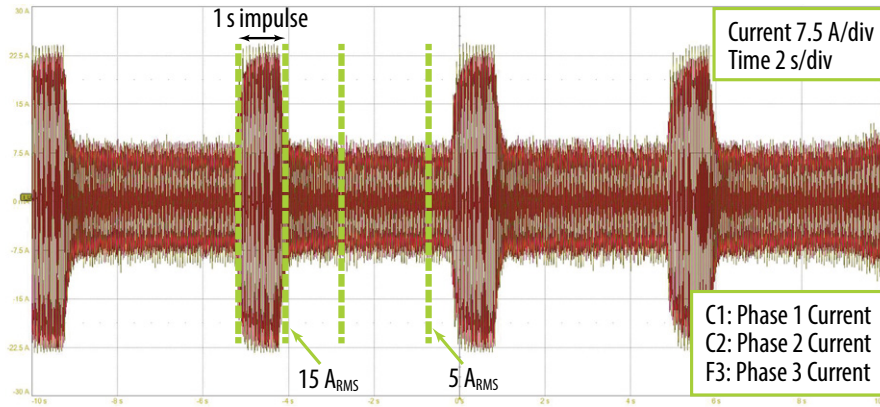


Figure 11: Phase current waveforms during pulsed torque test at 20% pulse duty

For support files including schematic, Bill of Materials (BOM), and Gerber files please visit the EPC91132 landing page at: <https://epc-co.com/epc/products/demo-boards/EPC91132>

Change Log

STATUS	VERSION	DATE	REMARK
1.0	Production	26 May 2026	Production release

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