Installation guide

EPC Series

Bidirectional DC-DC converter

epic power

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Epic Power Converters S.L.

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1. INTRODUCTION

This manual contains information about EPC bidirectional DCDC converters. This document is up to date at the time of publication. Epic Power Converters S.L. reserves the right to change the content of this manual at any time without notice.

2. EPC GENERAL DESCRIPTION

The EPC is a new generation of DC/DC Converters with a wide range of voltage levels in both sides. The system is capable of managing power in both directions. As an ideal application, you can connect the low side voltage to batteries and feed any drive (VVVF) directly through the DC link. It also allows for off-grid applications where there is no three-phase mains available or, for example, in automatic warehouses when the platforms are moving off-grid. Different supply sources (solar, wind, etc.) can be connected to have multiple generator systems.

3. EPC EXTERNAL DESCRIPTION

Size 1

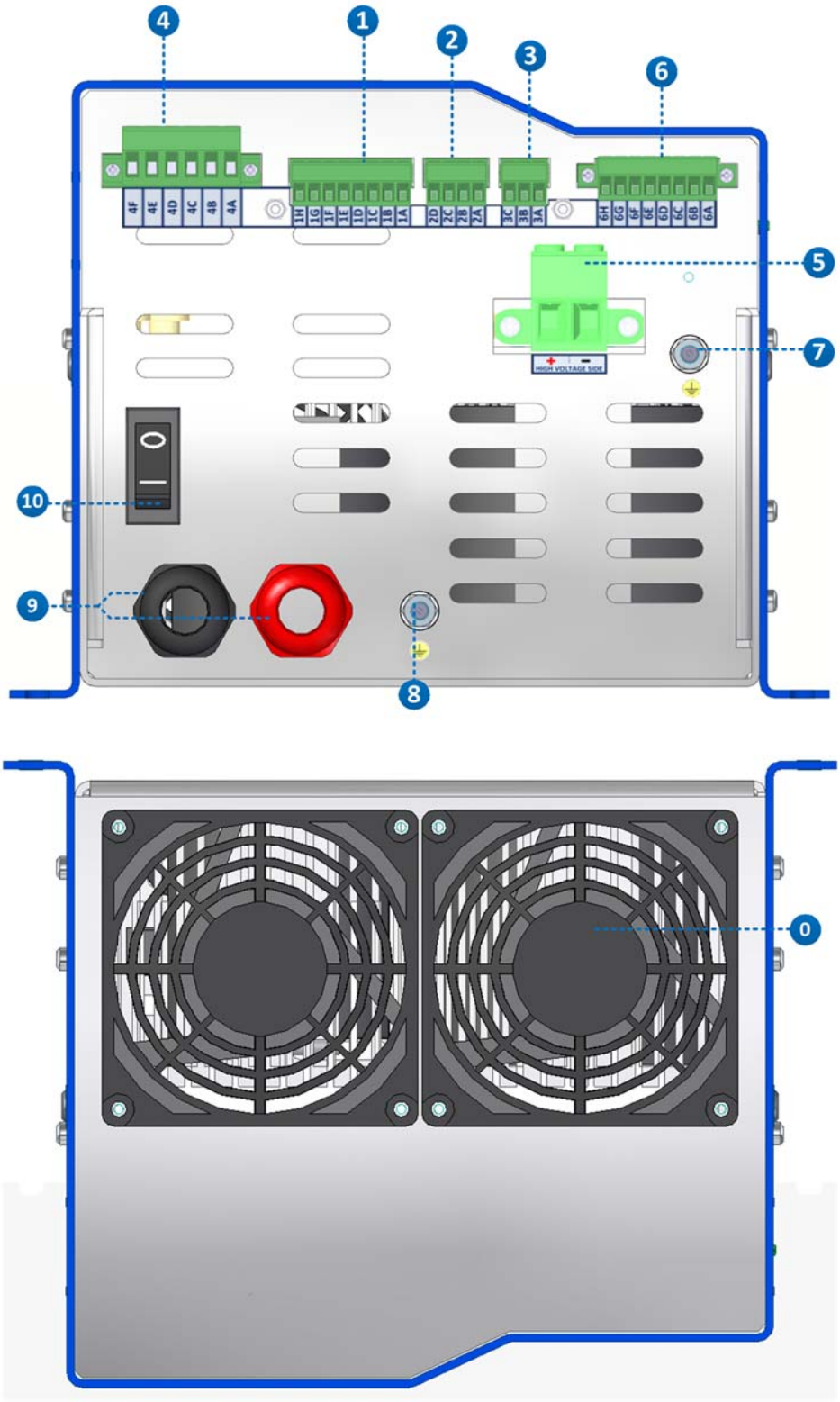


Fig. 1 DC/DC converter Size 1

Size 2

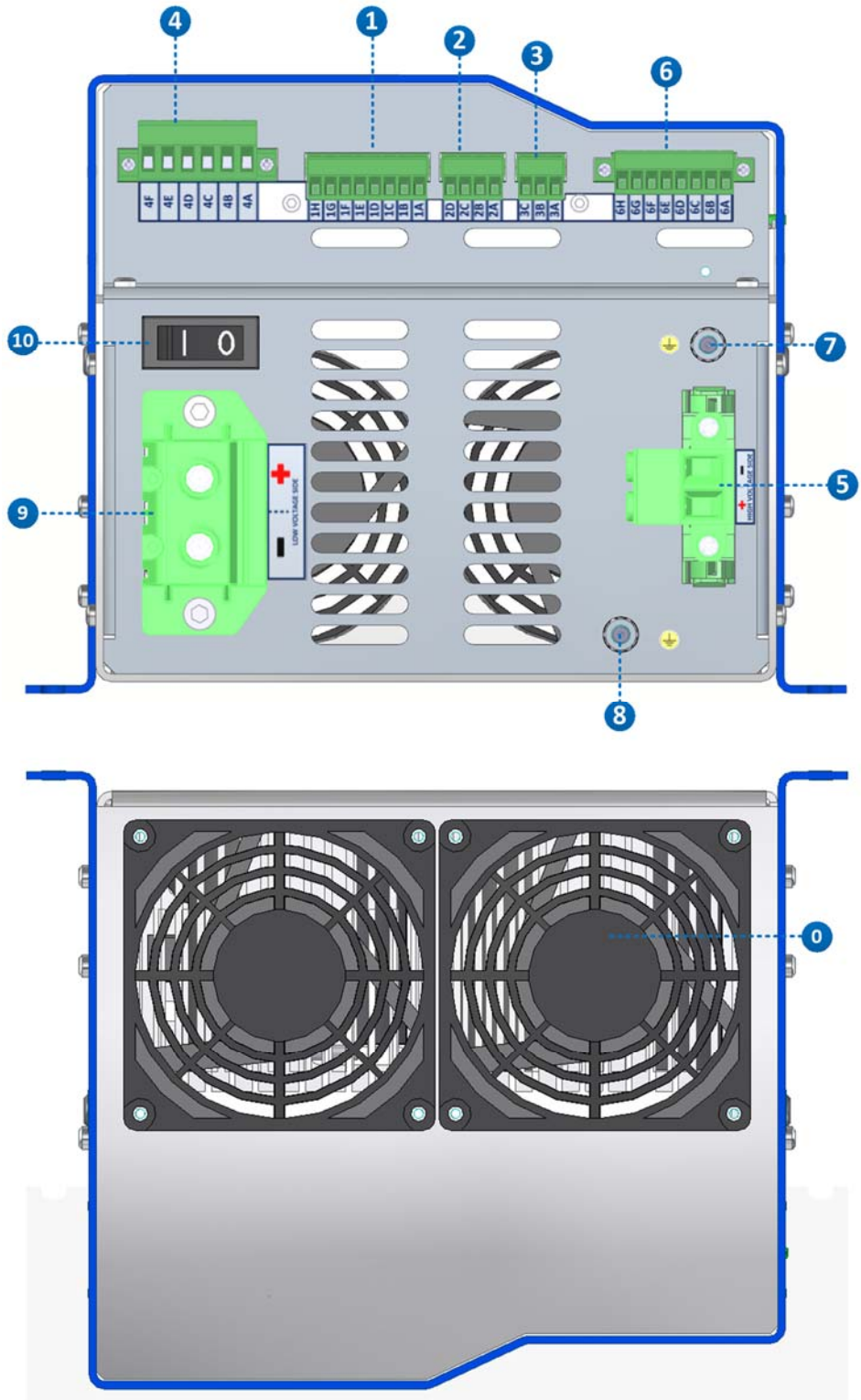
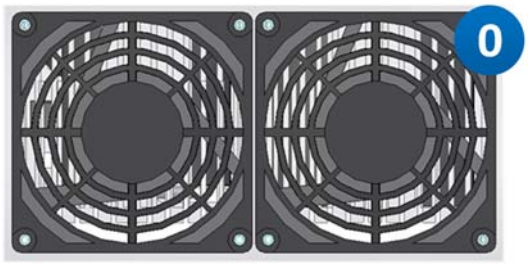
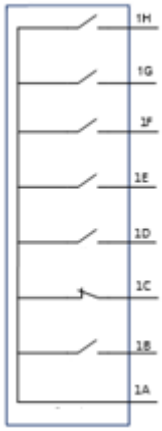


Fig. 2 DC/DC converter Size 2

0) FAN: It is important to not obstruct the fans.



1) OUTPUTS to CONTROLLER:



These are potential-free relay contacts:

- 1A) Common
