Off-Grid/Stationary Syllabus

with Discover Batteries

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Introduction

Welcome to Victron's Off-Grid Training! We're happy you took the time to come today and invest time into improving your professional abilities.

Over the course of this 2 ½ - Day Training event, you will work in small teams to construct, commission, and program an Off-Grid Stationary power system. You will mount components, wire, program, commission, troubleshoot and work on advanced programming challenges. More importantly, you'll have time to see the other systems you did not get a chance to build.

We are here not just to review how to construct a single system, but by comparing functionalities between several systems, we will also learn how to think about customer needs and translate those into the best possible system. We are learning to customize a system that meets the unique needs of the customer in the most compact and efficient form possible. During the programming section, there are many ways to accomplish something. Please brainstorm to find the best method. We can only teach you so much - your best teachers are each other.

The design of these systems is based around the common NA 120/240 Split Phase configuration. A prefabricated mounting board is provided at each workstation to mount the components with machine screws. All components are provided in the black containers along with pre-cut and crimped wires within stuff-sacks, and tools within the tool bags. Each tool kit has a list of what's inside, and each syllabus has a list of equipment you will use.

This training manual will outline the equipment/tools supplied along with the various steps. The attendees should take time to build, program, and test the systems. Please follow the syllabus step by step. Participants must stop prior to turning the system on to have a Victron Trainer check over your work. Trainers should not be overly relied on - the goal is to leave with the ability to construct and program a system on your own. However, they can assist as needed. Please also refer to the wire diagram and individual component manuals. You should not rush. Instead, make sure each team member participates in each task so everyone gets the chance to learn. There is plenty of time for everyone to finish.

These systems are designed purely for training purposes. They should NOT be replicated.

For example, the battery bank size may be too small for dual Quattro/MultiPlus II installations. You may also notice that certain components like breakers and wire sizes do not match the size shown in the wire diagram. This is due to lack of availability.

We assume - and expect - that you already understand basic safety precautions of working with AC and DC electrical systems. Be careful not to short any circuits with your wrench. This makes the use of fuses, breakers, and careful order of wire connections even more pertinent. The battery positive wire should be the last connection made.

Keep a clean and organized work station. Damaged, broken, or missing components can demonstrate a lack of professionalism and can prevent your team from finishing the system. Careful when unpacking - at the end of the training, you will pack down the kits and components exactly as they came. Use the dry erase marker to check off each component on the laminated list for each portion of the kits as you pack your stuff away. A trainer will inspect your kit before it can be returned to the trailer.

Tools, Equipment, Supplies, and Materials

Units	*Victron Components*	
2	Quattro 48V/5000 or Quattro 48V/3000 120V VE.Bus or Multi II 3000 48V UL	☐
1	VE Panel 3kVA or 5kVA or VEP II Primary	☐
1	VE Panel 3kVA or 5kVA or VEP II Follower	☐
1	Lynx Power IN	☐
1	Cerbo GX S	☐
1	GX Touch 70	☐
1	GX Touch 70 Wall Mount	☐
1	Smart Solar MPPT 250/60-Tr	☐
1	MK3 to USB Adapter	☐
1	VE Direct Cable	☐
4	UTP/RJ45 Cables (of varying lengths)	☐

Units	*Non Victron Components*	☐
1	RUVI temp sensor	☐
1	60A MPPT PV input breaker	☐
1	60A MPPT Battery output breaker	☐
1	AC Input Pig Tail	☐
1	AC Output Pig Tail	☐
1	MNS PV Combiner	☐
2	15 Amp Circuit Breakers	☐
1	Discover Lynk II Gateway	☐
3	Discover Batteries (DL Pro or RackMount)	☐

Training Process

- Step 1: Review components / wires / tools
- Step 2: Prepare/Mount VE Panels, Quattro/MultiPlus II Units (Inverter/Chargers)
- Step 3: Mount Remaining Components
- Step 4: Install and Wire MPPT/VE Panel Sub-Components
- Step 5: Wire Quattro/MultiPlus II/VEP AC Connections
- Step 6: Install Network Devices and Cables and Program Lynx II
- Step 7: Install Battery Connections
- Step 8: Wire Management
- Step 9: Commission
- Step 10: Configure Multiple Inverter/Chargers in 120V/240V Split Phase
- Step 11: Program MPPT
- Step 12: Program Victron Closed Loop Configuration/Program Lynk II Gateway
- Step 13: Post-Commissioning Checks
- Step 14: Efficiency Calculation
- Step 15: Swap Stations
- Step 16: Decommissioning

Step 1: Review components / wires / tools

- **Steps:**

1.	Place necessary components on board in approximate locations of their labels. Not all components will be used.	☐
2.	Remove wires from bag. Place into a location which gives you room to spread them out and view their labels. Possibly not all wires will be used.	☐
3.	Identify all tools available. If you feel there are any tools that would benefit you further, please let a trainer know.	☐

