# Commissioning Document

## Paralleling SkyBox

This commissioning document covers the proper set-up of a system with two SkyBoxes connected in parallel and applies for firmware versions 1.3.27 and greater. Parallel connection of multiple inverters is referred to as "stacking"; the combined system is referred to as a "stack". Paralleling two SkyBoxes enables system capacities of up to 10kW of power output. At this time stacks with more than two SkyBoxes are not supported. For a system power requirement that exceeds 10kW, please contact OutBack Sales.

## Theory of Operation

**Table 1 – Connected and Separate Components for Stacked Systems**

| System Component | Independent and Separate for Each Unit | Co-dependent and Connected for Each Unit |
|---|---|---|
| PV | ✓ | |
| Battery | ✓ | |
| Grid | | ✓ |
| Load | | ✓ |

A SkyBox stack operates differently when on-grid and off-grid. On-grid operation is straightforward; each unit acts independently to perform its programmed function. The master SkyBox maintains communication with the slave unit and propagates any grid setting changes. The master does not direct the operation of the slave unit. Each unit independently maintains its own battery bank and harvests power from its own PV array unless the stack is set up to limit power sold back to the grid.

In off-grid operation, the master unit controls only the AC output of the slave unit. The slave unit maintains autonomy over its solar production and battery charging. **This is the reason separate battery banks and separate solar arrays are required for each SkyBox in the stack.**

During a grid outage, the stack will power the loads on the protected loads panel by drawing power from the batteries and inverting it to produce the needed 120V/240VAC power. The master unit takes control of the output voltage and modifies the current it is sending to the loads to maintain a 120V/240VAC output. The master then communicates this value to the slave unit so it contributes to maintaining the 120V/240VAC power. If either unit is not harvesting enough PV to cover the power demanded by the loads, it will begin to discharge its battery. Once EITHER unit reaches the minimum state-of-charge (SOC) set point, the entire stack will stop providing power to the loads. The smallest of the independent battery banks determines the backup capacity for the stack.

**NOTE**: The minimum state-of-charge set point must allow enough remaining battery power to maintain SkyBox tare loss until the next solar day or until the grid returns.

Once the grid returns, the master unit will synchronize with the grid. Once the grid timer has expired, the master will close its grid relay and command the slave unit to do the same. This returns the system to on-grid operation.

# Physical Installation

This section covers the physical installation requirements and best practices for a two-unit SkyBox stack.  Only those components that are affected by stacking will be discussed.  Those that are not affected, such as PV wiring or the temperature sensor wiring, are not covered.  For specific details on mounting each SkyBox, please refer to the Quick Start Guide.

Each SkyBox should have a clear space of 6" on both sides to ensure adequate airflow for cooling and for ease of access to the Balance of System compartment (BOS).  Figure 1 represents this.
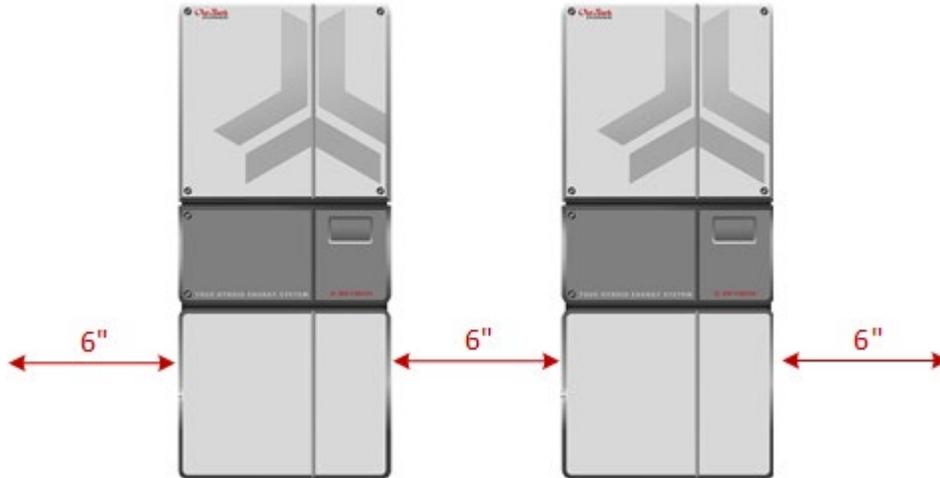


**Figure 1 – Correct spacing**

## Battery

Each SkyBox must have its own battery bank.  Units cannot share the same battery bank as each controls its own battery monitoring program.

