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Your off-grid partner

Any-Grid™ PSW-H
Pure Sine Wave Hybrid
Inverter Charger with MPPT

2019-12-04

Alessio Alario
Product Manager - Global

www.phocos.com

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Introduction

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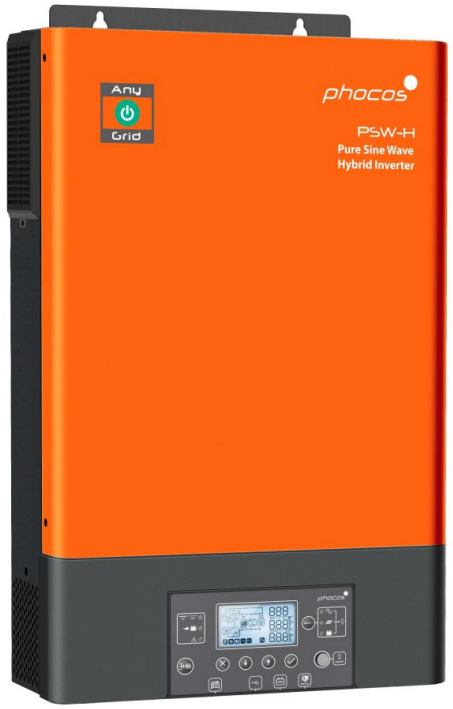
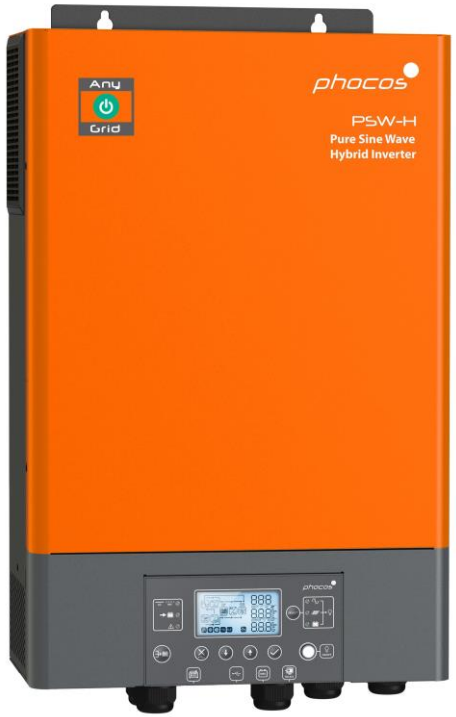
Introduction: What is Any-Grid™?

- Currently On- and Off-Grid are defined in the industry
- Any-Grid™ means On-Grid, Off-Grid and in between such as:
  - Unreliable grids (load shedding)
  - Regular or sporadic grid black-outs
  - Large swings in grid frequency or voltage that could damage loads
  - Voluntary disconnection from grid to prioritise PV for cost savings
  - AC generators as backup AC energy sources, too expensive to run all the time
  - Taking advantage of changing grid power tariffs throughout the day
  - Grid feed-in where permitted to sell excess energy to the grid

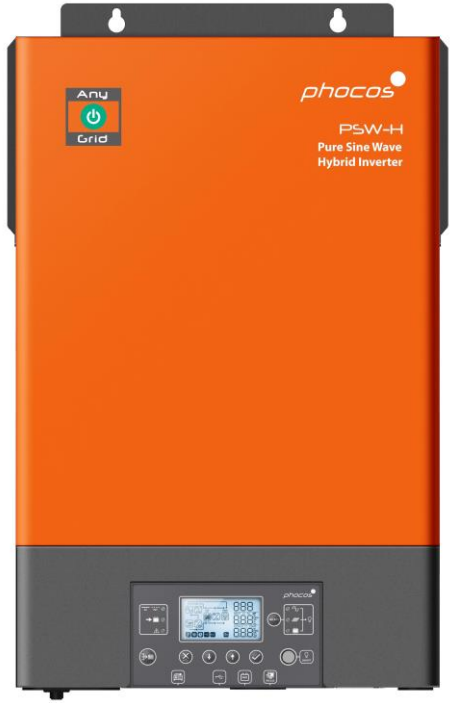
Introduction: Any-Grid PSW-H Family



PSW-H-3KW-230/24V
3 kW, 230 Vac
for 24 Vdc batteries



PSW-H-3KW-120/24V
3 kW, 120 Vac
for 24 Vdc batteries

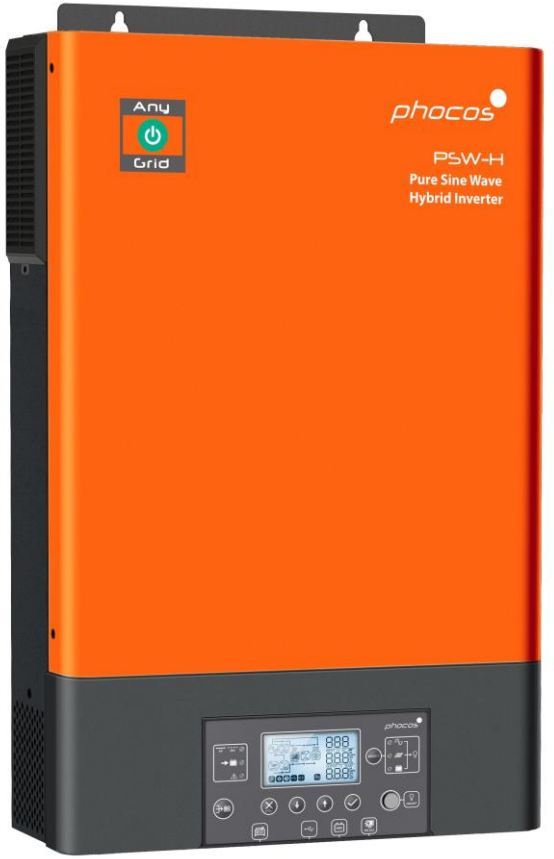


PSW-H-5KW-230/48V
5 kW, 230 Vac
for 48 Vdc batteries

PSW-H-5KW-120/48V
5 kW, 120 Vac
for 48 Vdc batteries

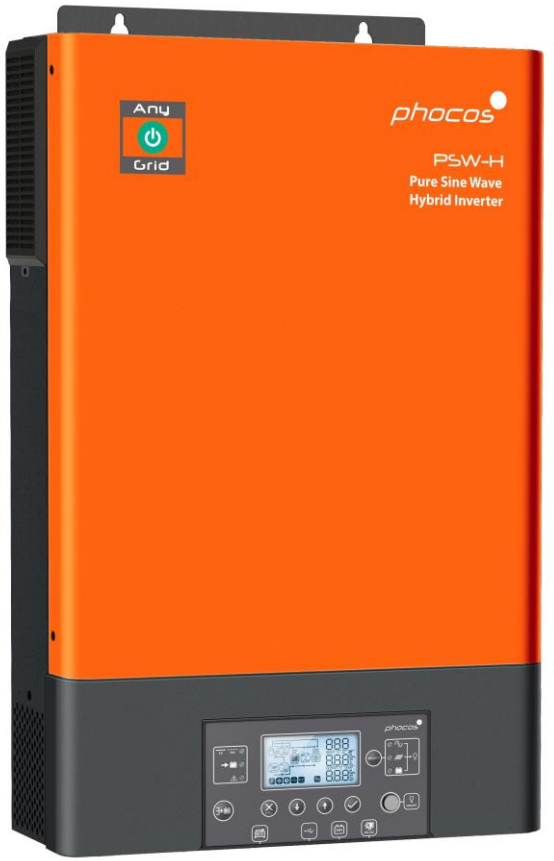
Introduction: Any-Grid PSW-H Family

- All models:
  - 80 Adc MPPT solar charge controller
    PSW-H-5KW-120/48V has two independent MPPTs, 80 Adc total
  - AC charger with 80 Adc
  - Works with or without battery, Flooded Lead-Acid, AGM, Gel, Lithium, Salt-Water supported
  - Grid feed-in possible
  - Pure Sine Wave Inverter surge capability 2x nominal AC power for 5 seconds
  - 10 ms typical switchover time between Grid and Off-grid modes
  - Removable display unit
  - Datalogger, up to 60 days of data
  - Communication: RS-232, USB-OTG and BLE for the unit, RS-485 / CAN / RS-232 for battery
  - Genset starter relay
  - IP 21 with washable dust filter and conformal coating
  - Up to 9 synchronized PSW-H units for increased power

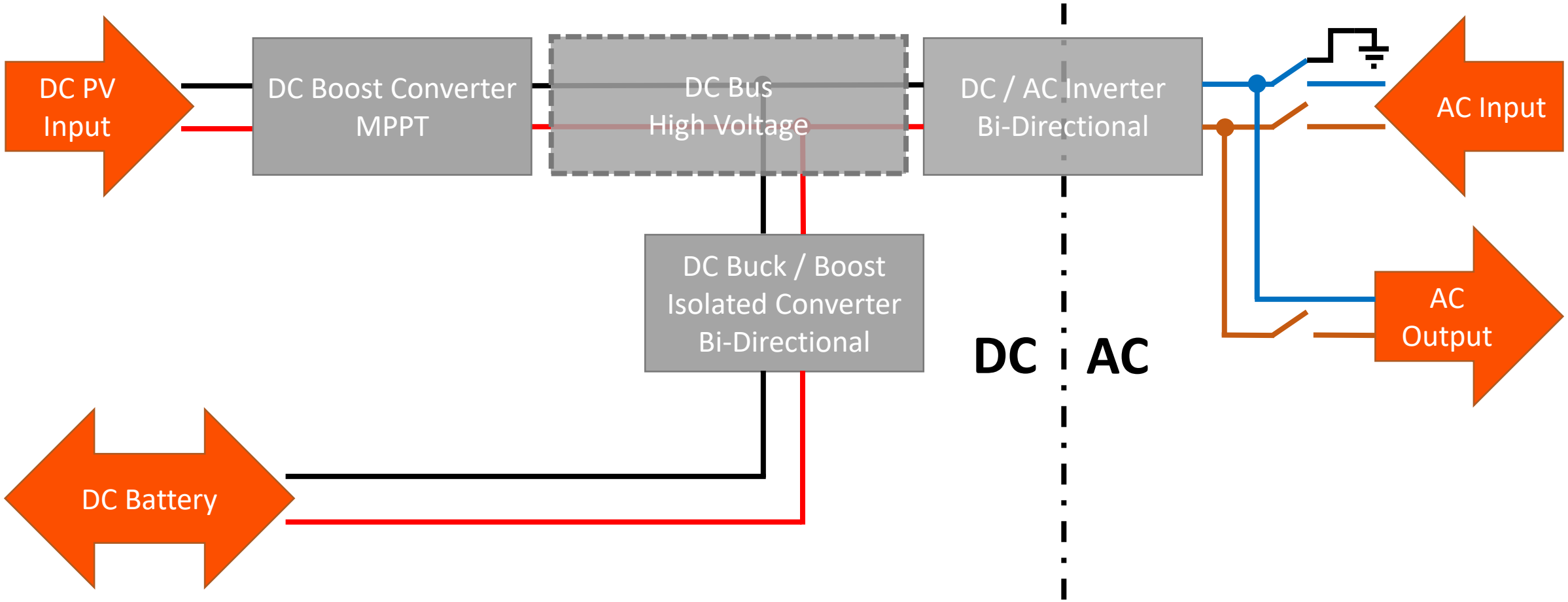


Introduction: Any-Grid PSW-H Model Differences

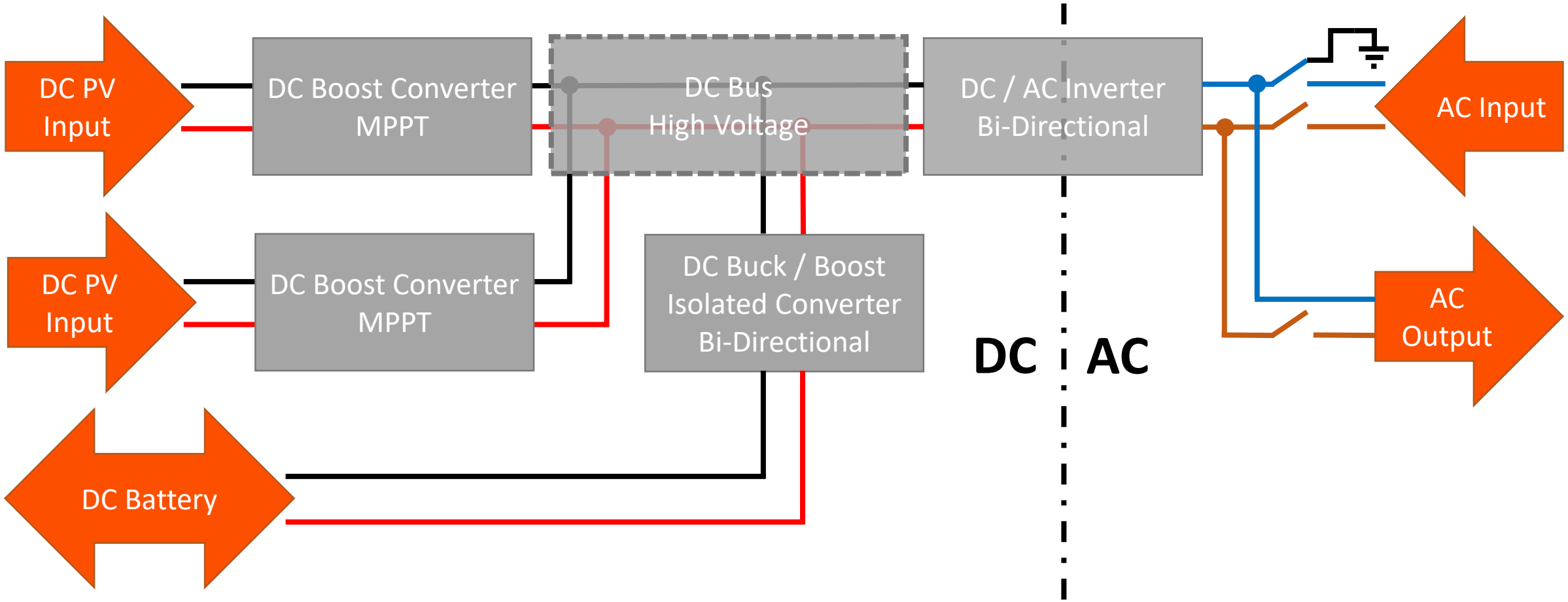
	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-5KW-120/48V	PSW-H-3KW-120/24V
Nominal Battery Voltage	48 Vdc	24 Vdc	48 Vdc	24 Vdc
Nominal AC Output Power	5 kW / 5 kVA	3 kW / 3 kVA	5 kW / 5 kVA	3 kW / 3 kVA
AC Output Voltage	220 ~ 240 Vac		110 ~ 127 Vac	
Max. AC Input Current	40 Aac	30 Aac	63 Aac	40 Aac
Max. PV Panel Voltage	450 Vdc		2x 250 Vdc	250 Vdc
Max. Usable PV Power	4800 W	4000 W (2400 W for battery charging)	4800 W	4000 W (2400 W for battery charging)



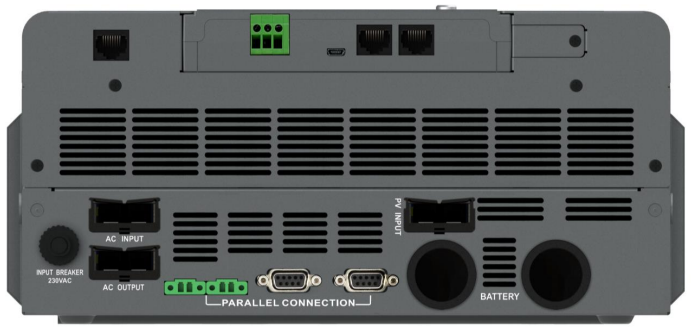
Introduction: General PSW-H Topology



Introduction: PSW-H-5KW-120/48V Topology

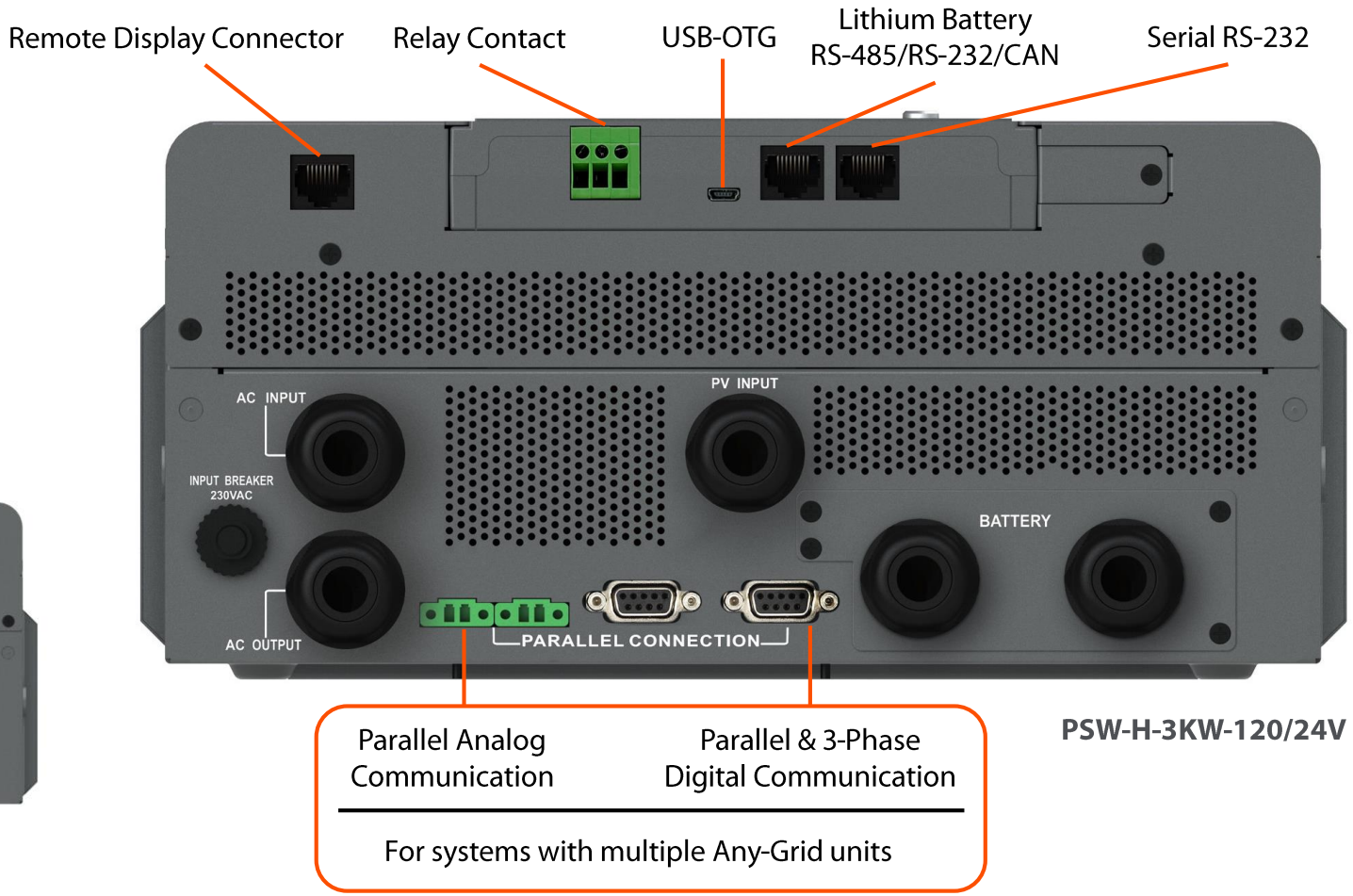


Introduction: Terminals



PSW-H-3KW-230/24V
PSW-H-5KW-230/48V

PSW-H-5KW-120/48V



PSW-H-3KW-120/24V

Introduction: Removable Display Unit

Display unit can slide down and be connected to Any-Grid with a standard Ethernet Patch cable up to 20 m long.