Step 2: Prepare/Mount VE Panels and Quattro/MultiPlus II Units

- **Steps:**

1.	Prior to mounting Inverter/Chargers and VE panels, remove face plates and fan shrouds (if installed).	☐
2.	Mount VE Panels and Inverter/Chargers. • Note-Only hand tighten	☐
3.	Attach equipment ground to equipment grounding stud located located on lower right side of Quattro frame on Labs 1 - 4 - Torque to 14N-m/124 Inch Pounds.	☐

Step 3: Mount Remaining Components

- **Steps:**

1.	Mount all remaining components to board.	☐

Step 4: Install/Wire MPPT/VE Panel Sub-Components

- **Steps: For all below connections, use torque specs located in VE Panel manual section 4.2**

1.	Install (2) 15A MPPT DIN rail breakers in PV3 combiner box	☐
2.	Install (2) 60A MPPT PV DIN rail breakers in Follower VEP	☐
3.	Install MPPT (+) PV conductor from breaker busbar in PV3 combiner to (+) PV busbar in VEP Follower	☐
4.	Install MPPT (+) PV conductor from (+) busbar in VEP Follower to bottom of 60A MPPT PV breaker	☐
5.	Install MPPT (+) PV conductor from top of 60A breaker to (+) PV terminal on MPPT	☐
6.	Install MPPT(-) PV conductor from (-) busbar in PV3 combiner to (-) PV busbar in VEP Follower	☐
7.	Install MPPT(-) PV conductor from (-) busbar in VEP Follower to (-) PV terminal in MPPT	☐
8.	Install (+) battery conductor from (+) battery busbar in VEP Follower to the bottom of the 60A MPPT battery breaker	☐
9.	Install (+) battery conductor from top of 60A breaker to (+) battery terminal in MPPT	☐
10.	Install (-) battery conductor from the (-) busbar attached to the top of the shunt in VEP Follower to the (-) battery terminal of the MPPT	☐

Step 5: Wire Quattro/MultiPlus II/VEP AC Connections

- **Steps:**

For all below connections, use torque specs located in VE Panel manual section 4.2

1.	Install AC In and AC Out conductors (labeled lines), and neutrals from both Primary and Follower VE-Panels into Inverter/Chargers. • Neutral to Ground bond is internally bonded in the Inverter/Charger through a relay (for Mobile) but the diagram shows the Neutral to Ground Bond made in the Primary VEP. We will not install this bond for the training.	☐
2.	Torque all AC terminals in Inverter/Charger. (See VEP Manual)	☐
3.	Install L2 INPUT and L2 OUTPUT conductors between VEPs	☐
4.	Install conductors between Ground and Neutral busbars between Primary and Follower VEPs	☐
5.	Install AC IN pigtail into the AC IN L1, Ground and Neutral Busbars in Primary VEP	☐
6.	Install AC OUT pigtail into the AC Out L1, Ground and Neutral Busbars in Primary VEP	☐
7.	Verify all VEP breakers are in OFF position	☐

Step 6: Install Network Devices and Cables and Program Lynk II Gateway

- **Steps:**

  For Lynk II Gateway programming see and Pin Configurations see Discover Lynk II/Victron Manual Section 4.0 and use the Lynk Access Program

	LYNX II GATEWAY	☐
1.	Configure Jumpers in Lynk II Gateway page 10	☐
2.	Program Lynk II Gateway Section 6.2	☐

	CERBO GX	☐
1.	Install power conductors for the Cerbo on the battery positive and negative battery busbars located in the Follower VEP.	☐
2.	Connect USB and HDMI from the Touch 70 to the Cerbo.	☐

	NETWORK CABLES	☐
1.	Install UTP/RJ45 cable from VE.Bus port on Cerbo to the Follower Inverter/Charger VE Bus ports.	☐
2.	Install UTP/RJ45 VE Bus cable between Follower and Primary Inverter/Chargers.	☐
3.	Install VE.Direct cable between Cerbo and MPPT.	☐
4.	Install AES Bus cable between all batteries	☐
5.	Install AES Bus cable to AES port on Link II	☐
6.	Install UTP/RJ45 from CAN port on Link II to CAN Bus port on Cerbo	☐
7.	Install UTP/RJ45 terminator on remaining/empty CAN Bus port on Cerbo	☐
8.	If required Install UTP/RJ45 terminator on first RackMount Battery	☐
9.	**Stop to discuss: Do we need to terminate any other network connections?**	☐

Step 7: Install Battery Connections (DL Pro Batteries)

- **Steps:**

  (Verify all Breakers and batteries are in the OFF position)

  (For all below connections, use torque specs located in VE Panel Manual section 4.2 and DL Pro Manual

	BATTERY HOME RUNS AND FUSING	☐
1.	Install VE-Panel to Inverter/Charger battery/inverter conductors. Torque.	☐
2.	Install Negative battery cables from Negative battery terminals to the Lynx Power In. Torque.	☐
3.	Install Negative battery cables from Lynx Power IN to the Primary and Follower shunts in VEPs. Torque.	☐
4.	Install Positive battery fuse assembly to battery. Torque	☐
5.	Install Positive battery cable to each battery fuse assembly and torque to 75 in-lb (8.47 Nm) then to the Lynx Power IN. Torque to 14N-m/124 Inch Pounds.	☐
6.	Install Positive battery cables from Lynx Power IN to the Primary and Follower Inverter/Charger Breakers in VEPs. Torque (125A Inverter/Charger breaker torque in VEPII is 30 In-Lbs (3.4NM)	☐
7.	Install VEP covers. Remove PV breaker knock outs if needed	☐
8.	**Stop to discuss: The specification for this is 24.9N-m/18 ft-lbs. Why do we multiply by 1.1?**	☐

