1 Overview

PCS-100-LS is a grid-tied active front end capable of bidirectional conversion between AC grid and battery.

It features a modular design capable of parallel operation and can be used as a part of a multi MW system.

Typical application: large scale BESS with 690V grid and 1500V batteries.

1.1 Versions

Table 1.1: Versions

	Configuration
PCS-100-LS	Single (1x 126kVA)
PCS-100-LS-D	Dual (2x 126kVA)

1.2 Features

- AC side
  - up to 876V_{rms} line to line
  - up to 100A_{rms} per phase
  - up to 126kVA
  - 50/60Hz grids
  - Grid following & grid forming capability
- DC side
  - Batteries or DC grid up to 1500V_{DC}
  - up to 123A_{DC}
- Peak efficiency exceeding 99%
- Liquid cooled
- CAN open compatible digital bus with advanced control and monitoring
- Ethernet TCP/UDP as an option

1.3 Block diagram

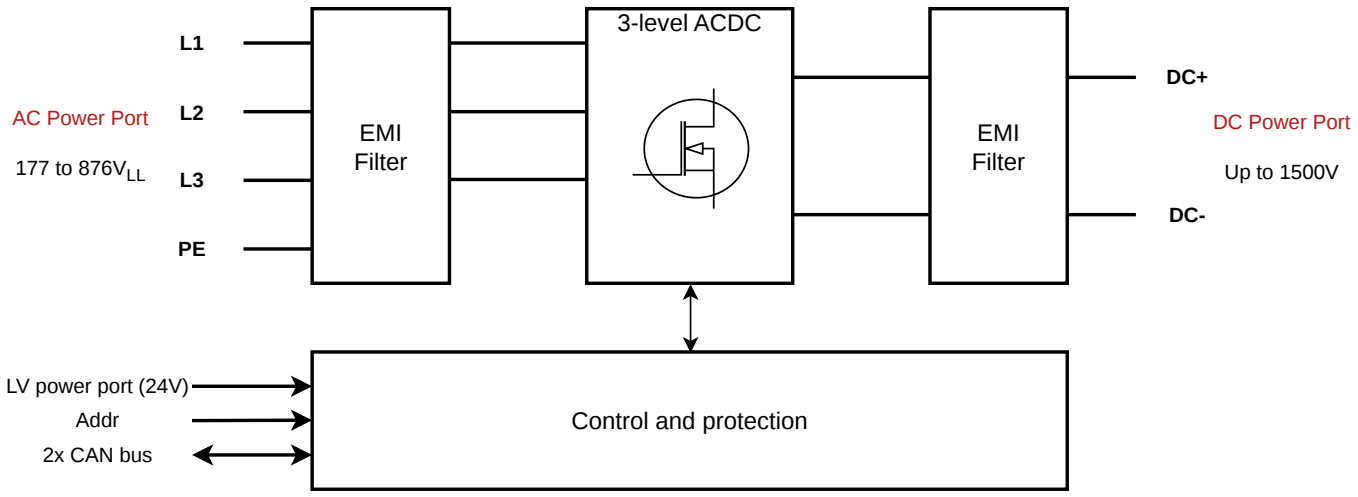

Fig. 1.1: Product block diagram

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+1 346-223-0379

Contents:

2 Figures, Tables and Changelog

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List of Tables

Table 2.1: Change log

Version	Date	Changes	Author
AA	2025-12-01	First release	F. FAURE
AB	2025-12-09	Update performances	F. FAURE
AC	2026-02-26	Add single & dual configuration. Update performances.	M. GUILBAUD

Hint

This document was generated with git version **git:doc/pcs_100_ac@420ab898_(2026-02-26)**.

3 Introduction

PCS-100-LS is a grid-tied active front end capable of bidirectional conversion between AC grid and battery.

It features a modular design capable of parallel operation and can be used as a part of a multi MW system.

Typical application: large scale BESS with 690V grid and 1500V batteries.

> **Note**
>
> This datasheet contains advanced information about an unreleased product. Values are subject to change in significant ways without prior notice (preliminary design).

3.1 Versions

Two versions are available:

- The single version integrates a single 126kVA power stack.
- The dual version integrates two identical 126kVA power stacks in a single mechanical package. These two stacks share only the cooling interface. All the other interfaces are segregated (power, control, etc…).

3.2 Features

- AC side
  - up to 876 V_{rms} line to line
  - up to 100 A_{rms} per phase
  - up to 126 kVA
  - 50/60Hz grids
  - Grid following & grid forming capability
- DC side
  - Batteries or DC grid up to 1500 V_{DC}
  - up to 123 A_{DC}
- Peak efficiency exceeding 99%
- Liquid cooled
- CAN open compatible digital bus with advanced control and monitoring
- Ethernet TCP/UDP as an option

4 Safety Instructions

IMPORTANT SAFETY INSTRUCTIONS
SAVE THESE INSTRUCTIONS

This manual contains important instructions for **PCS-100-LS** model that shall be followed during installation, operation and maintenance of the unit.

Warning

This equipment operates at voltages and currents that can result in electrical shock, fire hazard and/or personal injury if not properly handled or applied. Equipment must be used with necessary caution and appropriate safeguards employed to avoid personal injury or property damage. This board must be used only by qualified engineers and technicians familiar with risks associated with handling high voltage electrical and mechanical components, systems, and subsystems.

4.1 Caution

The following safety instructions must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this documentation violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections within. WATT & WELL shall not be liable for failure of users to comply with these requirements.

4.2 Installation

PCS-100-LS device must be installed according to the installation chapter. This product is a safety **Class 1** instrument. To minimize shock hazard, the instrument chassis must be connected to the ESS frame which is in turn connected to earth ground.

The protective earth terminal must be connected to the safety electrical ground before another connection is made. Any interruption of the protective ground conductor, or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

PCS-100-LS device is designed to be accessible only for trained staff operators in **restricted access locations**.

4.3 AC connection rating

Caution

To reduce the risk of fire, connect only to a circuit provided with **150** amperes maximum branch circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70. Rating of the overcurrent protective device shall not exceed the ampacity of the conductor intended to be connected to the converter. Do not use power supplies which exceed the input voltage rating of this instrument. The electrical rating of this instrument is given into the chapter *Electrical Characteristics* of this document

4.4 DC connection rating

Caution

To reduce the risk of fire, connect only to a circuit provided with **160** amperes maximum branch circuit overcurrent protection in accordance with the National Electrical Code, ANSI/NFPA 70. Rating of the overcurrent protective device shall not exceed the ampacity of the conductor intended to be connected to the converter. Do not use power supplies which exceed the input voltage rating of this instrument. The electrical rating of this instrument is given into the chapter *Electrical Characteristics* of this document.

4.5 Live circuits

Caution

Operating personnel are not allowed to open the case of this equipment. Internal adjustment or component replacement is not allowed by non-WATT & WELL qualified personnel. Never replace components with cable connected to this instrument. To avoid injuries, always disconnect power and remove external voltage sources before touching components. No user serviceable parts are inside the converter.

4.6 Hot Surface

Caution

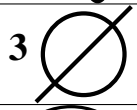
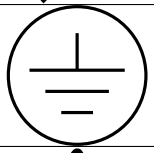
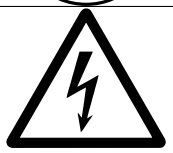
Surface of the product could be hot during and after operation. To reduce the risk of burns, use adequate protection before touching the device.

4.7 Touch current

Caution

A touch current > 3.5 mA AC RMS is possible in case of a fault condition of loss of electrical continuity of the earthing conductor in IT earthing systems. The minimum size of the protective earthing conductor shall comply with the local safety regulations.

