Parallel, split- and three-phase VE.Bus systems

This manual explains the details of designing, installing and configuring three-phase and parallel systems. It applies to components that use VE.Bus, for example, MultiPlus, Quattro and some larger VE.Bus inverters.

IMPORTANT:

- Always update all units to the latest firmware version during commissioning of the system: (firmware update instructions).
- Note that some parts of the description below apply only to firmware version 400 and later.
- All units in one system must be the same type and firmware version; this includes same size, system voltage, and feature set. The type is indicated by the first four digits of the firmware version number. For details, see the “VE.Bus Firmware Numbering System” section in the VE.Bus Firmware versions explained document.
- Specify with your Victron distributor that you will be connecting units in parallel or multi-phase and identical units must be supplied.
- All parallel units in the same phase should have matching compatibility ID letter. See information below.
- The same number of units need to be installed on each phase. An example to clarify: 3 units on L1, 3 on L2, and 3 on L3 is OK. But 2 on L1, 3 on L2 and 3 on L3 is not OK. The only way such non-symmetrical installation is supported is when using no monitoring at all, or a Digital Multi Control. Combining such system with any other monitoring device, such as the VE.Bus Smart Dongle or a GX device like the Cerbo is not supported. Numbers and information shown on the GX device as well as VRM portal will or can be wrong, and controlling the system, for example setting input current limits will not always work properly either.
- MultiPlus-II 8k, 10k, and 15k models can only be connected in parallel if an external AC transfer switch is used. For more information see the MultiPlus-II External Transfer Switch application manual.
- While VE.Bus System Configurator allows setting up a system using Multis (each having a single AC input), that is configured to have multiple separate AC inputs, such system is not supported by GX devices.
- This information does not apply to the Multi RS and Inverter RS models, which use a VE.Can interface (not VE.Bus) see the RS product manuals for specific information on programming them for three phase.

Compatibility IDs explained

The **compatibility ID** denotes which devices can be combined in a VE.Bus system.
This ID can be found on the stickers of the units.[1)]
A compatibility ID consists of a 4-digit number followed by a letter. (e.g. 2623_B)
VE.Bus systems can only be made with devices with identical 4-digit numbers and only devices with the same letter can be put in a single phase.

- Make sure that the 4-digit number in the compatibility ID of all units in the VE.Bus system is

identical .
- Make sure that units in a single phase (so parallel units) have an identical letter in the compatibility ID.

[1] If there is no compatibility ID on the sticker then the compatibility ID consists of the first 4 digits of the complete firmware number followed by the letter **A**.
The one exception to this rule is firmware 2699xxx: If there is no compatibility ID on the sticker then the compatibility ID is 26**2**9_A (instead of 26**9**9_A).

Note: The 4-digit number in the compatibility ID does not necessarily represent the firmware version of the unit itself. For instance a MultiPlus-II 24/5000/120-50 could require firmware version 2696xxx while the compatibility id sticker on that unit shows 2615_B.

Warning

Parallel and Multiphase systems are complex. We do not support or recommend that untrained and/or inexperienced installers work on these size systems.

Victron is able to provide specific training for these systems to distributors via their regional sales manager. There is advanced training theory and practical videos and competency exams for 3 phase and parallel installation and commissioning available on Victron Professional -> Online Training. You will require an installer account on Victron Professional to access it.

These should all be considered essential before attempting design or installation.

First get experience with smaller systems. If you are new to Victron, please start with simpler designs, so that you become familiar with the necessary training, equipment and software required.

It is also recommended to hire an installer that has experience with these more complex Victron systems, for both the design and the commissioning.

Maximum System size

Three phase systems

Using our 15kVA Quattros, the maximum system size is a 180kVA three phase system. Which then consists of four units on each of the three phases: 12 units in total.

When using smaller models, there is a maximum of five units in parallel, on each of the three phases: 15 units in total. For example, using 10kVA Quattros, the maximum system size is a 150kVA three phase system.

Single phase systems

This is the same as above, but then per phase:

- maximum single phase system with 15kVA Quattros is 75kVA: five units.