Step 7: Install Battery Connections (RackMount Batteries)

- **Steps:**

  (Verify all Breakers and batteries are in the OFF position)

  (For all below connections, use torque specs located in VE Panel Manual section 4.2 and Discover Battery Combiner Manual

	BATTERY AND BATTERY COMBINER WIRING	☐
1.	Install VE-Panel to Inverter/Charger battery/inverter Positive and Negative conductors. Torque.	☐
2.	Install all Positive and Negative battery conductors to Battery Combiner	☐
3.	Install Negative battery cable from Battery Combiner to Negative battery terminal in the Lynx Power In. Torque to 14N-m/124 Inch Pounds.	☐
4.	Install Negative battery cables from Lynx Power IN to the Primary and Follower shunts in VEPs. Torque.	☐
5.	Install Positive battery cable from Battery Combiner to Positive battery terminal in the Lynx Power IN. Torque to 14N-m/124 Inch Pounds.	☐
6.	Install Positive battery cables from Lynx Power IN to the Primary and Follower Inverter/Charger Breakers in VEPs. Torque (125A Inverter/Charger breaker torque in VEPII is 30 In-Lbs (3.4NM)	☐
7.	Install VEP covers. Remove PV breaker knock outs if needed	☐
8.	**Stop to discuss: The specification for this is 24.9N-m/220 in-lbs. Why do we multiply by 1.1?**	☐

Step 8: Wire Management

- **Steps:**

1.	Using clamps, mount them to unused holes to manage wires.	☐
2.	Using zip ties, neaten any remaining wiring.	☐
3.	Check All Connections	☐
4.	Replace VEP covers and remove knock outs if needed	☐
5.	Discuss other wire management to include conduit and guttering options that would be used in the field.	☐

Temporary Decommission

Only to be completed if temporary decommission is needed at any point during the training

- **Steps:**

1.	VERIFY ALL BREAKERS ARE OFF	☐
2.	Disconnect Positive battery cable(s)	☐
3.	Disconnect Negative battery cable(s)	☐

	ORGANIZE WORK STATION	☐
1.	Place all tools back into tool kits	☐
2.	Place any loose components or supplies back into the black container	☐
3.	Place any extra wires back into the stuff sacks.	☐

Step 9: Commission

- **Steps:**

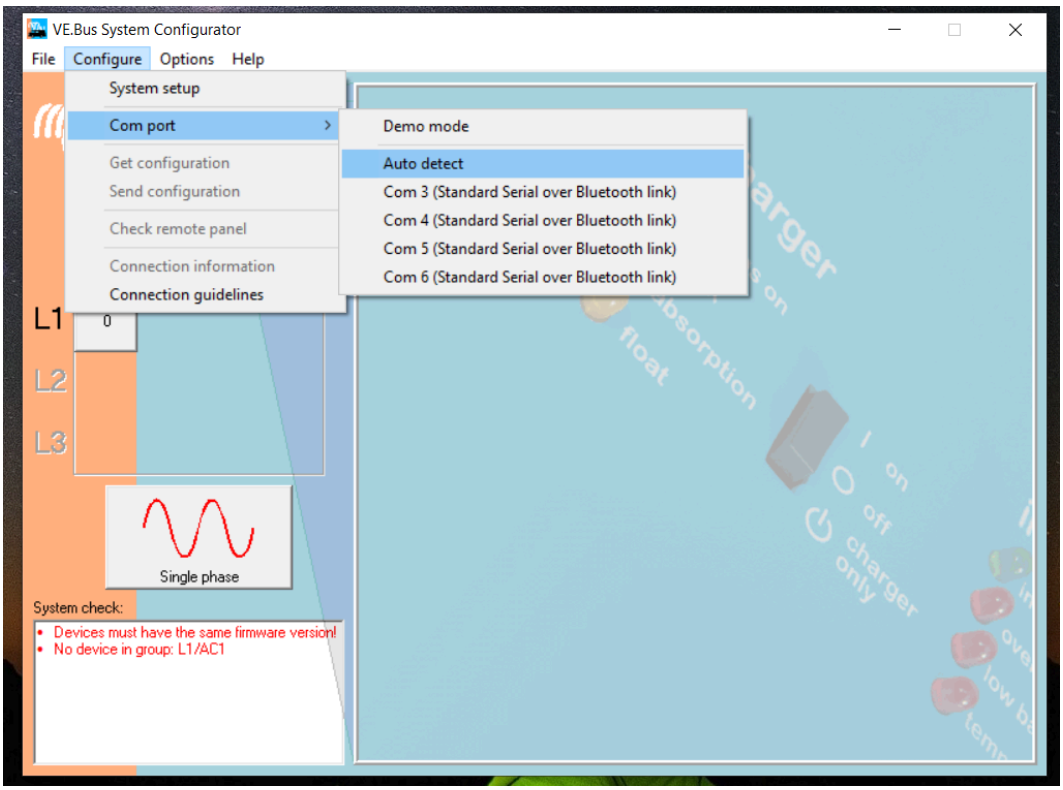
1.	Remove VEP cover.	☐
2.	Re-install battery cables at battery terminal or battery combiner home runs if needed	☐
3.	Turn ON batteries	☐
4.	Check battery voltage/polarity.	☐
5.	Turn OFF batteries	☐
6.	Re-install VEP covers	☐
7.	Turn ON batteries	☐