4.8 Marking

Symbol	English	French
	Input alternating current	Courant d'entrée alternatif
	Number of AC phases	Nombre de phases AC
	Grounding	Prise de Terre
	**CAUTION – Risk of electric shocks** Capacitor stores hazardous energy. Do not remove cover until 5 minutes after disconnecting all sources of supply.	**Attention – Risque de choc électrique** Le condensateur accumule de l'énergie dangereuse. Ne pas retirer le couvercle jusqu'à 5 minutes après le débranchement de toutes les sources d'alimentation.
	**CAUTION – HOT SURFACES** To reduce the risk of burns – Do not touch	**ATTENTION – SURFACES CHAUDES** Pour réduire le risque de brûlures – Ne pas toucher

4.9 Maintenance

Warning

Capacitors inside the unit store hazardous energy. Do not remove the cover until 5 minutes after disconnecting all sources of supply.

4.10 Safety related functions

Warning

All safety related mechanisms and functions are implemented by hardware. The software does not provide or perform safety-related functions.

4.11 Parts substitution and modifications

Parts substitutions and modifications are allowed by authorized WATT & WELL service personnel only. For repairs or modification, the unit must be returned to WATT & WELL's After Sale Service.
Contact After Sale Service aftersales@wattandwell.com to obtain a return merchandise authorization (RMA) number.

WATT & WELL After Sale Service 121 Rue Louis Lumière 84120 PERTUIS France

4.12 Environmental conditions

PCS-100-LS device safety approval applies to the following operating conditions:

Table 4.1: Environmental conditions

Parameter	Condition
Operating temperature(air)	-15 °C to +50 °C
Operating temperature(coolant)	-15 °C to +50 °C
Long term storage temperature	-40 °C to +70 °C
Maximum relative humidity	95 % RH at 50 °C non-condensing
Altitude	up to 2000m
Pollution degree	2[1]
Safety on AC side	1000 V_{AC}, OVC II, mains (DVC C)
Safety on DC side	1500 V_{DC}, OVC I, non-mains (DVC C)
Safety on auxiliary LV supply	30 V_{DC}, OVC II, non-mains (DVC A, dry)
IP degree of enclosure	IP00[2]
Acoustic noise	<50dBA
Weight **PCS-100-LS**	~45kg
Weight **PCS-100-LS-D**	~90 kg

The system where **PCS-100-LS** will be installed should meet the requirements of environmental protection as defined in IEC62477-1. This converter does not provide protective means for access to hazardous live parts. AC and DC connections are accessible. It is intended to be installed inside a supplementary enclosure which provides appropriate protection against access to hazardous live parts. For protection against hazardous accessible parts, spread of fire and for use of the converter in the above environment, the protection level of the structure where the converter is installed must reach IP65 or type 4.

Avoid using the inverter in the offshore environment near the sea or near a pollution source or in a corrosive and damaging environment.

4.13 Normative compliance

CE

PCS-100-LS meets the intent of directives:

- Low Voltage: 2014/35/UE
  - NF EN IEC 62477-1:2022
- EMC 2014/30/UE:
  - NF EN IEC 61000-6-2:2018 Electromagnetic compatibility (EMC) Part 6-2: Generic standards – Immunity standard for industrial environments
  - NF EN IEC 61000-6-4:2019 Electromagnetic compatibility (EMC) Part 6-4: Generic standards – Emission standard for industrial environments
- RoHS: 2011/65/UE
- WEEE: 2012/19/EU

The converter construction complies UL 1741-2023 Ed. 3 SA SB.

It is the user's responsibility to ensure that **PCS-100-LS** is installed and used in compliance with all local country laws and regulations.

The product will be CE marked from version 2.0. Previous versions are prototypes.
The product will be UL recognized from version 3.0.

[1] Attention should be paid to avoid ingress of water, metallic or conductive particles, dust or corrosive atmosphere that may cause early failures of equipment.
[2] While the module housing provides IP4X protection, the installer is responsible for ensuring that the busbar connection zone remains inaccessible to non-qualified personnel.

4.14 Moving and storage instruction

To ensure the safe handling and storage of the product and to prevent risks of fire, electric shock, or injury to people during subsequent use, please follow these instructions carefully.

4.14.1 Moving the Unit

- Before moving the product, ensure it is powered off and disconnected from all electrical connections.
- Use proper lifting techniques and equipment to handle the weight of the unit.
- Avoid dropping, tipping, or applying excessive force to the unit during movement. Sudden impacts can damage internal components, potentially leading to safety hazards.
- Protect the unit from exposure to moisture, dust, and extreme temperatures during transportation.
- Use the original packaging or equivalent protective materials to minimize the risk of physical damage.
- The unit is to be placed horizontally, cold plate shall face downward. All other positions are prohibited.

4.14.2 Storage Guidelines

- Store the inverter in a clean, dry, and well-ventilated area.
- Avoid environments with high humidity or exposure to corrosive chemicals.
- Maintain the storage temperature within the range specified in the technical specifications of this manual
- The unit is to be placed horizontally, cold plate shall face downward. All other positions are prohibited.

4.14.3 Inspection Before Reuse

- Before reusing the unit after storage, inspect it for visible damage, including cracks, corrosion, or loose connections.
- Check all electrical terminals and connections for signs of damage or wear. Tighten any loose connections as per the installation guidelines.
- If any damage is observed, do not power on the unit. Contact a qualified technician or the manufacturer for further assistance.

5 Electrical Characteristics

All specifications are given for coolant temperature up to 25 °C unless otherwise noted.

Table 5.1: Absolute Maximum Ratings

Parameter	Condition	Minimum	Maximum	Unit
AC grid voltage			876	V_{LLrms}
AC grid current			110	A_{rms}
DC voltage			1500	V_{DC}
DC current			123	A_{DC}
LV input voltage			26	V_{DC}
Coolant temperature		-40	+70	°C
Ambient temperature (air)		-40	+70	°C

Table 5.2: Control & Auxiliary Power Supply Ratings

Parameter	Condition	Min	Typ	Max	Unit
LV Supply voltage		19	24	26	V_{DC}
LV Power consumption	standby		5		W
LV Power consumption	operating			15	W
LV Inrush current	start-up @24V (1 ms)			3	A
CAN Baudrate			1		Mbps
CAN Common mode range		-7		7	V_{DC}
EMS Positive going input current		2		10	mA
EMS Negative going input current				0.1	mA
EMS Maximum reverse voltage				5.5	V_{DC}

Table 5.3: AC Grid Side Ratings

Parameter	Condition	Min	Typ	Max	Unit
Voltage		177	730	876	V_{LLrms}
OVRT				876	V_{LLrms}
UVRT				0	V_{LLrms} residual
Voltage measurement accuracy[3]	@730V_{LLrms}			3	%
Current		0		100	A_{rms}
Current measurement accuracy[3]	@100 A_{rms}			3	%
Power factor[4]		0 (capacitive)	1	0 (inductive)	-
THDi	@100 A_{rms}			3	%
DC current injection	@100 A_{rms}			0.5	%
Current harmonics[5]					-
Flicker[5]					-
Response time	Full charge to discharge		5		ms
Grid frequency		42.5	50/60	69	Hz
Apparent power				126	kVA
Switching frequency			35		kHz
Insulation to PE	50/60 Hz, 1 min		4000		V_{ACrms}

Table 5.4: DC Side Ratings

Parameter	Condition	Min	Typ	Max	Unit
Voltage		250[6]	1350	1500[7]	V_{DC}
Current		-123		123	A_{DC}
Voltage measurement accuracy[3]	@1500V_{DC}			3	%
Insulation to PE	50/60Hz, 1 min		4000		V_{ACrms}

[3] Initial accuracies.
[4] Converter can deliver full inductive or capacitive reactive power.
[5] Compliant with IEC 61727:2004 and IEEE 519:2022 levels.
[6] See *Operating Voltage Battery* section.
[7] Below 340 V_{LLrms}, **PCS-100-LS** cannot be interfaced with 1500V battery. DC voltage is limited to 4 times the grid voltage.

