ENGLISH

Microgrid application

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1. Introduction

This manual provides guidance on designing and configuring off-grid Microgrid systems using the MultiPlus, Quattro, MultiPlus-II, and Quattro-II inverter/charger ranges. In these systems, multiple independent inverter/charger units are interconnected via a common AC bus.

With the introduction of Microgrid functionality, Victron Energy enables several independent Victron Power Banks to operate together on a shared AC bus, forming a larger, scalable off-grid power system with decentralized load sharing. In this context, a Victron Power Bank refers to an inverter/charger system based on the MultiPlus, Quattro, MultiPlus-II, or Quattro-II range, connected to a single battery system.

By coupling multiple Power Banks using Hybrid Droop control, modular and redundant off-grid systems can be realized, particularly in applications where the required inverter capacity exceeds the limits of a single system – up to 400 kW inverter capacity, without any central controller.

1.1. Advantages

- **Scalable beyond single-cluster limits:** Multiple Victron Power Banks can be AC-coupled to exceed the power limits of a single VE.Bus system, enabling significantly larger off-grid systems without creating one large centralized inverter system.
- **Higher system redundancy and availability:** Each Power Bank operates as an independent unit. If one bank is taken offline for service or experiences a fault, the remaining Power Banks continue supplying the AC bus, increasing overall system resilience.
- **Modular and distributed system architecture:** Power Banks can be physically distributed (e.g., containerised units) and connected via a common AC bus, simplifying large-scale installations and enabling flexible system expansion over time.

1.2. Compatibility

See the listing below for a list of MultiPlus, MultiPlus-II, Quattro and Quattro-II models which are supported by this application.

You need to use a specific "Microgrid firmware" with the s97 subversion number. These firmware files are available from Victron Professional in the Firmware section.

The Microgrid functionality is also available in combination with the External Transfer Switch functionality for selected MultiPlus and MultiPlus-II models. Therefore, you need to use the "Microgrid – External Transfer Switch firmware" with the s98 subversion number. For configuration instructions regarding the External Transfer Switch setup, please also refer to the dedicated "MultiPlus-II External Transfer Switch application" manual.

Model	Firmware number
MultiPlus 2000VA, MultiPlus 5000VA and larger	xxxxyyy-s97
MultiPlus 15000VA, MultiPlus 20kW	xxxxyyy-s97, xxxxyyy-s98 (if applicable)
All MultiPlus-II	xxxxyyy-s97, xxxxyyy-s98 (if applicable)
Quattro 3000VA and larger	xxxxyyy-s97
All Quattro-II	xxxxyyy-s97

Note: Supported models include 230 V, 120 V and 277 V variants. 2x120 V models are not supported.

1.3. Hardware requirements per Power Bank

- **Victron VE.Bus Inverter/Charger:** One or multiple devices for 3-phase and/or phase-parallel operation are supported.
- **Circuit breakers and RCD:** For circuit protection.
- **Electrical wiring:** Refer to the Installation chapter for detailed instructions.
- **DC charging source:** Each Microgrid Power Bank is required to have its own independent DC charging source.
- **Victron GX device:** This is not mandatory, but strongly recommended.

2. Functionality

The Microgrid functionality enables multiple independent inverter/charger systems (Victron Power Banks) to operate together on a shared AC bus in off-grid applications.

Each Power Bank consists of a MultiPlus, Quattro, MultiPlus-II, or Quattro-II system connected to its own battery system. Instead of forming one large VE.Bus system with a shared DC bus, several such systems are interconnected only via the AC side.

All participating Power Banks operate in Hybrid Droop mode and jointly establish and regulate the AC bus. Load sharing between the units is achieved through controlled frequency and voltage deviation on the AC bus.

When system load changes:

- **All Power Banks automatically adjust their output.**
- **Load is shared proportionally (with identical droop settings).**
- **No external Energy Management System (EMS) is required.**

The system operates exclusively off-grid. The AC bus is fully formed and stabilized by the participating Power Banks.

> ⚠ Coupling with other AC sources (AC PV Inverters, AC gensets, etc.) is not supported.