Introduction: Dust Filters

- Two dust filters
- Removable with one screw each, easily accessible when installed

1. Rinse with tap water
2. Dry with (paper) towel
3. Re-install

Introduction: The Any-Grid Inverter Charger

The Any-Grid hybrid inverters serve as a power hub to manage the various energy sources

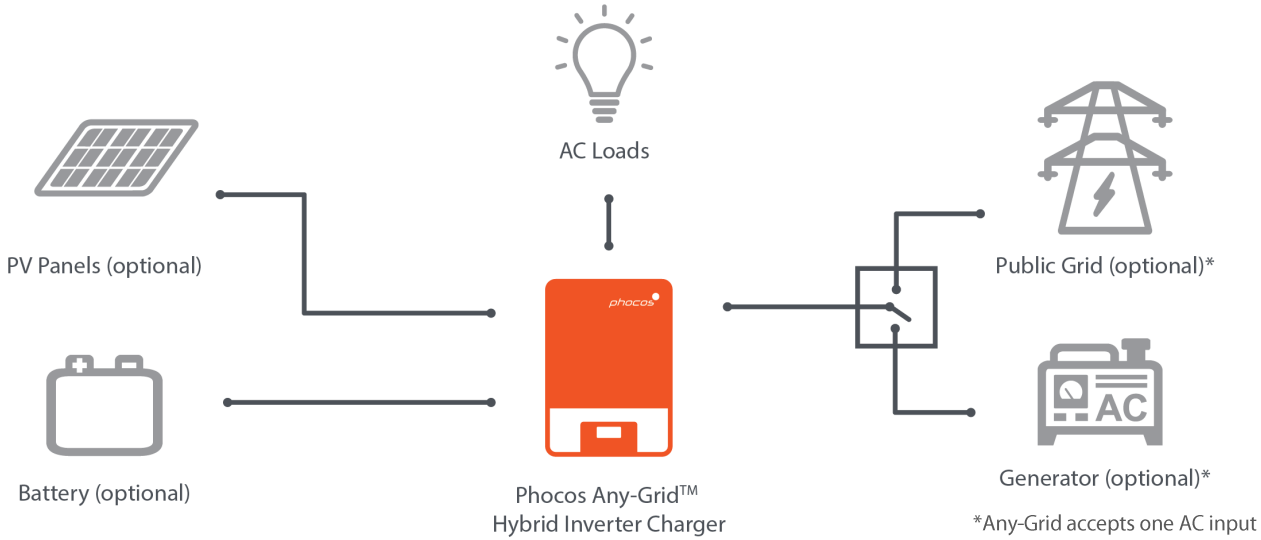
Introduction: The Any-Grid Inverter Charger

Possible energy sources (at least one required):

- Solar / PV
- Public Grid
- AC generator
  - If more than one AC source are used, an external source selector must be installed

Battery is optional:

- With battery:
  - Energy is stored
  - Unit acts as an uninterruptible power supply (UPS)
  - Unit can function Off-Grid
    → hard switch-over between Grid and Off-Grid modes
  - Grid feed-in possible
- Without battery:
  - Grid required (Off-Grid operation not possible)
  - Majority of system costs removed, as batteries typically make up >50% of total system costs
  - With sun, loads are supplied by PV as first priority and grid as second priority, no hard switch-over, optional grid injection



Use-Case Ideas

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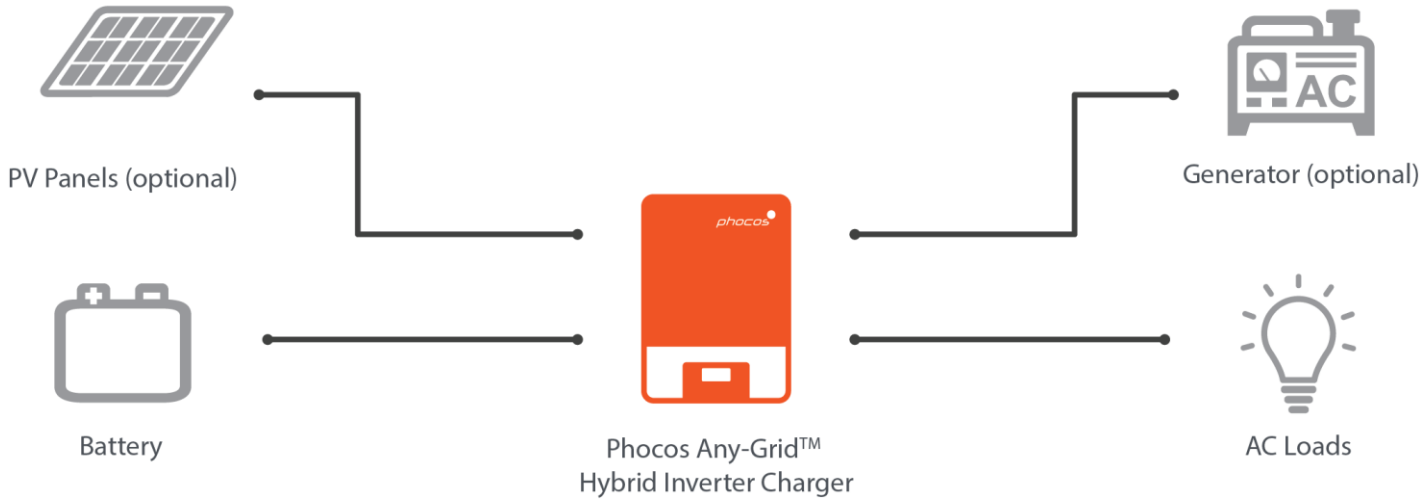
Use-Case 1

Off-Grid

- Battery required
- Either PV or AC generator required, both possible
  - Automatic generator start possible via integrated relay on Any-Grid

Benefits

- Simplified system and installation due to inverter, MPPT and AC generator control / charging in a single unit
- No requirement to coordinate communication between multiple devices



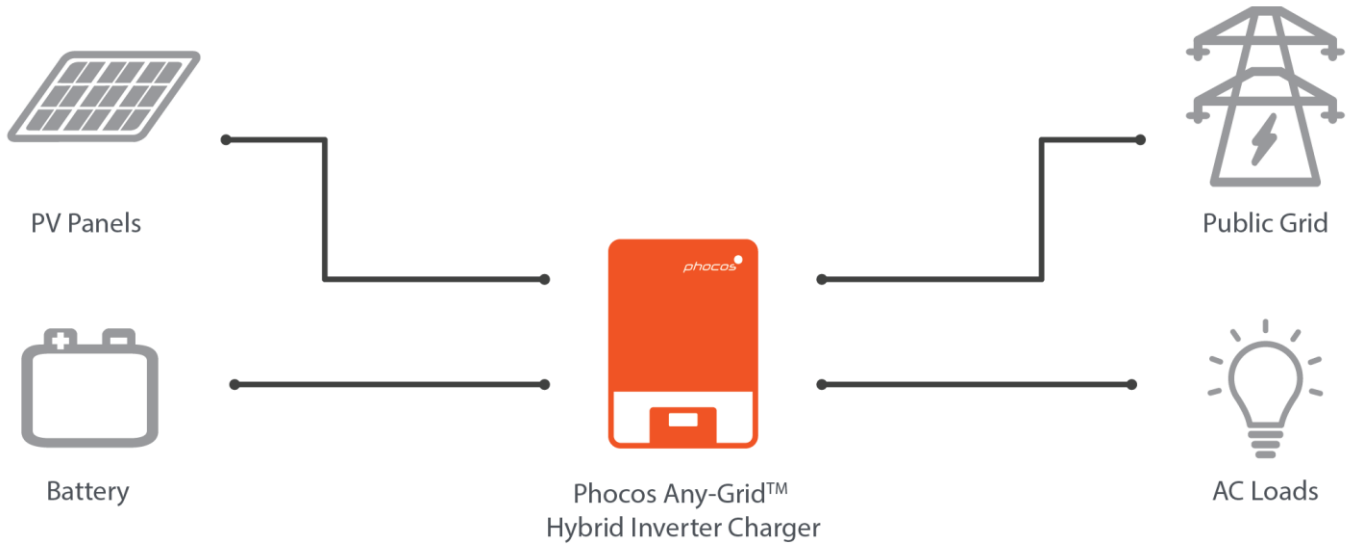
Use-Case 2

On-Grid with battery and PV

- Solar or Grid priority selectable
  - Solar priority for electricity cost savings
  - Grid priority to keep the batteries as full as possible in case of grid failure (solar-enabled UPS)
- Grid feed-in possible if legal (function locked by PIN code), physically impossible if function is not activated

Benefits

- Save grid electricity costs while at the same time providing UPS security to loads
- If legal, sell excess energy to the grid when battery is full for even faster return-on-investment



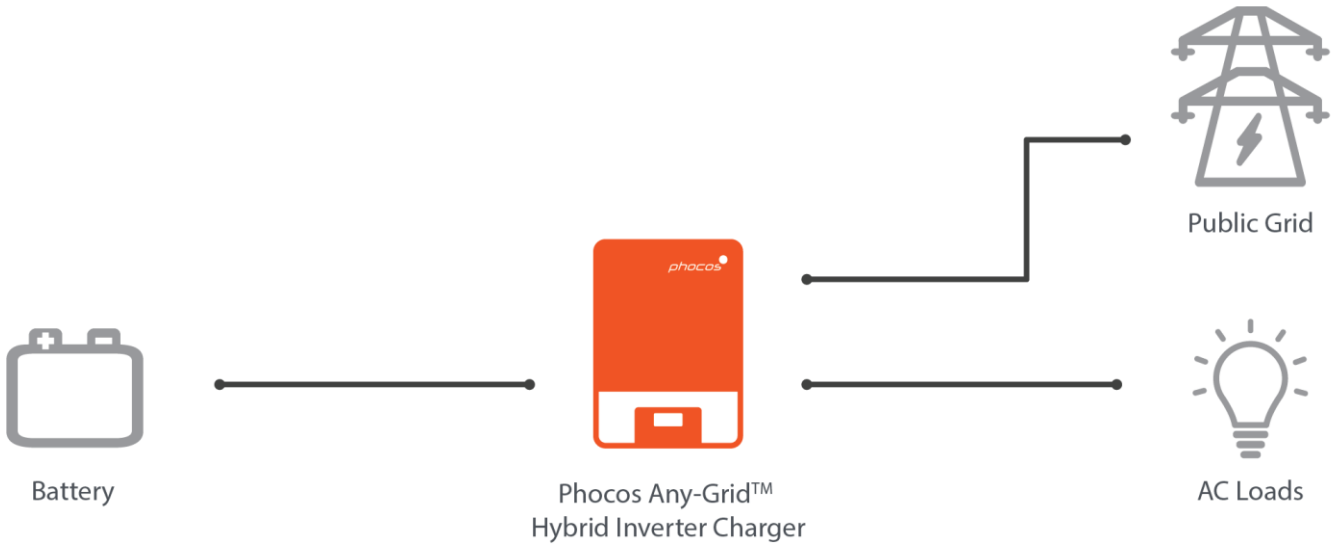
Use-Case 3

On-Grid with battery, without PV

- Uninterruptible power supply in case of temporary grid failure

Benefits

- High-power fast-switching UPS for an entire home, not just individual loads
- Loads will keep running without interruption if the grid fails, PV can be added later if desired



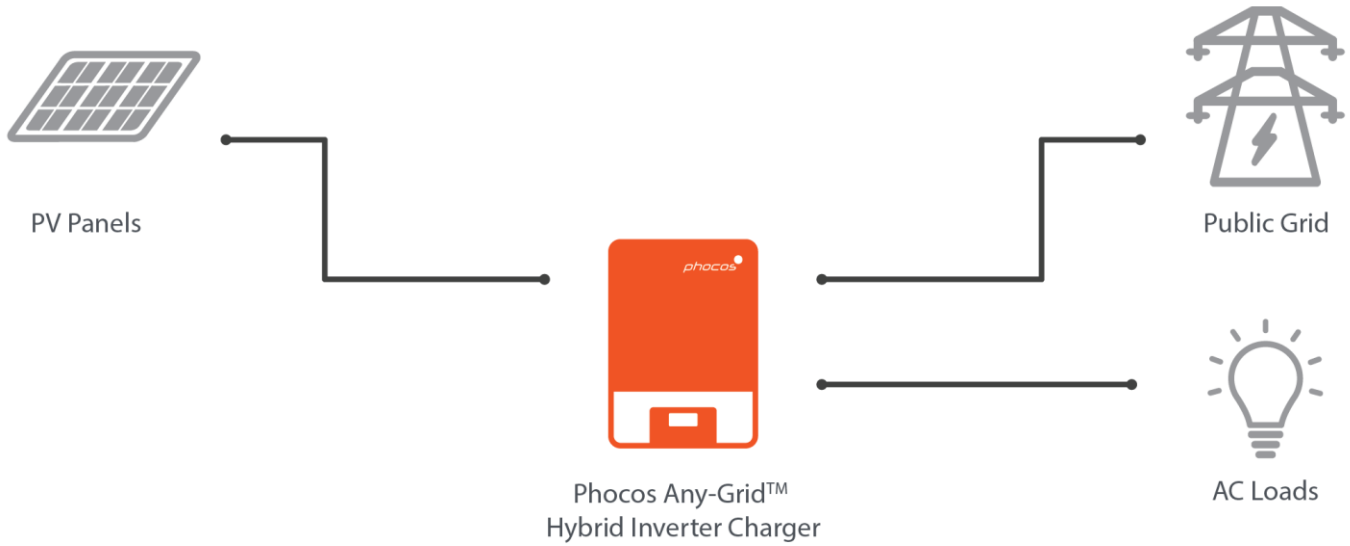
Use-Case 4

On-Grid with PV, without battery

- PV power used as first priority for grid electricity cost savings
- Grid feed-in possible if legal (function locked by PIN code), impossible if function is not activated
- Basically equivalent to a grid-tied inverter without the need for an external energy meter (current is measured in the Any-Grid and flows through unit to loads)

Benefits

- No need to invest in batteries, but PV energy can still be used to reduce grid energy costs
- Battery can be added later if desired for UPS / Off-Grid functionality



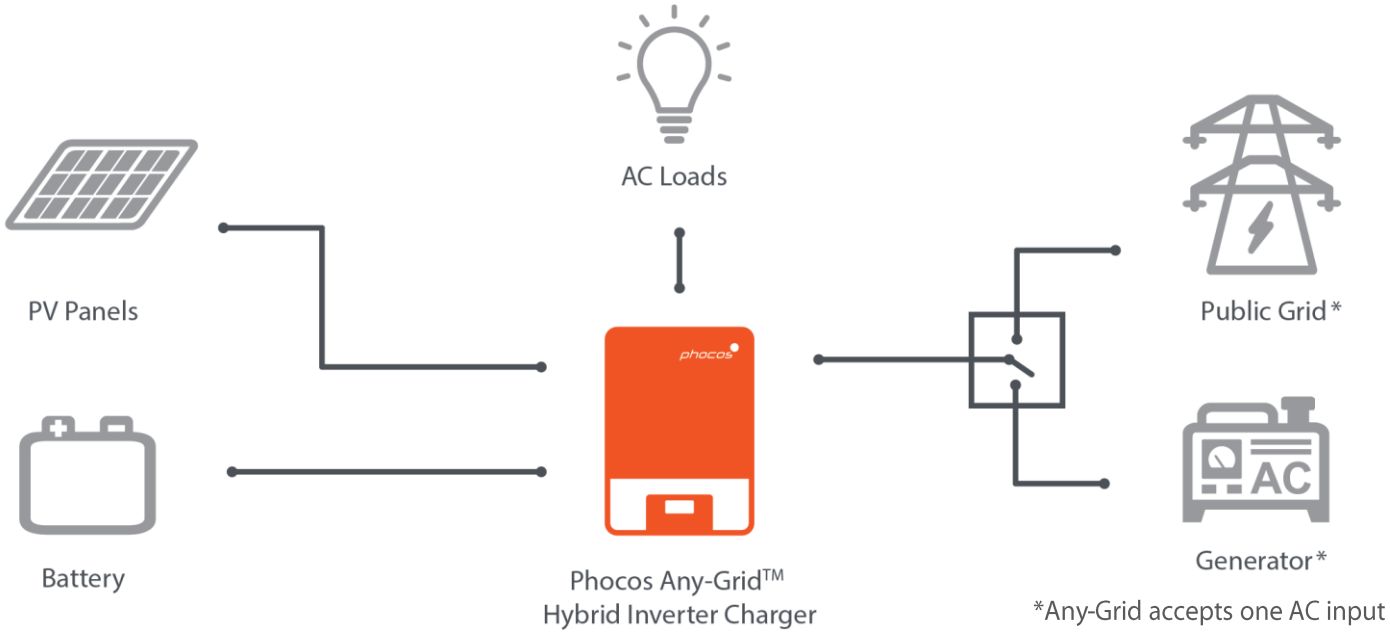
Use-Case 5

On-Grid with backup generator, battery and PV

- External Source Selector required between grid, generator and Any-Grid unit
- Priority: PV or Grid, via relay: generator auto-start when necessary

Benefits

- Save grid electricity costs while at the same time providing UPS security to loads and automatic backup generator use for prolonged grid failures



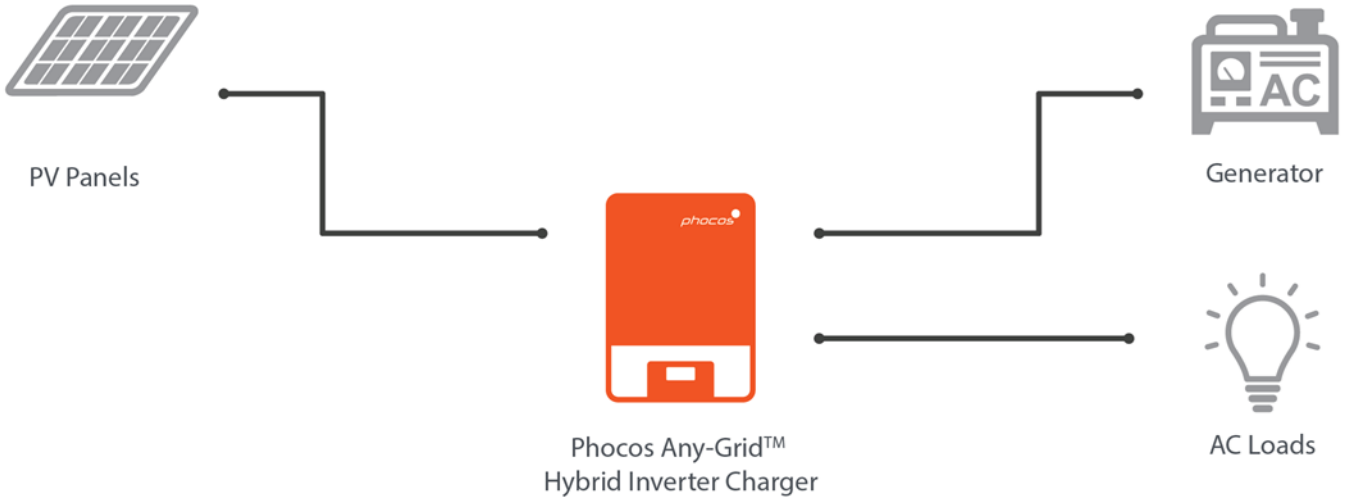
*Any-Grid accepts one AC input

Use-Case 6

AC Generator Fuel-Saver without Battery

Main Unit firmware version required: ≥ 30.06
Pre-installed in PSW-H units manufactured since December 2019

- AC generator required
- PV panels required

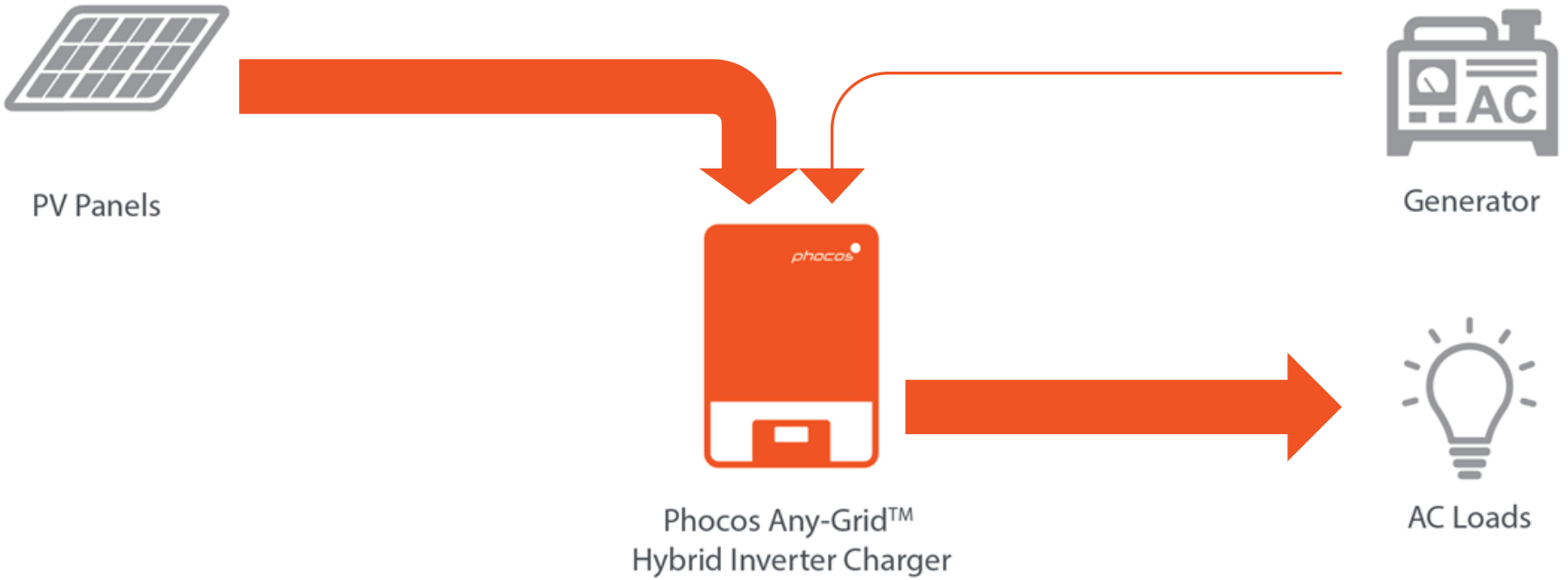


Benefits

- Significant generator fuel savings
- Less strain on the generator means less maintenance and service costs
- Lower CO_2 and other emissions
- Relatively low investment as no battery required, but can be added later