5.1 Earthing system compatibility

The inverter is compatible with TT, TN and IT earthing systems.
The converter does not integrate an Insulation Monitoring Device (IMD). When used in IT earthing systems, an external IMD must be installed at the system level to ensure compliance with safety regulations regarding first-fault detection.

5.2 Safe Operating Area (SOA)

PCS-100-LS automatically adjusts its operation to the typical operating zone of a battery.
A Safe Operating Area (SOA) is given where two modes can be identified:

- Inverter mode: current flow from battery to grid - Positive battery current
- Rectifier mode: current flows from grid to battery – Negative battery current
  PCS-100-LS is able to change between both operating modes and go to full power in either direction.

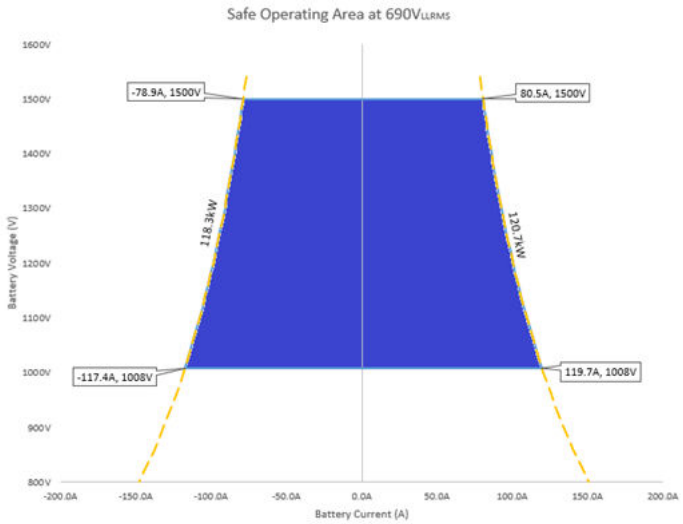


Fig. 5.1: Safe Operating Area at @690 V_{LLrms}

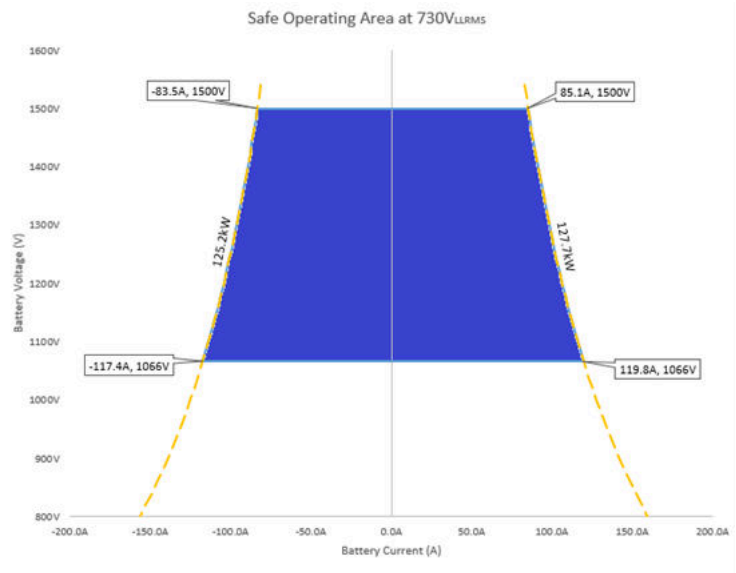


Fig. 5.2: Safe Operating Area at @730 V_{LLrms}

The **PCS-100-LS** is designed for continuous operation at rated current (100 A_{rms}). It does not support any transient overload beyond the maximum ratings (110 A_{rms}). Protection and control loops will immediately limit or trip the unit if the current exceeds

these values, including during Grid Forming transients.
PCS-100-LS is able to cover the full PQ circle with an apparent power of 126kVA.

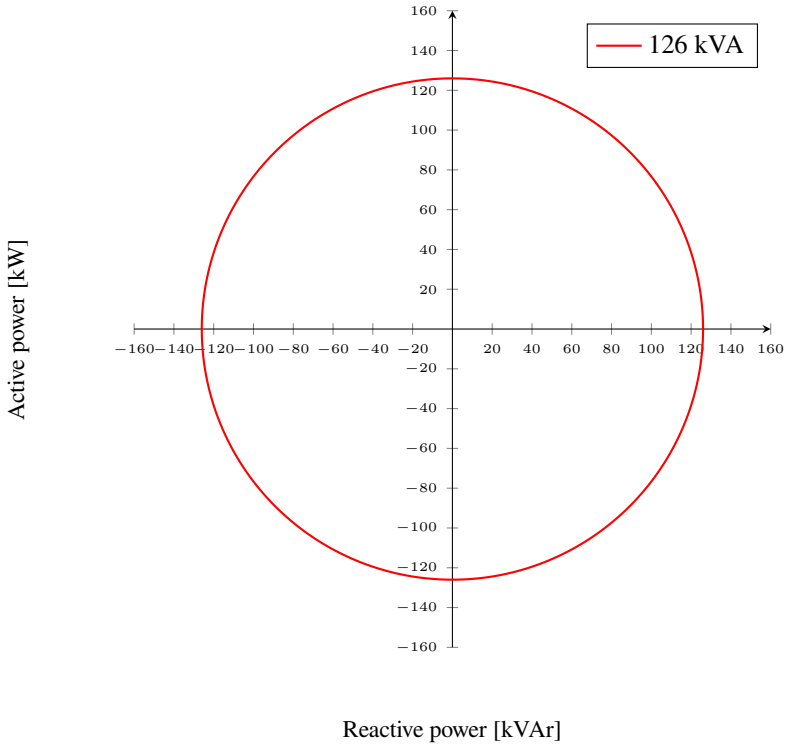


Fig. 5.3: PQ curve @730 V_{LLrms}

5.3 AC Grid deratings

PCS-100-LS is sized for 100 A_{rms} per phase in both directions.
Power increases or decreases linearly according to the grid voltage and the maximum phase current.
Above 730 V_{LLrms}, power is kept constant at 126 kW.

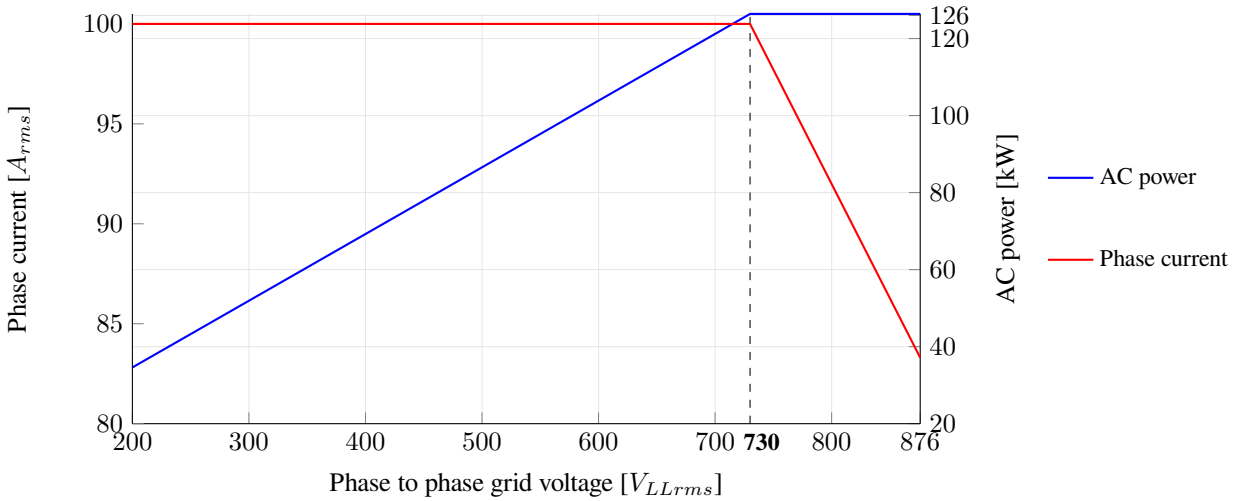


Fig. 5.4: AC grid power vs AC grid voltage & current

Table 5.5: AC Grid Side Ratings depending on grid voltage

Grid voltage	Maximum grid power
400 V_{LLrms}	69 kW
480 V_{LLrms}	83 kW
690 V_{LLrms}	119 kW
730 V_{LLrms}	126 kW

5.4 Operating Voltage Battery

The battery connected to the **PCS-100-LS** shall have its minimum voltage rated according to the grid voltage ($V_{DCmin} = 1.46 \times V_{LLrms}$).