2.1. Comparison to standard operation

In a standard VE.Bus system, AC input is used to connect to an upstream AC source (grid or generator), while loads are supplied via AC output. The internal or external transfer switch manages the transition between inverter operation and passthrough (or PowerAssist) operation.

In a Microgrid application using Hybrid Droop mode, this behaviour changes fundamentally:

- The AC input is used to connect the Power Bank to the shared Microgrid AC bus.
- The AC input is therefore permanently connected to a live AC system formed collectively by all participating Power Banks.
- AC outputs must not be connected to load in Microgrid applications.

Unlike a standard application, the AC input is not considered an upstream supply but the interconnection point to the common off-grid bus. The internal or external transfer switch is not used to switch between external AC input and inverter operation; instead, the inverter continuously participates in forming and stabilizing the AC bus via Hybrid Droop control.

This results in a different electrical topology compared to conventional VE.Bus installations and must be considered during system design and wiring.

> ⚠ In this application, AC input is live whenever a Power Bank assists the Microgrid. Therefore, **always treat AC input as a live terminal**.
>
> If removable connectors are used, **touch-safe connectors are required**. Powerlock connectors are one commonly used solution that can meet this requirement.

2.2. Limitations and constraints

The Victron Microgrid functionality is designed as a decentralized, droop-controlled, off-grid architecture focused on stable and proportional load sharing between multiple Victron Power Banks.

The system intentionally follows a simplified and robust design philosophy. While this enables modularity, scalability, and resilience, certain features commonly found in other microgrid architectures are not part of the current implementation.

The following constraints apply.

2.2.1. Off-Grid operation only

Hybrid droop operation is intended exclusively for islanded systems. The Microgrid AC bus is fully formed and stabilized by the participating Power Banks and must not be connected to a public utility grid. Grid-connected operation in Microgrid mode is not supported.

This makes the system suitable for stand-alone power systems, remote installations, and containerised distributed generation, but not for grid-interactive hybrid plants.

2.2.2. Maximum system size

Microgrid applications are supported with a total inverter output of up to 400 kW, defined as the sum of the inverter output power across all Power Banks.

2.2.3. Decentralized control philosophy

The Microgrid operates without centralized dispatch control. Load sharing is achieved exclusively through droop control, using frequency and voltage as the coordination mechanism between Power Banks.

External Energy Management Systems (EMS) for distributing active power setpoints to individual Power Banks are not supported; And there is no centralised economic dispatch or optimisation layer. The system is intentionally designed to function without fast communication links between units, increasing robustness while limiting advanced supervisory control strategies.

2.2.4. AC bus usage

The Microgrid AC bus is intended for interconnecting Victron Power Banks and supplying loads. It is not designed as a general-purpose paralleling bus for additional AC generation sources.

AC-coupled PV inverters, external grid-forming inverter systems, or directly paralleled generators are not supported on the Microgrid AC bus. Battery charging must be provided individually per Power Bank via DC-coupled sources or dedicated AC chargers supplied from an external source.

This architectural decision ensures controlled droop interaction and predictable system dynamics.

2.2.5. Independent battery systems

Each Power Bank operates with its own battery system and manages it independently. There is no shared DC bus and no automatic state-of-charge balancing between Power Banks.

Energy distribution between units is therefore governed solely by droop characteristics and system design. Coordinated charging strategies must be considered during project planning.

