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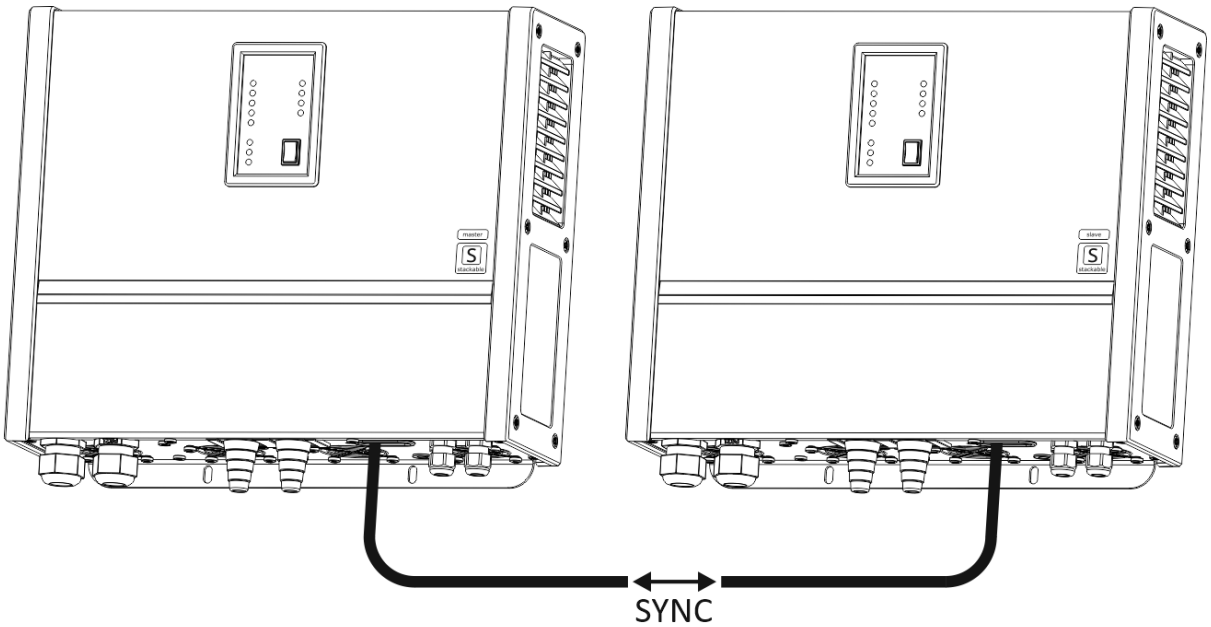
# Sync Cable Kit

Intended for stacking multiple Powersine Combi Inverter/Charger units




## EN Owner's manual

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## TABLE OF CONTENTS

**1.0** INTRODUCTION AND GENERAL WARNINGS ..... 4
**2.0** CONTROL AND DC WIRING ..... 5
**2.1** Control wiring ..... 5
**2.1.1** Remaining control and signal wiring plus configuration remarks ..... 7
**2.2** DC connections ..... 8
**3.0** PROGRAMMING THE STACKED INVERTERS ..... 11
**3.1** Resetting a formerly stacked inverter for stand alone use again ..... 16
**4.0** AC WIRING ..... 17
**4.1** Critical AC wiring note: Do not over-dimension the AC wires ..... 17
**4.2** AC connections ..... 18
**5.0** COMMISSIONING THE SYSTEM ..... 21

## 1.0 INTRODUCTION AND GENERAL WARNINGS

Thank you for purchasing the TBS Electronics (TBS) Sync Cable Kit. This cable kit can be used to parallel connect two Powersine Combi Inverter/Charger units. This is also known as stacking. When a third unit needs to be added, an additional Sync Cable Kit is required.

Please make sure that you have read and followed the installation instructions that came with your Powersine Combi carefully. The instructions in this Sync Cable Kit manual are intended as a supplement to the instructions of the general installation and operating manuals. For the most recent manual revision, please check the downloads section on our website.

### GENERAL WARNINGS

- Installing and setting up a high power stacked inverter system is more complex compared to a stand-alone installation. TBS Electronics does not recommend inexperienced people to install and set up such systems. Please hire an experienced installer in these cases.

- This manual is intended for installers that have knowledge and experience in installing electrical equipment, knowledge of the applicable installation codes, and awareness of the hazards involved in performing electrical work and how to reduce those hazards.

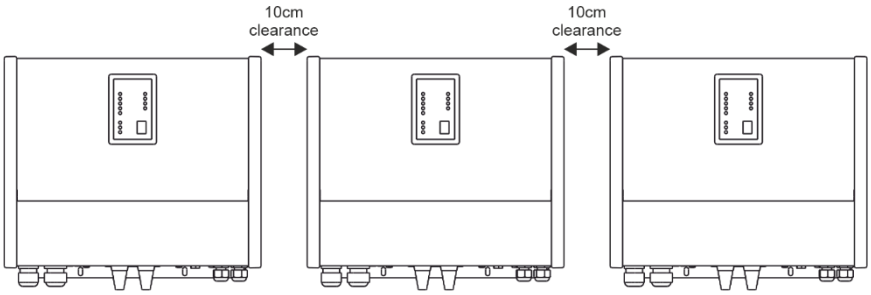
- The Powersine Combi 2000-12-80-S, 2500-24-50-S, 3000-12-120-S and 3500-24-70-S models are only compatible with stacking in single phase mode. Three phase mode is not supported yet. **A maximum number of 3 units can be stacked together**.

- Make sure that all units in one stacked system are of **the same type**. This can be checked by verifying the model description and article number printed on the unit's type number label. **Do not mix units with different power, voltage or current ratings in one system**.

- Always make sure that all units in the stacked system carry **the same firmware version**. When in doubt, or when an existing system is being upgraded by adding a more recent inverter/charger unit in parallel, please use the TBS Dashboard for Windows software to check and/or update the firmware to the latest version.