Step 10: Configure Inverters in 120/240V Split Phase

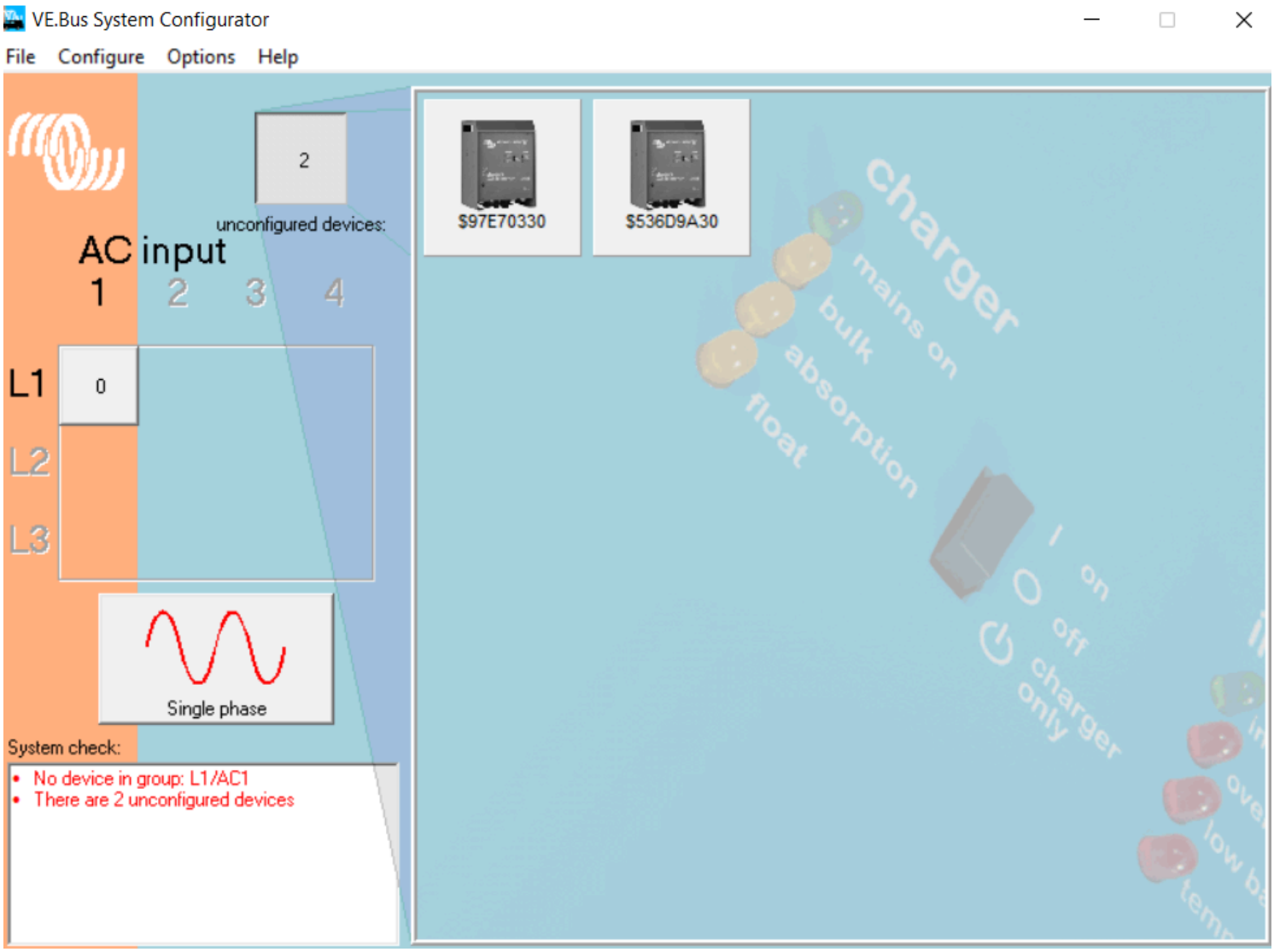
- **Steps:**

	USING VICTRON CONNECT TO UPDATE FW	☐
1.	Download Victron Connect App to your computer.	☐
2.	Disconnect UTP/RJ45 cable from Cerbo	☐
3.	Connect a single inverter's UTP/RJ45 cable to the MK3 to USB device. Connect the USB from the MK3 to USB port on your computer.	☐
4.	Turn on this Inverter/Charger using the 250A breaker.	☐
5.	Turn on the Inverter/Charger you are connected to using the on/off switch on it's face.	☐
6.	Open your Victron Connect App and go to the "local" tab. Click on the MultiPlus.	☐
7.	Click on the settings cog then click "enable settings".	☐
8.	Enter password "zzz" when prompted.	☐
9.	Click the 3 dots in the upper right hand corner of the screen.	☐
10.	Click "product info", then "update" if a firmware update is available.	☐
11.	Turn off switch on face and breaker. Disconnect this Inverter/Charger's UTP/RJ45. Connect the other. Repeat process so both Inverter/Chargers have same FW version.	☐