Before mounting the Skyboxes, ensure enough room exists around each unit to accommodate its battery bank.

| ⚠ | **CAUTION:  Hazard to Equipment**<br>Each SkyBox MUST have its own, separate battery.  Damage can occur if a battery is shared. |
|---|---|
| ⚠ | **CAUTION:  Hazard to Equipment**<br>If battery banks must have different capacities, place the larger bank on the master unit.  Damage can occur if the master has a smaller capacity. |

## AC Input

Connect both units to the same AC source, whether the grid or a generator.  See Figure 11 on page 10 for further clarification.  This may require the use of a bus bar.  OutBack does not provide general specifications on the size of this bus bar as it is site-specific.

Take the appropriate safety precautions when connecting the units to the AC source.

## AC Output

Connect both units to the same AC load panel.  While off grid, the master SkyBox sets the voltage and current parameters for the slave SkyBox.  Connecting units to separate load panels can cause equipment damage.  Ensure the AC phase relationship is correct between the unit input and output for both SkyBoxes prior to applying power.

Take the appropriate safety precautions when connecting the devices to the AC load panel.

> ⚠️ **CAUTION:  Hazard to Equipment**
>
> Ensure the AC phase relationship (input and output) is correct between units prior to applying power to the stacked system.  Damage can occur if L1 and L2 are reversed.

## Rapid Shutdown Wiring

Each SkyBox requires a connection between the rapid shutdown terminals for the inverter to operate.  Connect multiple units in series using the input and output terminals in each unit.  When a rapid shutdown event occurs in a stacked system, both units will stop harvesting solar power, the power buttons will turn yellow, and event messages will be logged.
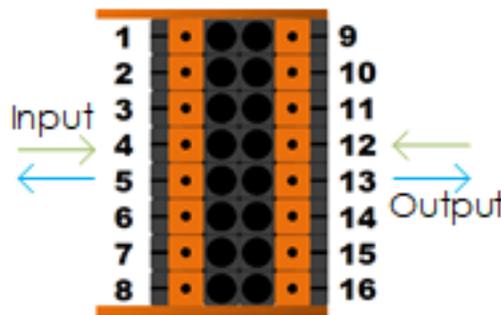


**Figure 2 – Rapid shutdown wiring**

Connect the rapid shutdown device, such as the RSD-1, to the master unit input terminals (4 and 12).  Connect the master output terminals (5 and 13) to the input terminals of the slave (4 and 12) using 18AWG wire.

If rapid shutdown is not required, connect an 18AWG jumper between terminals 4 and 12 on the master unit and do the same on the slave unit.  Failure to have continuity between terminals 4 and 12 will prevent inverter operation.

Refer to the appropriate technical documentation for details on rapid shutdown equipment.

| ⚠ | **IMPORTANT!**<br>Commission and test each individual SkyBox unit before proceeding. **The following instructions assume each unit has been tested for proper operation as a standalone unit.** Ensure grid settings are the same between units during the initial programming stage (Setup Wizard). |
|---|---|

# Communication Connections

In a stacked configuration, SkyBox units communicate with each other using standard Ethernet patch cables with a category rating of 5 or higher (CAT5 cable). Each SkyBox is equipped with two Ethernet ports, one labeled **WALL** and the other **SKYBOX**. When stacking SkyBoxes, the master SkyBox has a connection from its **WALL** port to the Internet router. To ensure a stable connection, the master unit should have a direct connection to the router. Using a bridge device may cause dropped connections.



