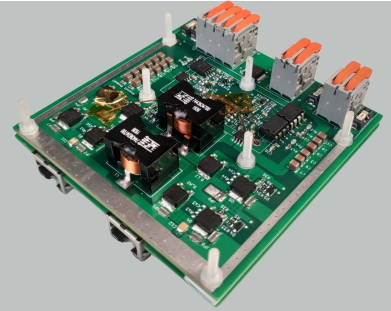


OwnTech O² Non-Isolated Dual Channel Reprogrammable Converter



OwnTech's O² reprogrammable power converter is a bi-directional 300W power converter. It features a dual 12V to 72V low side and a single 40V to 100V high side. Its maximum current value is 8A per power channel.

The power channels can be used independently, yielding two output voltages or combined to double the current.

The **O² converter** is fully open-source, with a strong compatibility with the Zephyr RTOS and modular programming approach.

A MATLAB[®] suit for code generation is also available for auto-generating the code.

SPECIAL FEATURES

- 2 phase design
- DUAL or SINGLE power channel configuration
- Up to 97% Efficiency
- Standard size: 100mmx100mmx35mm
- Wide voltage operating range
- DC or AC operation
- Can be connected in parallel for higher power
- CAN bus communication compatible
- Zephyr OS compatible
- MATLAB[®] compatible
- ThingSet compatible
- Fully open-source
- Visual Studio Code and PlatformIO[®] compatible
- Voltage and current mode libraries available
- [Gitlab source here](#)

AT A GLANCE

Rated Power

300W per module

Number of channels

Dual low side

Single high side

Current ratings

8A per channel

16A in parallel

Voltage ratings

12V to 72V low side

40V to 100V high side

 ThingSet

 Zephyr™



O² NON-ISOLATED DUAL CHANNEL CONVERTER

ELECTRICAL SPECIFICATIONS

Absolute Max ratings

Low-Side max voltage	90V _{DC}
High-Side max voltage	120V _{DC}
Low-Side max peak current	16A (8A per power channel)
Maximum Power Output	300W continuous

Low-Side ratings

Number of power channels	2
Voltage range	12V _{DC} to 72V _{DC}
Max low-side peak current	16A (8A per channel)
Voltage ripple	Typical 0.3V

High-Side ratings

Voltage range	40V _{DC} to 100V _{DC}
Voltage ripple	Typical 0.3V

Temperature and dimensions

Operating temperature	-20°C to +60°C
Cooling principle	Natural convection
Dimensions	L100mm W100mm H35mm

Control and Communication

Main controller	STM32G474RE
External communication buses	CAN-FD, SPI, USART
CAN communication connector	RJ45
Switching frequency	200kHz
USART/SPI connector	6 inline headers
SD Card module compatibility	Yes
Embedded EEPROM memory	258KB
External software compatibility	Zephyr RTOS MATLAB Simulink Code Generator STM32Cube IDE
Programming connector	STDC14 (STLINK V3) - JTAG

Operation modes

GND to N connector	MOSFET 20mΩ
DC-DC conversion	NGND connector ON
DC-AC conversion	NGND connector OFF



O² NON-ISOLATED DUAL CHANNEL CONVERTER

CONTROL BOARD OVERVIEW

OwnTech's O² Reprogrammable power converter has a dedicated control board composed of a STM32G474RE microcontroller connected to power drivers and a series of peripherals. This board is electrically isolated from the power board.