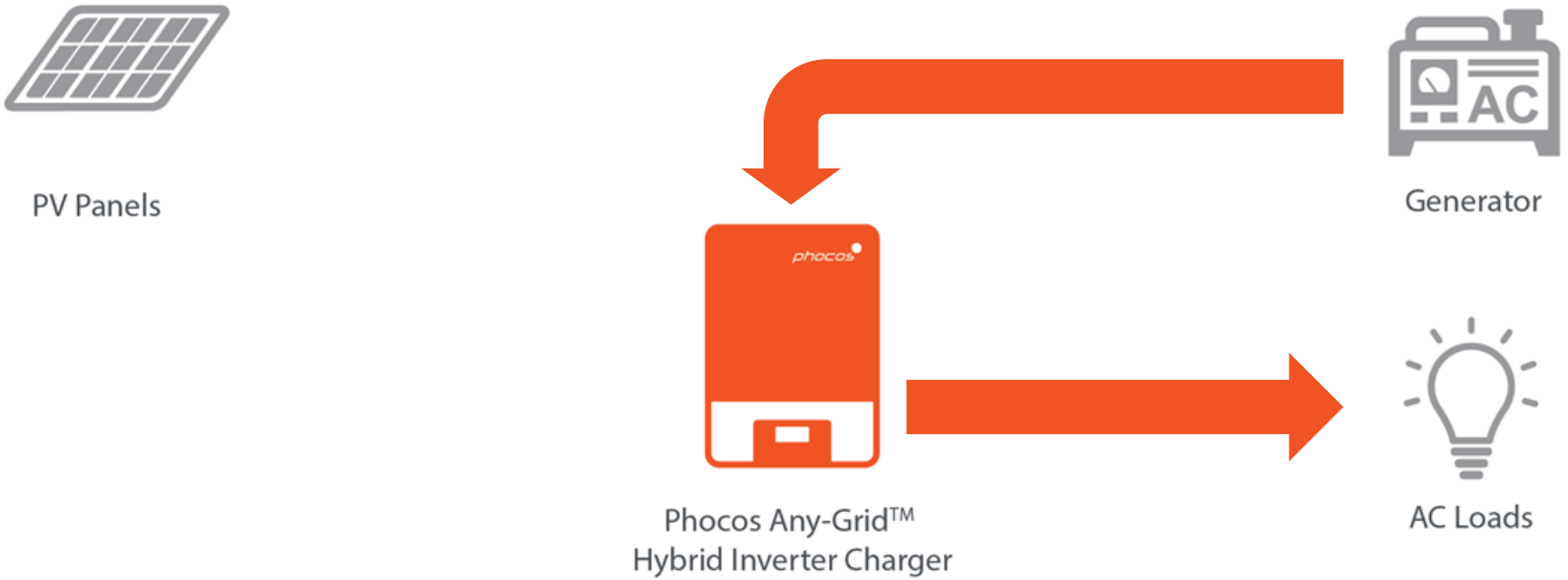
Use-Case 6: States

- AC generator running
- PV available



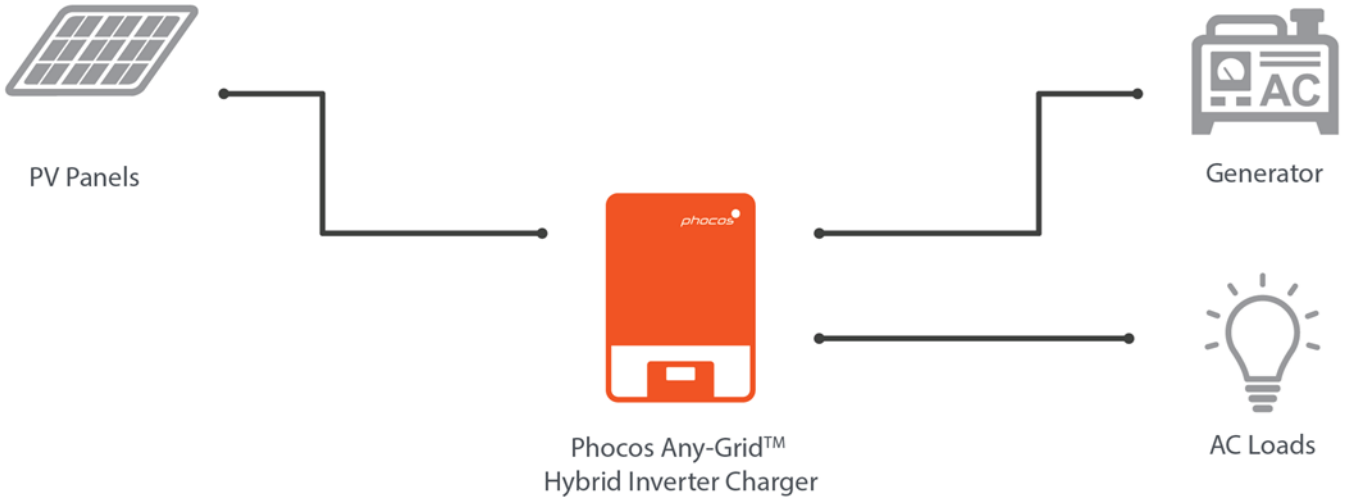
Use-Case 6: States

- AC generator running
- PV not available



Use-Case 6: Requirements

- AC priority setting: S.U.B. → Solar, AC source/utility, battery (battery is not used)
- Any-Grid settings menu 02 can be set to "Appliances" mode to avoid rejection of deformed sine wave from the genset and widen the accepted AC input voltage range
- Sufficiently powerful AC generator required
  - At least 7.5 kW for 5 kW inverter
- The more PV power, the higher the fuel savings

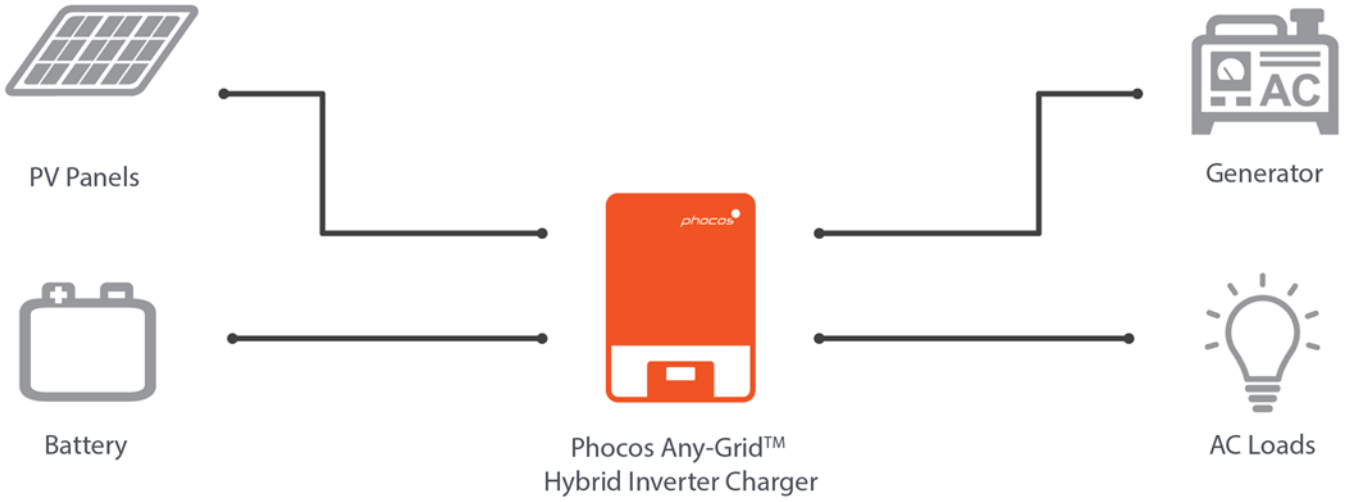


Use-Case 7

AC Generator Fuel-Saver with Battery

Main Unit firmware version required: ≥ 30.06
Pre-installed in PSW-H units manufactured since December 2019

- Battery required
- AC generator required
  - Automatic generator start possible via integrated relay on Any-Grid
- PV panels required

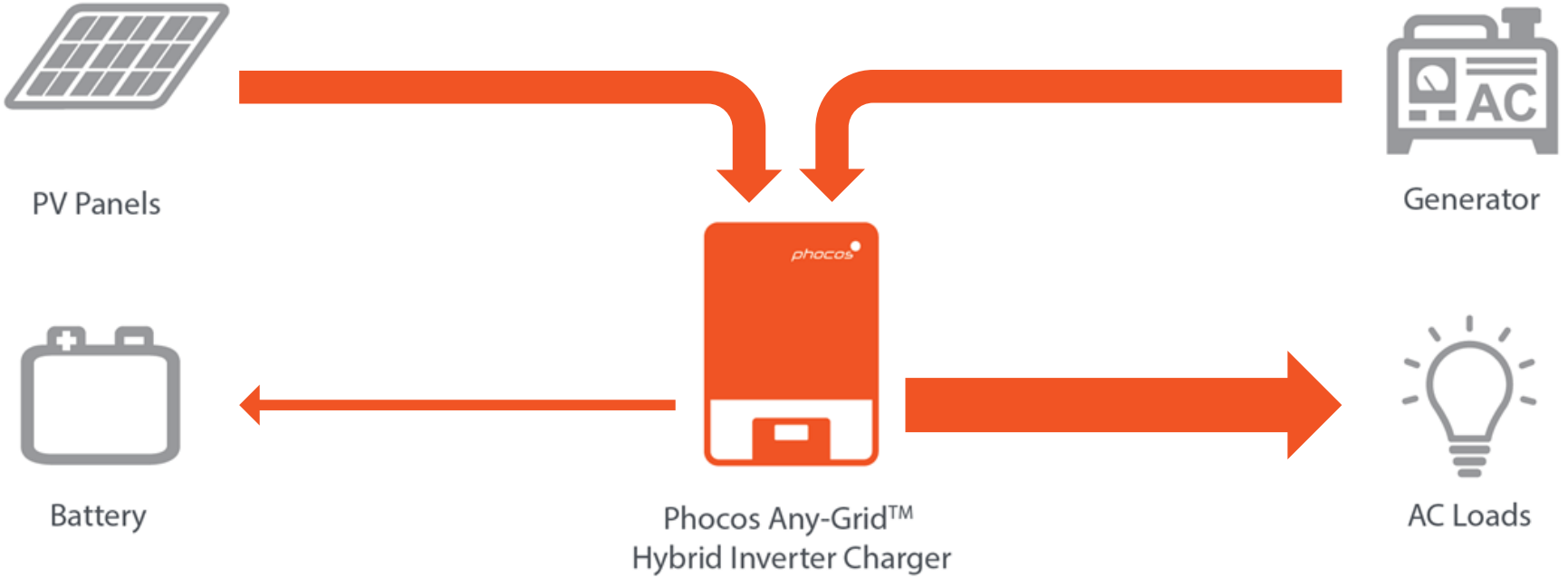


Benefits

- Significant generator fuel savings
- Fewer running hours of the generator means less maintenance and service costs
- Less noise
- Much lower CO_2 and other emissions

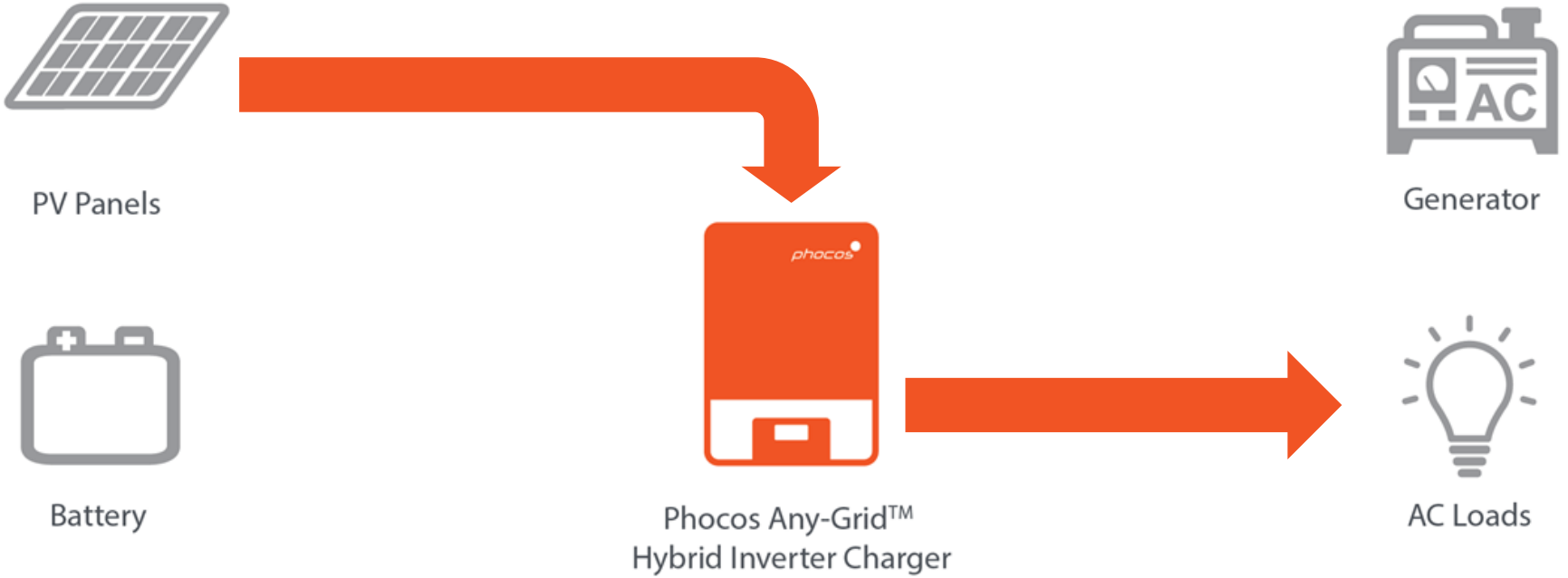
Use-Case 7: States

- AC generator running
- PV available
- Battery not full



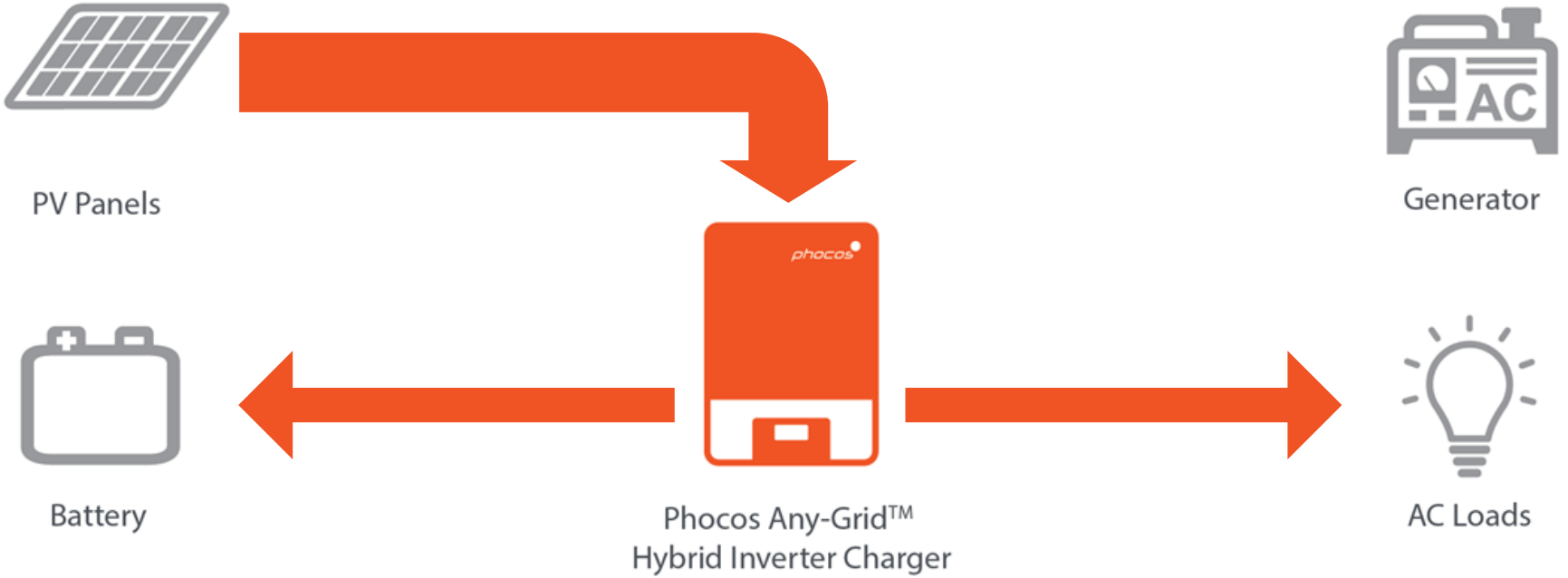
Use-Case 7: States

- AC generator not running
- PV available
- Battery full



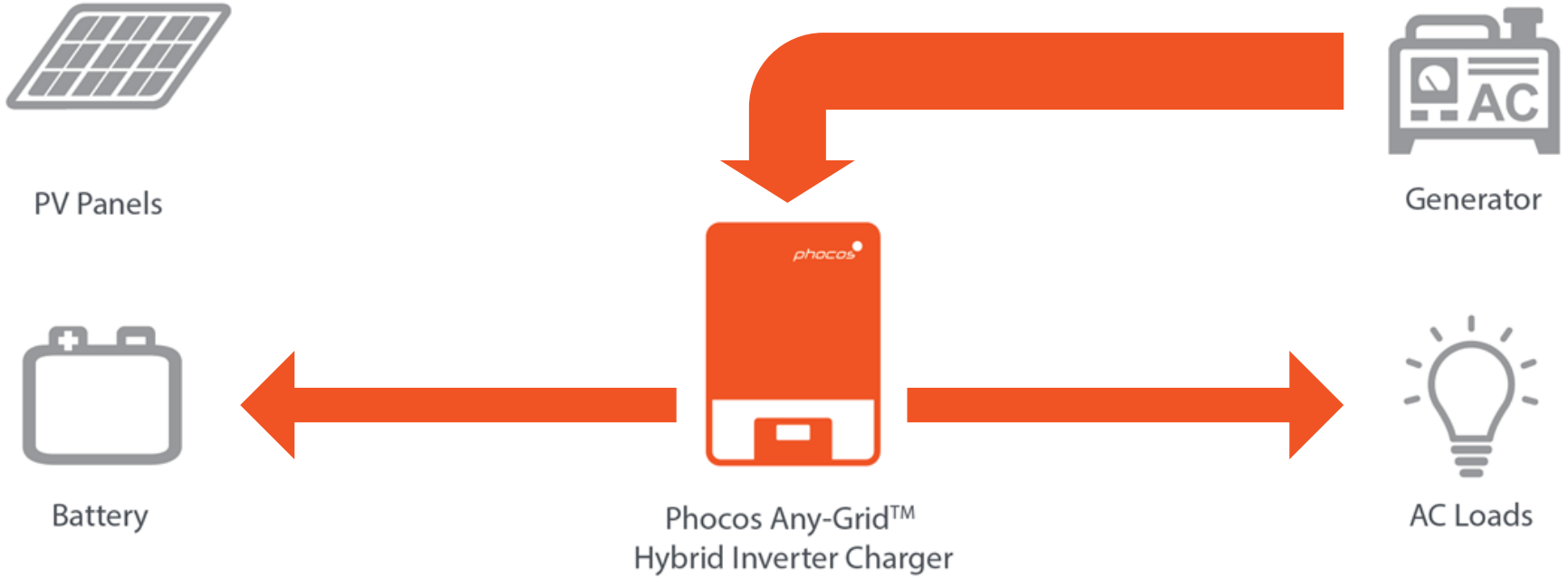
Use-Case 7: States

- AC generator not running
- PV available
- Battery not full



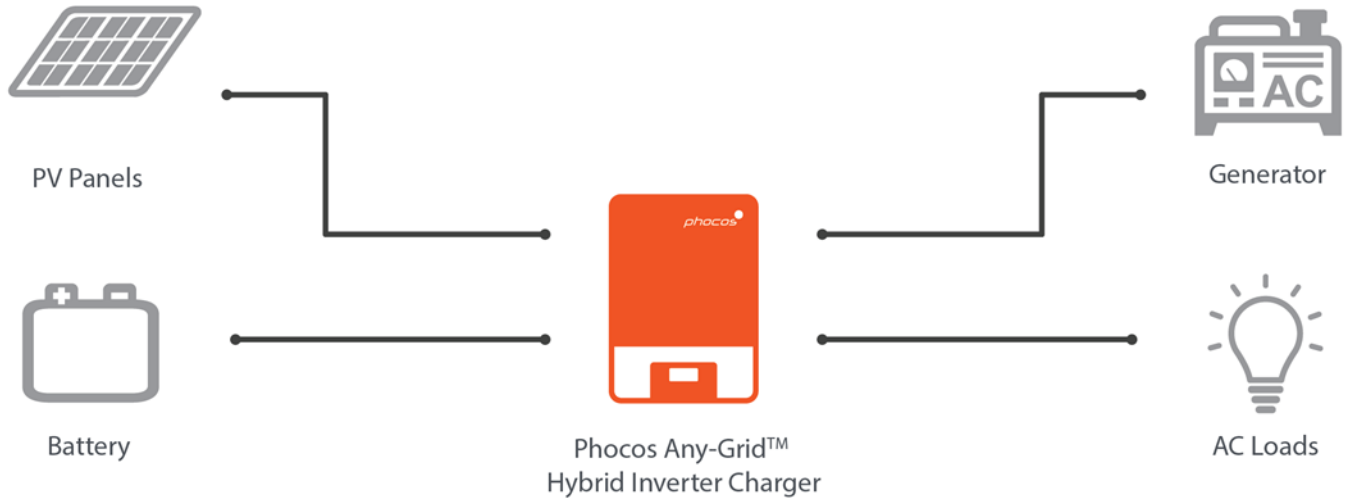
Use-Case 7: States

- AC generator running
- PV not available
- Battery low



Use-Case 7: Requirements

- AC priority setting: S.B.U. → Solar, battery, AC source/utility
- Battery charging priority setting "SNU" for Solar and Utility
- Any-Grid settings menus 12 and 13 determine when generator turns on or off
- Any-Grid settings menu 02 can be set to "Appliances" mode to avoid rejection of deformed sine wave from the genset and widen the accepted AC input voltage range
- Sufficiently powerful AC generator required
  - At least 7.5 kW for 5 kW inverter
- Sufficiently large battery required
  - At least 200 Ah per inverter, possibly less for Lithium
- The more PV power and battery capacity, the less time the AC generator will have to run and the higher the fuel savings



Special Features

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Special Features: AC output source priority

How it works:

- This setting defines what the order of power source priorities is to feed power to connected AC loads (mostly independent of battery charging).
- The available options in *settings menu 01* are:
  - "USB" for: Utility → Solar → Battery
  - "SBU" for: Solar → Battery → Utility
  - "SUB" for: Solar → Utility → Battery
- "USB" prioritises AC input, useful when using primarily as a UPS to secure loads on a utility grid. Ensures the battery is always full and only uses PV energy when the AC source fails.
- "SBU" prioritises PV, followed by battery (Off-Grid mode as long as possible). Only once the battery has reached a programmable discharge voltage, will the unit switch to powering AC loads directly from AC input (Grid Mode). Useful for saving as much utility energy costs as possible by using PV and cycling the battery.
- "SUB" prioritises PV and works in parallel to the grid (Grid Mode). Any energy required beyond PV will be sourced from the AC input. Useful for saving as much utility energy costs as possible by using PV, but <u>without</u> cycling the battery.