2.2.6. Black-Start behaviour

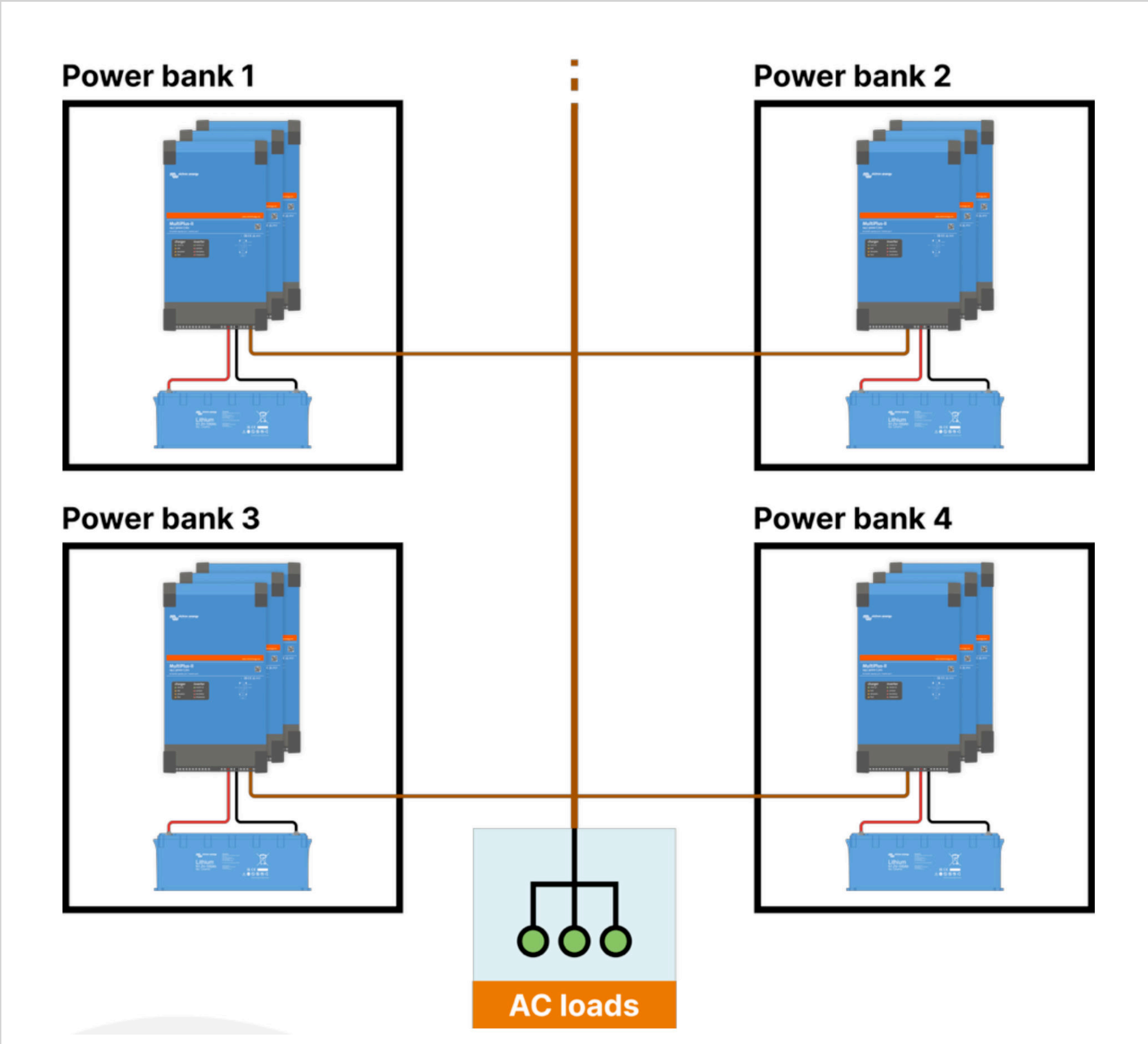
Black-start capability is intentionally limited to prevent uncontrolled restart loops. Once a Power Bank has successfully established or joined an energized Microgrid, its ability to initiate a new black start is disabled until the inverter/charger(s) was restarted.

2.2.7. System positioning

The Victron Microgrid architecture extends the well-known VE.Bus system concept into a modular AC-coupled environment. It enables scaling beyond the limits of a single inverter/charger system while maintaining a decentralized and inherently stable operating principle.

It is not intended to replace centralized microgrid controllers with advanced dispatch, grid-forming hierarchies, or complex generator coordination. Instead, it provides a robust and scalable foundation for off-grid AC-coupled power systems based on proven droop control principles.

2.3. Topology



3. Installation

Microgrid systems with one or multiple Victron Power Banks are advanced power systems and exceed the complexity of standard parallel or multiphase installations. Installation and commissioning must only be performed by trained and experienced professionals.