SkyBox Port →
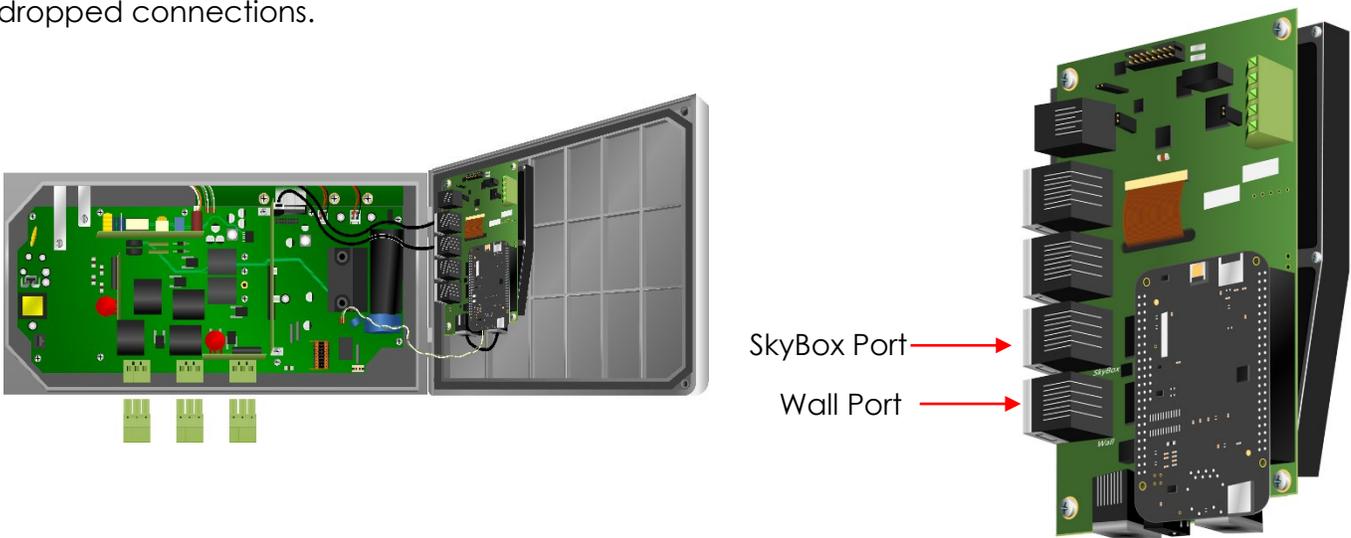
Wall Port →

**Figure 3 – Wall and SkyBox Ports**

To complete the physical connections, connect the **SKYBOX** port on the master to the **WALL** port on the slave. See Figure 5 on the next page. Route the cables through the provided channel (13). For a more detailed wiring diagram, refer to the *Quick Start Guide*.
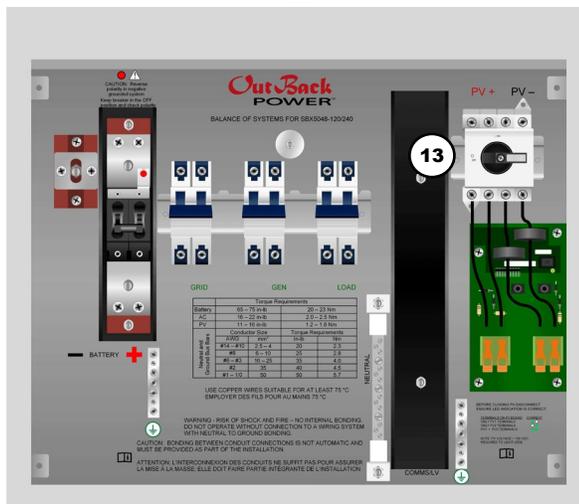


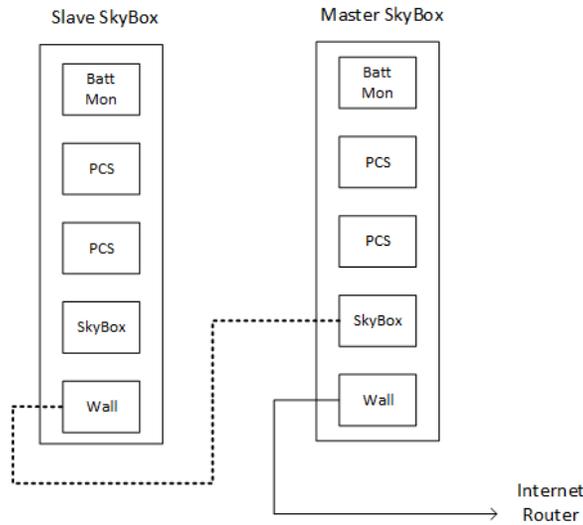**Figure 4 – SkyBox BOS with communications channel**

**Figure 5 – Ethernet connections**

# User Interface Setup

After making the physical connections and checking system voltages for the appropriate phase relationship, apply power to the entire system using the startup procedure below.