- 1B) STATUS OK: (Normally Open). When this terminal is short-circuited to 1A, it indicates that the DC/DC converter is in operation and therefore, it is supplying the DC link of the drive, so the drive is energized.
- 1C) TEMPERATURE WARNING NC (Normally Close): Open circuit indicates that there is warning due to high temperature inside the converter.
- 1D) TEMPERATURE WARNING NO (Normally Open): Short-circuit to 1A indicates that there is warning due to high temperature inside the converter.
- 1E) NO (Reserved)
- 1F) NO (Reserved)
- 1G) EARTH LEAKEAGE DETECTION (Normally Open).
- 1H) NO (Reserved)

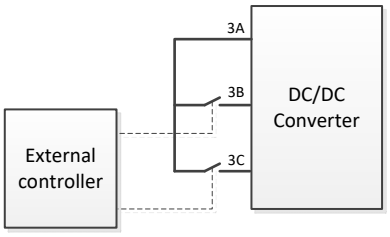
IMPORTANT NOTICE: These outputs should never withstand voltages higher than 24V DC or 250V in AC. Outputs should never conduct currents higher than 3A.

2) CONNECTOR 2:

- 2A) (Reserved)
- 2B) (Reserved)
- 2C) RC Charger + (Optional)
- 2D) RC Charger – (Optional)

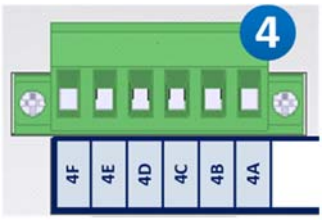
3) INPUTS from the CONTROLLER:

- 3A) GND: Common ground for the ENABLE inputs (3B and 3C).
- 3B) ENABLE DC/DC: DC/DC Converter enabling or disabling input. To provide energy to the DC bus, it is mandatory for the controller to short-circuit terminals 3A and 3B. The controller may use this option to turn off the drive to avoid standby consumption.
- 3C) Safety Disconnection: DC/DC converter will stop immediately if 3C input is left open. An external controller should short-circuit terminals 3A and 3C to enable the DC/DC Converter.