## 2.0 CONTROL AND DC WIRING

Before proceeding with the control- and DC wiring of each unit, it is assumed the inverters are already securely mounted in place, following the guidelines described in the installation guide. Please make sure that the minimum clearance requirement of 10cm between mutual units is met, in order to guarantee a good airflow for proper cooling (see image below).

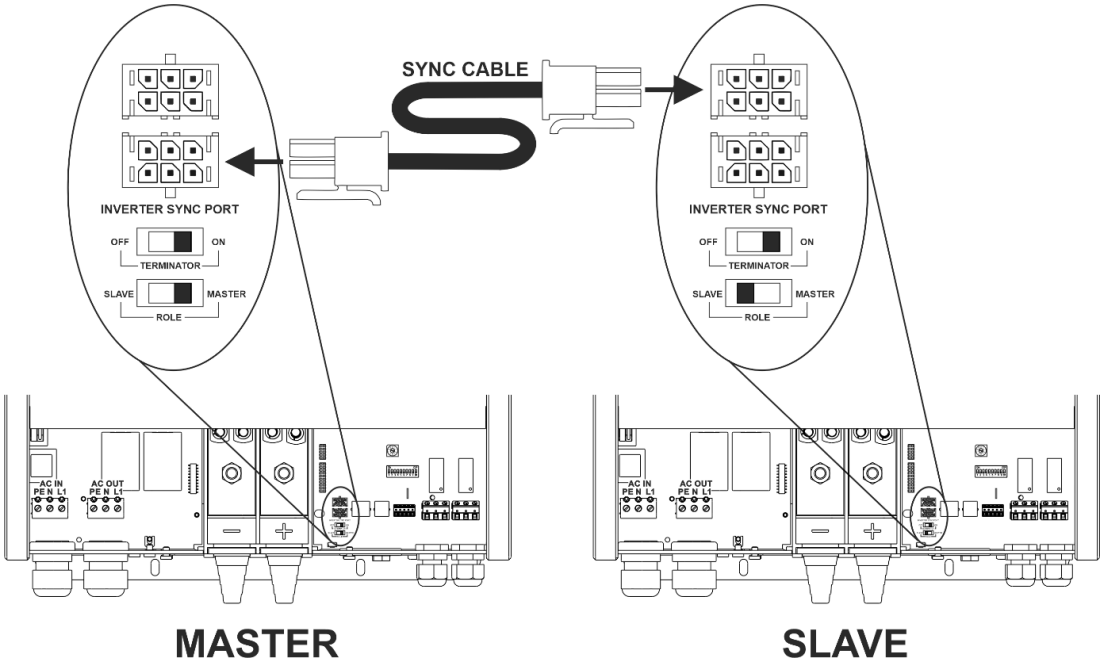



When stacking multiple Powersine Combi inverter/chargers, you are actually creating one large inverter/charger. Each stacked system consists of a Master unit and one or two Slave units. Before setting up the units for parallel operation and subsequently making the AC connections, we will focus first on the control wiring and DC connections.

### 2.1 Control wiring

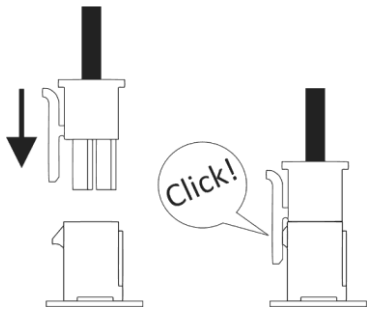
For the correct wiring sequence we start by adding the control wiring and make sure that all sync port slide switches are set correctly.

The sync cable must be connected first. The image below shows the locations of the sync connectors and port setup switches. In a system containing two inverters, the sync cable can be inserted into one of the two available sync port PCB connectors inside each inverter.

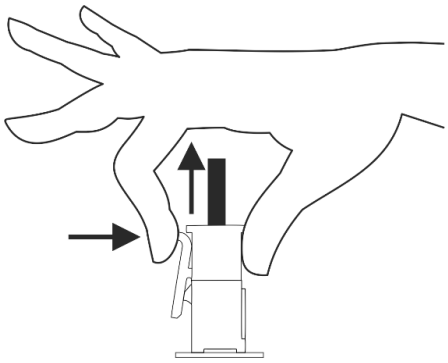


The sync cable can exit the inverter enclosure through the oval shaped cable entry in the bottom panel. Please make sure that this cable is sufficiently secured using ty-wraps or similar, to avoid any mechanical stress.

It is very important to make sure that the sync cable connectors are correctly inserted into the PCB connectors. When making the connection, you should eventually hear a click sound, confirming that the cable connector clip is properly locked to the notch of the PCB connector. Please see the illustrations on the right.



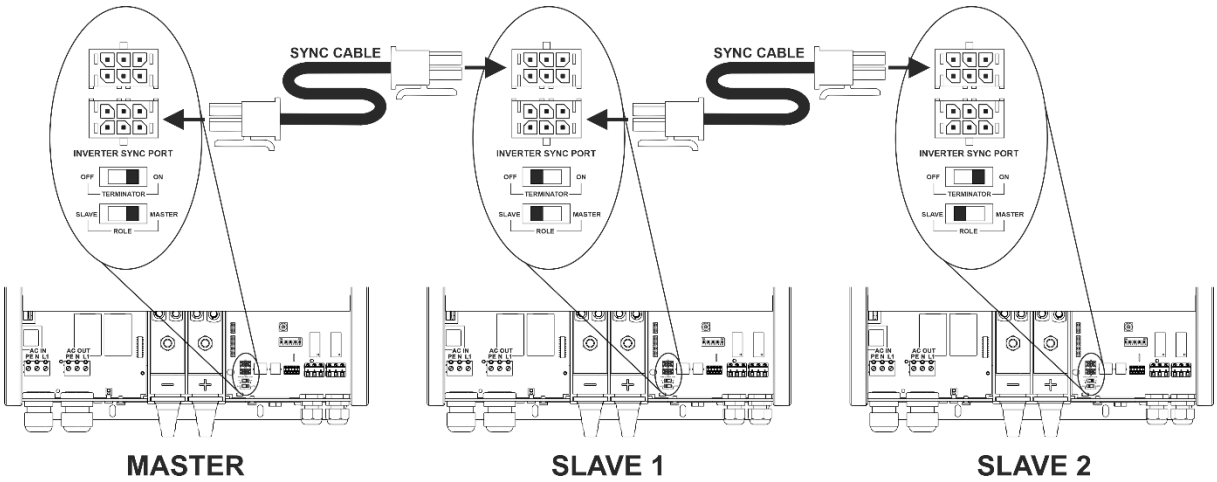

When disconnecting the sync cable, please make sure to firmly press the locking lever before pulling the cable connector. Since these PCB connectors are located quite close to each other, you can also use flat nose pliers instead of your fingers. Never pull the sync cable by the wiring! Please see the illustration on the right.