Table 5.6: Minimum battery voltage vs maximum grid voltage

Maximum Grid Voltage	Minimum Battery Voltage
876 V_{LLrms}	1279 V_{DC}
730 V_{LLrms}	1066 V_{DC}
690 V_{LLrms}	1008 V_{DC}
480 V_{LLrms}	701 V_{DC}
400 V_{LLrms}	584 V_{DC}

5.5 Thermal derating

Maximum power is available when the inlet coolant temperature is below 25 °C with a maximum of 100 A_{rms} on the AC side. Between 25 °C and 50 °C, a derating is applied until limiting the maximum AC current to 83 A_{rms}.

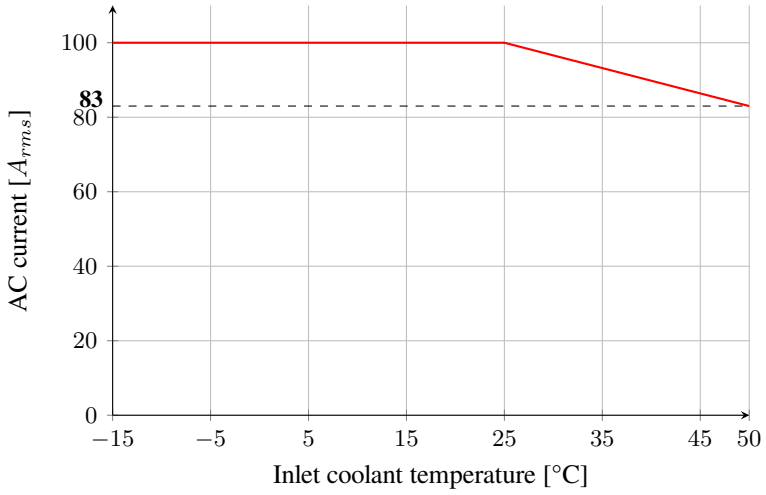


Fig. 5.5: Maximum available AC power vs inlet coolant temperature

5.6 Efficiency

PCS-100-LS is based on highly efficient full SiC (Silicon Carbide) technology.
Peak efficiency exceeds 99%.

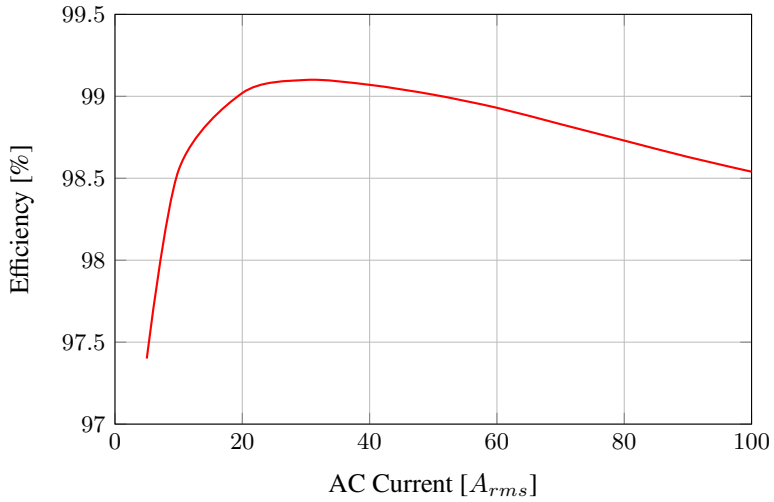


Fig. 5.6: Estimated efficiency @730 V_{LLrms}, @1350 V_{DC}

5.7 Reliability

Table 5.7: Reliability characteristics

Parameter	Condition	Min	Typ	Max	Unit
MTBF	Coolant temperature 25 °C		400,000		Hours

6 Installation

The unit must be properly assembled in accordance with the assembly instructions before it is used. Do not use or install PCS-100-LS product in case of visible physical damage. PCS-100-LS should be installed in ESS structure that complies with frame and enclosure requirement of UL1741. Installation and maintenance shall not be performed while the converter is energized. These installation instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform servicing other than that specified in the following instructions unless you are qualified to do so.

6.1 Mechanical installation

6.1.1 Handling

PCS-100-LS product is heavy. For correct handling, follow the instruction below:

- The product must be handled in a flat position.
- For operator safety use personal protective equipment.
- Do not stack units (each unit should be self-supported and secured with the dedicated screws threads)

6.1.2 Mounting

PCS-100-LS is a heavy instrument and requires the frame to be equipped with slides or rails that provide full-depth support for the chassis.
The unit must be mounted in one specific orientation only.
The unit is to be placed horizontally, cold plate shall face downward.
All other positions are prohibited.

6.1.3 Cooling system

PCS-100-LS is liquid cooled.
A mix of demineralized water and ethylene glycol shall be used as coolant.
The following table shows the cooling system parameters. The internal cold plate is made of aluminum. To prevent galvanic corrosion, the external cooling loop must be designed with compatible materials.

Table 6.1: Cooling system parameters **PCS-100-LS** (single version)

Parameter	Condition	Minimum	Typical	Maximum	Unit
Coolant Flow		5			L/min
Coolant pressure drop	@5L/min			0.5	bar
Inlet coolant pressure			2.5	4	bar
Ethylene glycol proportion		20		50	%
Inlet coolant temperature		-15	+25	+50	°C

Table 6.2: Cooling system parameters **PCS-100-LS-D** (dual version)

Parameter	Condition	Minimum	Typical	Maximum	Unit
Coolant Flow		10			L/min
Coolant pressure drop	@10L/min			0.5	bar
Inlet coolant pressure			2.5	4	bar
Ethylene glycol proportion		20		50	%
Inlet coolant temperature		-15	+25	+50	°C

6.2 Electrical installation

6.2.1 Regulatory Compliance

Electrical installation shall comply with international standards such as IEC or the requirements in national standards of each country.

6.2.2 Safety Notice

Never invert the polarity of the connector. Never force to place a connector.
Use only approved manufacturer parts for electrical or mechanical connection.
It is strongly recommended to fix the cables or bus bar to avoid any stress on the connection.
All high-power connections must be screwed up to avoid any disconnection.
Be careful if other devices are connected, there is a risk of electrical charge transfer.
It is forbidden to open the cover.
Only WATT & WELL approved personnel are allowed to do maintenance operations.
Waiting time after complete suppression of AC and DC voltage before opening the device should be respected.