4) CONNECTOR 4

Connector 4 provides LVDC link access to connect optional accessories.



- 4A) Load + (Optional).
- 4B) Load - (Optional).
- 4C) AC + Charger (Optional).
- 4D) AC - Charger (Optional).
- 4E) Solar charger + (Optional).
- 4F) Solar charger - (Optional).

Maximum current of each terminal in connector 4 is 20 A.
Place gR 25A external fuses with fuseholders.

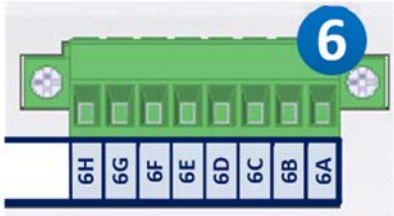
5) "Inverter POWER": Output to the DC bus of the drive (High Side Voltage). Typically, to connectors named N(-), P(+) in the drive.

i) Minimum wire section is 2.5mm^2
ii) The impedance between DC+ and EARTH is approx. 170 kΩ
iii) The impedance between DC- and EARTH is apporx. 170 kΩ

Internally protected with 15 A 1000 V fuses

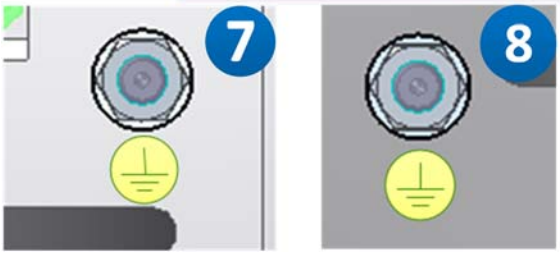
6) CAN Bus:

- Connection to optional EPC CAN Interface



7) Earth connection

8) Earth connection



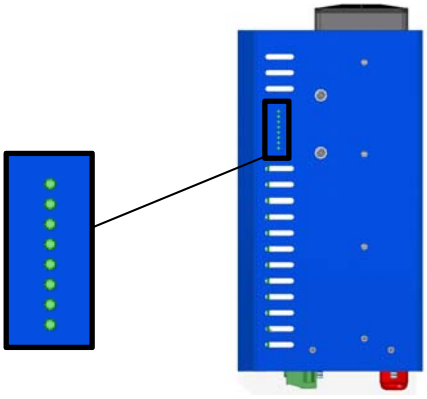
9) Low Voltage DC Side (LVDC) connection. Cables with cable gland connection for high current and low voltage side (size1). For size 2 a terminal block is used.

Fig. 3 LVDC link Size 1

Fig. 4 LVDC link Size 2

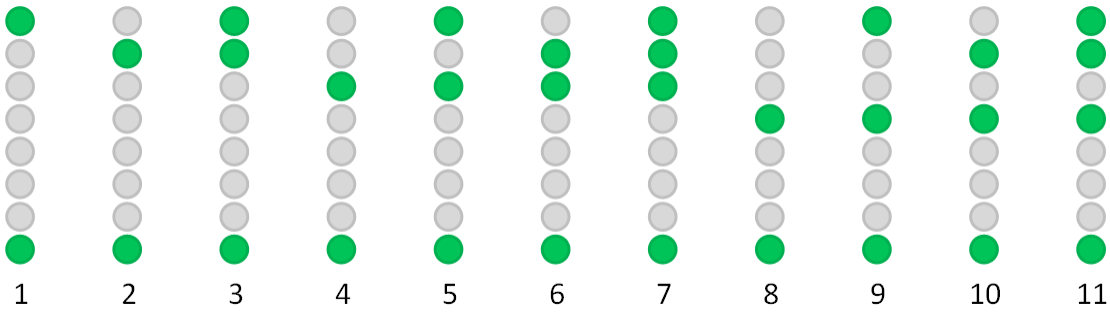
10) "ON OFF Switch" Main switch of DC/DC converter

LED STICK: It is located on one side of the converter:



This LED stick will show different codes depending on the situation:

- If the DC/DC converter is disabled, the LEDs blink from bottom to top and from top to bottom.
- If the DC/DC converter is enabled and it is transferring energy, they show transferred power.
  - In case of discharging power, the LED stick fills up from bottom to top.
  - In case of charging power, the LED stick fills up from top to bottom.
- If an error occurs, the LED stick will show a code:



Error number	Description
1	HVDC link voltage error detected by software
2	LVDC link voltage error detected by software
3	HVDC link overcurrent detected by software
4	Internal error 1
5	Overheating error
6	Error when HVDC link is switched ON (for Autonomous Mode)
7	Earth fault in HVDC link
8	Internal error 2
9	HVDC link voltage error detected by hardware
10	LVDC link voltage error detected by hardware
11	HVDC link overcurrent detected by hardware

3.1. CAN interface module (Optional)

CONNECTOR 7. CAN 1. Reserved for custom applications

- 7A) GND
- 7B) CAN Low
- 7C) CAN High
- 7D) 5V 0.1A Out

CONNECTOR 8. CAN 2. Connection with external controller

- 8A) GND
- 8B) CAN Low
- 8C) CAN High
- 8D) 5V 0.1A Out

CAN 1 and CAN 2 are electrically isolated.

4. EPC Control Modes

EPC converter can be controlled in two different modes. Modes are selectable through CAN communication explained in "*5 Communications*".