Once the sync cable is connected at both ends, it is essential to correctly set up the sync port slide switches. These are set differently in each inverter. The slide switch positions for a stacked system containing two inverters, can be seen in the detailed image on the previous page and the table below:

| **Inverter** | **Terminator switch** | **Role switch** |
|---|---|---|
| Master | ON | Master |
| Slave | ON | Slave |

The next image shows a stacked system containing three inverters:




Once all sync cables are connected as indicated above, it is essential to correctly set up the sync port slide switches. These are set differently in each inverter. The slide switch positions can be seen in the details image above and the table below:

| Inverter | Terminator switch | Role switch |
|---|---|---|
| Master | ON | Master |
| Slave 1 | OFF | Slave |
| Slave 2 | ON | Slave |

### 2.1.1 Remaining control and signal wiring plus configuration remarks

All remaining control and signal wiring for the:

- Universal- or Basic Remote control
- battery temperature sensor
- trigger inputs
- remote on/of input

as shown in step 4 of the general installation guide, must be connected **only to the Master unit**. Please avoid making any of these connections to a Slave unit.

If desired, it is allowed to join the 4A secondary charger outputs of the Master and Slave units together, in order to increase the available charge current for the secondary (starter-) battery.

In case there is an alarm or active Trigger-Action that is linked to one of the two programmable relays, not only the corresponding relay inside the Master will be triggered, but also the one inside the Slave(s). Please do note that the programmable relays inside the slaves will be triggered after a very small delay, compared to the relays inside the Master unit.

Configuring the stacked system via the DIP switches, TBS Dashboard software and/or Universal Remote Control, **must be done on the Master unit only**. The Slave units will automatically take over all settings from the Master. Such settings are for example: inverter output voltage and frequency, AC input current limit, maximum charge current, power boost on/off and charge voltages.

### 2.2 DC connections

The next step is to make the DC connections. As mentioned earlier, please follow all DC wiring instructions and guidelines as explained in step 4 of the Powersine Combi installation guide. Specifically for a stacked system, this chapter will only highlight the additional details that are important for a well-functioning system.

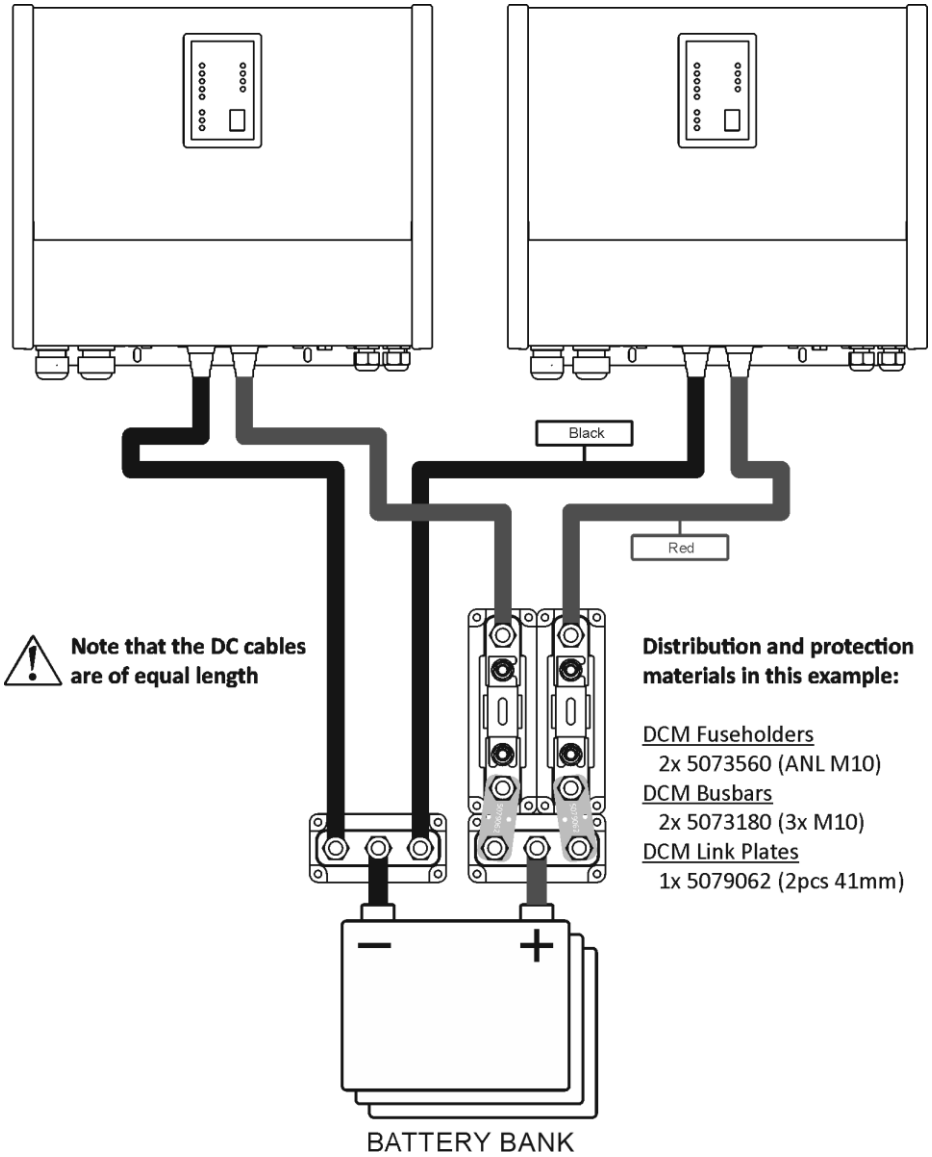
**WARNINGS**

- Symmetry is key! **The DC (battery-) wiring must be equal for each stacked unit**. This means that each unit must be equipped with DC cables of the same length, cross-section and type. Besides that, each cable must be equipped with the same cable lug types using identical crimping force. Lastly, all connections must be fastened with the same torque applied.