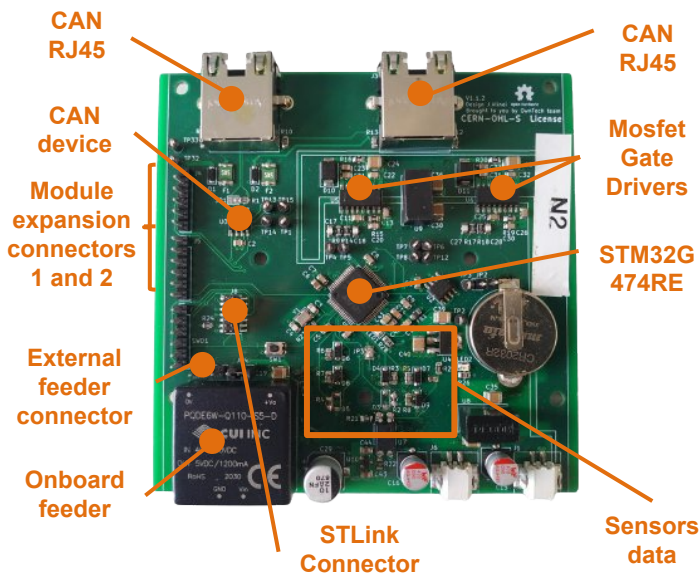


Figure 1 - A photo of the control board

Figure 1 shows a photo of the **O² control board** where the different connectors are identified along with the micro-controller. The STM32G474RE micro-controller has been chosen for its peripherals that are dedicated to power electronics and motor drive. The board is capable of a daisy chain CAN communication via its two RJ45 connectors and its on board CAN device. Sensor data arrives from the power board in the bottom. PWM signals are sent to the power board via isolated gate drivers on the top.

EXPANSION POSSIBILITIES

OwnTech's O² has two expansion connectors compatible with USART and SPI. They can be used to interface typical add on modules such as SD card readers without the use of adapters.

Expansions	Connector	Type	Typical Application
Module 1	Inline 6	USART	USB to USART module
Module 2	Inline 6	SPI	SD card

POWERING THE CONTROL BOARD

The onboard feeder is shown on the bottom left of Figure 7. A jumper must be connected to (5V_JP) to allow the control board to be fed from its onboard power feeder. It requires a minimum of 40V on the high side to operate. A 5V external power supply can be provided through the 3-pin header (5V_EXT).

Power input	Vmin	Connection	Included with the board
V _{High}	40V	5V Jumper	Yes
External	5V	5V Ext Jumper	No

O² NON-ISOLATED DUAL CHANNEL CONVERTER

MEASUREMENT CHAIN

EMBEDDED SENSORS FEATURES

OwnTech's O² implements full observability on all low-side and high-side power channels though isolated measurements.

Variable	Sensor technology	Sensibility	Signal bandwidth
V_{Low1}	250mV Voltage divider and $\pm 250mV$ 60kHz isolation amplifier	$\pm 80V$	$\sim kHz$
i_{Low1}	1MHz $\pm 20A$ Isolated Hall effect sensor	$\pm 10A$	200kHz
V_{Low2}	250mV Voltage divider and $\pm 250mV$ 60kHz isolation amplifier	$\pm 80V$	$\sim kHz$
i_{Low2}	1MHz $\pm 20A$ Isolated Hall effect sensor	$\pm 10A$	200kHz
V_{High}	Voltage divider and +2V 100kHz isolated amplifier	120V	$\sim kHz$
i_{High}	120kHz $\pm 20A$ Isolated Hall effect sensor	$\pm 20A$	$\sim kHz$
Heatsink temperature	Thermistor-based temperature sensor	-40 to 110°C	Hz

EMBEDDED ADC FEATURES

Isolated measurements are fed to the micro-controller ADC which has the following characteristics.

ADC Ratings	
ADC Type	Successive Approximation (SAR)
Number of ADC peripherals	2
Number of channels per ADC	3
ADC Typical sampling time	530ns
ADC Trigger	Programmable trigger instant on PWM period
Trigger event typical frequency	200kHz

O² NON-ISOLATED DUAL CHANNEL CONVERTER

POWER BOARD OVERVIEW

OwnTech's O² Reprogrammable power converter has two low-side power channels (V_{Low1} and V_{Low2}) and one high-side power channel (V_{High}). It is built from the association of two inverter legs in parallel.