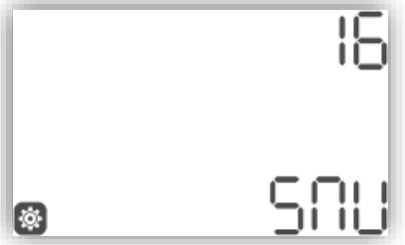
Any-Grid Screens

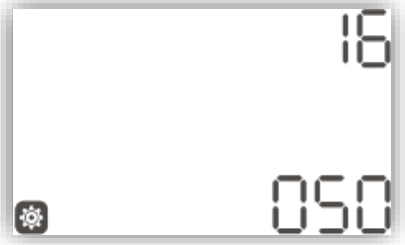
Special Features: Battery charger source priority

How it works:

- This setting defines what the order of power source priorities is to charge battery (mostly independent of supplying power to the AC output / loads).
- Available options in *settings menu 16* are:
  - Solar first: "CSO" for Charger Solar
  - Solar and Utility: "SNU" for Solar and Utility
  - Only Solar: "OSO"
- "CSO": PV power is used to charge the battery. Only if zero PV power is available (night), the AC input will be used to charge the battery (the unit must be in Grid mode).
- "SNU": PV power is used to charge the battery whenever available. If the unit is in Grid mode, AC input charges battery at same time.
- "OSO": Only PV power is ever used to charge the battery. Not recommended because the self-consumption of the Any-Grid unit is supplied from battery (if connected). If there are long periods without sunshine (ex. snow), unit may shut down due to low battery voltage. Instead, select "CSO" here and only "2 Adc" in *settings menu 11* to compensate for self-consumption with some safety margin.

Any-Grid Screens



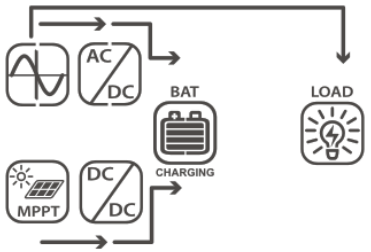


Special Features: Overload by-pass

How it works:

- In Off-Grid scenario with no AC source, if AC load power exceeds nominal power of the Any-Grid for longer than a few seconds, inverter must protect itself by turning off AC output.
- If AC source is available, enabling "Overload by-pass" in *settings menu 23*, Any-Grid will temporarily switch to Grid mode to supply AC loads with more than its nominal power rating directly from the AC input. Once AC load power demand has dropped below nominal power of inverter, Any-Grid switches back to Off-Grid mode.
- Maximum current that can be sourced from the AC input is 40 Aac, 9.2 kW at 230 Vac, or almost twice nominal power of the inverter. If even this limit is exceeded, a resettable fuse will pop out on Any-Grid, protecting it from damage.

Any-Grid Screens



Special Features: Battery current limitation

How it works:

- Every battery has a maximum current rating. Typically the smaller the battery capacity, the lower the maximum current. Different battery chemistries also have different current capabilities.
  The Any-Grid allows limiting both charging and discharging currents separately.
- Charging current: total charging current is current going to the battery from the PV source plus AC source. This current can be capped in *settings menu 02*, with values 10 ~ 80 Adc in 10 Adc increments.
- Discharging current: if AC load power is drawing too much current from the battery there are only two options. Either turn off the load, or, if an AC source is available, transfer loads to the AC source temporarily. "Overload by-pass" does this if inverter is overloaded. But we can also set a discharge current limit to match the battery capabilities in *settings menu 41*. Available settings: "Disabled" (no limit) and 30 ~ 120 Adc in 10 Adc increments.

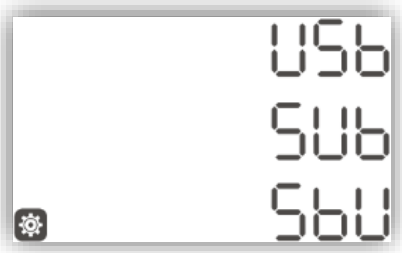
Any-Grid Screens

Special Features: Priority timers

How it works:

- While AC output source and Battery charging source priorities are defined globally, these can be over-ridden by using timers. Can be useful for:
  - Differing energy tariffs for utility power throughout the day
  - Forcing use of certain energy sources only available at certain times of day
  - Preparing for scheduled load-shedding
- AC output source and the Battery charger source can be changed temporarily. For each, Any-Grid has a timer that can activate and deactivate a different priority setting at any full hour of the day, each day.
- Example right: "USB" AC output source priority.
- Press and hold SELECT for 3 seconds to enter timer setting for AC output source priority.
- Press and hold for 3 seconds to enter timer setting for Battery charger source priority.

Any-Grid Screens

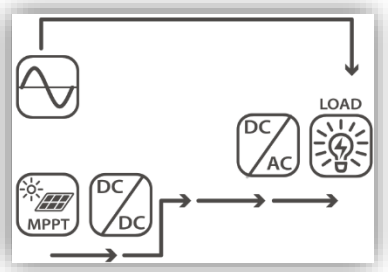


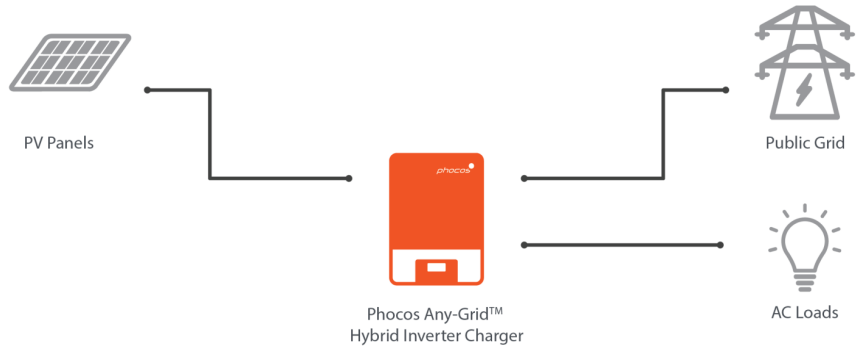
Special Features: Battery-Free mode

How it works:

- Simply do not connect a battery to the Any-Grid and connect only AC source such as public grid and AC loads
- Display will show energy flow from PV and AC source
- Whenever PV power is available, it is fed to AC loads as first priority. If more power is required it is mixed in from the grid.
- If grid feed-in is deactivated, Any-Grid prevents power flowing back to the grid by always ensuring at least 80 ~ 100 W of energy is taken from the AC source at all times, avoiding reverse power flow (PV power is reduced as needed)
- If grid feed-in is activated, full available PV power can always be used. It is fed as first priority to the AC load, any remaining power flows back into grid

Any-Grid Screen



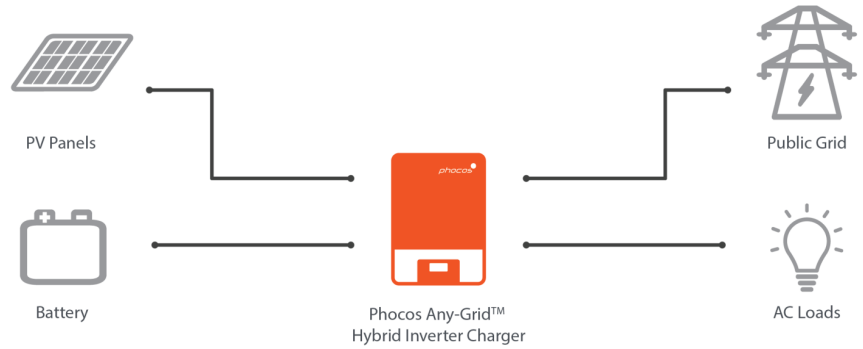


Special Features: Grid Feed-In

How it works:

- Regardless of whether a battery is connected or not, grid feed-in can be enabled. PV must be connected for feed-in to function.
- Ensure feed-in is legal at area of installation and special injection norms are not required. Ensure an adequate energy meter is installed to measure feed-in energy for billing to grid operator.
- Enable grid feed-in on Any-Grid in *settings menu 08* by switching from "Grd" (grid feed-in disabled) to "GrE" (grid feed-in enabled). Enter PIN (obtained from Phocos support) and confirm.
- Whenever battery is full or if actual PV charging current exceeds the programmed maximum limit, excess PV energy is exported to the AC input / grid

Any-Grid Screen



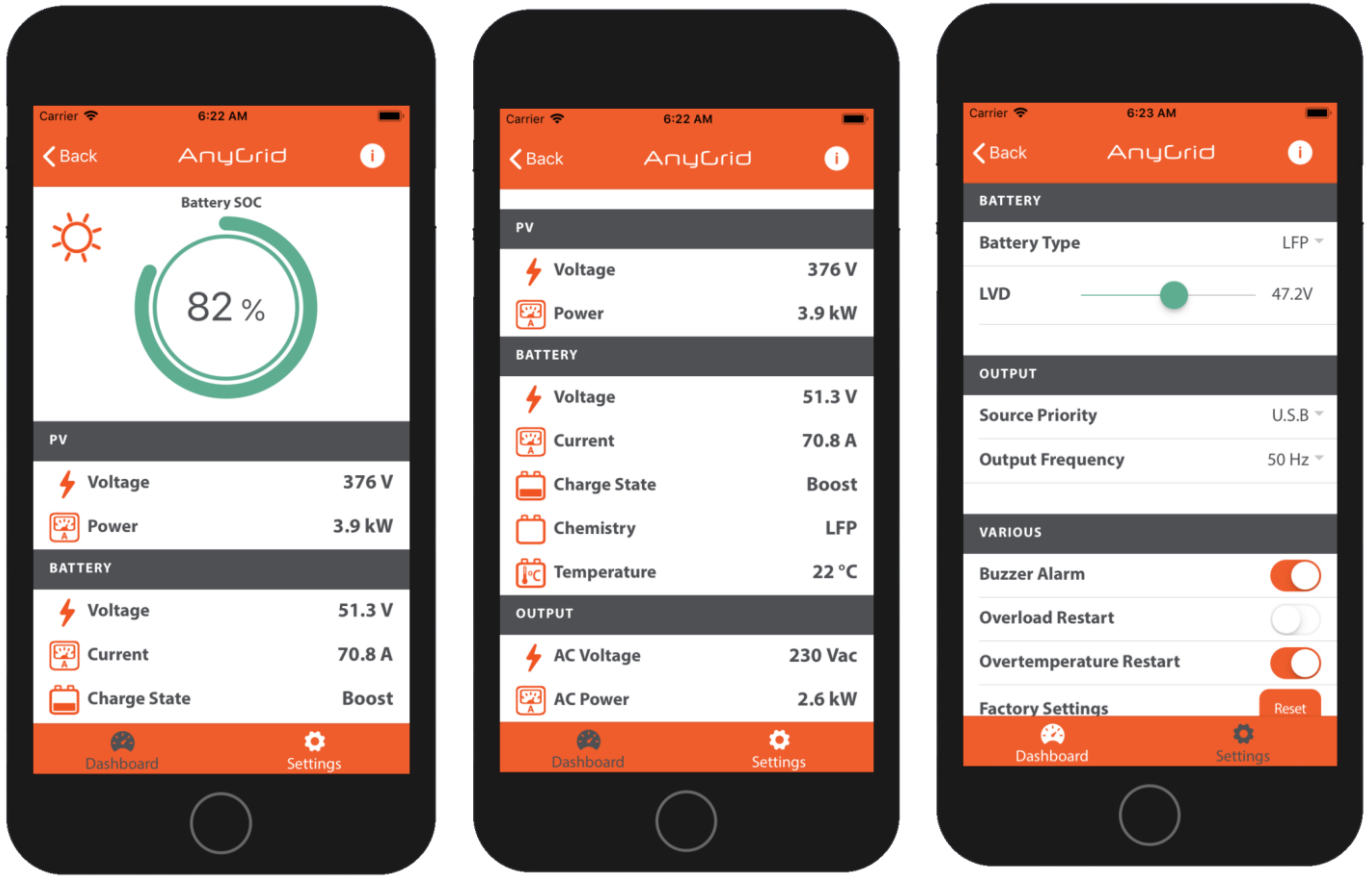
Special Features: PhocosLink, mobile BLE App

How it works:

- Download "PhocosLink" App from Google Play™ store or Apple's App Store® with Android™ or iOS device
- With App, connect to Any-Grid with password "123456", no pairing button required
- See system values in real-time and even program most common settings

Google Play™

Apple App Store®



Benefits

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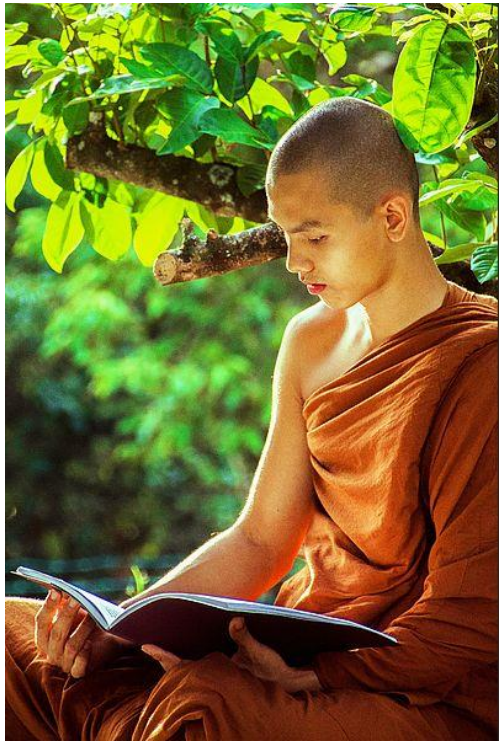
Benefits: Compared to discrete system components

- A single device functioning as inverter, AC charger, MPPT solar charge controller and UPS means:
  - Much lower cost
  - Easier installation, lower complexity
  - Automatic synchronisation to AC source and extremely fast switching
  - No need for inter-unit communication, except for systems with multiple Any-Grids
  - Easy definition of energy source priorities for charging and supplying AC loads
  - Much fewer cables in system, less points of failure
  - All system data on single removable cable-bound display unit
  - “Set and forget” system takes care if itself once initialised



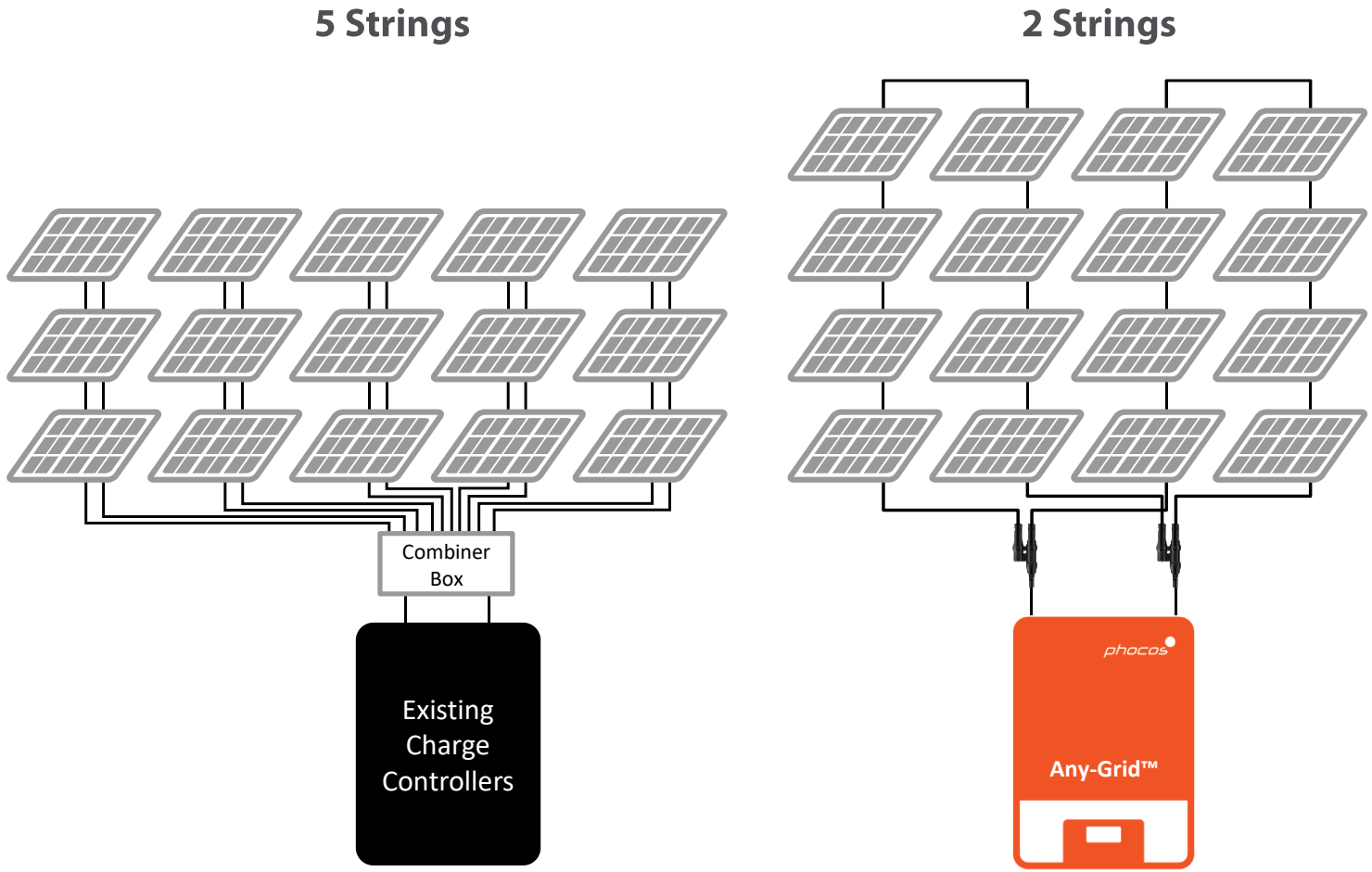
Simplicity

Benefits: Ecosystem

- Support for Pylontech batteries out-of-the-box with BMS communication
- Further lithium batteries supported if battery protocol available
- PhocosLink mobile App
- Extensive documentation, training & technical support
- Reliable help from Phocos team for system sizing
- Phocos: expertise in PV systems since the year 2000