## Startup Process

If batteries are not present, start units from grid.

1. Shut battery breakers on each unit in the system, starting with the master unit.
    A. Startup from battery will take approximately 45 – 60 seconds.
2. Verify grid settings are the same between the units.

## Network Settings

SkyBox stacking requires static IP addressing in firmware version 1.3.27.  In version 1.4 and greater, static IP addressing is still preferred, but dynamic addressing is also acceptable.

Beginning with the master unit, log in as *Installer*.  Under the *Network* tab edit menu, ensure the *Ethernet Connection* toggle is on *Wall* and set *DHCP enable* to *No*.

Repeat this step on the slave unit and change the *Ethernet Connection* to *SkyBox*.

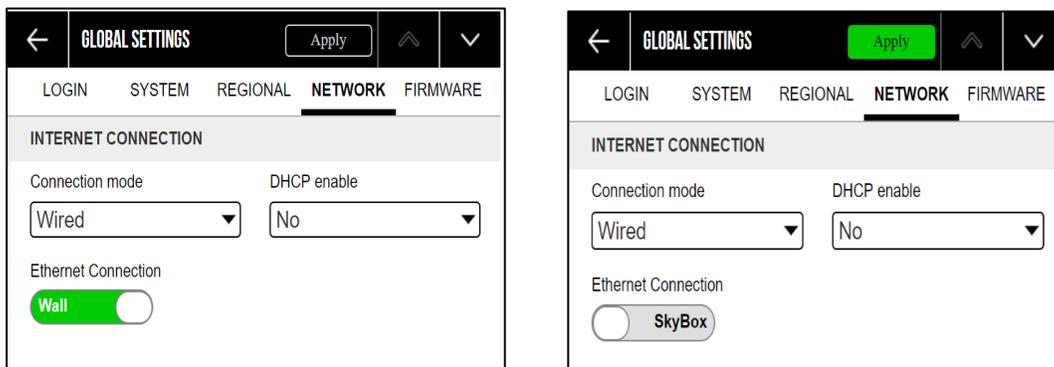**(Home screen → Settings (gear) → Login → Network → Configure → Edit)**



**Figure 6 – Ethernet connection page, master and slave unit**

1. Using the table below, record the IP address and the DNS address for the LAN side of the gateway router. Determine two unused static IP addresses used for each of the units in the stack. To learn how to do this, search "determining available static IP addresses" on the desired search engine.

**Table 2 – Local network settings**

| Information Title | Site Info | Notes |
|---|---|---|
| Gateway LAN Address | | |
| Primary DNS Address | | |
| Secondary DNS Address | | Only use if known, otherwise leave blank. |
| Available Static IP Address 1 | | For master SkyBox |
| Available Static IP Address 2 | | For slave SkyBox |
| Subnet Mask | 255.255.255.0 | Use for both units |

Next, on the master unit, arrow down once and make the following changes:

2. Change the **IP address** to the value identified in the previous step for the master SkyBox.
3. Enter the **Subnet mask, 255.255.255.0**.
4. Enter the **Gateway LAN address**.
5. Arrow down once more.
6. Enter the **Primary DNS**.
7. Tap **Apply** to save changes.
8. Repeat steps 3-7 on the slave unit, ensuring the IP address identified for the slave SkyBox is used.

**NOTE:** The screens shown below are for reference only. The values will vary from site to site.
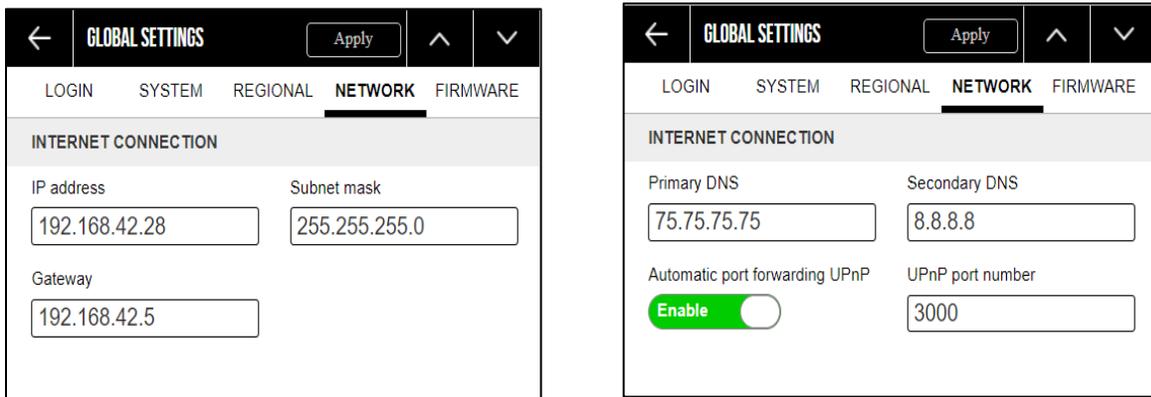