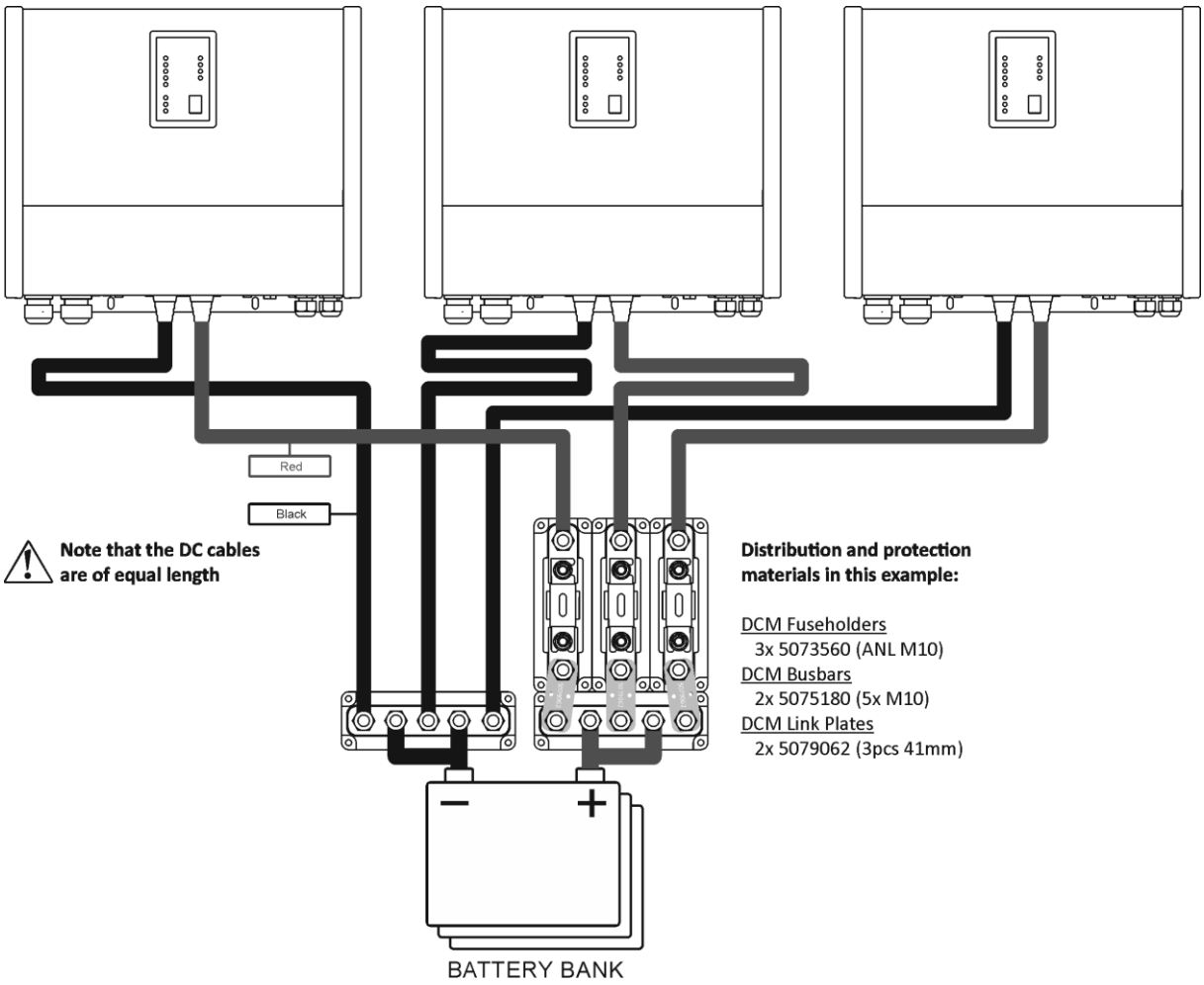
- **Each stacked unit needs to be individually fused at the DC input side**. Please make sure to use the same fuse type and rating for each unit. To further avoid resistance differences in each DC input circuit, also use the same fuse holder type for each DC fuse.

- A stacked inverter system must be connected to the same battery bank. **Never use a separate battery to connect to only a single unit within a stacked system.** This will result in system stability issues. It is advised to create one solid DC bus using quality busbars and fuse holders to connect to multiple batteries in parallel.

Please see below a DC wiring example for a stacked system containing two Powersine Combi units.



The next wiring example shows a stacked system containing three Powersine Combi units.




## INFORMATION

Good installation practice is to check for imbalances in the DC wiring once the complete system is running. This can be done by loading the system with at least 75% of the maximum AC output load, followed by measuring the current flowing through the DC cables of each stacked unit by a current clamp meter. The current readings of each unit should be very similar. When no current clamp meter is available, you can also measure the DC voltage at the input terminals of each unit. The voltage value should be the same for each unit. When this is not the case, all DC connections need to be rechecked.