- maximum single phase system with 10kVA Quattros is 60kVA: six units.

DC and AC wiring

Main text

The VE.Bus cluster maintains a single 'global' status for SoC, DC voltage, and DC current. Every DC connection (on every Multi/Quattro and on every battery) has to be connected together to a single DC bus. Do *not* build systems with separated batteries on multiple (separated) DC bus structures connected to subsets of the Multi/Quattro units in the cluster. This will *not* work.

Also beware of sizing the battery cable and jumpers between cells/batteries.

For units in parallel: Both the DC and AC wiring needs to be symmetrical per phase: use the same length, type and cross-section to every unit in the phase. To make this easy, use a bus-bar or power-post before and after the inverter/chargers. Also, apply the same torque on all connections.

With regards to AC fusing, each unit needs to be fused individually. Make sure to use the same type of fuse on each unit due to same resistance. Consider using mechanically connected fuses, so that if one trips, they all trip - leading to a clear fault.

With regards to DC fusing, each unit needs to be fused individually. Make sure to use the same type of fuse on each unit due to same resistance.

For both AC and DC fusing and protection, consult the product manual for details and recommended ratings.

Beware of phase rotation between the inverter and AC in. When wired in a rotation that is different to the programming of the Multis, the system will not accept the mains input and only operates in inverter mode. If a GX device is connected, it will signal a phase rotation alarm. In that case swap two phases to correct it, or re-program the units to match the wiring rotation.

Warning against over-dimensioning the AC wiring

Note: Do not over-dimension the AC cabling. Using extra thick cabling has negative side effects.

Technical background: for a properly working parallel system, the AC current should be evenly distributed between the paralleled units. The resistance in the cabling helps with that and is needed for that; to overcome small differences between one inverter/charger and another, for example in the AC contact on the AC input. When the resistance in the cabling is too low, such small differences in resistance of the current path in a unit itself can results in a large relative difference. This results in bad current distribution.

An exaggerated example:

- Using 2 units (A and B) parallel and using too good cabling, one might achieve a total resistance for Unit_A of 0.0001Ω and a total resistance for Unit_B of 0.0002Ω. This results in Unit_A carrying twice as much current as Unit_B.
- Using the same 2 units in parallel with, for the sake of this example underdimensioned AC

cabling one might end up with a total resistance for Unit_A of 15Ω and a total resistance for Unit_B of 16Ω. This results in a much better current distribution (Unit_A will carry 1.066 times more current than Unit_A) even if the absolute difference in resistance is much bigger than in the previous example (1Ω vs 0.0001Ω).

A side effect of over dimensioning the AC cabling can be faulty Power Assist operation. Out of all units, the phase master is in control and measuring the AC input current. And in case that current is (grossly) unevenly distributed between the paralleled units, the resulting total AC input current can end up being too low (under charging the battery).

Delta configurations not supported

For units in 3 phase configuration: Our products have been designed for a star (Y) type three phase configuration. In a star configuration all neutrals are connected, a so called: “distributed neutral”. We do not support a delta (Δ) configuration. A delta configuration does not have a distributed neutral and will lead to certain inverter features not operating as expected.

Theory and background information

Wiring is further explained here:

- presentation - DC Ripple
- presentation - Theory on wiring large systems'
- Wiring Unlimited - Chapter 4 - DC Wiring - Parallel and/or 3 phase systems.

Communication wiring

- All units must be daisy chained with the VE.Bus cable (RJ-45 Cat5 or better). The sequence for this is not important. Do not use terminators in the VE.Bus network.
- The temperature sensor can be wired to any unit in the system. For a large battery bank it is possible to wire multiple temperature sensors. The system will use the one with the highest temperature to determine the temperature compensation.
- Wire the voltage sense on the master of L1.
  (If the system has more than 1 AC input, connect it to the Master corresponding to the first AC input.)
  All other units ignore their voltage sense input and receive the voltage sense value from the L1 master.
- Further information on best practices for VE.Bus wiring, can help with reducing VE.Bus errors caused by interference as system size increases.