Before initial power-up, carefully verify all AC and DC wiring. Wiring errors can lead to equipment damage and unsafe operating conditions.

Each Victron Power Bank in a Microgrid system can be designed largely according to the established principles of a standard VE.Bus inverter/charger system or MultiPlus / MultiPlus-II External Transfer Switch application.

Each Power Bank:

- May be configured as a single-phase or multi-phase inverter/charger system.
- May include multiple inverter/chargers in parallel per phase.
- Is connected to one common battery bank forming a shared DC bus.
- May include a GX device for monitoring and control.

All inverter/chargers within one Power Bank must be interconnected via VE.Bus.

There is no VE.Bus connection between different Power Banks.

3.1. Connection of the AC cabling

The Microgrid AC bus is connected to the AC input of the inverter/chargers:

- For MultiPlus and MultiPlus-II, use AC-IN.
- For Quattro and Quattro-II, use AC-IN-2.
- For an External Transfer Switch configuration, follow the notes below.

This AC connection serves as the interface to the shared Microgrid bus and is used both to supply and stabilize the AC system in Hybrid Droop mode.

AC-OUT-1 and AC-OUT-2 are not used in this application and must remain disconnected.

Combining Microgrid with External Transfer Switch function

The use of an External Transfer Switch is supported in Microgrid systems, and it is permitted to power the contactor from either AC-IN or AC-OUT.

It requires inverter/chargers running firmware with the s98 subversion number (instead of the s97 firmware). Refer to the Configuration chapter for firmware selection and setup details.

When implementing an External Transfer Switch in a Microgrid system, the following additional considerations apply. The supply source of the External Transfer Switch directly affects system behavior:

- If the External Transfer Switch is powered from AC-IN, the system cannot black-start the Microgrid.
- If the External Transfer Switch is powered from AC-OUT, black-starting is possible. However, the system will not reconnect to the Microgrid if the batteries are fully depleted.

To allow both, black-start capability, and startup with a fully discharged battery, a design solution must be implemented that ensures the External Transfer Switch can always be energized, independent of battery state or AC bus condition.

The supply concept of the External Transfer Switch must therefore be carefully considered during system design.

3.2. DIP switch configuration

Some inverter/charger models require a manual DIP switch change to allow Microgrid (Hybrid droop) operation.

By default, these units will not close the internal AC input relay unless voltage is detected on AC IN. For Microgrid operation, this behavior must be overridden so the unit can close the AC input relay even when no voltage is present on AC input.