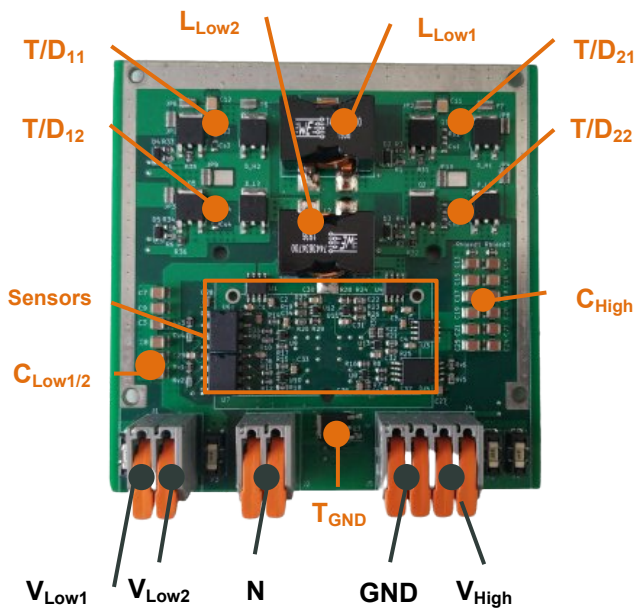


Figure 2 - A photo of the power board

Figure 2 shows a photo of the **O² power board** where the low side voltage and high side voltage connectors are identified. The Neutral and the Ground connectors are also identified with the T_{NGND} MOSFET that can connect them together.

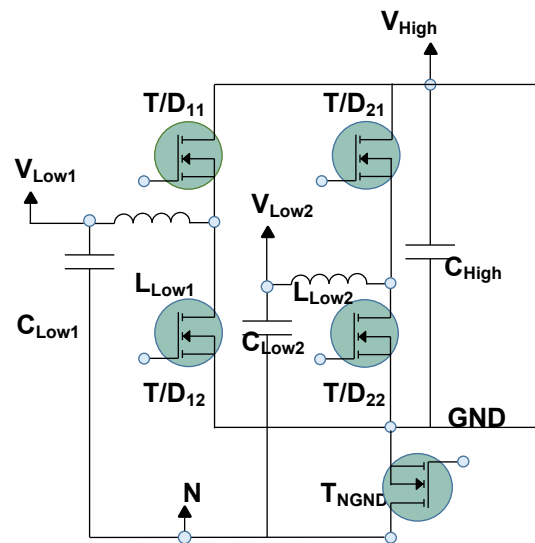


Figure 3 - The power circuit of the O²

Figure 3 shows the circuit of the **O² power board** where the low side voltage and high side voltage sides are identified.

The Neutral to Ground connection through the T_{NGND} MOSFET allows the converter to work on either DC-DC or DC-AC.

PROTECTION FEATURES

OwnTech's O² is protected by a series of fuses connected on the power board. Each power channel has its own dedicated fuse.

Fuse	Rating
Low side	8A
High side	16A



O² NON-ISOLATED DUAL CHANNEL CONVERTER

TYPICAL APPLICATIONS

TYPICAL MODES OF OPERATION

OwnTech's O² has a series of modes of operation shown in the table below.

Mode Name	High Side	Low Side	GND-N	Typical Application	Figure
DC-DC Buck	Input	Output	ON	Battery charger	4
DC-DC Boost	Output	Input	ON	Fuel-cell converter	5
1phase DC-AC Buck inverter	Input	Output	OFF	AC micro-grids	6
3phase DC-AC Buck inverter	Input	Output	OFF	Permanent magnet low-voltage motor	7

INTERLEAVED DC-DC MODES

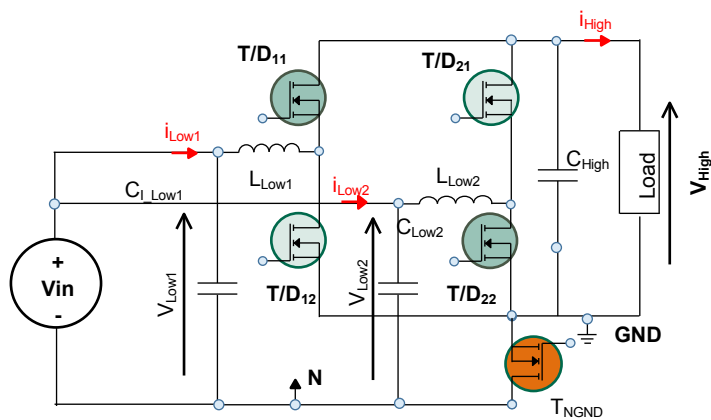


Figure 4 - O² converter on Boost Mode

Variable	State
T _{NGND}	ON
Function	Boost
V _{IN}	24V _{DC}
V _{OUT}	48V _{DC} to 54V _{DC}
Typical Application	Fuel cell Battery charger