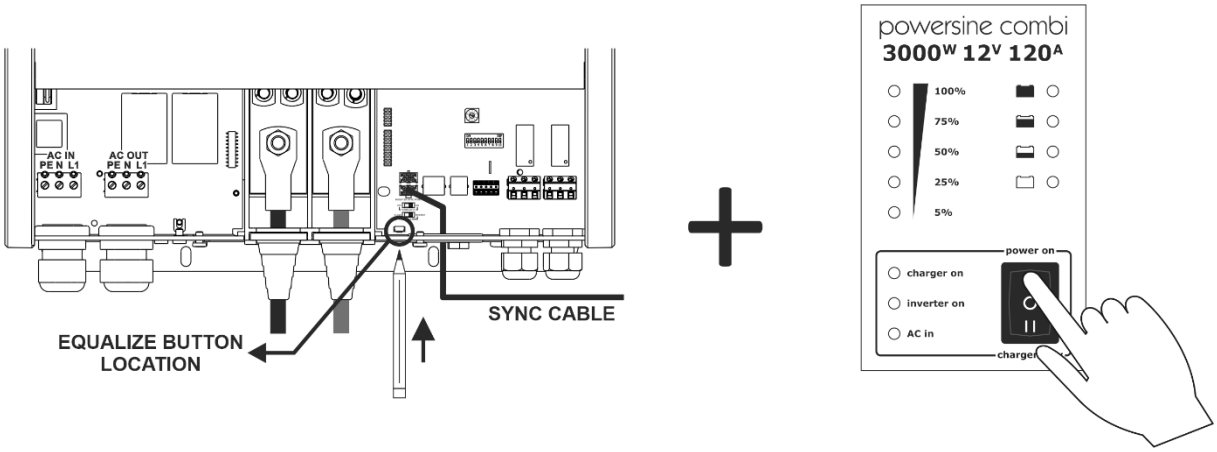
## 3.0 PROGRAMMING THE STACKED INVERTERS

Once all inverters in the stacked system are equipped with connected sync cables, properly set sync port switches and battery connections, it is time to program these in order to enable parallel operation.

**WARNING**

Before proceeding with the inverter programming procedures, **please make sure that the AC in- and outputs of all inverters are <u>not</u> mutually connected yet**.

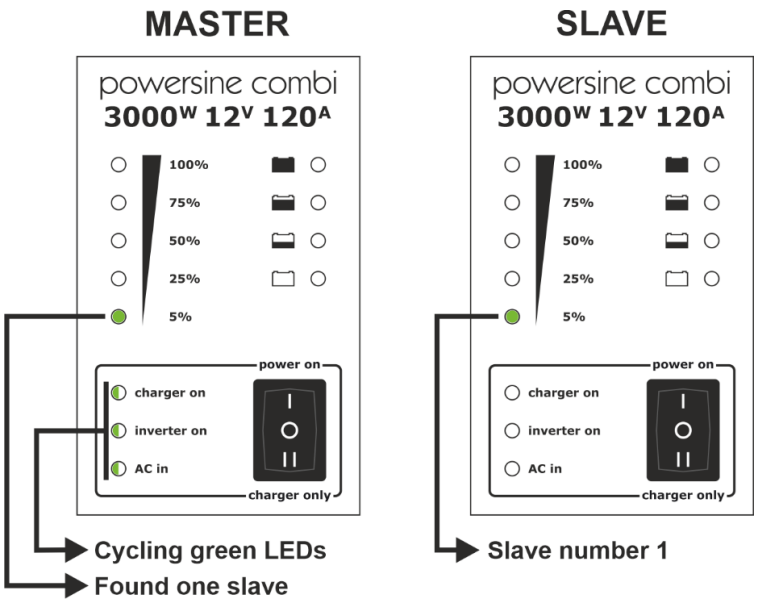
First we need to put the Master inverter into the search mode so that it can discover connected Slave(s). This can be done by pressing the recessed 'equalize' button with a pencil or other small tool and <u>at the same time</u> turning on the inverter via the front panel switch (from position '0' to 'I'), as illustrated below:



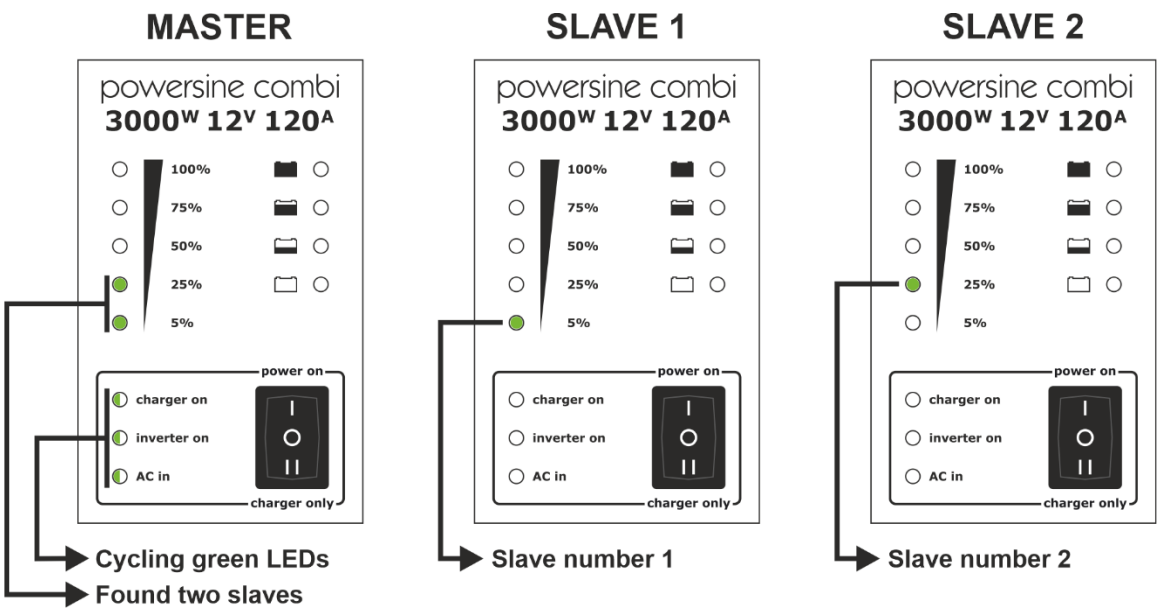

The Master will now enter search mode, indicated by a continuously cycling orange LED from 'charger on' to 'inverter on' to 'AC in' and back.