6.2.3 Protective earth

PCS-100-LS should be referenced to the BESS frame which is in turn connected to earth ground.
Any interruption of the protective ground conductor, or disconnection of the protective earth terminal will cause a potential shock hazard which may result in serious personal injury or death.
Protective earth connection is made through earth connection point (screw thread available on the front panel of the converter).
In addition, all parts of the chassis where **PCS-100-LS** is to be installed (i.e., the ESS frame) need to be grounded. An electrical connection to “G” through mechanical parts must be done.
The protective earthing conductor and the protective conductor shall be green/yellow striped color with a cross section rated to carry the required current in accordance with the overcurrent protective device.
Any interruption of the protective ground conductor, or disconnection of the protective earth terminal could cause a shock hazard that might cause personal injury or death. **PCS-100-LS** must only be operated by skilled personnel or instructed personnel.

6.2.4 AC Grid connection

AC input is defined as three phases.
PCS-100-LS product must be protected against short-circuit, overload protection and earth leakage current protection with external devices.
AC connection is not internally bonded to the ground connection. A surge protection shall be installed outside of the inverter to protection against voltage transients.
AC input connection must be connected through an overcurrent protection device in the end product.
For European countries, we recommend using a residual current breaker/device (RCB/RCD) and a circuit breaker (MCB) with short circuit protection and thermal overload protection.
The AC interface is a 3-wire connection (L1, L2, L3 + PE). The converter does not require and does not support a neutral conductor connection. In Grid Forming mode, the system creates a delta-connected voltage source.

6.2.5 DC Input

PCS-100-LS DC input must be protected with a rapid fuse. DC input connection must be connected through an overcurrent protection device in the end product.
Rating of the overcurrent protective device shall exceed the ampacity of the conductor intended to be connected to the converter.
The DC input cable must be shorter than 30 m.

6.2.6 LV Input

LV input must be connected to a class 2 AC/DC converter with a nominal 24 V_{DC} output voltage, limited to 26 V_{DC} maximum and 20 W.
This input must be protected with a short circuit protection device either integrated into the AC/DC power supply or with an external fuse of adequate rating.
Rating of the overcurrent protective device shall exceed the ampacity of the conductor intended to be connected to the converter.
The LV input cable must be shorter than 3 m.

6.2.7 EMC requirements

Converters are designed to be compliant with IEC EMC standards, see chapter *Normative compliance*. However, Integrator is responsible to use best practice for final system to avoid high EMI emissions.

6.2.8 DC precharge

The converter does not provide an internal DC precharge circuit. To avoid damage to the converter, internal capacitors must be precharged before connecting the converter to the AC grid.
For the precharge, we advise using the following system:

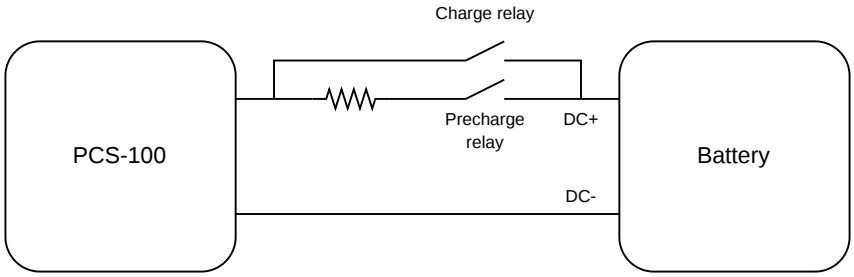


Fig. 6.1: Precharge synoptic

The converter DC bus integrates $330\mu F$ of capacitances to be precharged.
The external resistor value is to be designed in order to limit the precharge current under the maximum acceptable DC current (ie 123 A_{DC}) of the converter.
External resistor and precharge relay circuits must be designed to support the full battery voltage and the precharge current according to the resistor value.
The charge relay must be designed to support the full battery voltage and the maximum DC current of the converter.
After the precharge is done, the converter sends a signal to acknowledge the precharge. Then, the charge relay can be closed safely, and the AC grid can be connected to the converter to operate nominally.
Attention should be given to the minimum DC battery voltage according to the AC grid voltage. See chapter *Operating Voltage Battery*.

6.2.9 Connection and disconnection procedure

For the connection procedure, follow these instructions:

- Remove power from AC and DC sources to avoid risk of electrical shock using disconnector or other mean to provide safety to installation personnel while installing the converter in its final structure.
- Fix the unit to the final structure with the intended screw threads
- Connect the earth to the enclosure. See 6.2.4
- Connect DC terminals to battery cable or bus bar. See 6.2.2
- Connect AC terminals to grid cable or bus bar. See 6.2.3
- Connect LV terminals to the 24V power supply See 6.2.1
- Connect CAN communication terminal. See 6.2.6
- Connect the liquid cooling system. See 6.2.5
- Close the enclosure of the structure
- Enable liquid cooling system
- Enable LV power supply
- Connect the converter to the CAN communication system
- Close DC disconnector
- Perform DC precharge. See *DC precharge*

- Once the precharge is done, AC voltage can be connected to the converter
- Converter is ready to operate

For the disconnection procedure, follow these instructions:

- Set the converter in standby through the CAN communication
- Disconnect the AC grid with the disconnector
- Disconnect the DC battery with the disconnector
- Stop the liquid cooling system
- Drain the liquid cooling system
- Disable LV power supply
- Wait 5 minutes before touching the hazardous accessible parts to wait for the complete capacitor discharge
- Disconnect liquid cooling terminals
- Disconnect CAN communication terminal
- Disconnect LV terminals
- Disconnect AC terminals
- Disconnect DC terminals
- Disconnect earth terminal
- Unfix the converter from the structure

6.2.10 Series operation

No series operations is allowed.

6.2.11 Disposal

Mandatory application within the European Union.
Do not dispose of electronic tools together with household waste material.
In accordance with WEEE European Directive (2012/19/UE), Electric material that has reached the end of their life must be collected separately and return to an environmentally compatible recycling facility.
Please contact WATT & WELL for any questions about WEEE.

7 Control Specifications

7.1 Theory of operations

The **PCS-100-LS** features a high-performance control loop based on a dual-core DSP architecture.
It implements advanced current control ensuring high dynamic performance and low harmonic distortion.

The control system of**PCS-100-LS** consists of the following components:

- The overall behavior of **PCS-100-LS** is governed by a state machine that defines the possible actions of the converter based on the master's state request.
- PFC control system that regulates phase currents and voltages, and manages grid codes.
- Software protections against over/under-voltage, over/under-current, over-temperature, communication loss, etc.
- A fast discharge control for the DC output.
- CAN communication based on the CANopen protocol.
- Contactor management and LED lighting.

7.2 Control Modes

The unit can be configured to operate in various modes depending on the system requirements:

- **Grid Following (CSI):** The inverter synchronizes with the grid and acts as a controlled current source.
- **Grid Forming (VSI):** The inverter acts as a voltage source, establishing the grid frequency and voltage (including black start).
- **DC Voltage Regulation:** Automatically adjusts AC power to maintain a stable DC bus voltage.

7.3 Communication Protocols

The device is designed to be integrated into a larger Power Plant Controller (PPC) or an Energy Management System (EMS).

7.3.1 CANopen Interface

The primary control interface is based on **CANopen** (ISO 11898).

- **Baudrate:** 1 Mbps.
- **PDO (Process Data Objects):** Real-time transmission of electrical measurements (Voltages, Currents, Temperatures) and high-priority setpoints.
- **SDO (Service Data Objects):** Access to configuration parameters and detailed diagnostics.

7.3.2 Modbus TCP (Optional)

When equipped with the Ethernet option, the unit supports **Modbus TCP** and **Ethernet UDP**.

7.4 Firmware Updates

The firmware can be updated through the CAN interface using the **WATT & WELL Bootloader utility**.
This allows for field updates of control laws and communication features without removing the unit from its enclosure.