Benefits: High PV voltage

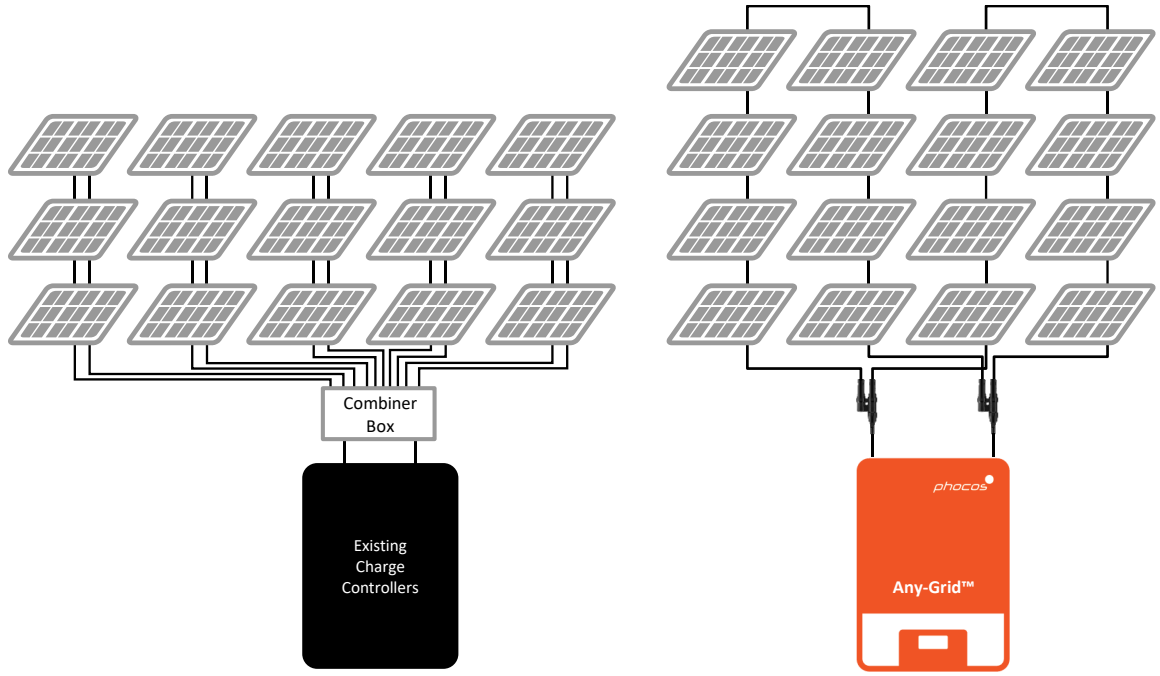
- Any-Grid requires only 1 or 2 strings **for every PSW-H model** if crystalline PV panels are used
- Other competitor's charge controllers need 5+ strings for similar-sized PV arrays



Benefits: High PV voltage

Cost savings & easier installation:

- Smaller cable cross-sections usable to save cost and space (2.5 mm^2 to 4 mm^2)
- No combiner box required, only much cheaper Y-connectors if two strings are used or no additional equipment if one string is used
- No string fuses or diodes required
- Less or thinner cables to route from the PV array into the building
- MPPT can handle up to 450 Voc for:
  - PSW-H-5KW-230/48V
  - PSW-H-3KW-230/24V
- MPPT can handle up to 250 Voc for:
  - PSW-H-5KW-120/48V (two MPPTs)
  - PSW-H-3KW-120/24V

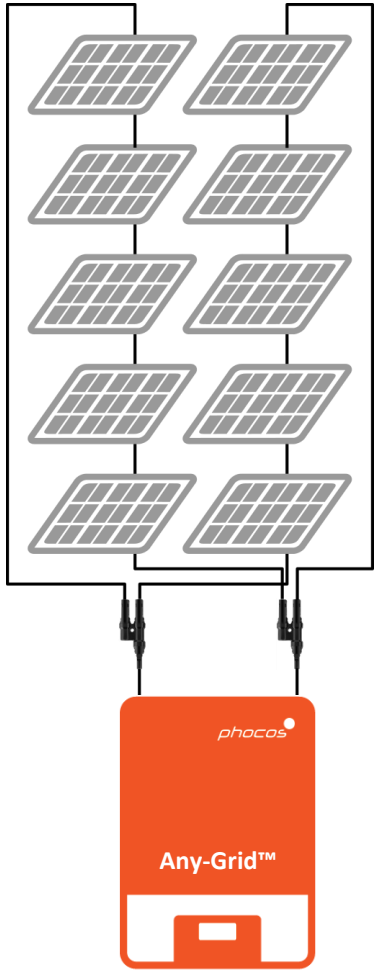


Benefits: High PV voltage, PSW-H-3KW-120/24V

- 120 Vac models have 250 Voc max. PV voltage
- For PSW-H-3KW-120/24V one or two strings are still sufficient to approach maximum usable PV power and surpass maximum battery charging power

Example:

- 72-cell PV panels with 46 Voc, 340 Wp
- 5 panels per string x 2 strings parallel: 10 x 340 Wp = 3400 Wp
- Remember: max. battery charging power 2400 W,
  max. 4000 W usable (1600 W going directly to AC load simultaneously)

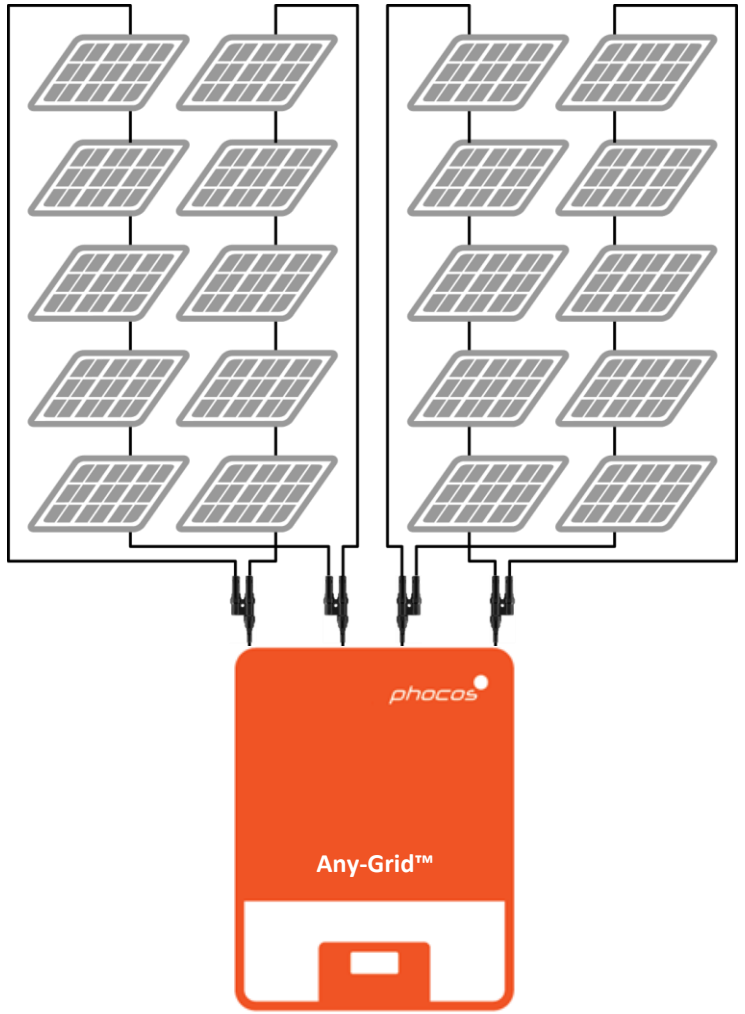


Benefits: Two MPPTs, PSW-H-5KW-120/48V

- The PSW-H-5KW-120/48V has two independent MPPTs:
  - Max. 250 Voc per MPPT
  - Higher tolerance for partial shading
  - Optimal for East / West installations
  - Two different PV panel types can be used
  - No combiner box required

Example:

- 60-cell PV panels with 38 Voc, 270 Wp
- 5 panels per string x 2 strings parallel x two MPPTs: 20 x 270 Wp = 5400 Wp
- Remember: max. 4800 W usable PV power



Extensibility

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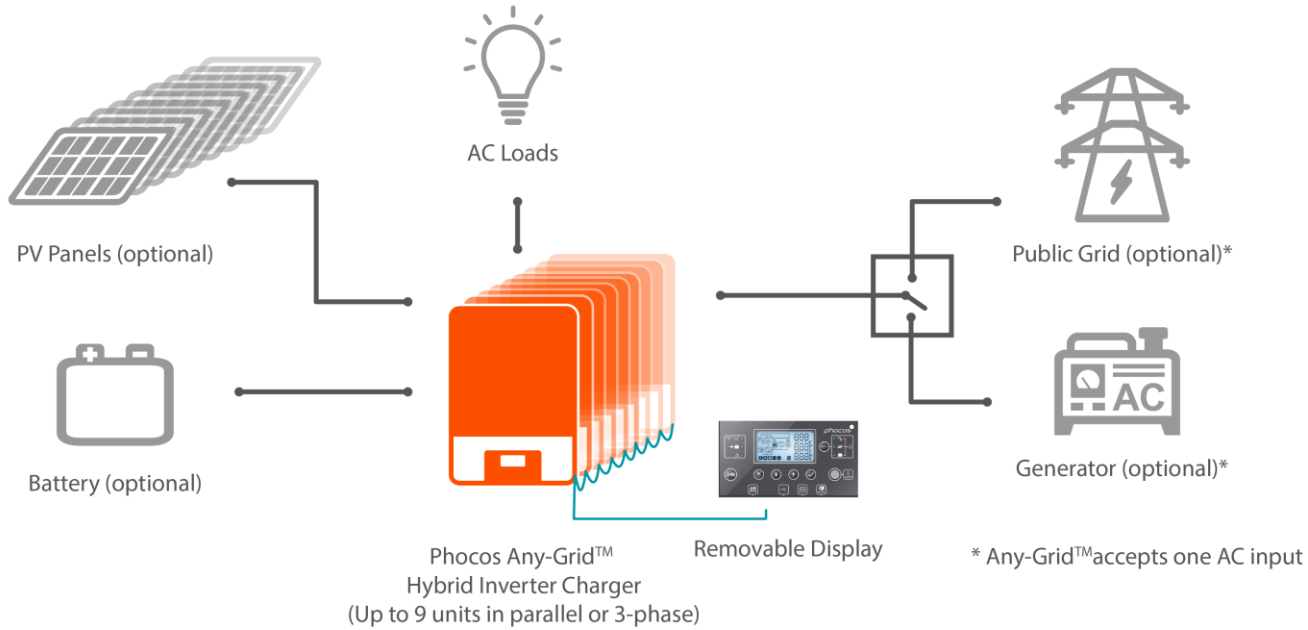
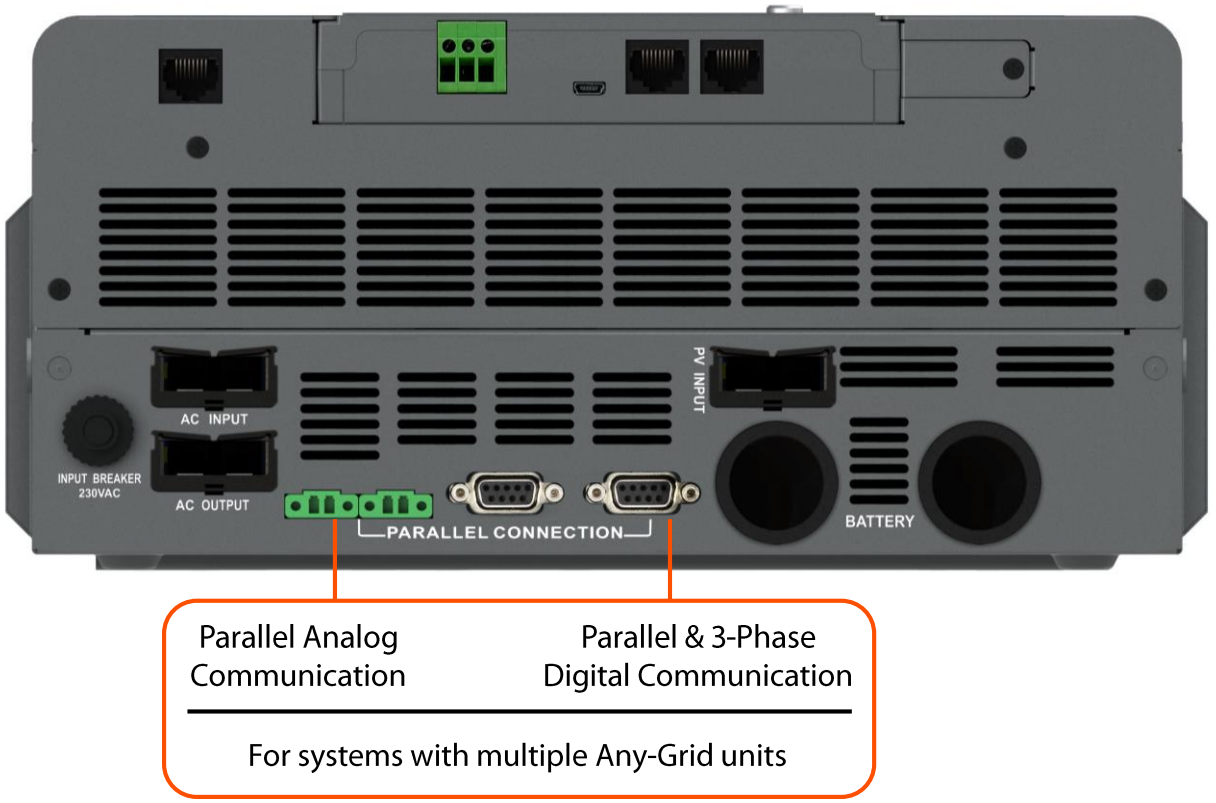
Extensibility

- Up to 9 synchronised units
- 3-phase or single phase
- Asymmetrical phases possible, for example:
  - 7 units on ph. 1, 1 unit on ph. 2, 1 unit on ph. 3
  - 3 units on ph. 1, 2 units on ph. 2, 1 unit on ph. 3
- Up to 45 kW of synchronized AC power and 43.2 kW of usable PV power
- All necessary communication cables and interface included
- Note: switching time between Grid and Off-Grid modes can increase up to 50 ms



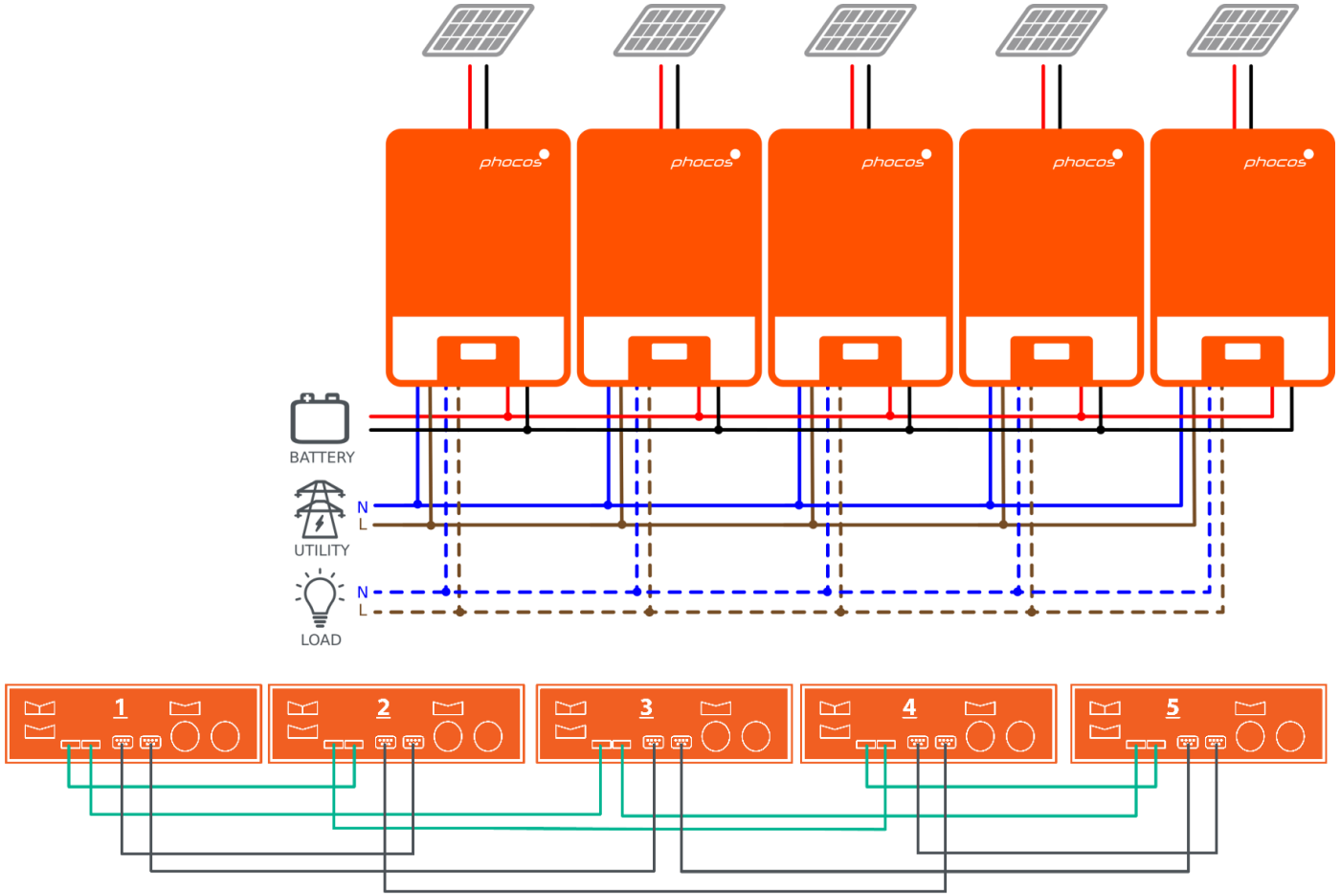
Extensibility: relevant communication terminals

- Parallel & 3-Phase Digital Communication cables:
  - Always required when using multiple synchronised Any-Grids, between each unit
- Parallel Analog Communication cables:
  - Green colour, only required between multiple Any-Grids on the same phase, between each unit on the same phase



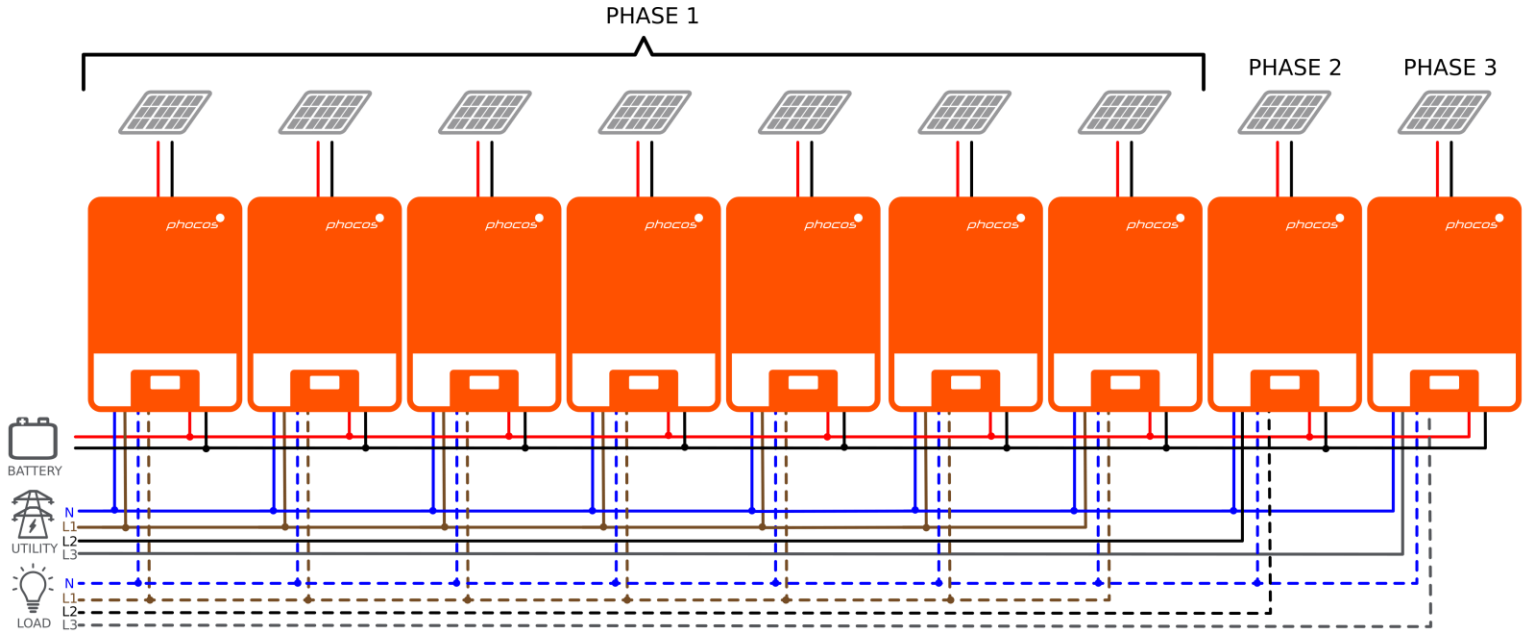
Extensibility: 5 units parallel example

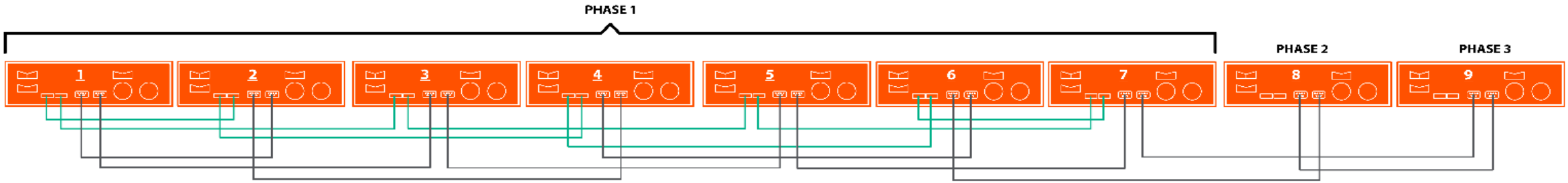
- All units in parallel on a single phase: 5 x 5 kW = 25 kW nominal
- Use analogue current-sharing cables (green below) and digital parallel cables (grey below) as shown
- Make sure each Any-Grid has its own battery circuit breaker and AC input circuit breaker
- All units will provide the same amount of power to ensure they are balanced at all times