**Figure 7 – IP Address and DNS Menus**

## Parallel Settings

After completing the network settings, navigate to the home screen on the master and tap the SkyBox icon. On the **Configure** menu screen labeled **PARALLEL SETTINGS**, change the **Units Installed** number to the appropriate value (2). Enable the **Endpoint Termination**. These settings tell the system how many units are in the stack and which units will start and end communications.

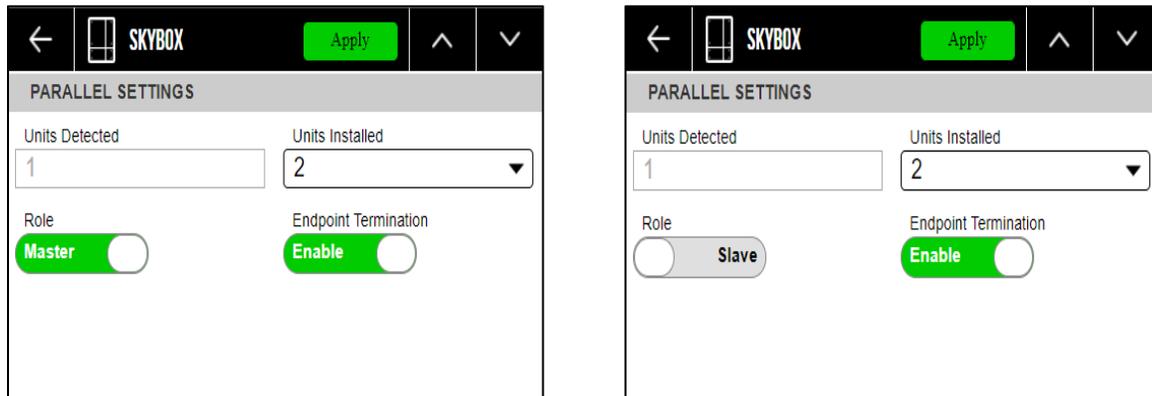**(Home screen → SkyBox icon → Configure → Edit → Arrow down twice)**



**Figure 8 – Parallel settings for a master unit and a slave unit**

Next, move to the slave unit. Log in as **Installer**. Change the **Ethernet Connection** toggle to **SkyBox**. Change the **Units Installed** to the appropriate value (2). Enable the **Endpoint Termination**.

# Full System Start-Up

To align the new settings between the SkyBoxes, completely power down the system by opening all breakers. Proceed through the following steps to re-start the system.

If batteries are not present, start units from grid.

1. Shut battery breakers on each unit in the system, starting with the master.
   a. Startup from battery should take approximately 45 seconds to 1 minute.
2. Check that **Units Installed** matches **Units Detected.**
   a. Login as **Installer**
   b. Return to home screen
   c. Tap SkyBox icon in the upper right section of the screen
   d. Tap **Configure**
   e. Arrow down twice
   f. If **Units Detected** equals the **Units Installed** proceed to Step 3.
   g. If these values are different, check the communications cables for proper seating. Cycle power to the affected unit.
3. Shut the grid breakers to each unit.
4. Using the power button, turn the system on from the master UI.
5. Shut the PV disconnects to each unit.

# (Optional) Advanced Generator Start

For a stack, only the master controls the generator through advanced generator start (AGS). Connect the generator start circuit to the auxiliary dry contacts (7 and 15) or the 12V contacts (8 and 16) on the master auxiliary terminal. Enable and program AGS on the master SkyBox only.

# (Optional) External CT

If using external current transducers (CT), connect them to the master unit. Enable this function on the master SkyBox only.