4.1. Autonomous Mode (AMode)

In this mode, the DCDC converter is able to supply a load in the HVDC link side. An example load is a VVVF (Variable Voltage Variable Frequency motor drive). The EPC converter performs a "Soft Start" with a current-controlled ramp-up from 0V to the HVDC target voltage. If the HVDC side is connected incorrectly (HVDC plus and minus wrongly connected or under short-circuit), current-controlled soft start will provide 1.5 to 2 A and will stop showing an error.

When the load/motor consumes energy, the EPC provides power to the DC link. If the motor generates energy and LVDC is within the limits, EPC will charge the LVDC (batteries for example).

4.2. Current Controlled Mode (CCMode)

In this mode, the external controller will set the current reference for the High Voltage DC side (HVDC side). Positive current is defined as Low Voltage DC side (LVDC side) charging current (batteries get charged). Negative current is defined as LVDC discharging current. To avoid errors during charging and discharging processes, there is another signal that sets the current direction.

If the voltage (in high or low side) goes beyond the limits, the DCDC converter will stop and show an error. Once the voltage returns to the nominal range and a reset is performed, current control is re-established. When the EPC is disabled through CAN or hardware enable input, reset of errors is performed.

5. Communications

EPC must be controlled via CAN communication. CAN communication does not override enable input. If communication with the external controller is lost, DCDC converter can be disabled through enable input.

EPC CAN communication requires:

- CAN 2.0B compatible hardware
- 125 kbps
- Extended identifiers (29 bits)
- Endianness: Little Endian

5.1. Message description

5.1.1.Messages from external controller to EPC

Message ID: 0xEB00; Message Name: EPC control; Message length: 3 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
Enable	0	1	-	unsigned	This signal enables the EPC to charge or discharge power from/to the HVDC (High Voltage DC) bus connected 0 = EPC disabled 1 = EPC enabled Default value: 0 in CCMode; 1 in AMode
Power direction	1	1	-	unsigned	This signal sets the current direction in CCMode 0 = Charge 1 = Discharge Default value: 1
Current reference	8	16	0.1A/1	Signed	HVDC current reference Minimum value: -200 = -20.0 A Maximum value: 200 = 20.0 A Default value: 0.0 A

Each time that external controller sends a 0xEB00 message, EPC answer with a 0xFB00 message.

If the EPC bus is disabled (through CAN or hardware enable) errors are cleared.

To charge (energy coming from HVDC to LVDC), *Enable* must be 1, *Power direction* must be 0 and *Current reference* must be positive.

To discharge (energy coming from LVDC to HVDC), *Enable* must be 1, *Power direction* must be 1 and *Current reference* must be negative.

Message ID: 0xEB01; Message Name: EPC configuration; Message length: 8 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
Mode	0	2	-	unsigned	With this signal 2 control modes can be chosen: 0 = Autonomous Mode 1 = Current Controlled Mode 2 = Reserved 3 = Reserved Default value: 0 This signal can be changed only if *Enable* signal of *EPC control* message is 0.
High side maximum voltage	2	10	1V/1	unsigned	Default value for EPC-XkX-3XX models: 450 = 450 V Default value for EPC-XkX-6XX models: 800 = 800 V Minimum value: 0 = 0 V Maximum value: 900 = 900 V
High side minimum voltage	12	10	1V/1	unsigned	Default value for EPC-XkX-3XX models: 290 = 290 V Default value for EPC-XkX-6XX models: 510 = 510 V Minimum value: 0 = 0 V Maximum value: 900 = 900 V
Low side maximum voltage	22	10	0.1V/1	unsigned	Default value for EPC-XkX-X24 models: 291 = 29.1 V Default value for EPC-XkX-X48 models: 592 = 59.2 V Minimum value: 0 = 0.0 V Maximum value: 800 = 80.0 V
Low side minimum voltage	32	10	0.1V/1	unsigned	Default value for EPC-XkX-X24 models: 210 = 21.0 V Default value for EPC-XkX-X48 models: 420 = 42.0 V Minimum value: 0 = 0.0 V Maximum value: 800 = 80.0 V
Charge power limit	42	10	10W/1	unsigned	Default value for EPC-2k2-XXX models: 260 = 2600 W Default value for EPC-3k5-XXX models: 420 = 4200 W Default value for EPC-3k5-XXX models: 480 = 4800 W Default value for EPC-5k5-XXX models: 650 = 6500 W
Discharge power limit	52	10	10W/1	unsigned	Default value for EPC-2k2-XXX models: 260 = 2600 W Default value for EPC-3k5-XXX models: 420 = 4200 W Default value for EPC-3k5-XXX models: 480 = 4800 W Default value for EPC-5k5-XXX models: 650 = 6500 W

Each time that external controller sends a 0xEB01 message, EPC answer with 0xFB03 message.

Message ID: 0xEB02; Message Name: EPC measurements configuration; Message length: 3 bytes					
Variable Name	Start bit	Bit length	Scaling		Description
Enable 0xFB01 and 0xFB02 messages	0	1	-		If this signal is 1, EPC will send 0xFB01 and 0xFB02 messages with the period defined in “0xFB01 and 0xFB02 message period” signal. Default value: 0
0xFB01 and 0xFB02 messages period	8	16	1ms/1		This signal defines the period within the messages 0xFB01 and 0xFB02 will be sent. Default value: 250 ms Minimum value: 50 = 50ms Maximum value: 1000 = 1000 ms