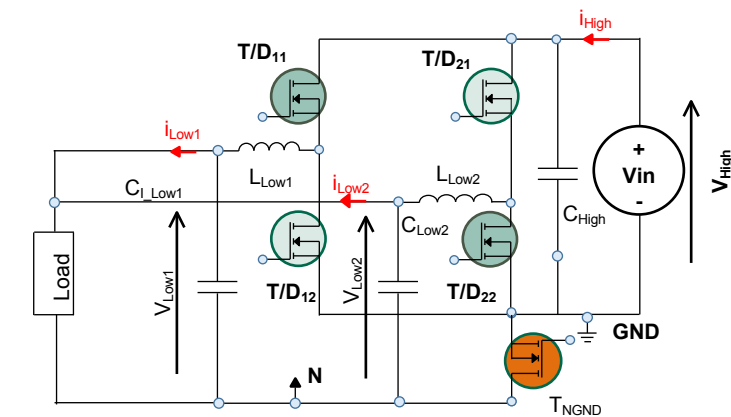


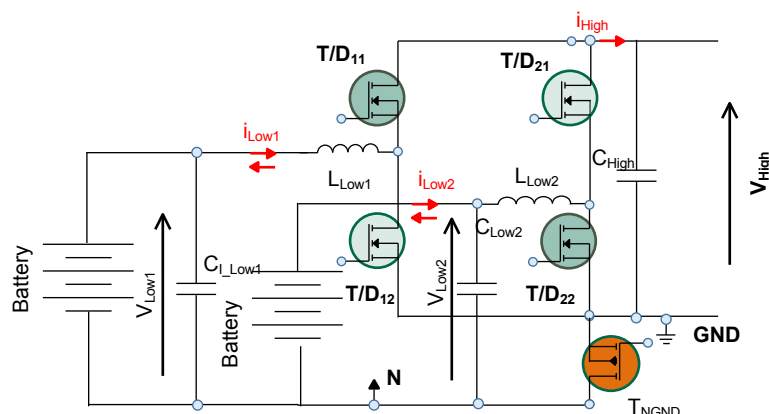
Figure 5 - O² converter on Buck Mode

Variable	State
T _{NGND}	ON
Function	Buck
V _{IN}	36V _{DC} to 48V _{DC}
V _{OUT}	10V _{DC} to 14V _{DC}
Typical Application	Solar MPPT battery charger

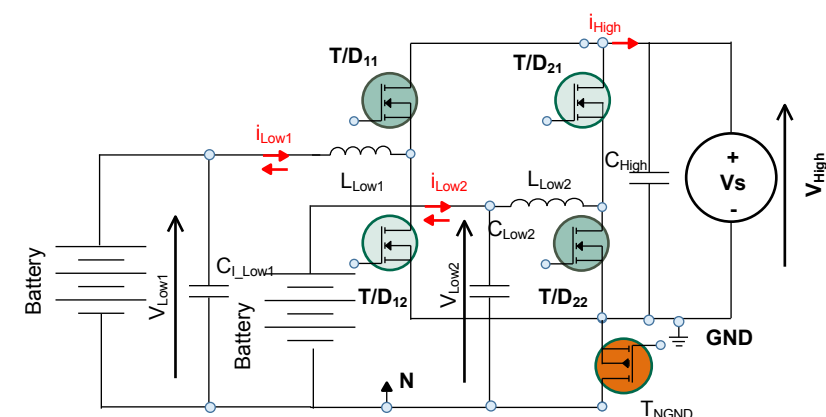


TYPICAL APPLICATIONS

Variable	State
T_{NGND}	ON
Function	Leg 1 Battery Leg 2 Buck
V_{Source}	$48V_{\text{DC}}$
V_{Battery}	$24V_{\text{DC}}$
V_2	$12V_{\text{DC}}$
Typical Application	Solar Home system



Variable	State
T_{NGND}	ON
Function	Leg 1 Battery Leg 2 Battery
V_{High}	Floating V_{DC}
V_1	$24V_{\text{DC}}$
V_2	$12V_{\text{DC}}$
Typical Application	Peer-to-peer micro-grid transfer



Variable	State
T_{NGND}	ON
Function	Leg 1 Battery Leg 2 Battery
V_{High}	Fixed V_{DC}
V_1	$24V_{\text{DC}}$
V_2	$24V_{\text{DC}}$
Typical Application	Battery management UPS supply