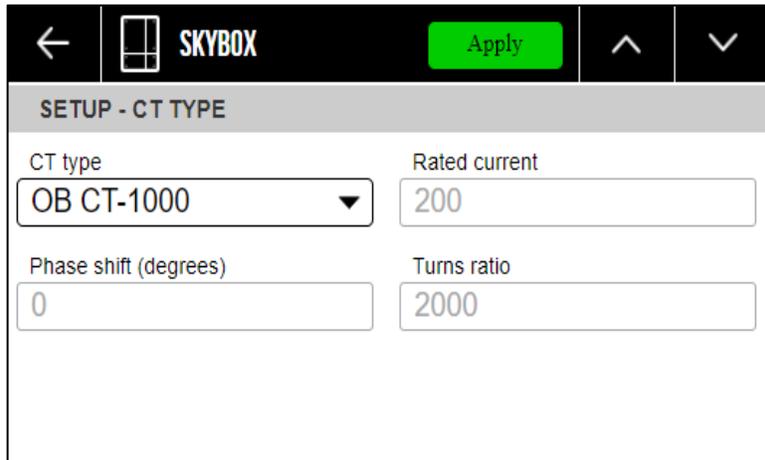**(Home screen → SkyBox icon → Configure → Edit → arrow down once)**



**Figure 9 – XCT setup menu**

Enabling this function causes the master SkyBox display to show the total grid demand seen at the external CT location. This measurement is used to calculate the **Total Combined Load** value that is displayed on the master SkyBox **LOAD** tile. Under the load tile, protected and unprotected load values are shown (Figure 10).
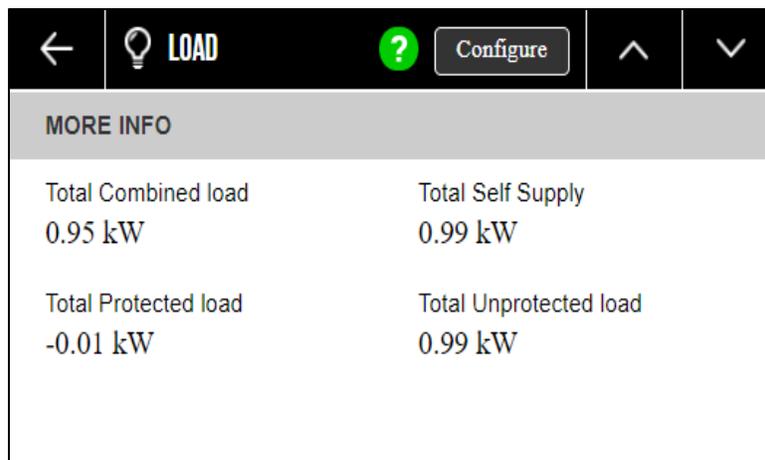


**Figure 10 – Protected and unprotected loads**

# (Optional) OPTICS RE Integration

OPTICS RE provides the means to remotely monitor and operate a SkyBox stack. Integrate the stack as one *Site*. Register each SkyBox in the stack as a separate *System* within the *Site*. Individual SkyBoxes will be posted under the respective *Device Map*.

A video tutorial for integrating multiple OPTICS RE sites can be found on the WattSchool YouTube channel (How to: Aggregate Multiple OpticsRE Sites).

# Frequently Asked Questions and Basic Troubleshooting

Q. Why will units not turn on via master UI power button?

A. Check **Units Installed** vs. **Units Detected**. See Parallel Settings.

A. If off-grid, a battery bank may be at or below minimum SOC.

Q. Do all units need a separate battery bank?

A. Yes, each unit requires a separate battery bank.

Q. Version Match Verification Failure

A. This notification will appear when the firmware versions do not match between all units in the system. This notification will also appear when updating the units to a new firmware version.

Q. Can two non-stacked systems share the same network connection point (router)?

A. No, stacked systems must be on their own separate networks. Multiple stacks on the same network will detect each other causing an error in the **Units Installed** versus **Units Detected**.

Q. Why is there a rapid shutdown alert when commissioning the SkyBox?

A. To operate, the SkyBox requires a closed circuit on the aux terminal pins 4 and 12. Check these pins on both SkyBoxes. For more information, an article is available in the OutBack Power Knowledge Base.