5.1.2.Messages from EPC to external controller

Message ID: 0xFB00; Message Name:EPC status; Message length: 6 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
VVVF status (AMode)	0	2	-	Unsigned	0 = HVDC link OFF 1 = HVDC link ON It shows 0 when Current Controlled Mode is selected
Enable hardware enable echo	2	1	-	Unsigned	0 = Hardware input between pin 3A and 3B disabled 1 = Hardware input between pin 3A and 3B enabled
Warning codes	16	8	-	Unsigned	0 = No warning
Error codes	24	8	-	Unsigned	0 = No error 1 = HVDC link voltage error detected by software (voltage out of limits defined in “EPC configuration” message) 2 = LVDC link voltage error detected by software (voltage out of limits defined in “EPC configuration” message) 3 = HVDC link overcurrent detected by software (over 6 A) 4 = Internal error 1 5 = Overheating error (internal temperature over 80°C) 6 = Error when HVDC link is switched ON (for Autonomous Mode) 7 = Earth fault in HVDC link (for Autonomous Mode) 8 = Internal error 2 9 = HVDC link voltage error detected by hardware (Vbus>900 V) 10 = LVDC link voltage error detected by hardware (battery voltage over 29.6 V) 11 = HVDC link overcurrent detected by hardware (over 11 A)
Error value	32	16	-	signed	This signal contains the variable that triggers the error. When error code = 0, it displays 0 When error code = 1, it displays DC link voltage [1V/1] When error code = 2, it displays battery voltage [0.01V/1] When error code = 3, it displays DC link current [0.1A/1] When error code = 4, it displays 0 When error code = 5, it displays the internal temperature [°C] When error code = 6, it displays DC link voltage [1V/1] When error code = 7, it displays 0 When error code = 8, it displays 0 When error code = 9, it displays DC link voltage [1V/1] When error code = 10, it displays battery voltage [0.1V/1] When error code = 11, it displays DC link current [0.1A/1]

0xFB00 message is sent if some variable included in the message has changed or 0xEB00 message has been received.

Message ID: 0xFB01; Message Name: EPC measurements 1; Message length: 8 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
LVDC link voltage	0	16	0.01V/1	unsigned	Minimum value: 600 = 6.00 V Maximum value: 8000 = 80.00 V
LVDC link current (average of current during time defined in *"0xFB01 and 0xFB02 messages period"*)	16	16	1A/1	signed	Minimum value: -256 A Maximum value: +255 A Positive current charges the battery Negative current discharges the battery
HVDC link power (average of power during time defined in *"0xFB01 and 0xFB02 messages period"*)	32	16	1W/1	signed	Minimum value: -10000 W Maximum value: +10000 W Negative power when the energy is discharged from the battery Positive power when the energy is charged to the battery.
HVDC link voltage	48	16	1V/1	unsigned	Minimum value: 0 V Maximum value: 1000 V

Message ID: 0xFB02; Message Name: EPC measurements 2; Message length: 4 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
HVDC link current (average of current during time defined in *"0xFB01 and 0xFB02 messages period"*)	0	8	0.1A/1	signed	Minimum value: -128 = -12.8 A Maximum value: +127 = +12.7 A Negative current when the energy is discharged from the battery Positive current when the energy is charged to the battery.
Output current of optional load connection	8	8	0.1A/1	unsigned	Minimum value: 0 = 0 A Maximum value: 255 = 25.5 A
Input current of optional charger connection	16	8	0.1A/1	unsigned	Minimum value: 0 = 0 A Maximum value: 255 = 25.5 A
Input current of optional solar charger connection	24	8	0.1A/1	unsigned	Minimum value: 0 = 0 A Maximum value: 255 = 25.5 A

Message ID: 0xFB03; Message Name: EPC configuration answer; Message length: 8 bytes					
Variable Name	Start bit	Bit length	Scaling	Type	Description
Mode	0	2	-	unsigned	0 = Autonomous Mode selected 1 = Current Controlled Mode selected 2 = Reserved 3 = Reserved
High side maximum voltage	2	10	1V/1	unsigned	High side maximum voltage selected
High side minimum voltage	12	10	1V/1	unsigned	High side minimum voltage selected
Low side maximum voltage	22	10	0.1V/1	unsigned	Low side maximum voltage selected
Low side minimum voltage	32	10	0.1V/1	unsigned	Low side minimum voltage selected
Charge power limit	42	10	10W/1	unsigned	Charge power limit selected
Discharge power limit	52	10	10W/1	unsigned	Discharge power limit selected

0xFB03 message is sent if 0xEB01 message has been received.

6. Installation

Before beginning the installation, make sure that you have unplugged the connector 3

Installation procedure:

1. Fixing and attaching EPC to the installation:

To prevent EPC system from water splashes or dust, choose a vertical surface on which to hang it. Be sure that the installation place is a dry area with no condensation.

EPC DC/DC converter should always be attached to a vertical surface, with the fans pointing upwards. Make room in front of both ventilation grills (at least, 250 mm). Otherwise, cooling system may not operate properly, and the converter may be damaged.

2. Wiring EPC:

BEFORE WIRING THE SYSTEM ENSURE THAT THE MAIN SWITCH OF THE DC/DC CONVERTER IS SWITCHED OFF DURING THE INSTALLATION

a. Earth connection

Ensure that earth is connected thanks to connections 7 and 8.

b. Low side voltage wiring:

LOW SIDE MUST BE PROTECTED WITH FUSES IN BOTH CONDUCTORS. KEEP THE FUSE HOLDERS OPEN DURING CONNECTION.

Select gR fuses capable of 125% of max LVDC current. If in doubt contact epic power

i. Connect DC/DC converter 9 terminal to positive terminal of Low Voltage DC link (for example battery +).

ii. Connect DC/DC converter 9 connector to negative terminal of Low Voltage DC link (for example battery -).

IMPORTANT NOTE:

Observe polarity at DC/DC converter 9 cable. A reverse polarity connection may cause permanent damage to the unit and should be sent back to epic power for repair.

c. High side voltage wiring:

High-side voltage of the DC/DC Converter is typically connected to a VVVF.