O² NON-ISOLATED DUAL CHANNEL CONVERTER

TYPICAL APPLICATIONS

DC-AC MODES

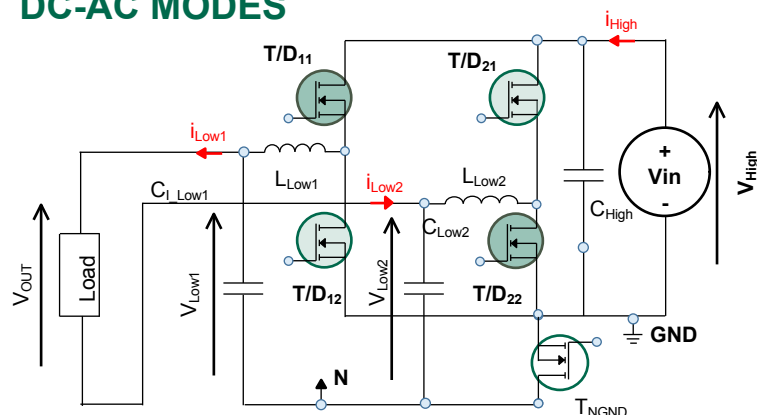


Figure 6 - O² converter on 1-phase inverter Mode

Variable	State
T _{NGND}	OFF
Function	Buck Inverter
V _{IN}	68V _{DC}
V _{OUT}	48.sin(wt)
Typical Application	Single phase AC inverter

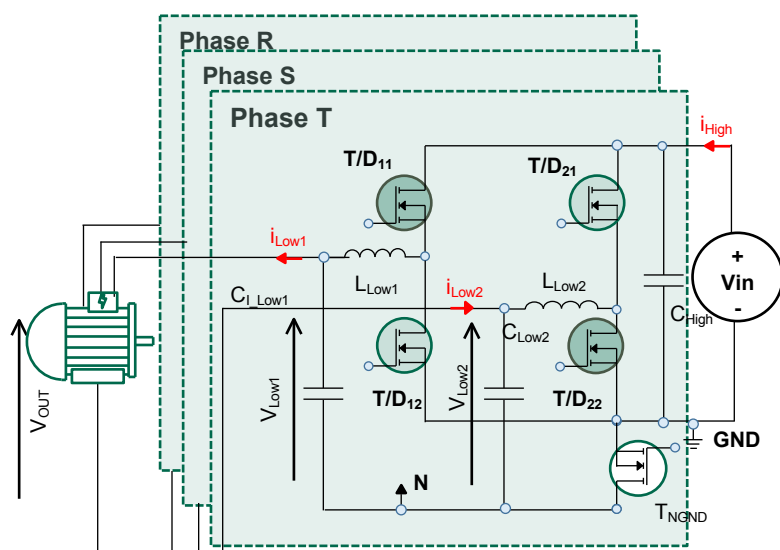


Figure 7 - O² converter on 3-phase inverter Mode

Variable	State
T _{NGND}	OFF
Function	3 phase Buck Inverter
V _{IN}	90V _{DC}
V _{OUT}	48.sin(wt) 48.sin(wt+2π/3) 48.sin(wt-2π/3)
Typical Application	48V motor control

CONTROL LIBRARIES

OwnTech's O² has implemented and validated two different control mode libraries. The simple voltage mode control average current and voltage values through a PID. The advanced current mode controls cycle by cycle peak current on the inductors and is a more reactive control system.

More implementations are currently under development.

Libraries	Mode	Algorithm	Features
DC/DC Buck or Boost applications	Voltage	Digital control of average voltage PID Digital control of average current PID	Simplicity of development of multi-loop control
	Current	Analog control of peak current	Fine and fast control of current levels



O² NON-ISOLATED DUAL CHANNEL CONVERTER

MECHANICAL FEATURES

CONVERTER PINOUT

OwnTech's O² control board pinout is shown in figure 8.

Three 6-pin headers are available on the left-side of the board. The upper header is dedicated to USART. The Middle header is SPI compatible and the bottom header is JTAG compatible.

A series of pins are available throughout the upper part of the board. Through them a user can observe the PWM signals sent to both converter legs or the CAN signals sent to the CAN peripheral.