Configuration

Note: Special considerations exist before initial power-up for large systems using Redflow batteries: Click here for details.

In the VE Configuration tools there are two different programs. One to configure small systems and one for larger systems:

- Up to three units: use VE.Bus Quick Configure
- 4 units or more: use VE.Bus System Configurator

Activate VEConfigure from within these programs to make settings per unit. Right click, and select VEConfigure.

Make the following settings in the master of L1:

- All charger settings, such as absorption voltage, float voltage and max charge current.
  (The maximum charge current is multiplied by the number of units in the system: in a 9 unit system set it to 50A to get a 450A maximum charge current.)
- System frequency

The following settings need to be made in the master of each phase:

- Inverter output voltage
- Input current limits
  (the effective input current limit is the limit set on the master multiplied by the number of units per phase. For example, setting a 10A limit with VEConfigure in a system with two units per phase results on a 20A limit for that phase. Being able to set a different limit per phase allows for maximum configurability.

  Setting an input current limit works differently when setting it on a remote control panel, for example a DMC or GX device. Then (a) only one value can be set by the user, not a different for each phase, and (b) the configured limit will be used as the total limit for each phase. Example, setting 30A in a three phase system of six units (two per phase), on a DMC or GX Device, results in a max input current limit of 30A per phase. The difference of both methods is due to the different use case of both ways of setting it: settings in VEConfigure are supposed to be fixed in the install and done be the installer, for example matching an installed generator. And the input current limit as set on the GX device is intended to be set by the end-user, for example on a yacht or in a motor home, and being able to set it depending on the actual shore connection - and ofcourse without having to do the maths of multiplying with the number of installed units on a phase.)
- UPS function on/off
- PowerAssist settings
- Accept wide input frequency range on/off
- Weak AC input on/off

The following settings need to made in each unit in the system:

- Country / grid code standard and other grid related values (AC high/ low values)
- DC input low shut-down values.

Charger settings (voltage and current limits) are overridden if DVCC is configured and if a CANBus BMS is active in the system.

A quick way to make settings in all units is the 'send to all units' feature. You'll see the option after making the changes to the first unit.

Note that AES is only operational in stand-alone systems. Not in parallel and multi-phase systems.

Virtual switch

A unique virtual switch configuration can be configured for each unit in the system. With the exception of the Ignore AC input function: configure that in the master of L1.

Assistants

Assistants can be used to expand the potential configuration options of your system, and are required in some installation types. When using assistants with multiple units, some assistants are required to be loaded onto all units in the system individually, and some assistants are able to be just loaded onto some or one of the units.

- If you are using a self-consumption assistant, such as ESS, Hub-1 to Hub-4, the assistant will need to be loaded into each unit in the system individually.
- PV Inverter Assistant needs to be loaded into each unit in the system.
- The VE.Bus BMS and the Two-Signal BMS support Assistant also need to be loaded in each unit in the system individually. Program each Multi separately.
- For the Two-Signal BMS assistant, during the first Multi setup there are questions about which Aux connection ports the BMS is connected. When setting up the second and third Multi assistant setup, you choose that BMS is connected to “other” Multi, and the setup will end. Only the unit that is physically wired to the BMS will be set up fully with the options selected matching the physical hardware interface connections.

With all the other Assistants: genset start/stop, relay locker etcetera, a unique configuration can be made in each unit.

Tips and hints

- presentation - DC Ripple
- presentation - Theory on wiring large systems
    - Multi and Quattro parallel and 3 phase training presentation
- VE.Bus error codes
- Victron Toolkit App with LED code definitions
- Use the help-file in VEConfigure, and also in VE.Bus Quick Configure and VE.Bus System Configurator.

System Monitoring

It is strongly recommended that a GX Family Product is used in conjunction with these larger systems. They provide highly valuable information on the history and performance of the system. System notifications are clearly presented and many additional functions are enabled. Data from VRM will greatly speed support if it is required.

Training Video

There is an advanced training video and competency exam for 3 phase and parallel installation and commissioning available on Victron Professional -> Online Training. You will require an installer account on Victron Professional to access it.

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