Q. What is an $I_{ref}$ error and why is it appearing?

A. An $I_{ref}$ error will appear when the slave SkyBox does not receive the reference current level from the master. Check all communications cables and settings for proper setup.
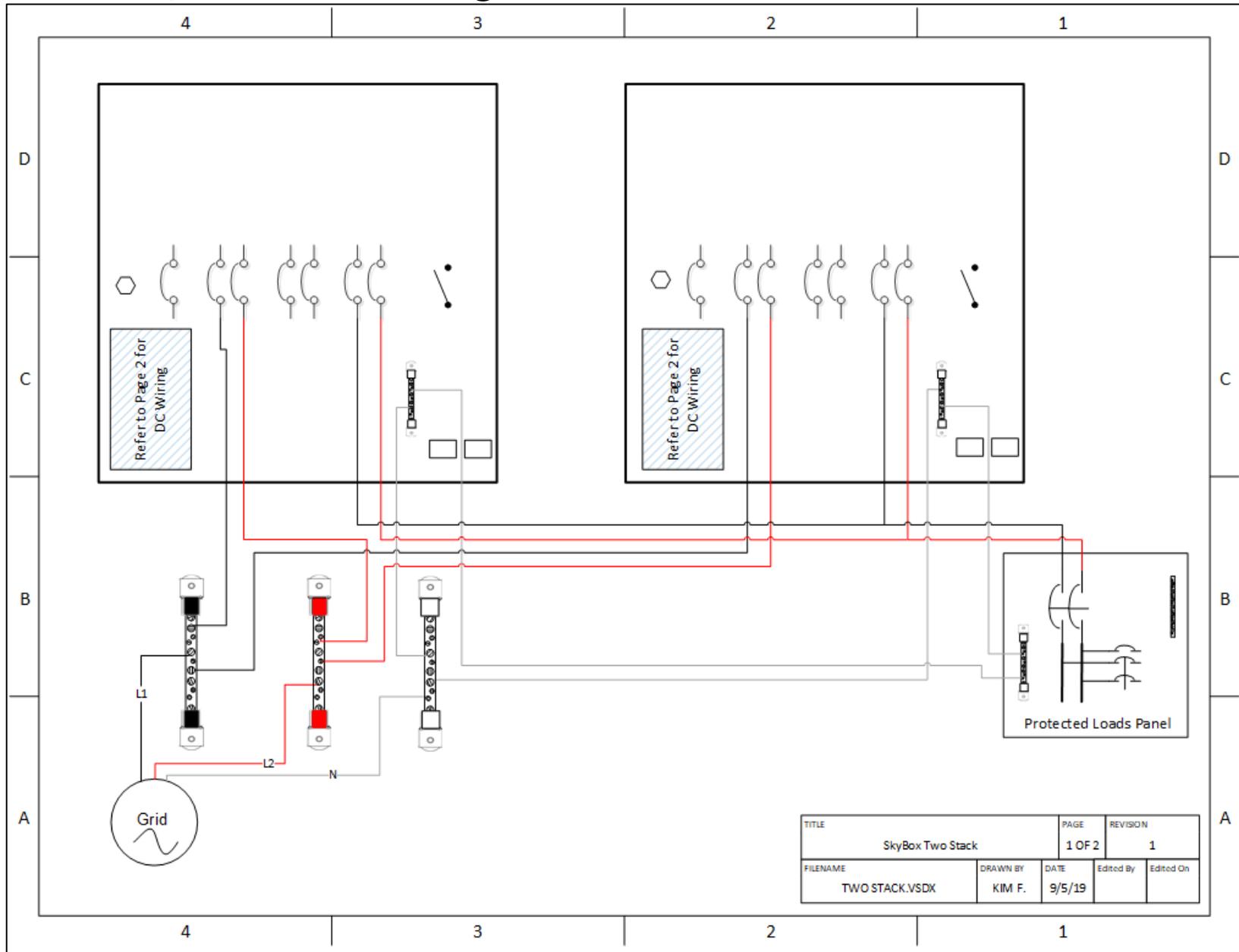
**Figure 11 – AC wiring of two SkyBoxes**

Within the figure:

Refer to Page 2 for DC Wiring

Refer to Page 2 for DC Wiring

Grid

L1

L2

N

Protected Loads Panel

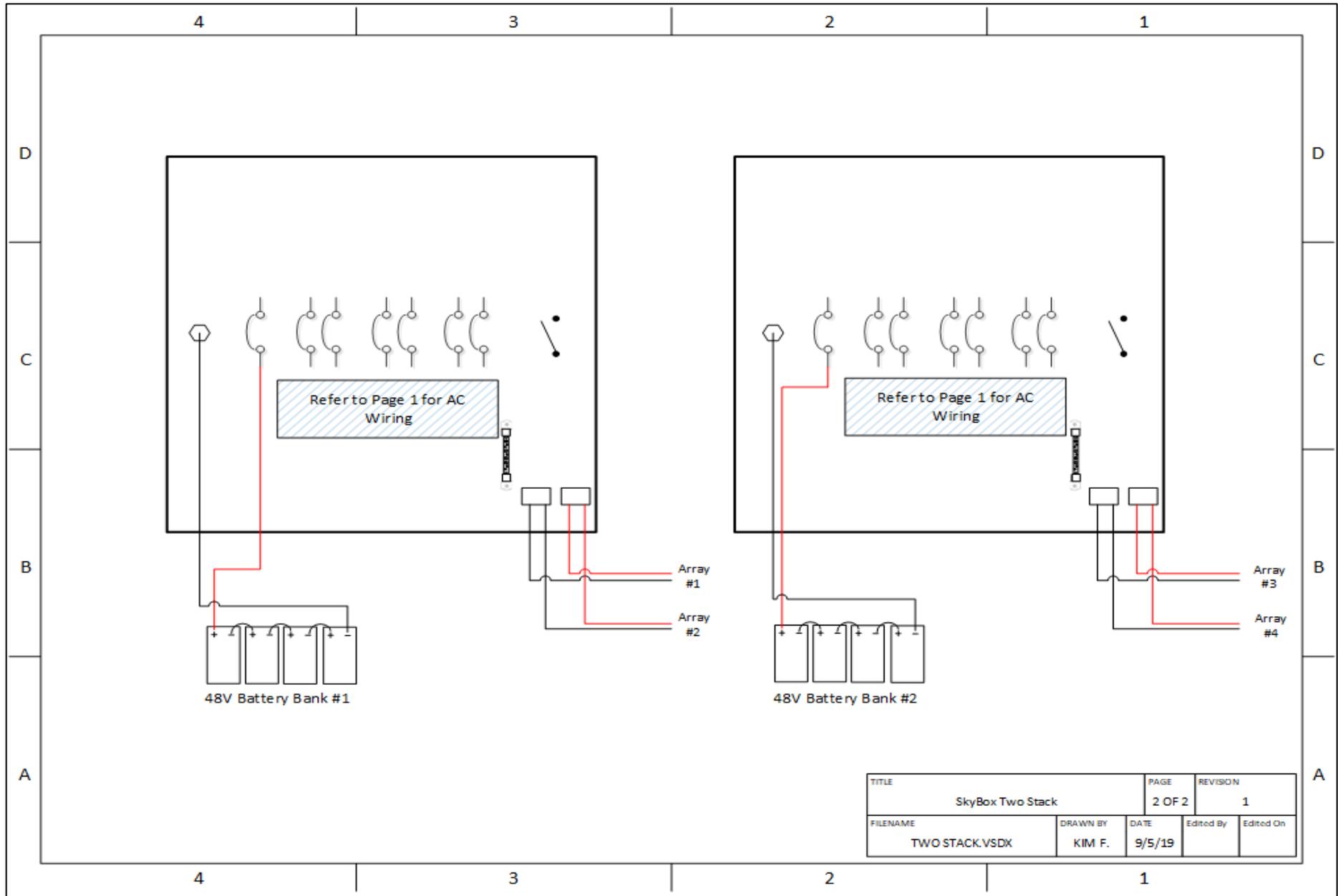| TITLE | | PAGE | REVISION |
|---|---|---|---|
| SkyBox Two Stack | | 1 OF 2 | 1 |
| FILENAME | DRAWN BY | DATE | Edited By / Edited On |
| TWO STACK.VSDX | KIM F. | 9/5/19 | |

**Figure 12 – DC wiring of two SkyBoxes**

## About OutBack Power

OutBack Power is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, batteries, accessories, and assembled systems.

## Contact Information

| | |
|---|---|
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## Other

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