ENSURE THAT THERE IS NO VOLTAGE LEFT IN THE NODES ABOUT TO BE HANDLED

i. Locate the DC- link. P (+) and N (-) is a commonplace designation. See Fig. 5.

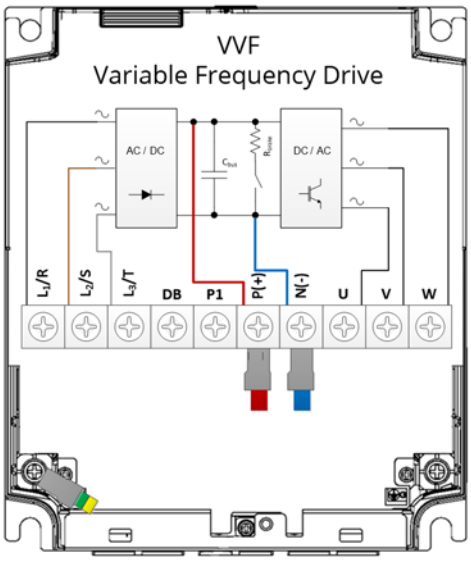


Fig. 5 VVVF connection example

ii. Connect the "Inverter POWER" terminal from DC/DC converter 5 to the HVDC link (for example VVVF drive). The female connector is located on the underside of DC/DC converter. The cable should have male connector.

CAUTION: DC/DC converter "ON OFF" switch 10 must be in "OFF" position, and "ENABLE DC/DC" must be disabled (not short-circuited 3B and 3A).

NOTE ABOUT "ENABLE" CONNECTION IN AUTONOMOUS MODE:

- The controller can decide to turn off the HVDC link for a period of time, with the purpose of saving standby consumption through "ENABLE DC/DC" terminal. This leads to a drastic reduction in energy consumption.
  - ◊ Closed contact, the HVDC link is energized.
  - ◊ Open contact, the HVDC link is not energized (HVDC link is turned off).
- The DC/DC converter accomplishes a soft-start of the drive, so the lifespan of the DC-link capacitor will be lengthened.
- When the controller closes the contact again to energize the drive, the DC/DC converter will turn on the HVDC (time depends on HVDC link capacitance) with a controlled-current ramp. In less than 1 second, the HVDC link return to nominal voltage.

IMPORTANT NOTE:

This device can be used in a wide range of applications; the customer is responsible for complying with all regulations that may apply in their final installation, in particular with protective devices. Epic Power Converters is not responsible for any loss or damage caused by the improper installation and/or failure to satisfy required regulations.

At this point, ***EPC*** system is already installed and ready for the first start up.

WARNING	IT IS ESSENTIAL to earth the conductor (minimum 2.5 mm^2 section). If the connection stops, the system will continue working, but will be isolated from the earth connection. It may become dangerous for operators, and the system may be damaged.
WARNING	Supply must be shut down, and HVDC link must be disconnected from three-phase mains or any source of energy before making any connections. Failure to do so creates risk of electrocution for the operator. The EPC system may also become damaged.
WARNING	The system has been designed for pollution level 2. Consult epic power in any other circumstances.

	 WARNING	Connection cable must have bullet style connectors, to prevent wires from fraying.
	 WARNING	In case of deliberate electric supply disruption, the “ENABLE” connection must be opened, disabling EPC power conversion. If not, HVDC link will keep being supplied, and maintenance staff may **receive an electrical shock**.
	 WARNING	**DO NOT TOUCH THE HVDC LINK WITHOUT BEING SURE EPC SYSTEM IS SHUT DOWN, CONNECTOR (5) UNPLUGGED AND FUSES OPENED.**
	 WARNING	It is essential to strictly follow installation and/or maintenance steps in order. Failure to do so may result in overvoltage or overcurrent occurrence, increasing the risk of shock or causing damage to the drive.
N	 WARNING	In case of malfunction, or doubt, contact epic power. **NEVER OPEN EPC**. It is an extremely complex electronic system. Reparation must only be undertaken by epic power. Any unskilled handling may damage the system or may cause a serious accident.

6.1. Minimum DC link capacitance required

A minimum DC link capacitance is required to guarantee the correct operation of the EPC converter. The capacitance required depends on the converter used, but the most common value is 400 µF. If the drive selected does not have the minimum capacitance required, further capacitance must be added.

Epic power can supply the extra capacitor if required. It must be connected to the DC link as shown in the image below.

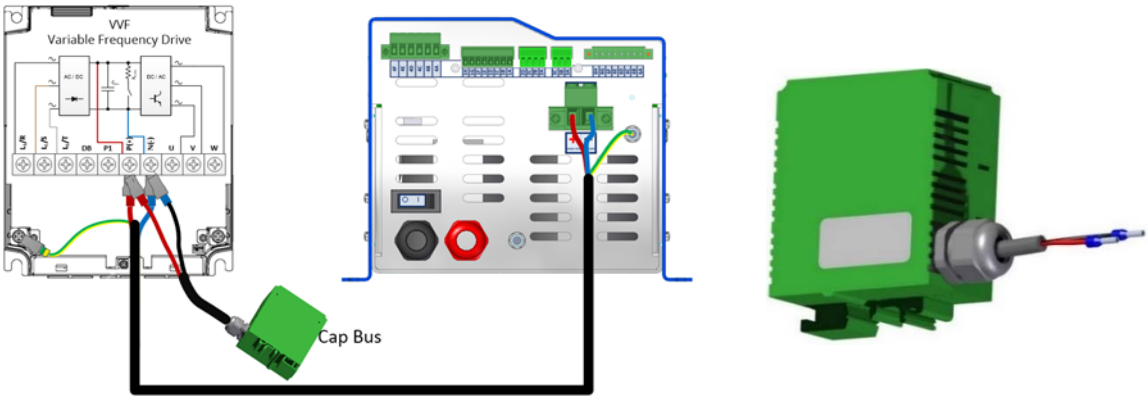


Fig. 6 Bus capacitance installation.