Extensibility: 9 units asymmetric 3-phase example

- 7 units on phase 1, one unit on phase 2 and one unit on phase 3:
  Phase 1: 7 x 5 kW = 35 kW nominal
  Phase 2 & 3: 5 kW nominal
- Use analogue current-sharing cables (green below) and digital parallel cables (grey below) as shown
- Make sure each Any-Grid has its own battery circuit breaker and AC input circuit breaker
- All units on phase 1 will provide the same amount of power to ensure they are balanced at all times





Redundancy & Recovery

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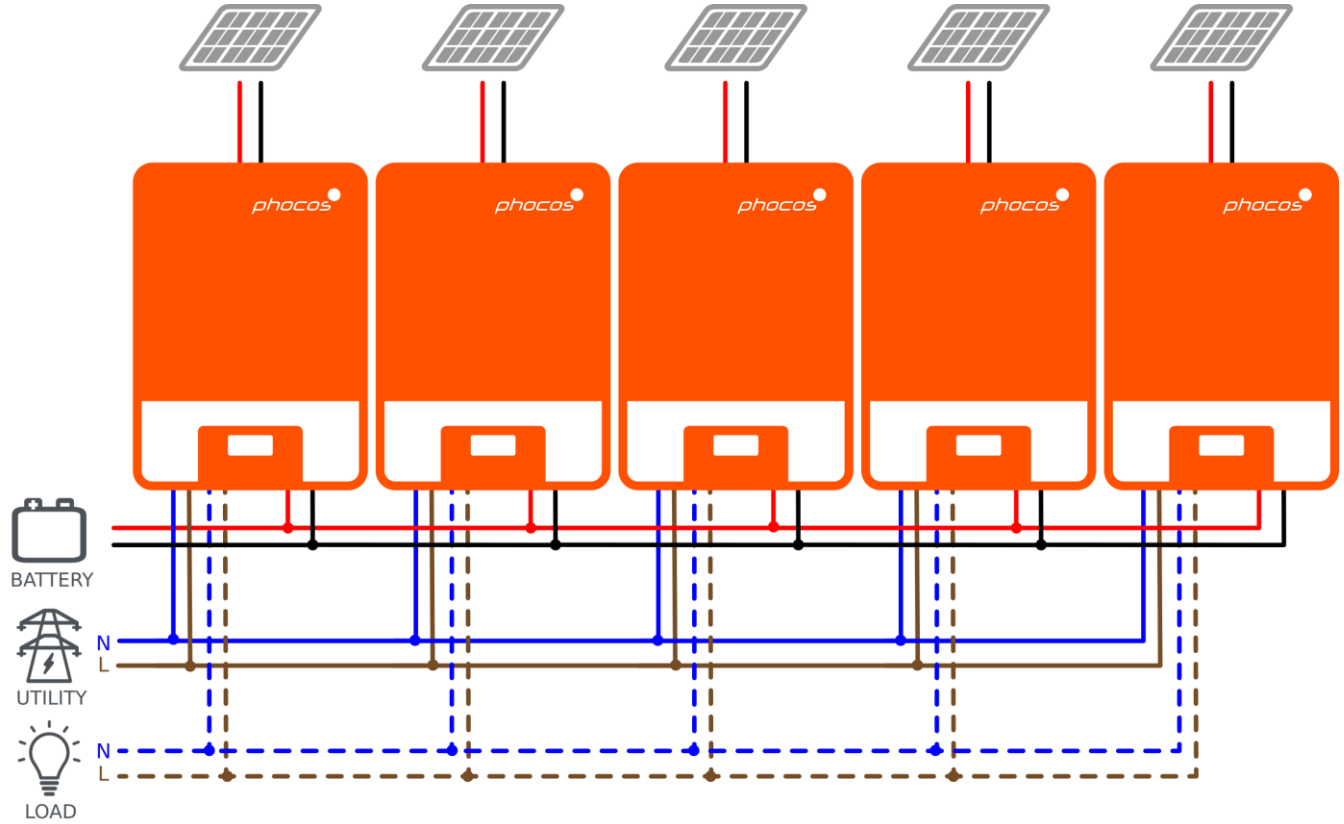
Redundancy & Recovery: 5 units parallel example

System keeps running all units if:

- Parallel current-sharing cable is disconnected:
  - Disconnected unit may provide more or less power than other parallel units, potentially causing a system imbalance, reducing total load capability or causing the affected unit to be overloaded earlier than the others
- PV fails on any unit because of:
  - High PV voltage
  - MPPT overheating
  - Any other fault

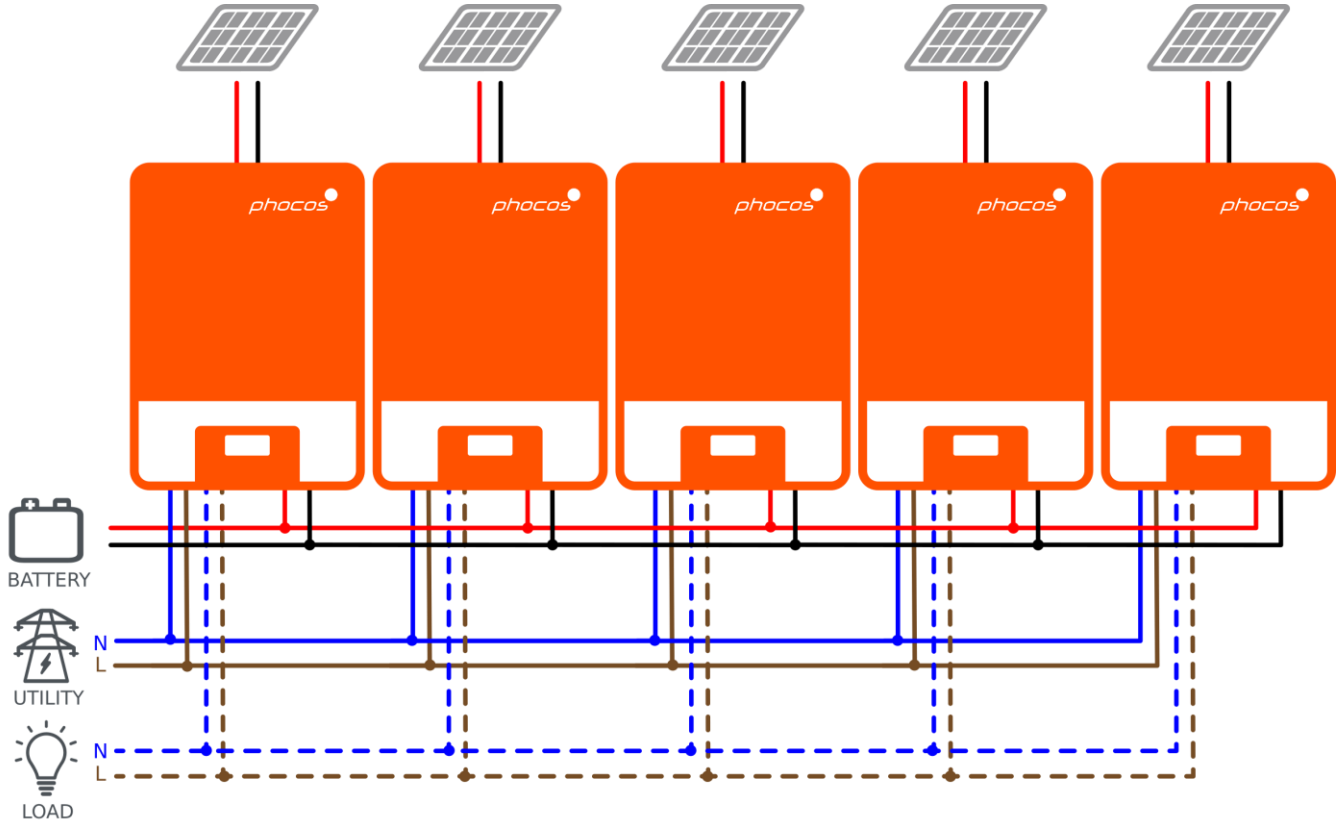
  System PV production will drop 1/5, AC output capacity is unaffected



Redundancy & Recovery: 5 units parallel example

System keeps running at 4/5 output capacity if a unit is affected by:

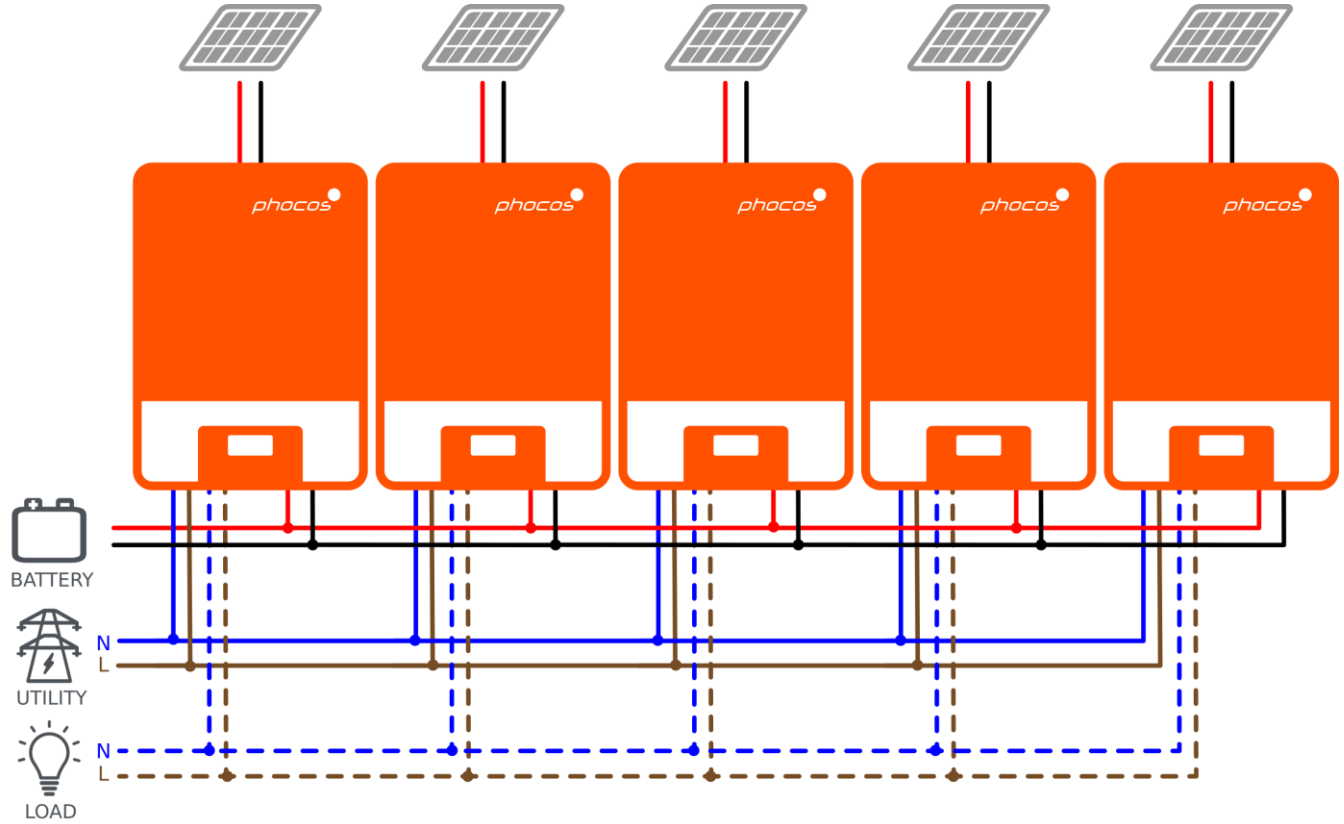
- Parallel digital communication cable disconnected on:
  - Master unit → Master is re-negotiated on-the-fly
  - Slave unit → Unit ignored
- Microcontroller fails completely
- Shut-down of inverter due to temperature or other issue



Redundancy & Recovery: 5 units parallel example

System keeps shuts down und must be restarted manually after correcting fault:

- Parallel digital communication cable short-circuited
- AC output is internally short-circuited
- AC output is externally short-circuited
  Inverters re-attempt power delivery every 10 seconds, 3 times before shutting down permanently



System Sizing

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System Sizing: Battery

- Lead-acid batteries: min. 200 Ah per Any-Grid
- Lithium batteries:
  - Compatible with PYLONTECH LFP 48 Vdc battery models:
    - Phantom-S
    - US2000
    - US3000
    - UP2500

    For sales channels contact Rita Ping from Pylontech: rita.ping@pylontech.com.cn

    Note: use the **PSW-H-BAT-CABLE-PYLON-2** for battery communication, sold separately via your Phocos dealer.

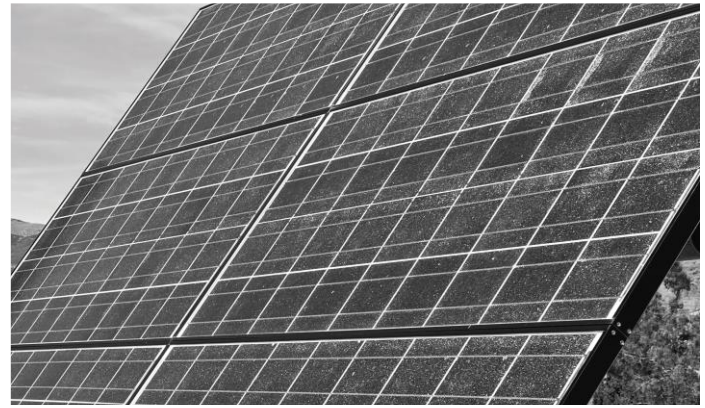
  - Ensure connected lithium battery, regardless of brand, can withstand maximum continuous and peak currents of Any-Grid

    → Discharge: 140 A continuous, 280 A peak (max. 5 seconds) for 48 Vdc models
    → Discharge: 167 A continuous, 334 A peak (max. 5 seconds) for 24 Vdc models
    → Charge: 80 A continuous

System Sizing: PV Panel Array

The PV panel array must meet these requirements:

- Exceed minimum PV voltage
- Never exceed maximum PV voltage
  - Take into account higher PV voltages at low temperatures!
- Maximum usable PV current per MPPT: 18 A (up to 22.5 A max.)
- For 60-cell PV panels (typical):



	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-5KW-120/48V	PSW-H-3KW-120/24V
Min. no of PV panels	5 (≥1.25 kWp)	4 (≥1 kWp)	4 (≥1 kWp)	4 (≥1 kWp)
Max. no of PV panels	11 x 2 strings (no not exceed 6 kWp)	11 x 2 strings (no not exceed 5 kWp)	6 x 2 strings x 2 MPPTs (no not exceed 6 kWp)	5 x 2 strings
Strings	1 or 2	1 or 2	1 or 2 per MPPT	1 or 2
Max. usable PV power	4800 W	4000 W (2400 W for charging)	4800 W	4000 W (2400 W for charging)
Max. connected PV power	6000 Wp	5000 Wp	6000 Wp	5000 Wp

System Sizing: AC Generator

An AC generator must meet these requirements:

- Pure sine wave (< 10% THD)
- 180 ~ 270 Vac output voltage
- Crest factor: < 1.6 V_{Peak} / V_{RMS}
- 42 ~ 63 Hz output frequency
- Frequency slew rate: < 0.3 Hz/second
- Recommendation for nominal generator power:
  Any-Grid nominal power x 1.5

  → for a single 5 kW PSW-H: 5 kW x 1.5 = 7.5 kW
  → for a single 3 kW PSW-H: 3 kW x 1.5 = 4.5 kW

  Why 7.5 kW for a 5 kW Any-Grid?:
  - To supply power to all connected loads (up to 5 kW)
  - To charge the battery at the same time
  - To avoid the generator sine wave deforming too much when starting large AC loads

Source: QuietHut via photopin

Grounding & Protection

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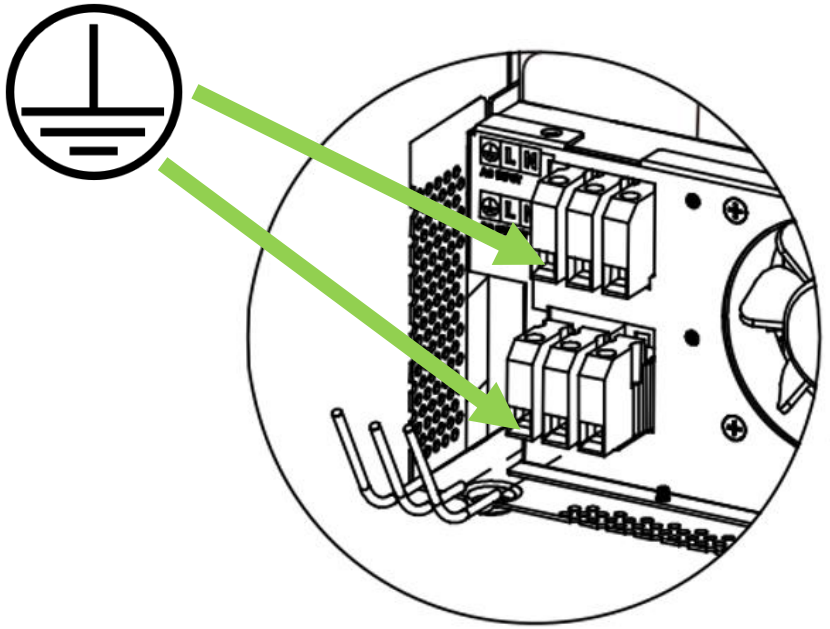
Grounding: AC

- Good ground connection is required at installation site:

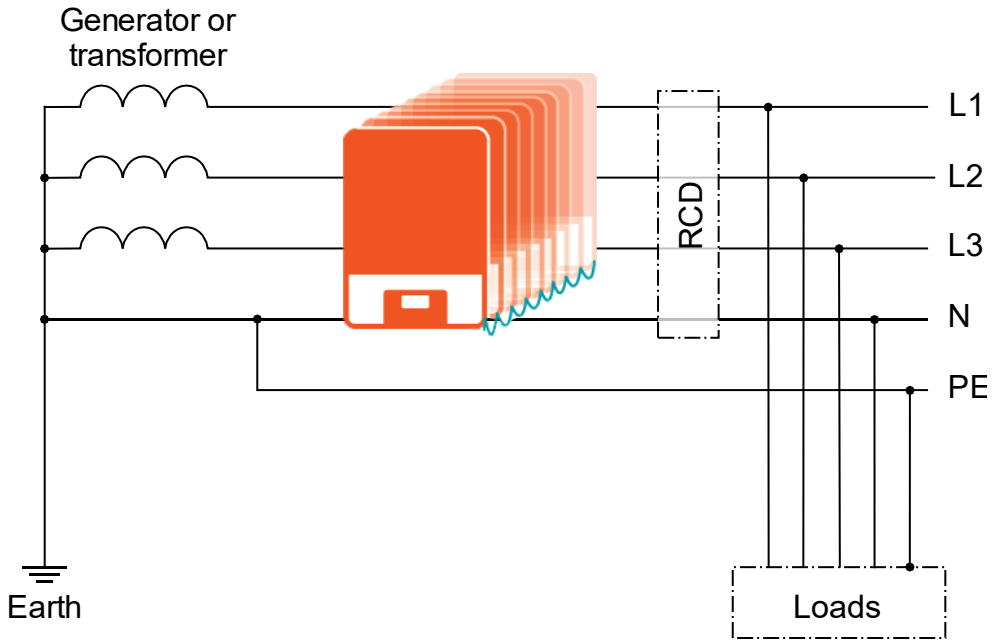
  → Typically less than 5 ohms resistance to ground, see local regulations

- Protective Earth (PE / Ground terminals) at AC input and AC output must be grounded for safety