Next, while the Master unit is running in search mode, the exact same procedure as described above must be performed at the Slave unit(s) as well. When the Slave(s) are properly recognized, the cycling orange LED of the Master will change color to green. Additionally the bottom LED of the power bar (5%) will turn green when one Slave is detected and the bottom two LEDs of the power bar (5% + 25%) will turn green when two Slaves are detected. On the Slave front panel only the bottom LED of the power bar (5%) turns green, indicating that this is Slave number 1. When two Slaves are connected, the power bar of the second Slave shows an active second LED (25%), indicating Slave number 2.

Please see the image below of the front panel status of each inverter in a two-unit setup, after successful programming.




Please see the next image of the front panel status of each inverter in a three-unit setup, after successful programming.

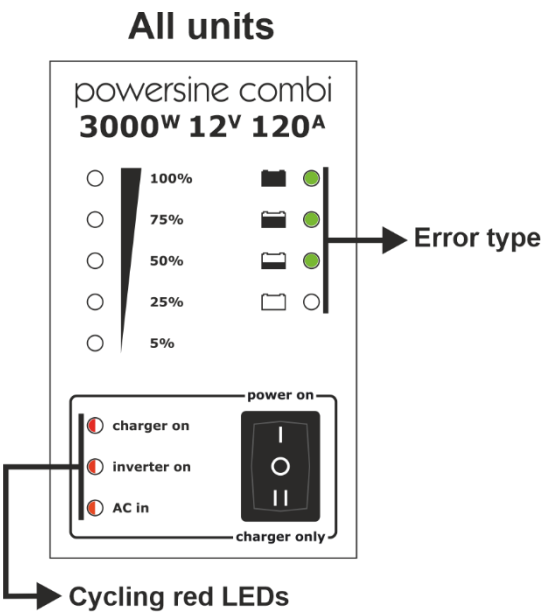



**When the programming was executed successfully, all units in the stacked system must be switched off in order to exit the programming mode.** When the Master is turned on again, it will wait till the Slave(s) is/are turned on as well and the system is ready to go. It is advised to check this before proceeding with the AC wiring (see chapter 4).

When instead of the above two front panel status illustrations, the cycling LEDs at the Master front panel stay orange instead of green, the following could be wrong:

- Sync cable between Master and Slave(s) not properly connected. Please check if sync connectors are pressed firmly enough to guarantee a solid connection. Please check if the sync cable is in good and undamaged condition.

When instead of the previous two front panel status illustrations, the cycling LEDs on all units turn red in combination with a pattern of solid green LEDs in the charge indicator bar, an error has been detected. See the illustration below for an example:




The table below indicates the charge indicator bar LED patterns versus the possible error types ('-' represents LED off and 'O' LED on):

| | | | | **Error type** | **Potential solution[1)]** |
|---|---|---|---|---|---|
| - | - | - | O | Error in configuration sequence | Reset all units to stand alone use (see chapter 3.1) and try to re-program for a stacked system again, starting with the Master |
| - | - | O | - | Error in configuration process | One of the units is probably not in search mode. See page 11 for details. |
| - | - | O | O | Error assigning address to slave | Please make sure that Slave has not been used before in other stacked system. Reset all units to stand alone use (see chapter 3.1) and try to re-program for a stacked system again. |

| | | | | Error type | Potential solution[1)] |
|---|---|---|---|---|---|
| - | O | - | - | Slave unit configuration does not match current stacked system configuration | Please make sure that Slave has not been used before in other stacked system. Reset all units to stand alone use (see chapter 3.1) and try to re-program for a stacked system again. |
| - | O | O | O | Sync signal not present on at least one unit in the stacked system. | Check sync cable connections and make sure that this cable is not damaged. |
| O | - | - | - | General Sync Port error | Check error indicators on individual devices for detailed information. |
| O | - | - | O | Master unit configuration does not match current stacked system configuration | Please make sure that Master has not been used before in other stacked system. Reset all units to stand alone use (see chapter 3.1) and try to re-program for a stacked system again. |
| O | - | O | - | General initialization error | Check sync cable connections and make sure that the 'terminator' slide switches are in the correct positions |
| O | O | - | - | Slave device unknown | Please make sure that only identical units with matched article numbers are part of the stacked system |
| O | O | O | - | Multiple Masters found in stacked system | Please make sure that only one unit in the stacked system is configured as Master via de 'role' slide switches |
| O | O | O | O | Trying to add more than 3 units in stacked system | A maximum number of 3 units can be part of a stacked system. Please try to not add more. |

1) When the potential solution does not fix your problem, please contact your supplier for further technical support.

**WARNING**

Please note that when adding a 3rd unit (= 2nd slave) to an existing parallel system, **the programming of all three units needs to be repeated again**. This is also valid when a Master- or Slave unit needs to be replaced. Before this reprogramming procedure will be executed, **please make sure that all units are fully disconnected from any AC input and output wiring**.