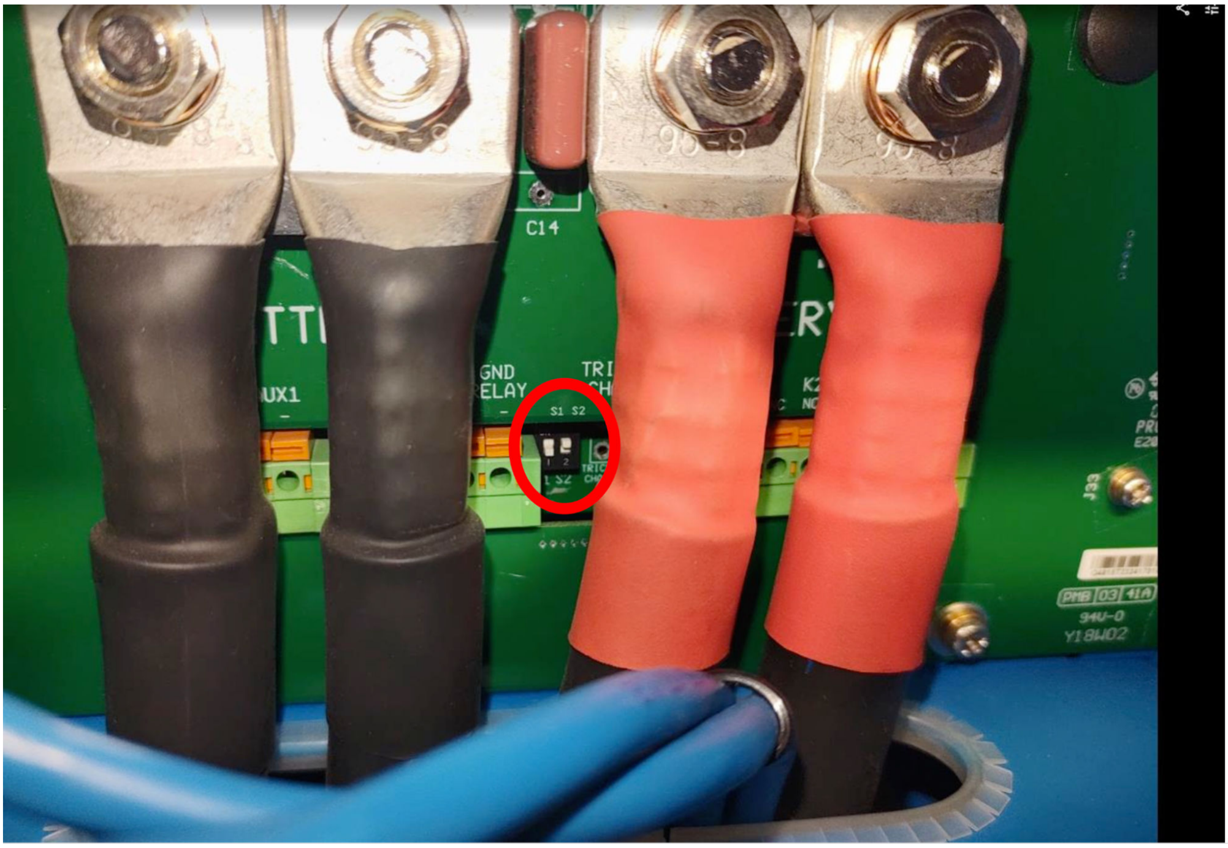
This applies to:

- MultiPlus 5000 VA and larger (excluding 20k model)
- Quattro 3000 VA and larger

Set the DIP switch "S2" on the connection board to **ON (switch in the up position)**.

For the MultiPlus 2000 VA, MultiPlus 20000 W, MultiPlus-II range and Quattro-II range, no such change is required.

Refer to the marked position in the following photo.



3.3. Three-phase systems and grounding concept

In three-phase Microgrid systems:

- L1, L2, and L3 of all Power Banks are connected to the corresponding phases of the shared AC bus.
- A common neutral conductor must be used across the entire Microgrid AC bus.

In Microgrid operation, the AC bus neutral is not internally bonded to protective earth (PE) by the inverter/chargers. The system therefore operates with a floating neutral, unless an external neutral-to-earth connection is established.

If the installation requires a defined earthing system, the neutral-to-earth bonding must be implemented externally at only one point in the Microgrid system – in accordance with local regulations and system design requirements.

> ⚠ Proper grounding and protection concept design remains the responsibility of the system designer.