12.	Verify both Inverter/Chargers are OFF.	☐
13.	Re-install UTP/RJ45 cables found in Step 6 (Network Cables) #1 & #2	☐

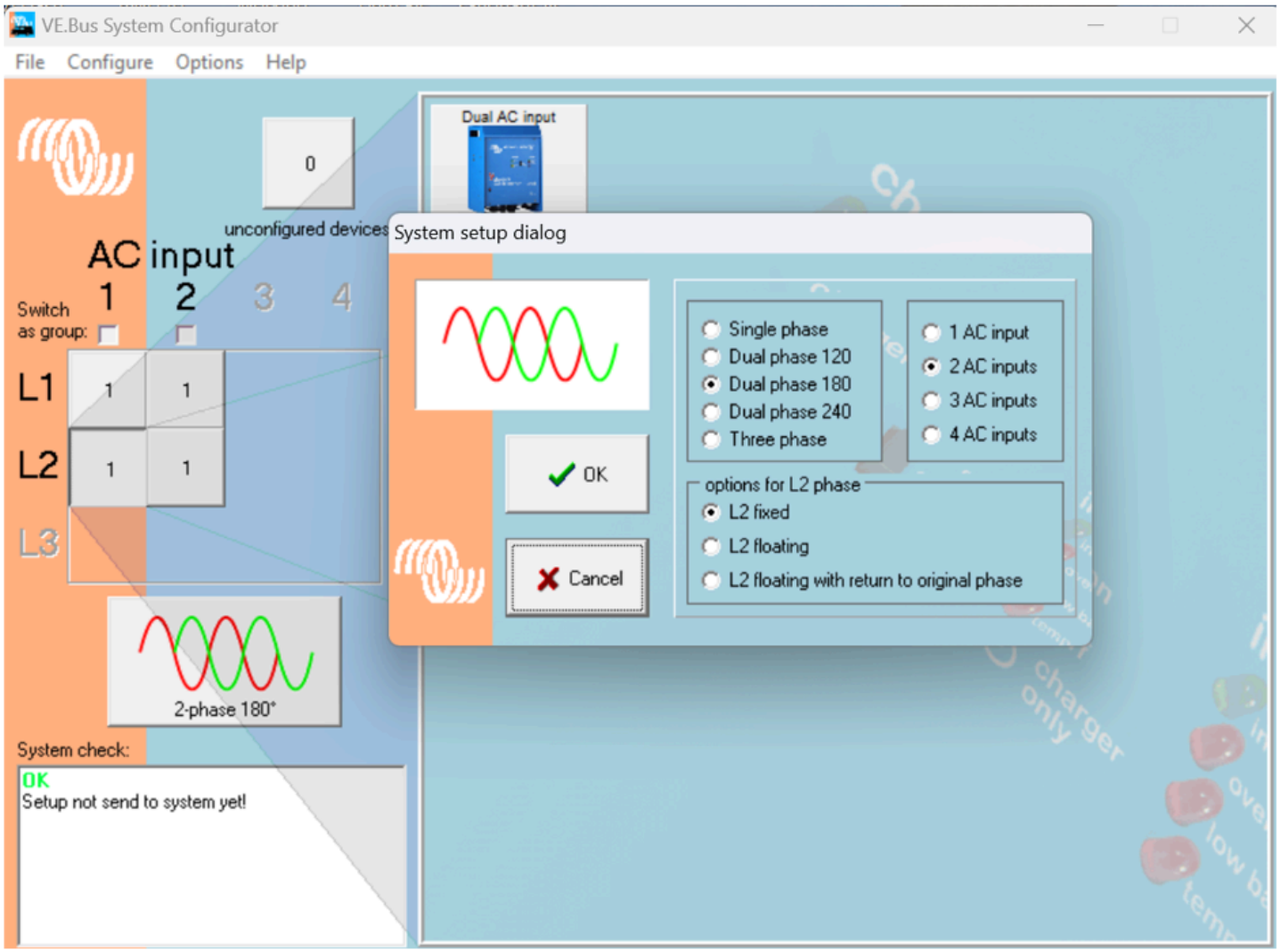
	USING VE.BUS SYTEM CONFIGURATOR *(PC ONLY OR PC EMULATOR ON MAC)*	☐
1.	Turn on all inverter/charger units simultaneously, or in close succession	☐
2.	Connect MK3-USB adapter to the VE. Bus port (select any) of the Follower Inverter/Charger to your computer.	☐
3.	Connect inverter/chargers with each other using a manufactured UTP/RJ45 cable and the VE. Bus port.	☐
4.	Ensure there are no other accessories connected to the inverter/chargers (including Digital Multi Control, Cerbo GX, VE. Bus Smart Dongle, VE. Bus BMS)	☐
5.	Download VE. Configuration Tools here. [VE Configuration Tools]	☐
6.	When prompted to “Select All Additional Tasks”, check all boxes and install.	☐
7.	Open VE. Configuration Tools folder and select VE. Bus System Configurator.	☐
8.	Once program is open, navigate to VE Configure > Com Port > Auto Detect	☐