### 3.1 Resetting a formerly stacked inverter for stand alone use again

When an inverter was part of a stacked system, but needs to be reset for stand alone use (factory default) again, the following procedure must be followed:

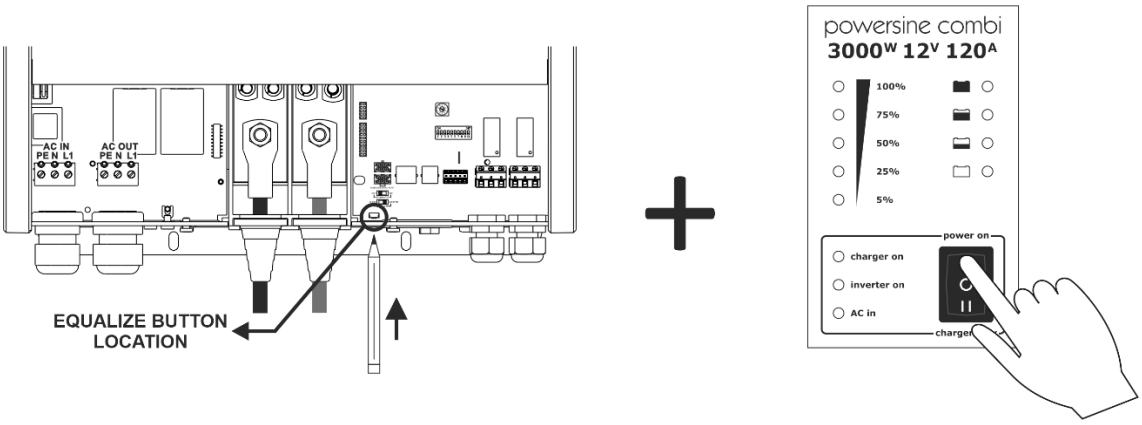
1. Turn off the inverter and disconnect all sync cable connections

2. Make sure that the AC input and output connections are not being shared with former stacked system members anymore

3. Set the sync port setup switches in the following positions:

| Terminator switch | Role switch |
|---|---|
| OFF | Master |

4. Press the recessed 'equalize' button with a pencil or other small tool and at the same time turn on the inverter via the front panel switch (from position '0' to 'I'), as illustrated below:




The inverter will now enter search mode, indicated by a continuously cycling orange LED from 'charger on' to 'inverter on' to 'AC in' and back. Turn off the inverter again.

5. The inverter is now reset to operate as a stand alone unit.

This procedure must also be followed when one of the two units inside a stacked system is defective (causing the total system to shut down), but for a temporary fix it is desired to keep at least the non defective unit running.

In case one unit inside a three unit stacked system is defective and further operation via the two remaining units is desired, this system must be reconfigured as a new stacked system with only two units (see chapter 3.0).

**Please make sure that in any of these two situations, the non-operating or defective unit has the sync cable disconnected and all AC input and output connections removed from its screw terminals.**

# 4.0 AC WIRING

The final stage of the stacked system installation is to install the AC wiring. Please follow all AC wiring instructions and guidelines as explained in step 4 of the Powersine Combi installation guide. Specifically for parallel systems, this chapter will only highlight the additional details that are important for a well-functioning system.

**WARNING**

- Please proceed with this chapter only when all control and DC wiring is already installed **and the stacked system is programmed and tested successfully.**
- Symmetry is key! **All AC wiring must be equal for each stacked unit**. This means that each unit must be equipped with AC input- and output cables of the same length, cross-section and type. Besides that, all connections must be fastened with the same torque value applied.
- Each stacked unit needs to be individually fused at the AC input- and output sides. Please make sure to use the same fuse type, rating and characteristic for each unit. Ideally use fuses of the same brand. All this to minimize resistance differences between the AC circuit branches of each unit. Consult the Powersine Combi installation guide for AC fuse details and recommended ratings.

## 4.1 Critical AC wiring note: Do not over-dimension the AC wires

Contrary to the general idea that wiring should preferably be slightly oversized to reduce losses, this line of thought should actually be put aside when it comes to the AC wiring of stacked inverters.

The reason behind this is that although the resistance values of the AC circuits within the Powersine Combi units are very low, the relative resistance differences between individually stacked units can still be significant. This can negatively impact current distribution across the stacked units. One should always strive for even current distribution between individual inverters in order to avoid suboptimal performance in parallel systems.

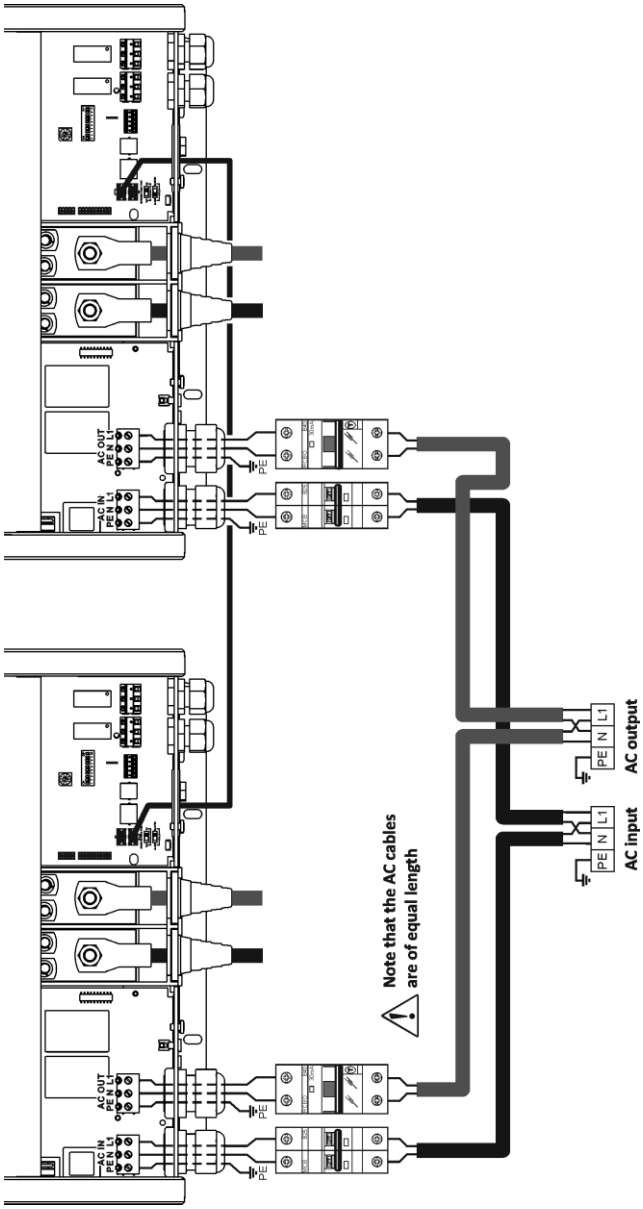
To compensate for internal resistance differences between stacked units, the resistance of the external AC wiring can play a significant role. Therefore, the following advise should be strictly followed:

1. **it is <u>not recommended</u> to over dimension the AC wiring by using excessively thick or short cables, which would reduce the overall resistance.**

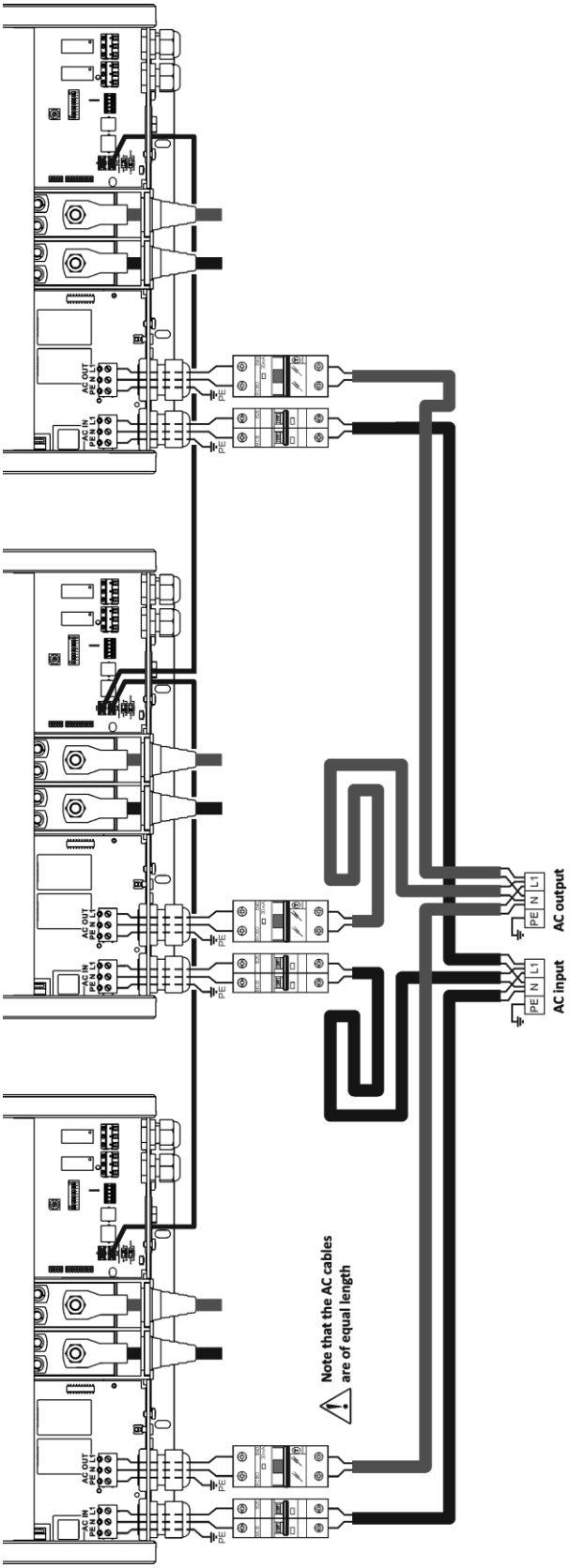
2. **Instead, use slightly <u>longer AC cables</u> than strictly necessary—ensuring equal length for each stacked unit—and <u>do not increase the conductor size</u> beyond what is prescribed by the installation guide or applicable safety standards.**

## 4.2 AC connections

Please see below an AC wiring example for a stacked system containing two Powersine Combi units.



Please see below an AC wiring example for a stacked system containing three Powersine Combi units.



## INFORMATION

- In the AC wiring example illustrations, for clarity most of the AC cable length is made before the circuit breakers. It is of course also allowed to shift the longer AC cable sections between the circuit breakers and the inverters. For example when a central AC distribution box is used. As long as all cables have matching lengths and are not too short.

- Good installation practice is to check for imbalances in the AC wiring once the complete system is running. This can be done by loading the system with at least 75% of the maximum AC output load, followed by measuring the AC output current of each stacked unit by a current clamp meter. The current readings of each unit should be very similar. When this is not the case, all AC connections need to be checked and/or modified to meet the requirements that are explained in chapter 4.1.

## WARNING

- Please take into account that when connecting multiple units in parallel, **the combined AC input is capable of drawing significantly more current from the AC supply source.** AC Input Current Limit- and Maximum Charge Current levels must be multiplied by a factor of 2 or 3, depending on the amount of units connected in parallel. So before connecting the system to the AC supply, please make sure that you have adjusted these settings in order to match the nominal AC supply capacity.

- **Please observe carefully that all stacked inverters are connected 'in-phase'.** This applies to both AC input and AC output. So all L1 (phase) and N (neutral) wires should be mutually connected without rotation/reversal. When a unit in the stacked system has a reverse connected AC input, the whole system will not accept the mains input and operate only in inverter mode. At the same time the 'AC in' LED will flash red on all devices. When a unit in the stacked system has a reverse connected AC output, the system will shut down due to an overload situation.

## 5.0 COMMISSIONING THE SYSTEM

When all stacked units are correctly installed and programmed, each unit can be switched on using the front panel switches. The units that are switched on will operate in search mode (continuously cycling orange status LEDs), until all stacked units are activated.

The stacked system can of course be switched on as well by a single remote switch that is connected only to the Master unit. For this, please make sure that DIP switch 10 of all units is set to OFF and that all front panel switches are set to position ‘I’ or ‘II’. All as explained in Owner’s Manual chapter 3.3 (DIP10) and Installation Guide step 4, note 5.

A running stacked system will furthermore behave exactly the same as a single unit installation, only with two or three times as much power capacity.

**INFORMATION**

- Please note that in a stacked system, the Automatic Standby Mode is disabled