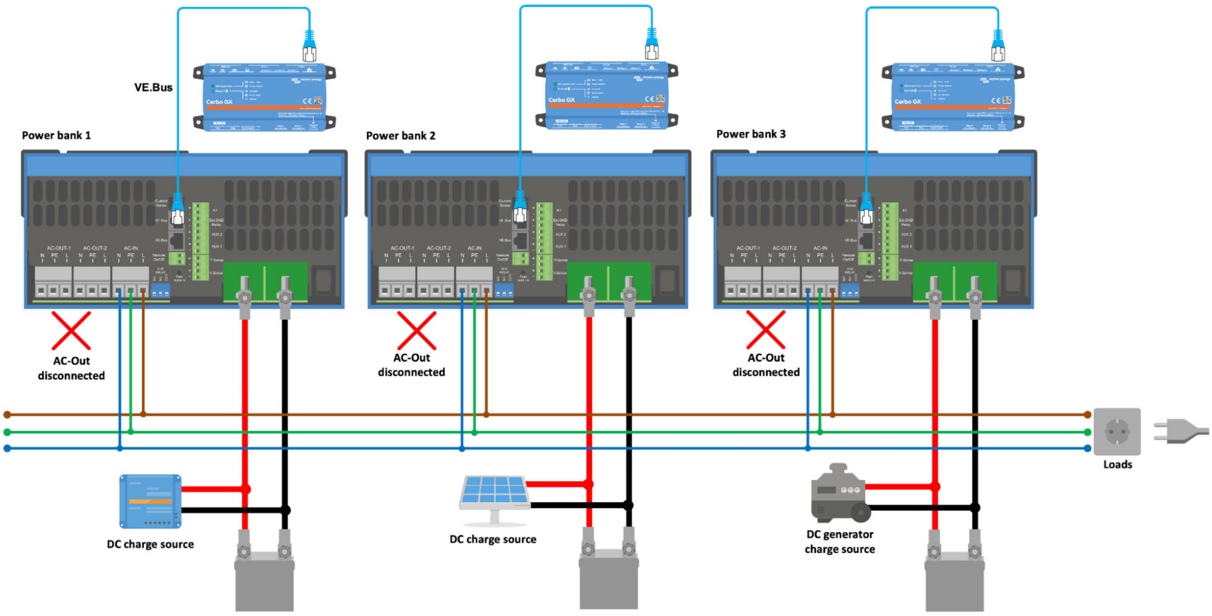
3.4. Three-phase load balancing

It is recommend to keep the load power difference between phases to a maximum of 30% of the max power of a phase.

When the imbalance is larger a difference in voltage between the phases will occur.

The Microgrid will continue to function with this difference in voltage, however some three-phase loads may not operate correctly.

3.5. Wiring example



4. Configuration

4.1. Upgrade to s97 / s98 VE.Bus firmware

The MultiPlus, MultiPlus-II, Quattro or Quattro-II units require application-specific VE.Bus firmware, identified by the s97 subversion number – and s98 subversion number when using the External Transfer Switch functionality.

Upgrade procedure:

1. Download the xxxxyyy-s97.vff or xxxxyyy-s98.vff file from https://professional.victronenergy.com/
2. Install the firmware using VEFlash, the VictronConnect app, or the VRM Portal.
3. Ensure you select the xxxxyyy-s97.vff or xxxxyyy-s98.vff file during the firmware upgrade.
4. Repeat the process for all MultiPlus, MultiPlus-II, Quattro or Quattro-II units.

> ⚠ CAUTION: Never use MultiPlus or MultiPlus-II unit with standard or s97 firmware in an "External transfer switch" application. This will cause the system to connect to the AC input and likely trigger the current protection on that measurement-only circuit.

4.2. VE.Bus System configuration

Each Victron Power Bank is built from one or multiple VE.Bus inverter/chargers. The inverter/charger configuration follows the same well-known principles as a standard VE.Bus system.

As with conventional Victron installations, a Power Bank can be designed as:

- A single-phase system
- A three-phase or split-phase system (depending on the models and market)
- With multiple inverter/chargers in parallel per phase

The configuration principles are identical to those commonly used with MultiPlus, Quattro, MultiPlus-II, and Quattro-II systems.

In the following sections, the configuration of a three-phase system consisting of nine inverter/chargers in total (three units per phase), and using an external transfer switch, is shown as an example.

Three-phase, parallel configuration example

When configuring Power Banks that have parallel, split phase, or three phase configurations use the "VE.Bus System Configurator" to set up the system.

Single VE.Bus Inverter/Charger Power Bank systems should proceed straight to the VEConfigure section.