9.	Run Auto Detect, and you should see the Inverter/Chargers populate in the main screen	☐

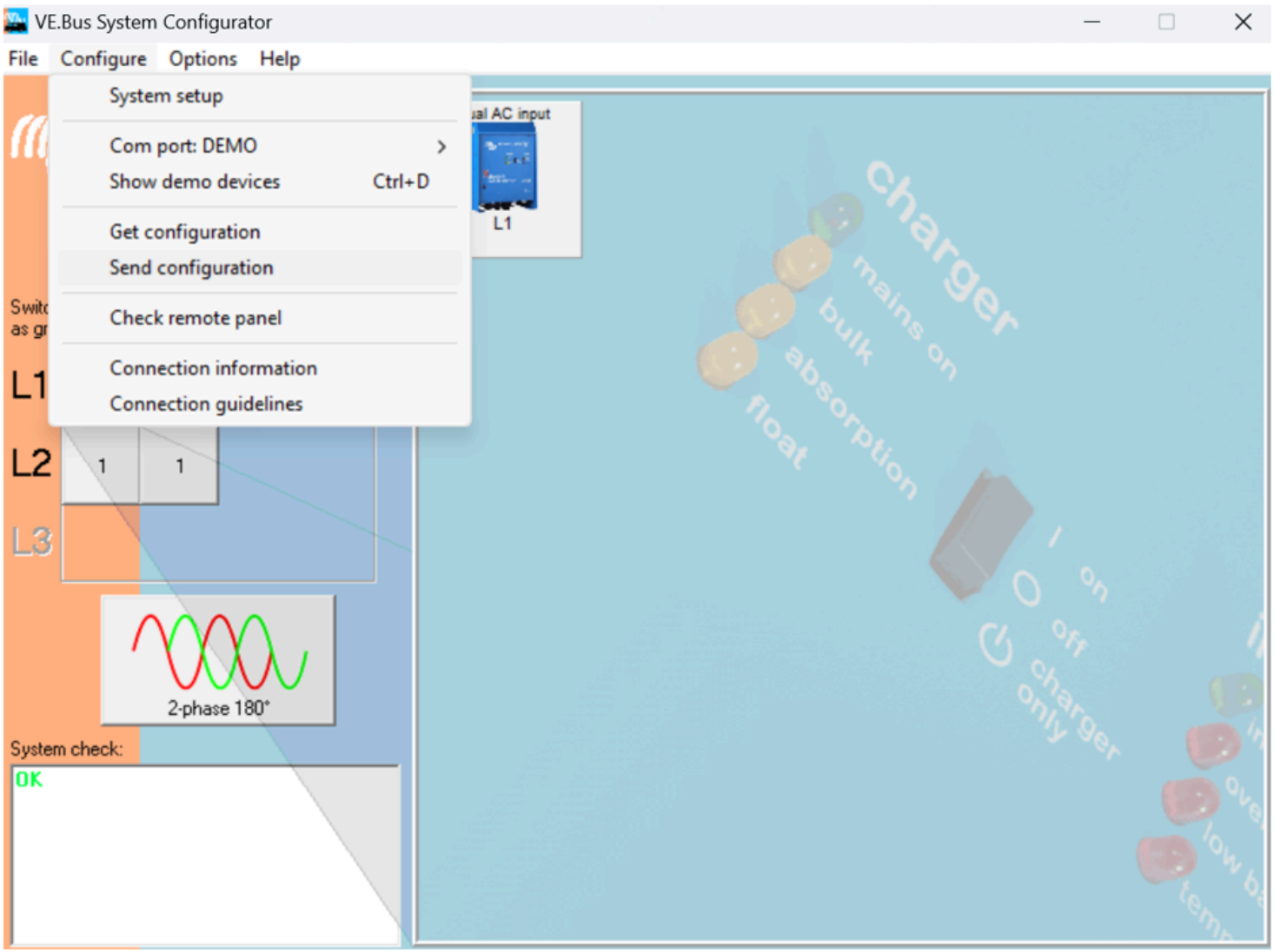


10.	Select the box that says “Single Phase” by default, and change the following settings:	☐

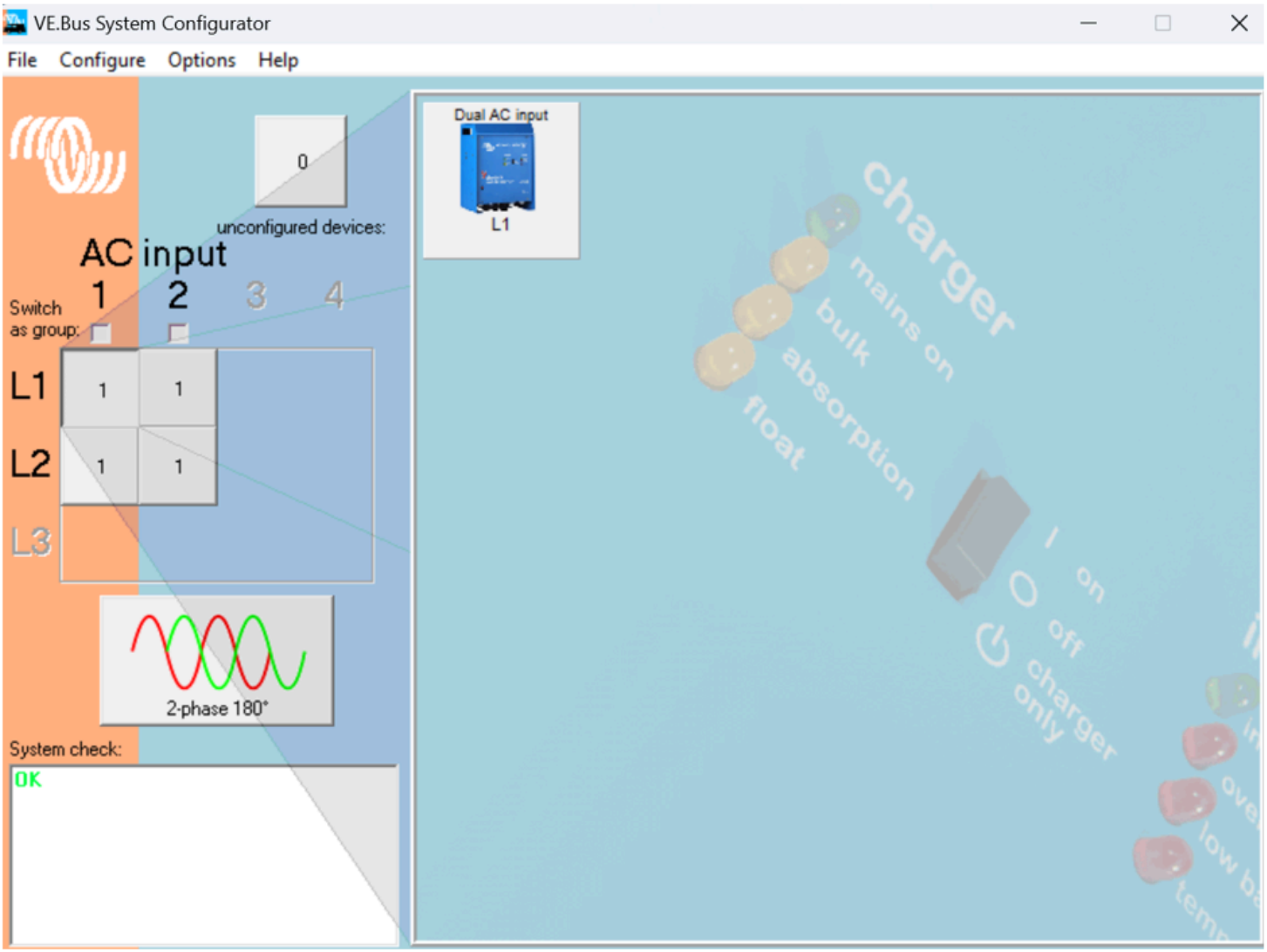


11.	Drag and drop the Primary Inverter/Charger icon into the gray box directly to the right of “**L1**”	☐
12.	Drag and drop the Follower Inverter/Charger icon into the gray box directly to the right of “**L2**”	☐
13.	Deselect “Switch as group”	☐