6.2. CAN interface module (Optional)

If CAN communication is required, a CAN interface module is available. Before installation, ensure the EPC is disconnected, the main switch is switched off, the fuse holders of LVDC link are open and 5 connector is disconnected. The following steps should be carried out by qualified personnel:

1. Installation

The 8 ways connector of Fig. 7 should be connected to connector 6 of the EPC (only one position is possible). After connecting the module, it must be secured using the M3 screw in the hole specified in Fig. 8.

Fig. 7 Optional CAN interface to EPC connector

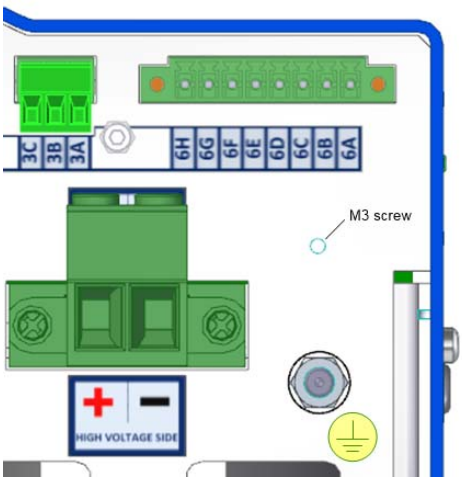


Fig. 8 EPC connector 6

2. Wiring

External controller should be connected to connector 8 as defined in *3.1 CAN interface module (Optional)* . Following this, the module is ready for CAN communication.

7. UNINSTALLATION

A correct EPC shutdown, as well as ensuring there is no supply, is necessary whenever ***THE HVDC LINK ARE TO BE HANDLED***. Keep in mind that EPC system is designed, among other things, to continue supplying the HVDC link in the case of a power cut.

If you want to disconnect:

a) Turn off EPC system by switching OFF with the Switch 10 and/or unplugging "ENABLE CONNECTOR" 3 .This way, EPC system will be disabled.

b) HVDC link should turn off automatically after the previous step

c) Remove the fuses from the fuse holders of the LVDC link connections

d) Wait until HVDC bus voltage lowers to safe level, for as long as is necessary (check your motor drive or inverter handbook).

e) Unplug DC/DC converter 5 connector. **It is now disconnected**.

Perform necessary actions with the installation. To reconnect:

f) Before turning on the HVDC link, reconnect connector 5.

g) Close the fuse holders of the LVDC link.

h) Switch ON EPC system by switching Switch 10 to ON and/or plugging "ENABLE CONNECTOR" 3

i) The HVDC link will be operational again, supplied from EPC system.

IMPORTANT NOTE ABOUT BATTERY MAINTENANCE:

This system is NOT a battery maintenance nor supervisor. Please, install the required system for battery maintenance and disable the DC/DC converter wherever necessary.

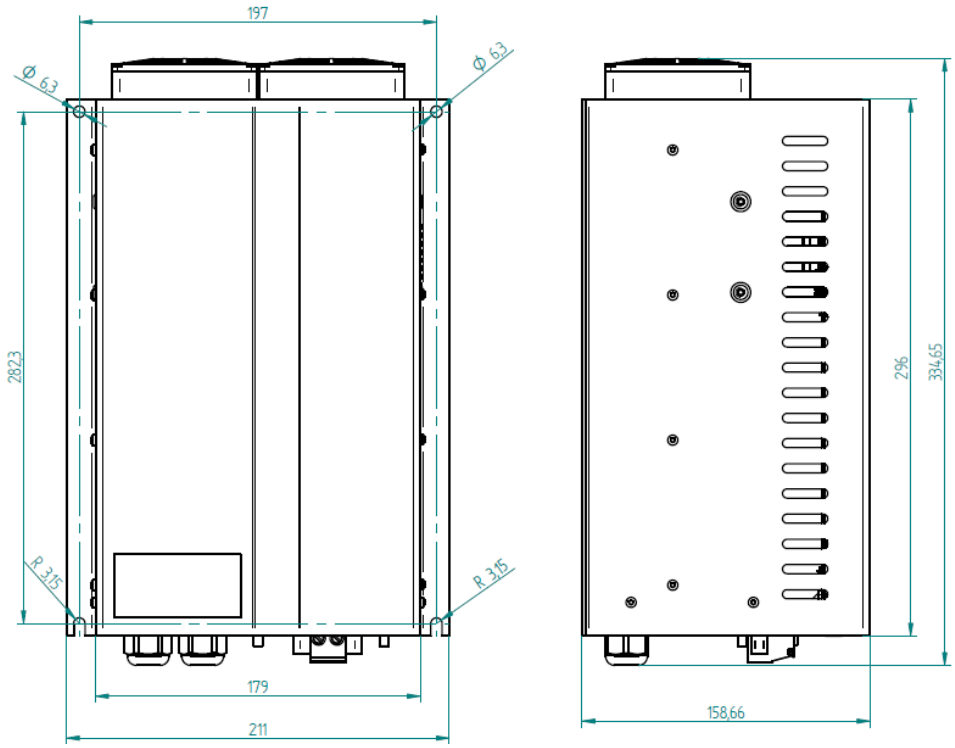
8. TECHNICAL DATA, DIMENSIONS AND WEIGHTS