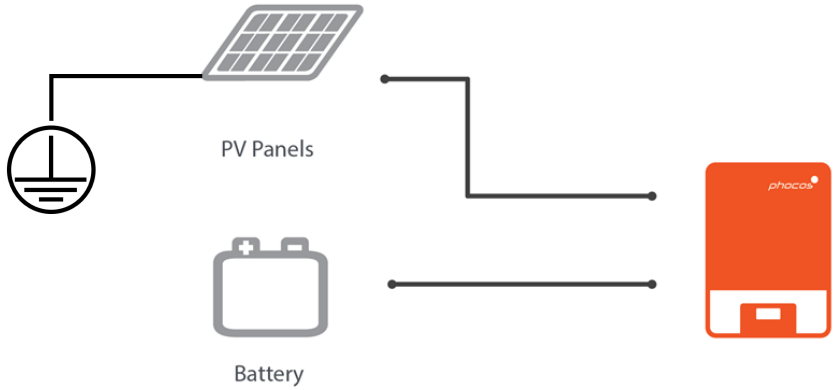
Grounding: AC

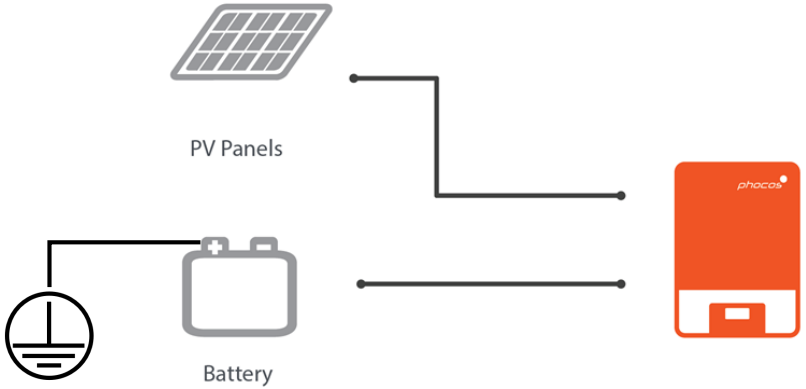
- Assumption: typical earthing scheme: TN-C-S
- Hard-wired bridge between N and PE between AC source and Any-Grid AC input
- Between loads and Any-Grid AC input install RCD (residual current device). RCD:
  - Offer protection to humans from electric shock
  - Interrupt for many load faults
  - Are mandatory in many countries (especially wet rooms)
  - Very low-cost compared to other protection
- When in Off-Grid mode the Any-Grid automatically bridges N and PE

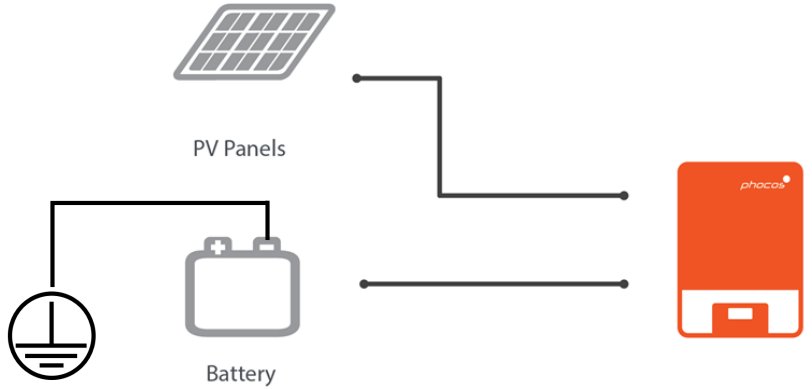


Grounding: DC

- DC grounding is generally not required or recommended, unless required by law
- Galvanic isolation between battery and inverter / PV means:
  - Battery positive or negative can be grounded
  - PV positive or negative cannot be grounded
  - PV frame can be grounded (this is recommended)

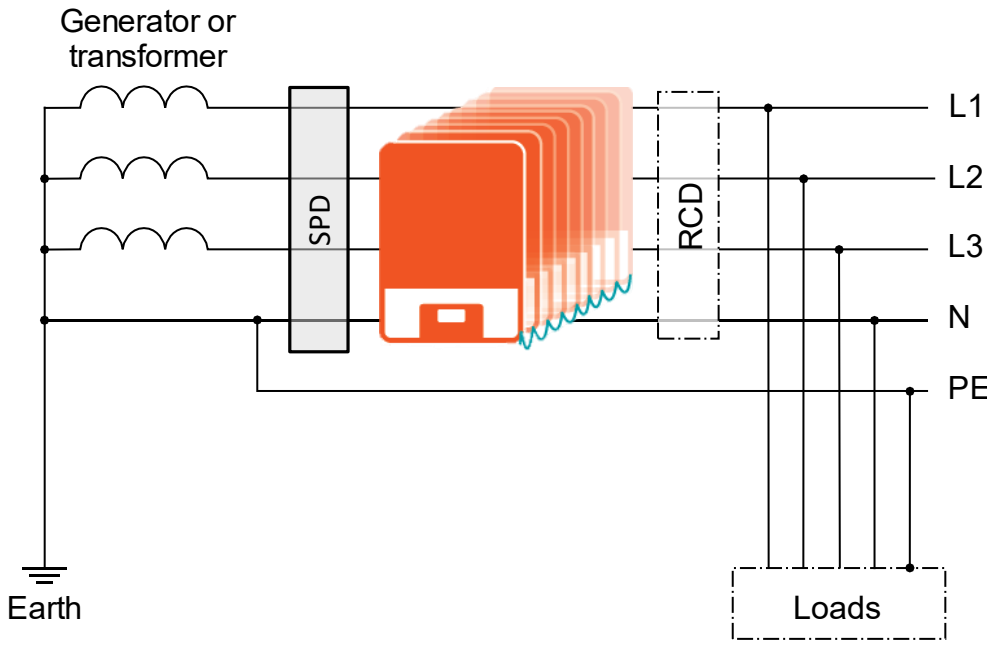






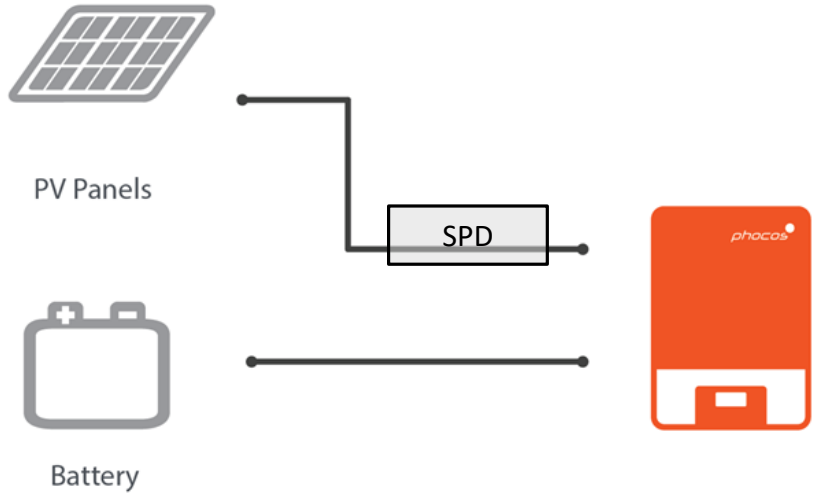
Surge Protection: AC

- Surges can come from the AC source, particularly a grid
- Use appropriate SPD (surge protective device) between AC source and AC input of Any-Grid
- Recommended SPD models:
  - Citel DS41S-230 → for most public grids or generators, higher protection)
  - Citel DS41S-320 → for public grids with large voltage swings, lower protection
- The max. AC operating voltage of the SPD must be between 275 and 300 Vac
- A good connection to ground is critical for the SPD to function correctly



Surge Protection: DC

- Surges can come from the PV source due to the exposed PV panels and wiring
- Use appropriate SPD (surge protective device) between PV panels and PV input of Any-Grid
- Recommended SPD model:
  - Citel DS240-350DC
- The max. DC operating voltage of the SPD must be between 450 and 480 Vdc
- A good connection to ground is critical for the SPD to function correctly



System Wiring Examples

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Wiring Examples

The following examples apply to:

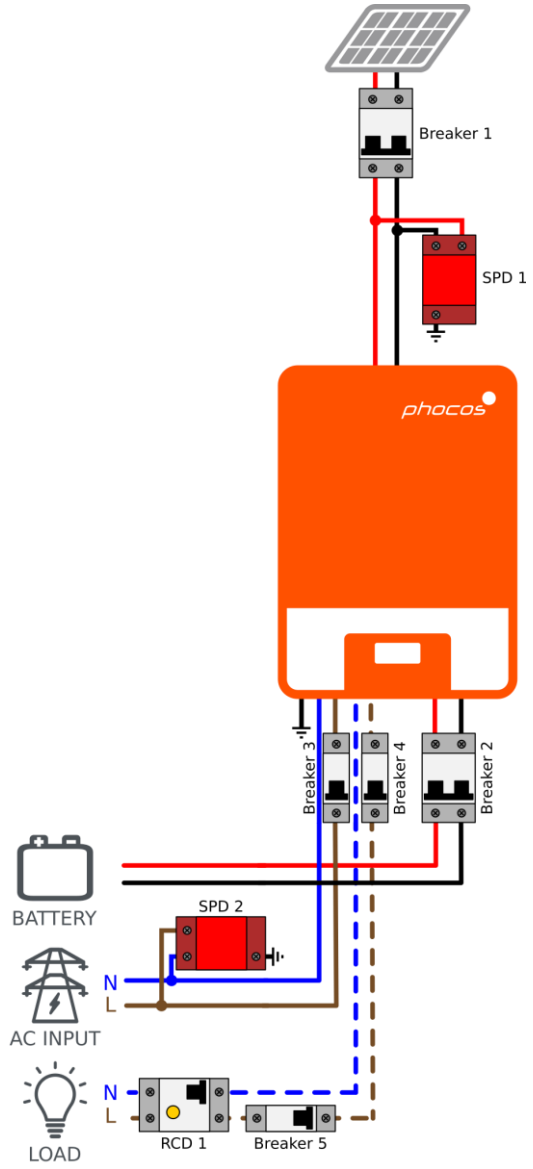
- PSW-H-5KW-230/48V
- PSW-H-3KW-230/24V
- PSW-H-3KW-120/24V

For the following phase configurations:

- Parallel
- 3-phase

Wiring Example: Single unit

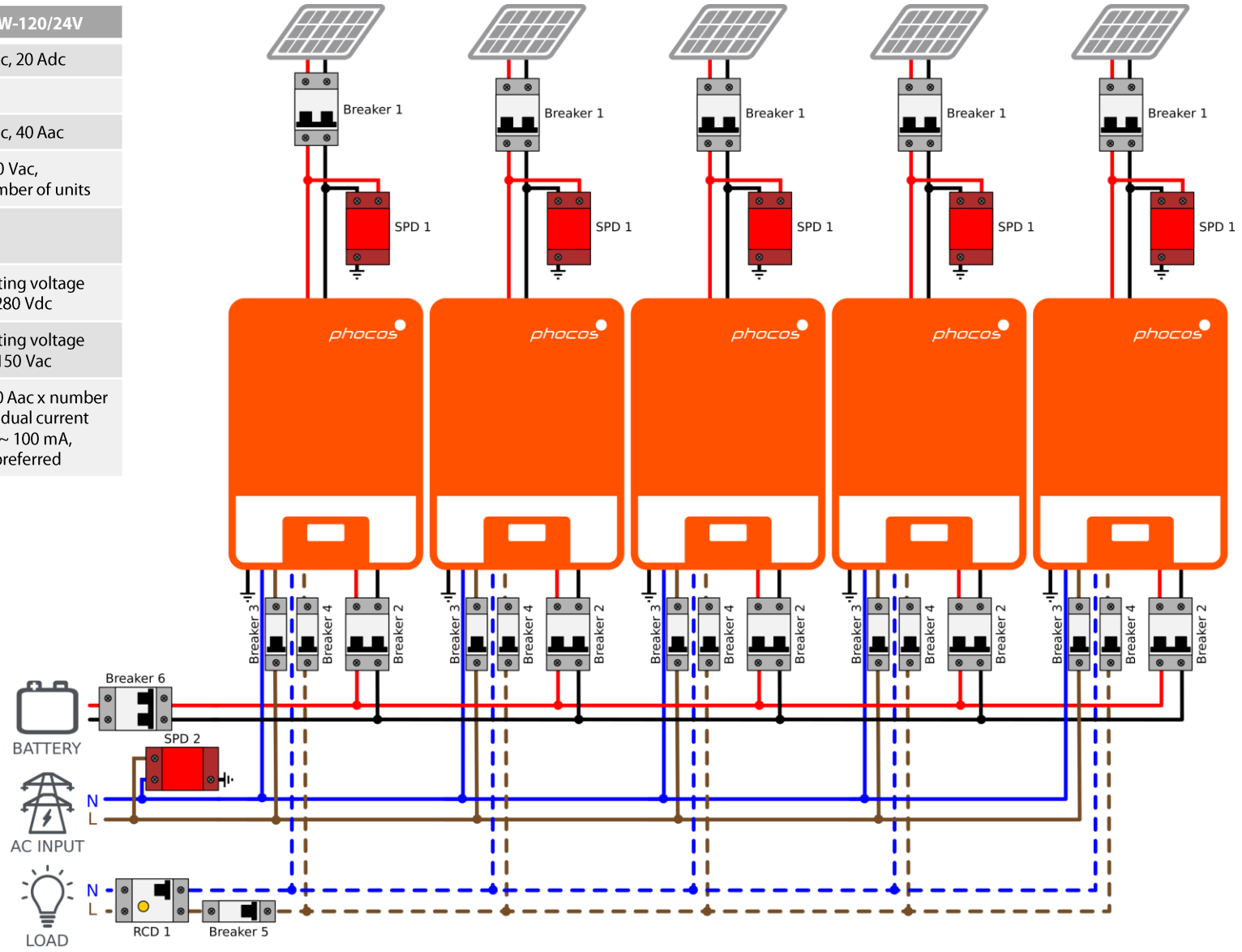
	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-3KW-120/24V
Breaker 1	≥ 450 Vdc, 20 Adc		≥ 250 Vdc, 20 Adc
Breaker 2	≥ 66 Vdc, 175 ~ 200 Adc	≥ 33 Vdc, 210 ~ 250 Adc	
Breaker 3 & 4	≥ 280 Vac, 40 Aac	≥ 280 Vac, 30 Aac	≥ 140 Vac, 40 Aac
Breaker 5	≥ 280 Vac, 40 Aac	≥ 280 Vac, 30 Aac	≥ 140 Vac, 40 Aac
SPD 1	Max. operating voltage 450 ~ 480 Vdc		Max. operating voltage 250 ~ 280 Vdc
SPD 2	Max. operating voltage 275 ~ 300 Vac		Max. operating voltage 140 ~ 150 Vac
RCD 1	≥ 280 Vac, ≥ 40 Aac, residual current rating 30 ~ 100 mA, Type B preferred	≥ 280 Vac, ≥ 30 Aac, residual current rating 30 ~ 100 mA, Type B preferred	≥ 140 Vac, ≥ 40 Aac, residual current rating 30 ~ 100 mA, Type B preferred



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Example: 5 units parallel

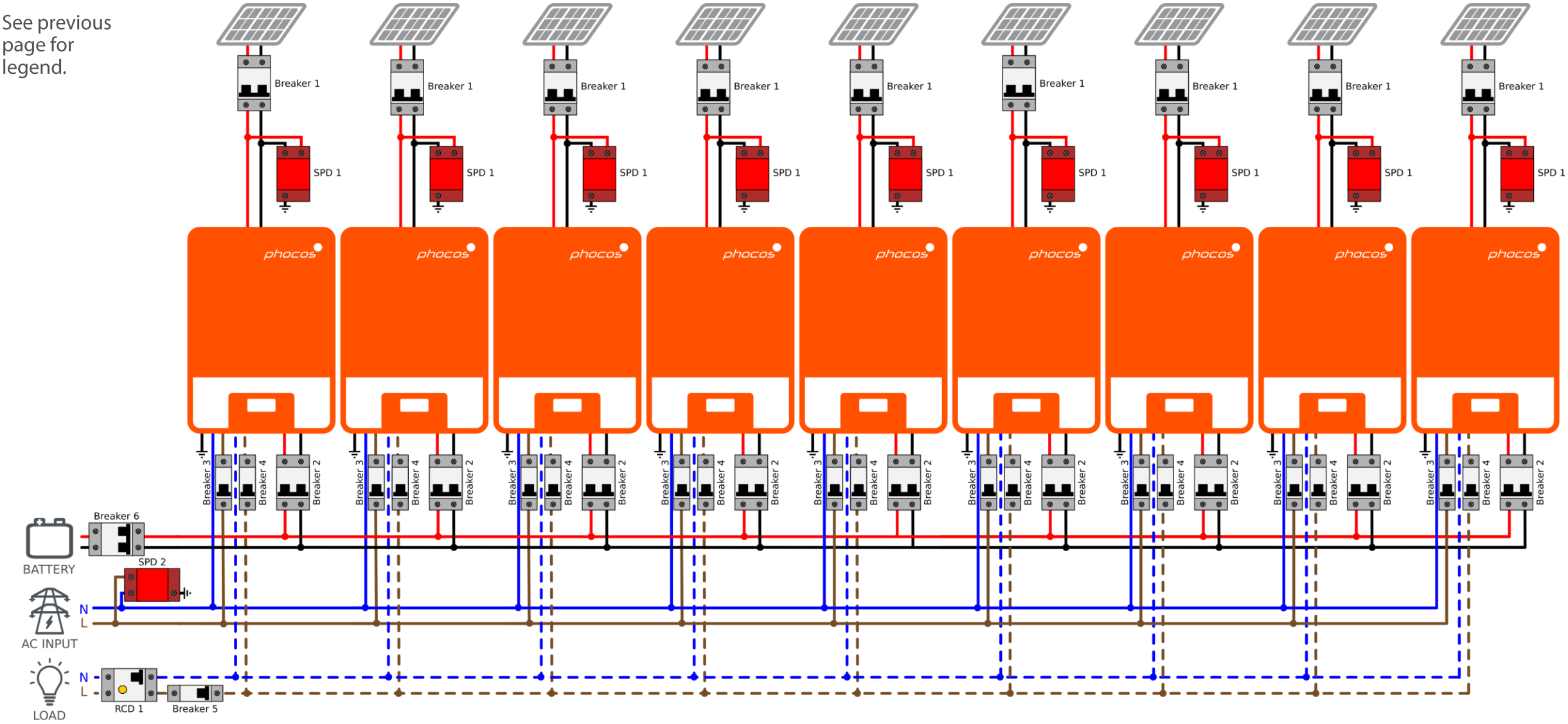
	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-3KW-120/24V
Breaker 1	≥ 450 Vdc, 20 Adc		≥ 250 Vdc, 20 Adc
Breaker 2	≥ 66 Vdc, 175 ~ 200 Adc	≥ 33 Vdc, 210 ~ 250 Adc	
Breaker 3 & 4	≥ 280 Vac, 40 Aac	≥ 280 Vac, 30 Aac	≥ 140 Vac, 40 Aac
Breaker 5	≥ 280 Vac, 40 Aac x number of units	≥ 280 Vac, 30 Aac x number of units	≥ 140 Vac, 40 Aac x number of units
Breaker 6	≥ 66 Vdc, 175 ~ 200 Adc x number of units	≥ 33 Vdc, 210 ~ 250 Adc x number of units	
SPD 1	Max. operating voltage 450 ~ 480 Vdc		Max. operating voltage 250 ~ 280 Vdc
SPD 2	Max. operating voltage 275 ~ 300 Vac		Max. operating voltage 140 ~ 150 Vac
RCD 1	≥ 280 Vac, ≥ 40 Aac x number of units, residual current rating 30 ~ 100 mA, Type B preferred	≥ 280 Vac, ≥ 30 Aac x number of units, residual current rating 30 ~ 100 mA, Type B preferred	≥ 140 Vac, ≥ 40 Aac x number of units, residual current rating 30 ~ 100 mA, Type B preferred



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Example: 9 units, parallel

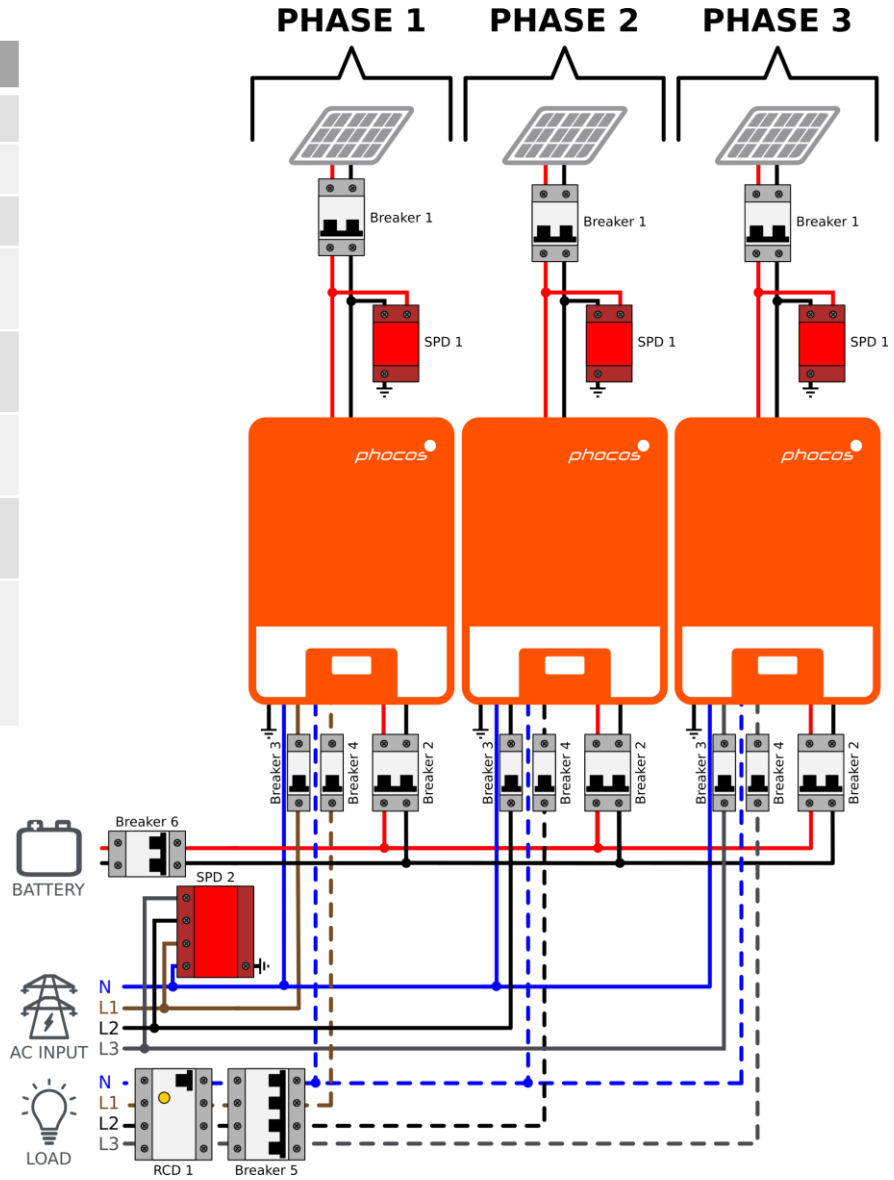
See previous page for legend.