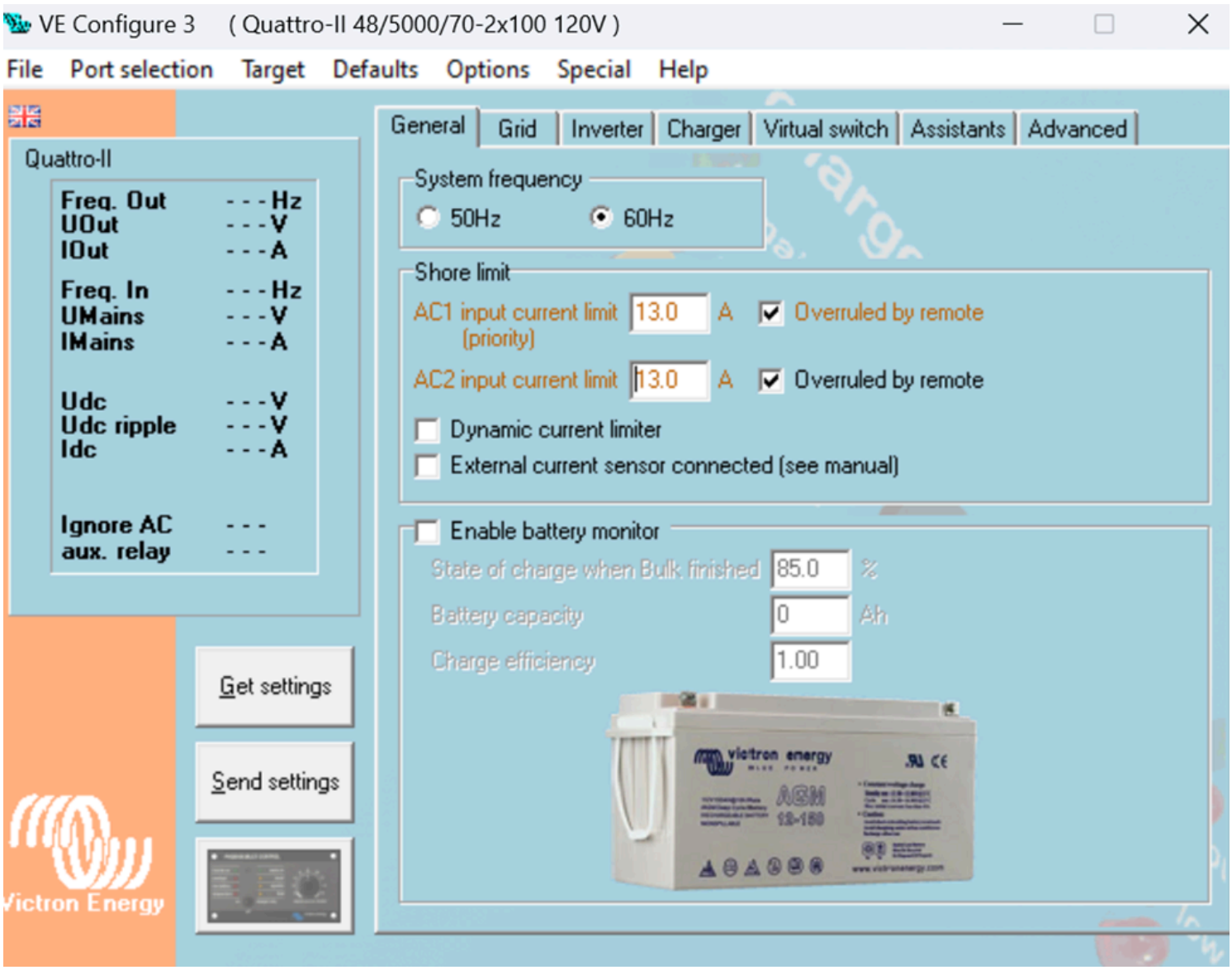
14.	**Stop to discuss: why must we disable “switch as group”? In what systems/applications would we skip this step?**	☐
15.	Navigate to Configure > Send Configuration	☐



***Note**: Before your system is fully operational, you'll still need to program these units. Right click each Inverter/Charger and select **"VE. Configure"** to proceed with programming. Further instructions below.*



16.	Follow instructions in Discover Lynk II/Victron Manual Section 6.1.	☐
17.	When prompted in the “General” tab, set AC INPUT Current to 13A for 5Ks or 8A for 3Ks.	☐



Step 11: Program MPPT

- **Steps:**

	VICTRON MPPT/DISCOVER BATTERY PROGRAMMING	
1.	Turn On MPPT 60A Battery Breaker	☐
2.	Within the Victron Connect application tap on the settings icon at the top right corner	☐
3.	Update Firmware	☐
4.	Tap The Battery Category	☐
5.	Follow instructions below or refer to Discover Lynk II/Victron Manual Section 6.1.2	☐

Step 12: Programming Victron Closed-Loop Configuration

- **Steps:**

1.	Follow steps in Discover Lynk II/Victron Manual Section 6.3	☐

Step 13: Post-Commissioning Checks

- **Steps:**

1.	Check voltages L1 to L2, L1 to N, L2 to N.	☐
2.	Check voltage at battery terminals while powering a heavy load. Make sure it matches readings from GX Touch Screen within reason.	☐
3.	Connect system to shore power. Check AC In voltages.	☐

Step 14: Efficiency Calculation

- **Steps:**

1.	While powering a load, take measurements and calculate the amount of power being dissipated across the battery to inverter wires.	☐

Step 15: Swap Stations

- **Steps:**

1.	Move clockwise to a new station	☐
2.	Discuss the differences in the system. When might this be a better fit for your customer?	☐
3.	Repeat every 20 minutes.	☐

Step 16: Decommissioning

- **Steps:**

	RESETTING AND POWERING DOWN SYSTEM	☐
1.	Reset all devices to factory defaults.	☐
2.	Turn OFF AC in/out breakers and unplug extension cord.	☐
3.	Turn OFF Inverter/Chargers using rocker switch on face	☐
4.	Turn OFF all Breakers	☐
5.	Switch OFF all Batteries	☐
6.	Remove all cables that were installed during training	☐
7.	Organize work station: • Inventory and place all tools back into tool kits. • Inventory and place all components back into the black container. • Inventory and place all cables and conductors back into stuff sacks.	☐