7.5 Grid Code Compatibility & Standards

7.5.1 Design for Compliance

The **PCS-100-LS** hardware and control firmware have been engineered to meet international grid connection requirements. While formal certification is currently in progress, the system architecture is designed to support the regulatory demands of major global markets.

7.5.2 Targeted Standards

The product is undergoing validation to achieve official certification for the following standards:

- **European Union:** EN 50549-1 / EN 50549-2.
- **Germany:** VDE-AR-N 4110 / 4120 / 4130.
- **North America:** IEEE 1547-2018 and UL 1741 SB (Interoperability).
- **Australia:** AS/NZS 4777.2.

7.5.3 Grid Support Features (Hardware Ready)

The control system includes the necessary hardware sensing and processing speed to implement:

- **Dynamic Grid Support:** Fast reactive current injection during voltage dips (LVRT) and swells (OVRT).
- **Active Power Control:** Frequency-dependent power droop ($P(f)$) and ramp rate limiting.
- **Voltage Regulation:** Programmable $Q(U)$ and $cos(\phi)$ curves to maintain local grid stability.

7.5.4 Protection Strategy

The hardware implements redundant protection layers (Voltage, Frequency, Loss of Mains) that can be parameterized to match specific local grid codes during the commissioning phase.

Important

Final grid code certification status will be provided with the version 3.0 of the product. Previous versions are intended for laboratory testing and pilot projects under supervised conditions.

7.6 System Aggregation & EMS Gateway (Optional)

To simplify the integration of large-scale systems, **WATT & WELL** offers an optional smart gateway board. This board acts as a communication concentrator and abstraction layer between **PCS-100-LS** and the Energy Management System (EMS).

7.6.1 Key Features

- **Node Abstraction:** The gateway aggregates multiple PCS-100-LS units and presents them to the EMS as a single, high-power virtual inverter.
- **Protocol Conversion:** It translates real-time CANopen data from the internal bus to industrial Modbus TCP or UDP over Ethernet.
- **Unified Control:** The EMS sends a single power setpoint (e.g., “Set Power to 1.5MW”), and the gateway intelligently dispatches the load across all available stacks, accounting for individual unit status or thermal derating.
- **Advanced Logging:** Integrated internal memory for high-resolution data logging of all sub-modules for diagnostic purposes.

7.6.2 Benefits

- **Network Simplification:** Reduces the number of IP addresses required in the container.
- **Cybersecurity:** Acts as a firewall between the power electronics’ internal CAN bus and the external customer network.
- **Reduced Latency:** Offloads the EMS by managing fast local loops and safety heartbeats directly at the gateway level.

8 Hardware Specifications

8.1 Theory of operations

PCS-100-LS consists of a bidirectional 3-level inverter that interfaces the AC grid and performs DC regulation.
It also features:

- Line inductors
- Line contactors on AC lines (before filters) for grid disconnection
- AC and DC EMC filters, in order to comply with IEC EMC standards, see chapter *Normative compliance*.
- AC current and voltage measurements, including AC voltage measurement before the AC line contactors.
- DC voltage measurement.
- Internal temperature measurement for derating and diagnostics

The product does not provide galvanic insulation between AC and DC sides.
The product does not provide AC neither DC pre-charge system.

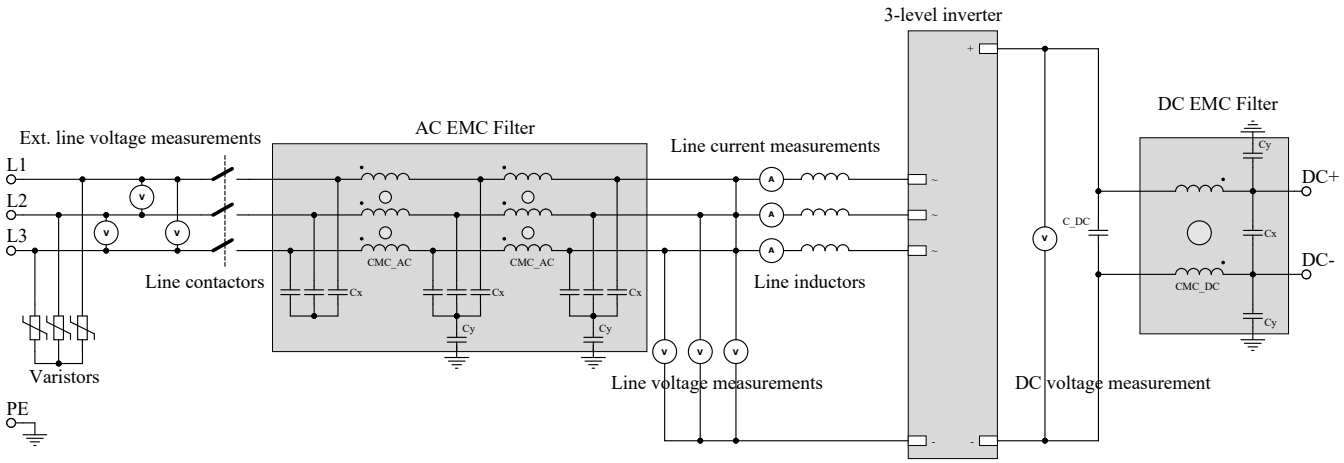


Fig. 8.1: **PCS-100-LS** Synoptic

8.2 Interfaces and Supply Cables

Please note that the supply cables of the inverter shall be chosen to have an ampacity based on Table 310-16 of the National Electrical Code, ANSI/NFPA 70 of no less than 125 percent of the maximum current that the circuit carries during rated conditions; and that a wiring terminal are provided with a pressure terminal connector that is securely held by a screw. All conductor materials shall be made with copper.
Please use an ordinary tool for securing all conductors.

8.2.1 Low Voltage Connector

Located on the rear panel.
Cable connected to these ports must be less than 3m long.
Connector Reference (converter side):

- Phoenix Contact MSTB 2,5/ 2-GF-5,08 1776508 (UL approval 300V/15A)
- TIELEE: TLPHW-200R-02P-G12 (UL approval 300V/16A)

Table 8.1: LV mating connectors

Connector	Manufacturer	Wire	Ferrule	Crimping tool
MSTB 2,5/ 2-STF-5,08 – 1777989	Phoenix contact	1 mm^2	A 1 -6 Ref 3200247	CRIMPFOX 6 Ref 1212034
TLPSW-200V-02P-G12S	TIELEE	1 mm^2	A 1 -6 Ref 3200247	CRIMPFOX 6 Ref 1212034

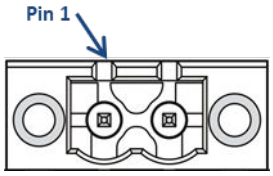


Fig. 8.2: Low voltage supply connector

Table 8.2: LV pinout

Pin	Function	Description	Preferred wiring color
1	LV_IN-	Low Voltage supply return (PE typ)	Black
2	LV_IN+	Low Voltage supply (24V typ)	Red

8.2.2 AC Grid connectors

Located on the front panel.
One connection per phase.