Model	EPC-2k2-324	EPC-2k2-624	EPC-3k5-648	EPC-5k5-648	EPC-4k8-6125
Peak power (7 seconds)	**2.6 kW**	**2.6 kW**	**4.2 kW**	**6.5 kW**	**4.8 kW**
Maximum continuous power	**2.2 kW**	**2.2 kW**	**3.5 kW**	**5.5 kW**	**4.8 kW**
High side voltage	**290 to 450 Vdc**	**510 to 830 Vdc**	**510 to 800 Vdc**	**510 to 800 Vdc**	**490 to 800 Vdc**
Maximum high side current	**7.5 A**	**4 A**	**7.5 A**	**12 A**	**9 A**
Low side voltage	**21 to 29 Vdc**	**21 to 29 Vdc**	**42 to 59 Vdc**	**42 to 59 Vdc**	**110 to 165 Vdc**
Size	**Size 1**	**Size 1**	**Size 1**	**Size 2**	**Size 1**
Maximum low side current	**100 A**	**100 A**	**110 A**	**180 A**	**45 A**
Isolation (Withstand voltage)	**High to Low side: 2.5 kV; High side to earth: 4kV; Low side to earth: 1.5 kV (2.5 kV for EPC-4k8-6125) Low side to user signals: 3kV (5 kV for EPC-4k8-6125)**				
Max. efficiency	**98 %**				
Control	**Digital control self-powered from high or low voltage side (low side prioritized)**				
Stand-by	**<3 W**				
Dimensions (WxHxD)	**Size 1: 211x335x160 mm Size 2: 211x506x160 mm**				
Weight	**6.05 kg**	**6.15 kg**	**6.05 kg**	**8.95 kg**	**6.70 kg**
Operating temperature	**-10 to 40 °C**				
Storage temperature	**-10 to 70 °C**				
Relative humidity	**<95%, with no condensation(*)**				
Enclosure	**IP 20**				
Cooling	**Air cooled (Fans only ON when needed)**				
Maintenance	**No electrolytic capacitors in DC links (Long life FILM capacitors) Fan replacement >70000 h**				

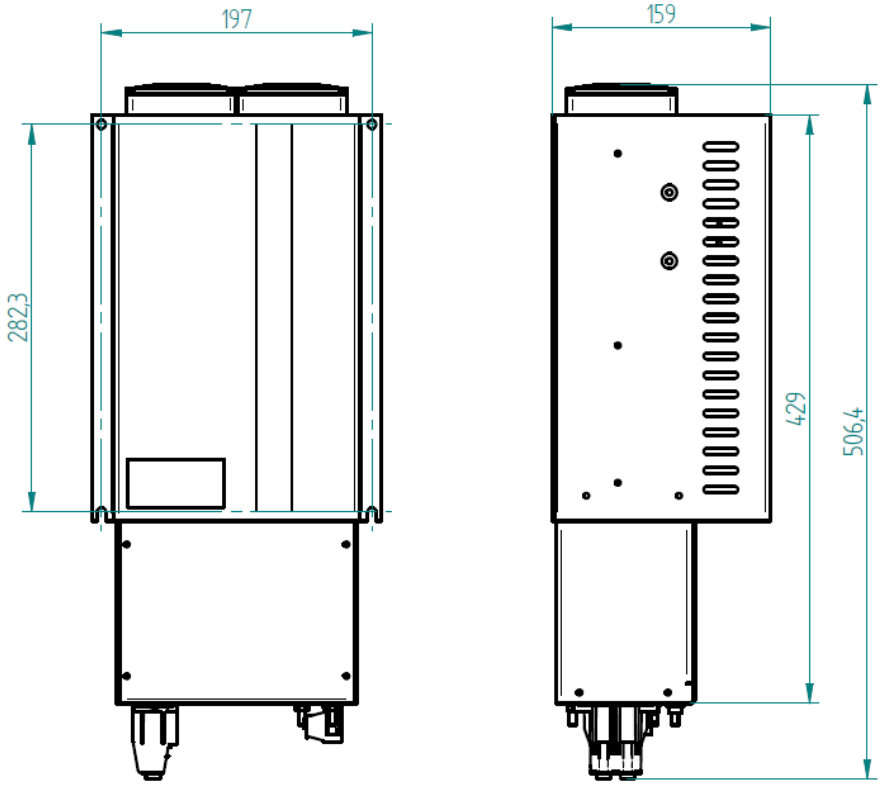
(*) Note: The system should not be summited to sudden temperature variations given that it could cause liquid condensation inside the device.

8.1. DC/DC converter dimensions (mm)

Size 1



Size 2:



9. REGULATIONS

EPC system has been designed and manufactured according to the following regulations:

- **Low Voltage Regulations (LVD)**: **European directive 2014/35/UE**, which establishes low voltage regulations for electronic systems.
    - UNE-EN 50178:1998
    - UNE-EN 60204-1:2007
    - UNE-EN 60529:2018
    - UNE-EN 60664-1:2008
    - UNE-EN 60664-4:2006
    - UNE-EN 61293:2002
    - UNE-EN 62109-1:2011
    - UNE-EN 62477-1:2012
- **Electromagnetic Compatibility Regulations (EMC): European directive 2014/30/UE**, which regulates electromagnetic equipment compatibility and seeks the proper functioning of internal market, demanding suitable EMC levels.
    - UNE-EN 12015:2005
    - UNE-EN 12016:2014
    - UNE-EN 61000-6-1:2007
    - UNE-EN 61000-6-3:2007
    - UNE-EN 61000-6-4:2007

- **Restriction of hazardous substances: European directive 2011/65/UE**, which regulates the use of certain hazardous substances in electrical and electronic equipment.
    - UNE-EN 50581:2012