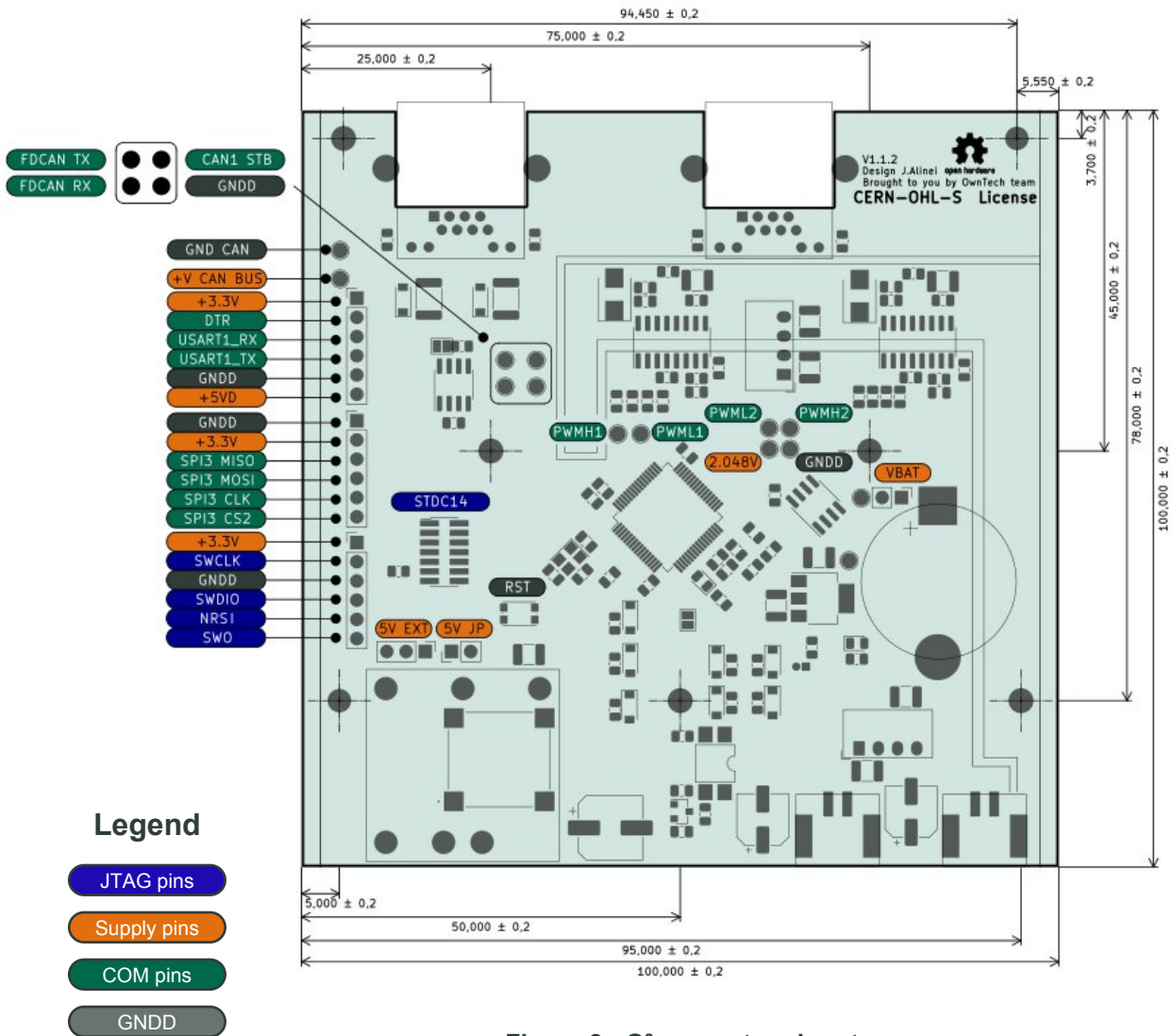


Figure 8 - O² converter pinout

O² NON-ISOLATED DUAL CHANNEL CONVERTER

MECHANICAL FEATURES

CONVERTER ASSEMBLY

OwnTech's O² is assembled on a back-to-back format between the control and the power boards.

A series of pogo pins grant the electrical connection between both boards. The mechanical connection is provided by screws that also hold in place its heatsink.

Figure 9 provides a multi-side view of the final converter assembly.



Figure 9 - O² converter assembly view