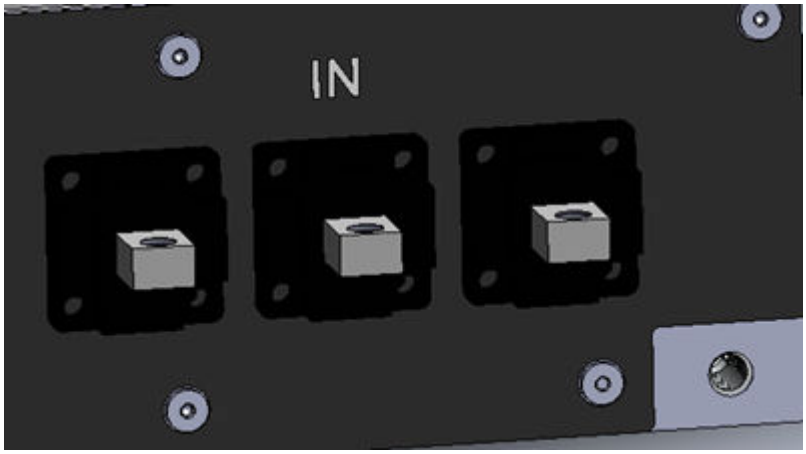


Fig. 8.3: AC Grid connectors

Table 8.3: AC power connectors

Label	Port	Reference	Manufacturer	Format	Color
L1	AC Phase 1	160A 1500V connector	Watt & Well	Busbar with 7 mm clearance holes	Black
L2	AC Phase 2	160A 1500V connector	Watt & Well	Busbar with 7 mm clearance holes	Black
L3	AC Phase 3	160A 1500V connector	Watt & Well	Busbar with 7 mm clearance holes	Black

8.2.3 DC Grid connectors

Located on the front panel.

Fig. 8.4: DC Grid connectorss

Table 8.4: DC power connectors

Label	Port	Reference	Manufacturer	Format	Color
-	DC negative	160A 1500V connector	Watt & Well	Busbar with 7 mm clearance holes	Black
+	DC positive	160A 1500V connector	Watt & Well	Busbar with 7 mm clearance holes	Red

8.2.4 CAN Connectors

PCS-100-LS provides two CAN interfaces for low latency communications.
Each CAN interface is accessible on 2 RJ45 connectors, to ease CAN bus chaining.
The cable connected to these ports must be less than 3m long.

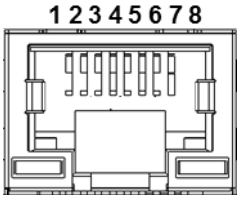


Fig. 8.5: CAN RJ45 connector

Table 8.5: CAN 1 pinout

Pin	Function	Description
1	CAN1 H	CAN 1 differential +
2	CAN1 L	CAN 1 differential -
3	GND_ISO	Ground reference for CAN (PE)
4	EM_SHUT_RTN	Emergency Shutdown (negative)
5	EM_SHUT	Emergency Shutdown (positive)
6	RESERVED	Reserved
7	GND_ISO	Ground reference for CAN (PE)
8	RESERVED	Reserved

Table 8.6: CAN 2 pinout

Pin	Function	Description
1	CAN2 H	CAN 2 differential +
2	CAN2 L	CAN 2 differential -
3	GND_ISO	Ground reference for CAN (PE)
4	NC	Not connected
5	NC	Not connected
6	NC	Not connected
7	GND_ISO	Ground reference for CAN (PE)
8	RESERVED	Reserved

Note on CAN bus termination:

- CAN bus is expected to be terminated at each bus end with a 120 Ω resistance.
- Wiring should be selected to have an intrinsic impedance of the twisted pair that match this 120 Ω.
- By default, PCS-100-LS does not include any 120 Ω resistor to avoid overloading the bus when multiple nodes are present.

Note on CAN bus shield:

- Although ISO 11898-2 does not specify the wires type or the need for a shield, a shielded cable is recommended for electronically harsh environments.
- It is recommended to ground the shield at a single point on the dedicated shield pin of the COM connector to avoid ground loops.
- Also, remember that the CAN bus being isolated, the CAN_GND should be wired between nodes

8.2.5 Protective earth

Protective earth is connected through a screw thanks to thread available on the front side of the inverter.
Thread is sized for M8 screw, 16mm thread length.

8.2.6 Liquid cooling connectors

Located on the right side.

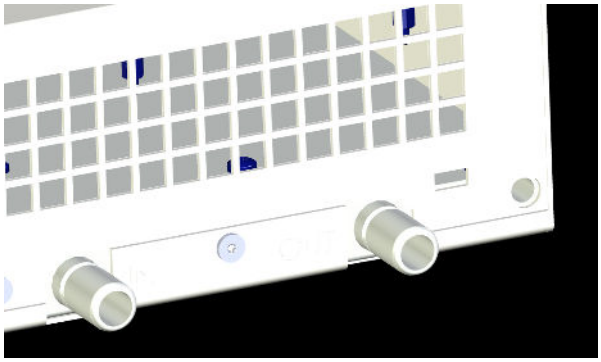


Fig. 8.6: Liquid cooling connectors

Table 8.7: Liquid cooling mating connectors

Label	Port	Connector	Manufacturer	Size
IN	Coolant inlet	VOSS 270 quick series	VOSS	S10
OUT	Coolant outlet	VOSS 270 quick series	VOSS	S10

8.2.7 Emergency Shutdown

The CAN1 connector also transmits an Emergency Shutdown (EM_SHUT) signal.
This signal can be used to trigger an unconditional shutdown of the **PCS-100-LS** operation. See *CAN Connectors* for the pinout of EM_SHUT within the CAN1 connector.

EM_SHUT logic is as follows:

- 0 V_{DC} or "floating": Emergency Shutdown triggered (EM_SHUT=1)
- 12 V_{DC} or 24 V_{DC}: normal operation (EM_SHUT=0)

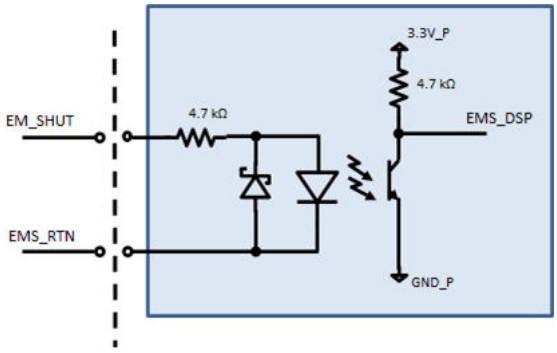


Fig. 8.7: Emergency Shutdown simplified circuit

8.2.8 Address selector

Each PCS-100-LS device takes its CAN address at boot based on the addressing dip switch on the back panel. ADDR0 bit is the rightmost position of the dip switch.

Table 8.8: CAN addressing

ADDR2	ADDR1	ADDR0	CAN ID (dec)
down	down	down	80
down	down	up	81
down	up	down	82
down	up	up	83
up	down	down	84
up	down	up	85
up	up	down	86
up	up	up	87

8.2.9 LEDs

4 LEDs on back panel indicate the status of the system.

Table 8.9: LED overview

LED	Color	Function	Description
1	Red	Fault	Indicates a fault in the system. System stops as a result
2	Green	Operating	Continuous: Operating mode
3	Green	Unused	Unused
4	Yellow/Orange	Voltage	Slow blink: 24V connected. Continuous: Grid and 24V connected

9 Mechanical specifications

9.1 Single version

The mechanical dimensions of the **PCS-100-LS**, excluding connectors, are detailed below:

- Length: 590 mm
- Width: 470 mm
- Height: 88 mm

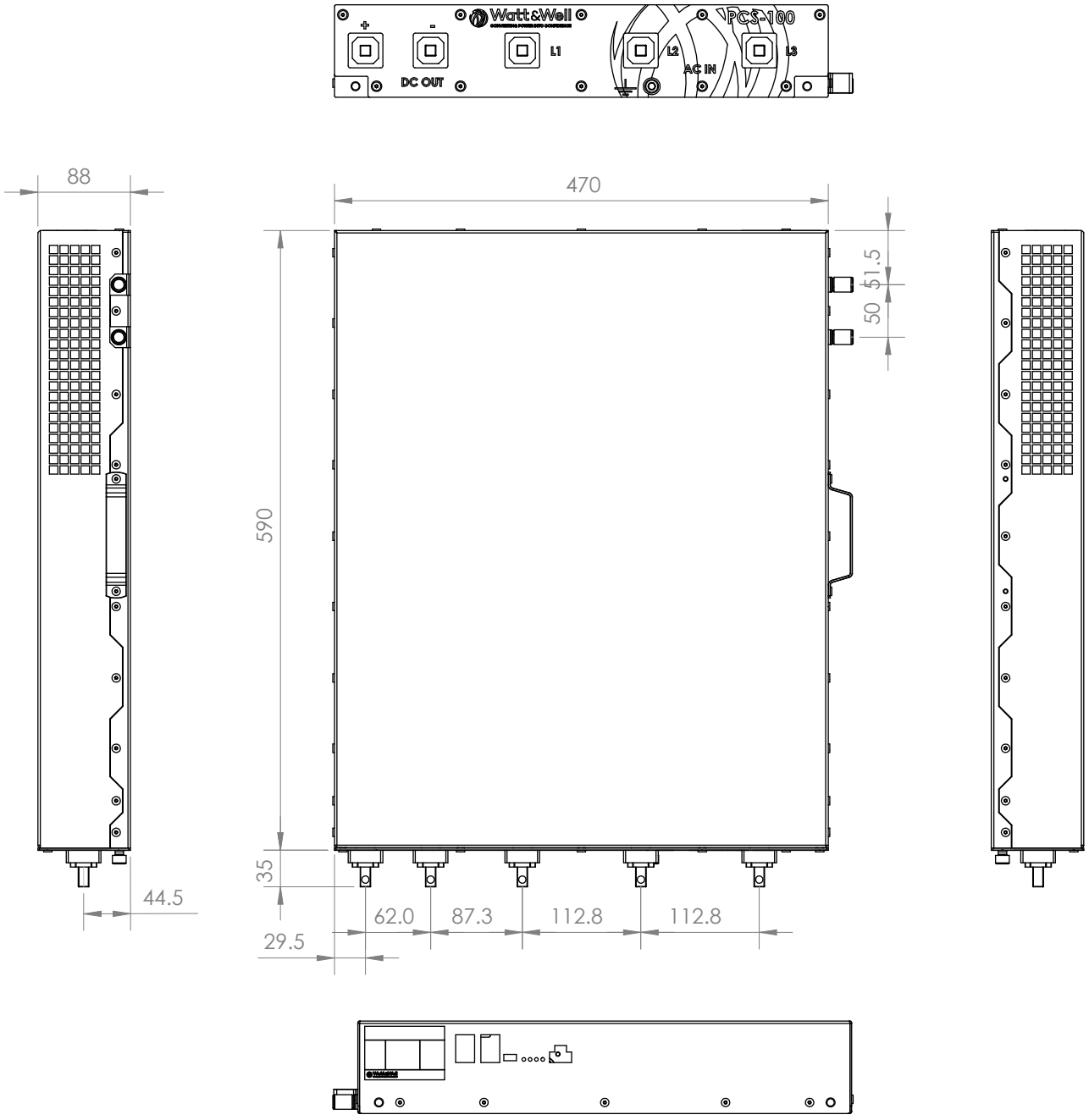


Fig. 9.1: Dimensions of the **PCS-100-LS** (single version)

9.2 Dual version

The mechanical dimensions of the **PCS-100-LS-D**, excluding connectors, are detailed below:

- Length: 590 mm
- Width: 950 mm
- Height: 88 mm

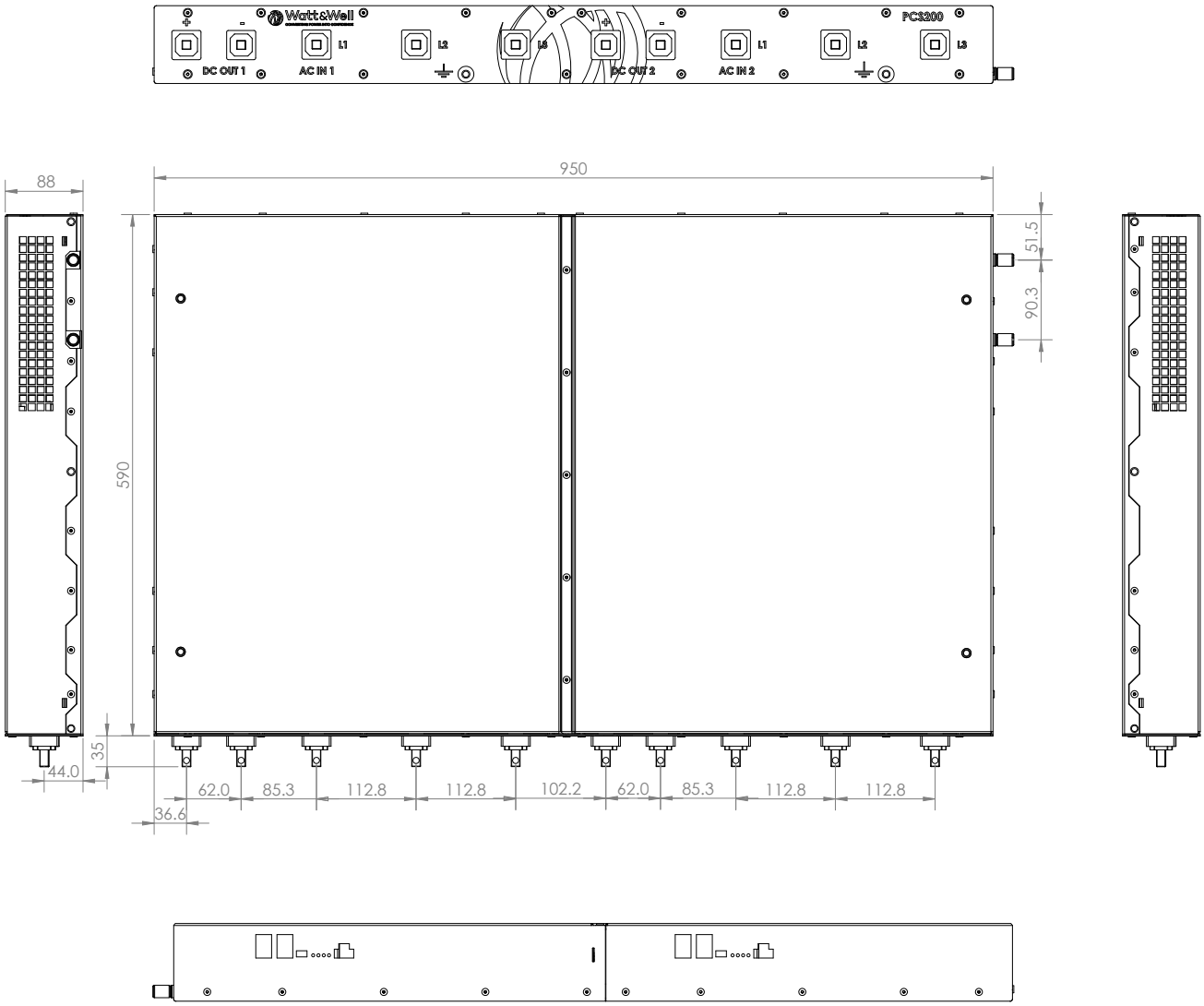


Fig. 9.2: Dimensions of the **PCS-100-LS-D** (dual version)

10 Ordering Information

10.1 Product Reference

Table 10.1: Product Reference

Reference	Status	Inverter number
PCS-100-LS	Under development	1 (single version)
PCS-100-LS-D	Under development	2 (dual verison)

10.2 Accessories

- **WA016:** Pre-wired 1meter LV harness.
- **WA007:** CAN bus adaptor (RJ45 to DB9) with 120 Ω termination.
- **WA009:** USB to CAN transceiver (Kvaser).