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Example: 3 units, 3-phase

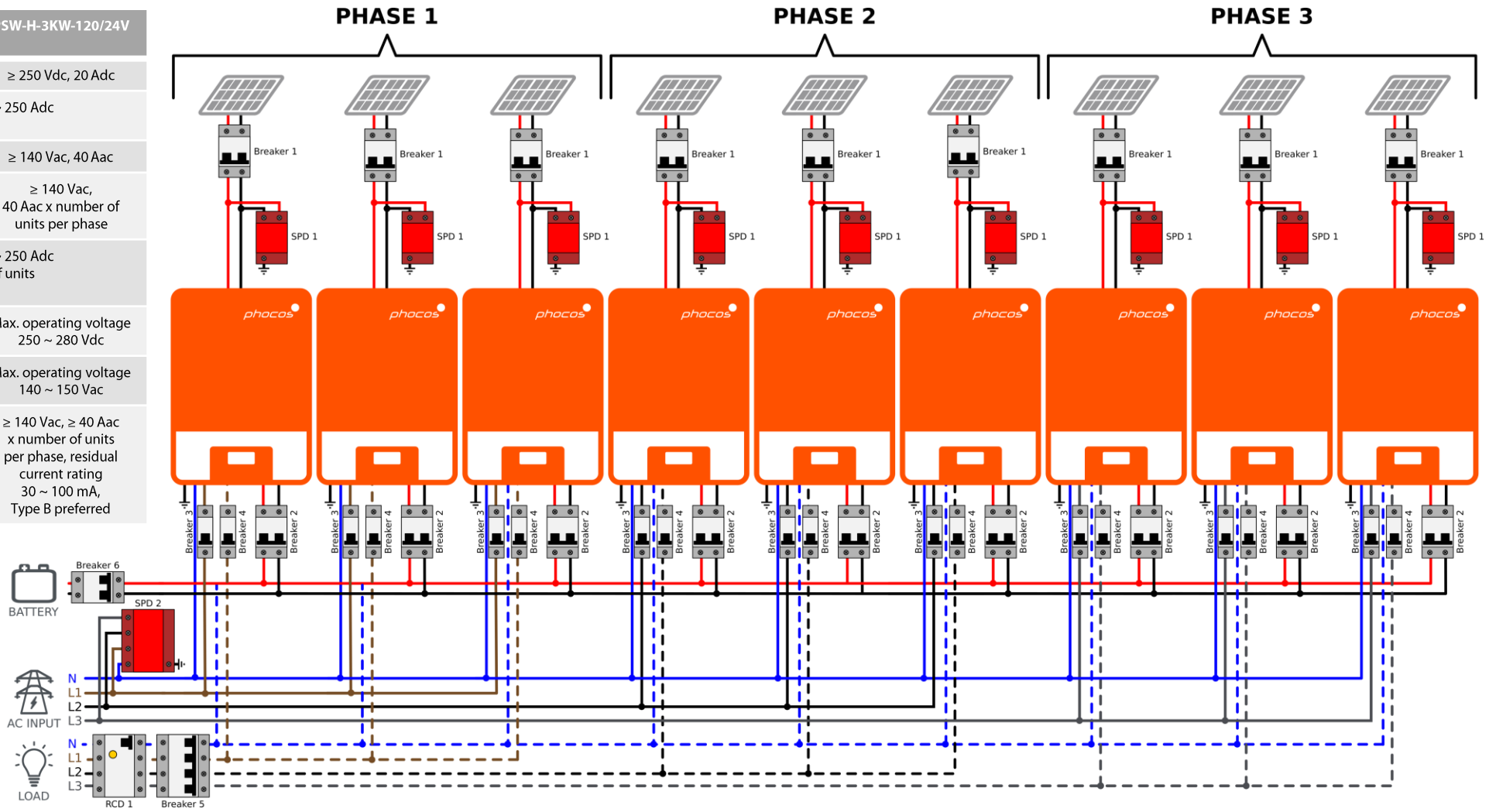
	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-3KW-120/24V
Breaker 1	≥ 450 Vdc, 20 Adc		≥ 250 Vdc, 20 Adc
Breaker 2	≥ 66 Vdc, 175 ~ 200 Adc	≥ 33 Vdc, 210 ~ 250 Adc	
Breaker 3 & 4	≥ 280 Vac, 40 Aac	≥ 280 Vac, 30 Aac	≥ 140 Vac, 40 Aac
Breaker 5	≥ 280 Vac, 40 Aac per phase	≥ 280 Vac, 30 Aac per phase	≥ 140 Vac, 30 Aac per phase
Breaker 6	≥ 66 Vdc, 175 ~ 200 Adc x number of units	≥ 33 Vdc, 210 ~ 250 Adc x number of units	
SPD 1	Max. operating voltage 450 ~ 480 Vdc		Max. operating voltage 250 ~ 280 Vdc
SPD 2	Max. operating voltage 275 ~ 300 Vac		Max. operating voltage 140 ~ 150 Vac
RCD 1	≥ 280 Vac, ≥ 40 Aac per phase, residual current rating 30 ~ 100 mA, Type B preferred	≥ 280 Vac, ≥ 30 Aac per phase, residual current rating 30 ~ 100 mA, Type B preferred	≥ 140 Vac, ≥ 40 Aac per phase, residual current rating 30 ~ 100 mA, Type B preferred



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Example: 9 units, 3-phase

	PSW-H-5KW-230/48V	PSW-H-3KW-230/24V	PSW-H-3KW-120/24V
Breaker 1	≥ 450 Vdc, 20 Adc		≥ 250 Vdc, 20 Adc
Breaker 2	≥ 66 Vdc, 175 ~ 200 Adc	≥ 33 Vdc, 210 ~ 250 Adc	
Break. 3 & 4	≥ 280 Vac, 40 Aac	≥ 280 Vac, 30 Aac	≥ 140 Vac, 40 Aac
Breaker 5	≥ 280 Vac, 40 Aac x number of units per phase	≥ 280 Vac, 30 Aac x number of units per phase	≥ 140 Vac, 40 Aac x number of units per phase
Breaker 6	≥ 66 Vdc, 175 ~ 200 Adc x number of units	≥ 33 Vdc, 210 ~ 250 Adc x number of units	
SPD 1	Max. operating voltage 450 ~ 480 Vdc		Max. operating voltage 250 ~ 280 Vdc
SPD 2	Max. operating voltage 275 ~ 300 Vac		Max. operating voltage 140 ~ 150 Vac
RCD 1	≥ 280 Vac, ≥ 40 Aac x number of units per phase, residual current rating 30 ~ 100 mA, Type B preferred	≥ 280 Vac, ≥ 30 Aac x number of units per phase, residual current rating 30 ~ 100 mA, Type B preferred	≥ 140 Vac, ≥ 40 Aac x number of units per phase, residual current rating 30 ~ 100 mA, Type B preferred



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Example

The following example applies to:

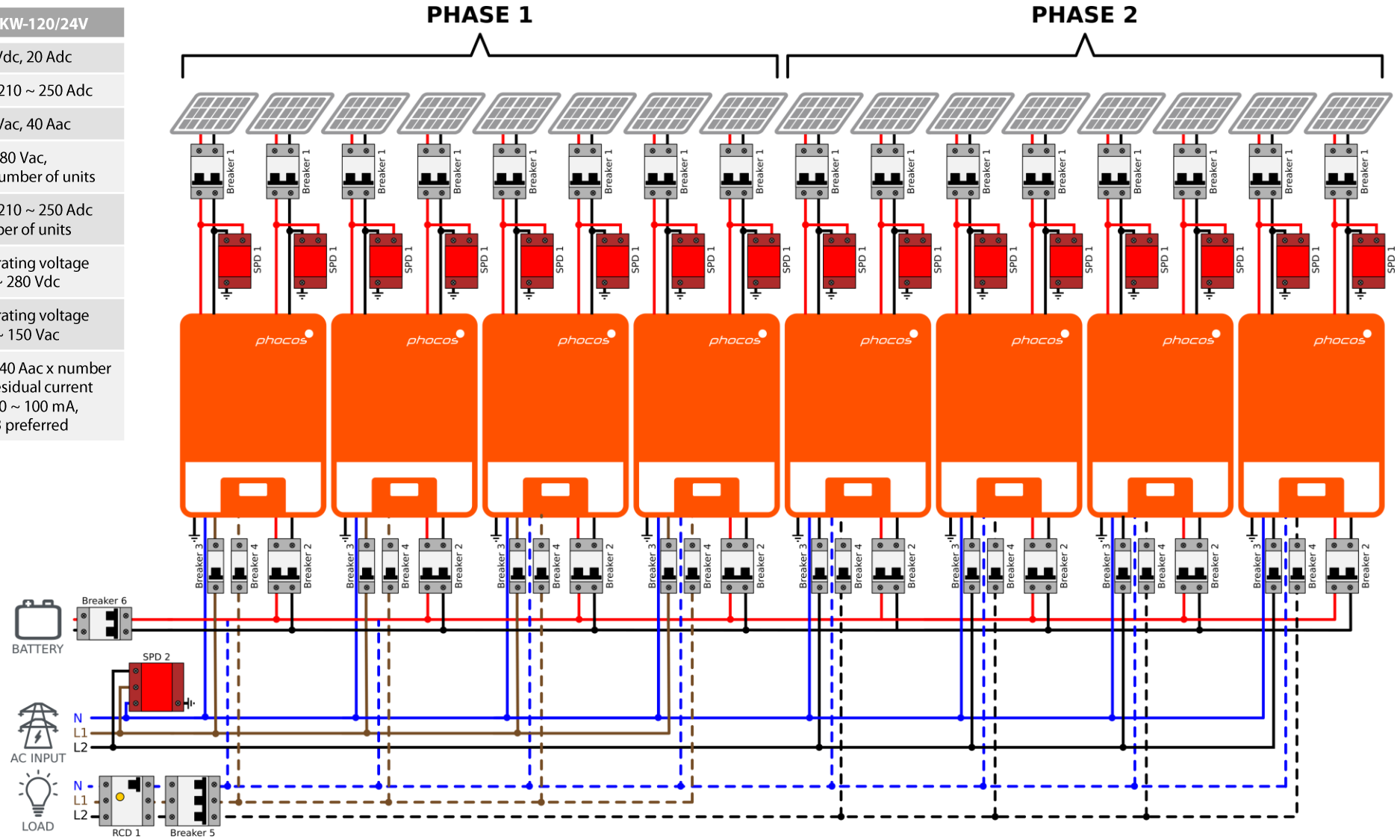
- PSW-H-5KW-120/48V
- PSW-H-3KW-120/24V (ignore the second PV array as this model has only one MPPT and thus one PV array per unit)

For the following phase configuration:

- Split-phase

Wiring Example: 8 units, split-phase

	PSW-H-5KW-120/48V	PSW-H-3KW-120/24V
Breaker 1	≥ 250 Vdc, 20 Adc	≥ 250 Vdc, 20 Adc
Breaker 2	≥ 66 Vdc, 175 ~ 200 Adc	≥ 33 Vdc, 210 ~ 250 Adc
Breaker 3 & 4	≥ 140 Vac, 63 Aac	≥ 140 Vac, 40 Aac
Breaker 5	≥ 280 Vac, 63 Aac x number of units	≥ 280 Vac, 40 Aac x number of units
Breaker 6	≥ 66 Vdc, 175 ~ 200 Adc x number of units	≥ 33 Vdc, 210 ~ 250 Adc x number of units
SPD 1	Max. operating voltage 250 ~ 280 Vdc	Max. operating voltage 250 ~ 280 Vdc
SPD 2	Max. operating voltage 140 ~ 150 Vac	Max. operating voltage 140 ~ 150 Vac
RCD 1	≥ 280 Vac, ≥ 63 Aac x number of units, residual current rating 30 ~ 100 mA, Type B preferred	≥ 280 Vac, ≥ 40 Aac x number of units, residual current rating 30 ~ 100 mA, Type B preferred



Note: Follow local safety and legal requirements. This is purely an example, Phocos cannot guarantee correctness. Parallel communication cables and current sharing cables not shown for clarity.

Wiring Examples: Autotransformer

What is it?

An autotransformer is a transformer with a single winding. It allows stepping up or down an AC voltage but does **not** provide galvanic isolation. It is typically cheaper and more efficient than an isolating transformer.

Remember: The PSW-H must always be connected to a neutral and phase of an AC source, never two phases!

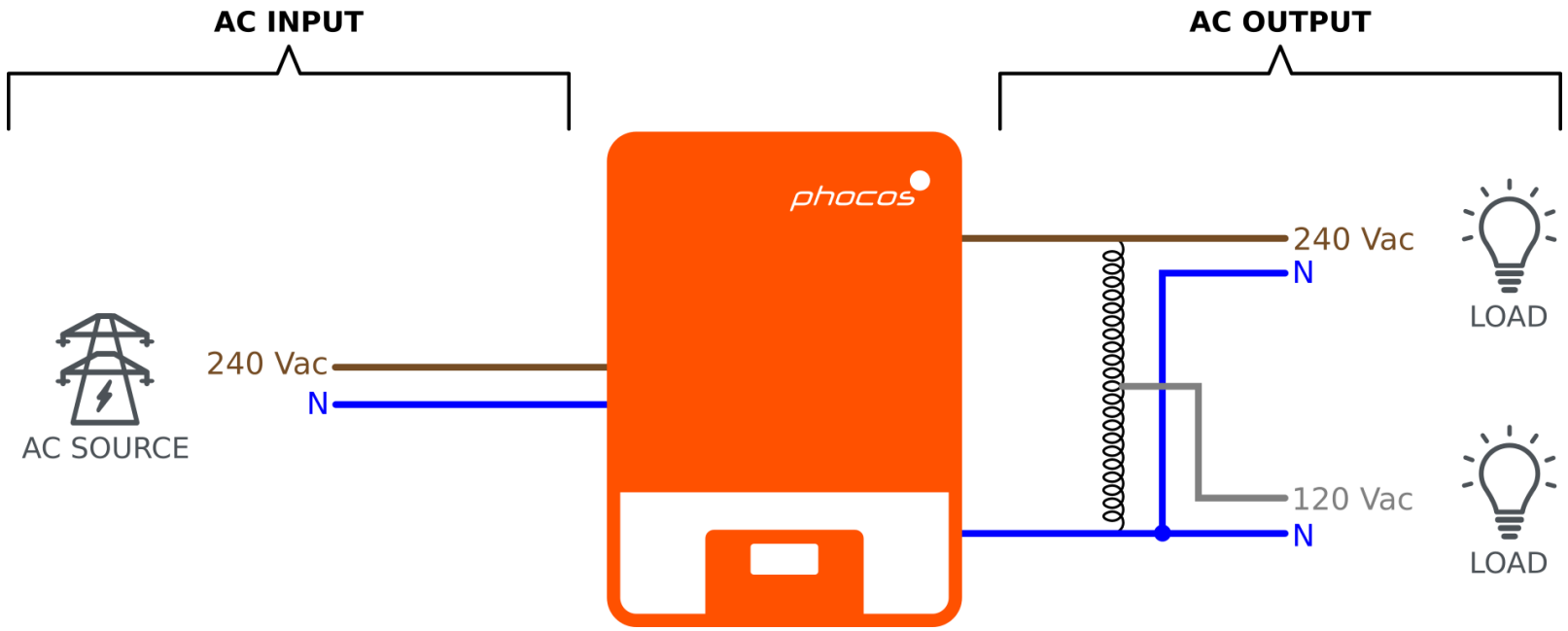
When to use it

- 120 Vac AC source, 240 Vac loads:
  - 1:2 auto transformer with 120 Vac PSW-H (transformer between PSW-H and loads) **or**
  - 1:2 auto transformer with 240 Vac PSW-H (transformer between AC source and PSW-H)
- 240 Vac AC source (not split-phase), 120 Vac loads:
  - 2:1 auto transformer with 120 Vac PSW-H (transformer between AC source and PSW-H) **or**
  - 2:1 auto transformer with 240 Vac PSW-H (transformer between PSW-H and loads)
- No split-phase AC source, 120 Vac and 240 Vac loads:
  - 2:1 auto transformer with 240 Vac PSW-H (transformer between PSW-H and loads)

Wiring Examples: Autotransformer

Single phase 240 Vac source, 120 Vac and 240 Vac loads

Transformer continuous power requirement: 5 kW for 5 kW inverter



Wiring Examples: Isolating Transformer

What is it?

An Isolating Transformer is a transformer with at least two windings. It allows stepping up or down an AC voltage and provides galvanic isolation.

Remember: The PSW-H must always be connected to a neutral and phase of an AC source, never two phases!

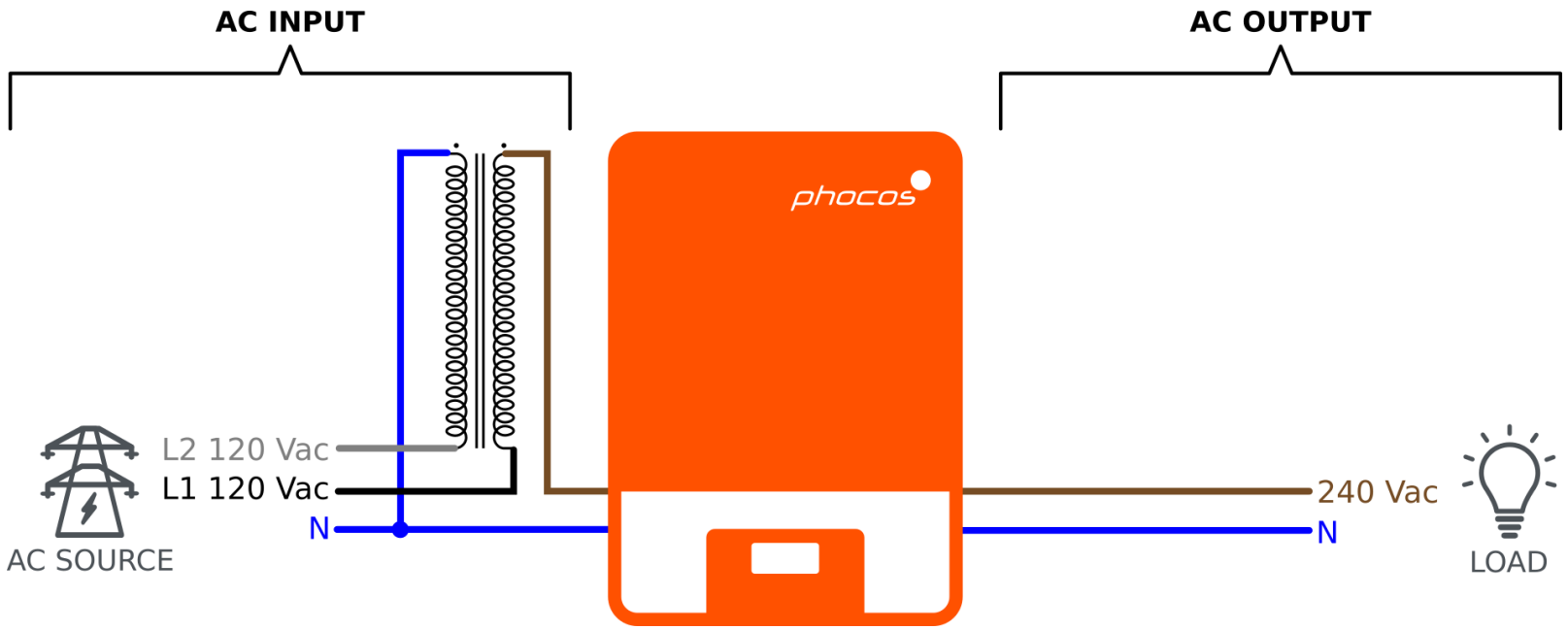
When to use it

- 240 Vac AC source as split-phase, 240 Vac loads:
  - 1:1 transformer with 240 Vac PSW-H (transformer between AC source and PSW-H)
- 240 Vac AC source as split-phase, 120 Vac loads:
  - 2:1 transformer with 120 Vac PSW-H (transformer between AC source and PSW-H)
    This spreads the load current across both phases of the AC input.

Wiring Examples: Isolating Transformer

Split-phase 240 Vac source, 240 Vac loads

Transformer continuous power requirement: 2.5 kW for 5 kW inverter



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Thank You