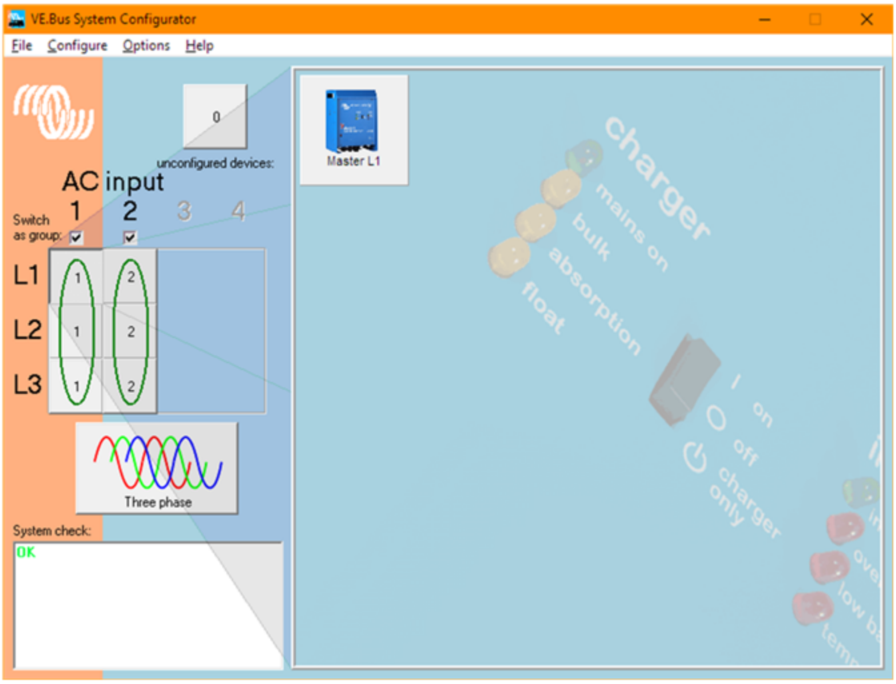
Three-phase, split phase & parallel system configuration procedure

1. Configure all phase masters in AC input group 1.
2. Configure all slaves in AC input group 2.

   (Note: assigning slaves to AC input group 2 is specific to external transfer switch applications. For systems using internal transfer switches both masters and slaves should be configured in AC input group 1)

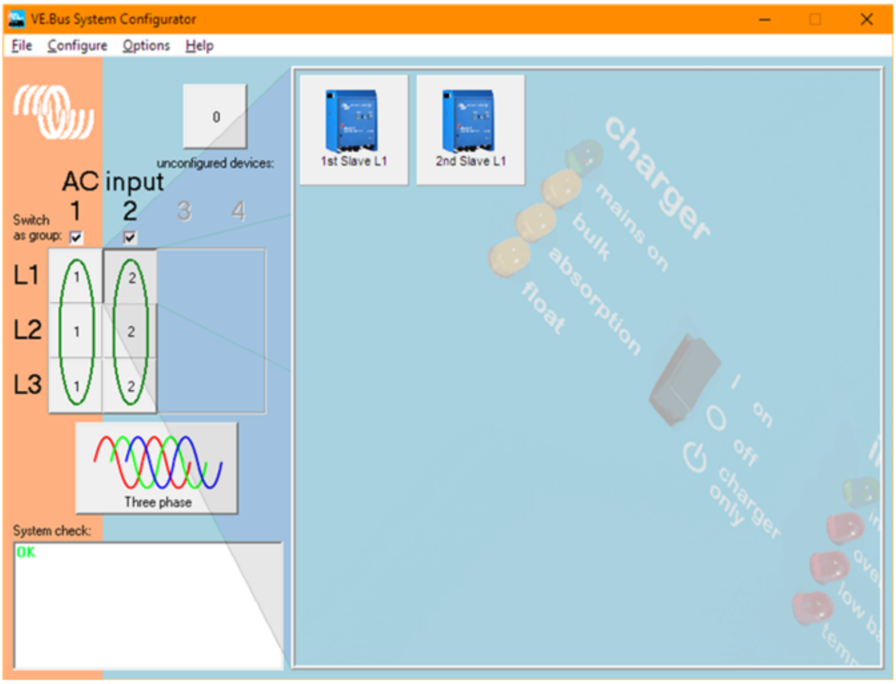
This screenshot shows the master on the first phase of a three phase system with 3 parallel inverter/chargers on each phase.

Right clickt on the "Master L1" tile, select VEConfigure, and follow the directions in the next section to program the master.



This screenshot shows the slave parallel VE.Bus inverter/chargers on phase 1 of a three phase system.

As with the masters, right click on the tiles and select VEConfigure to program the slaves successively.

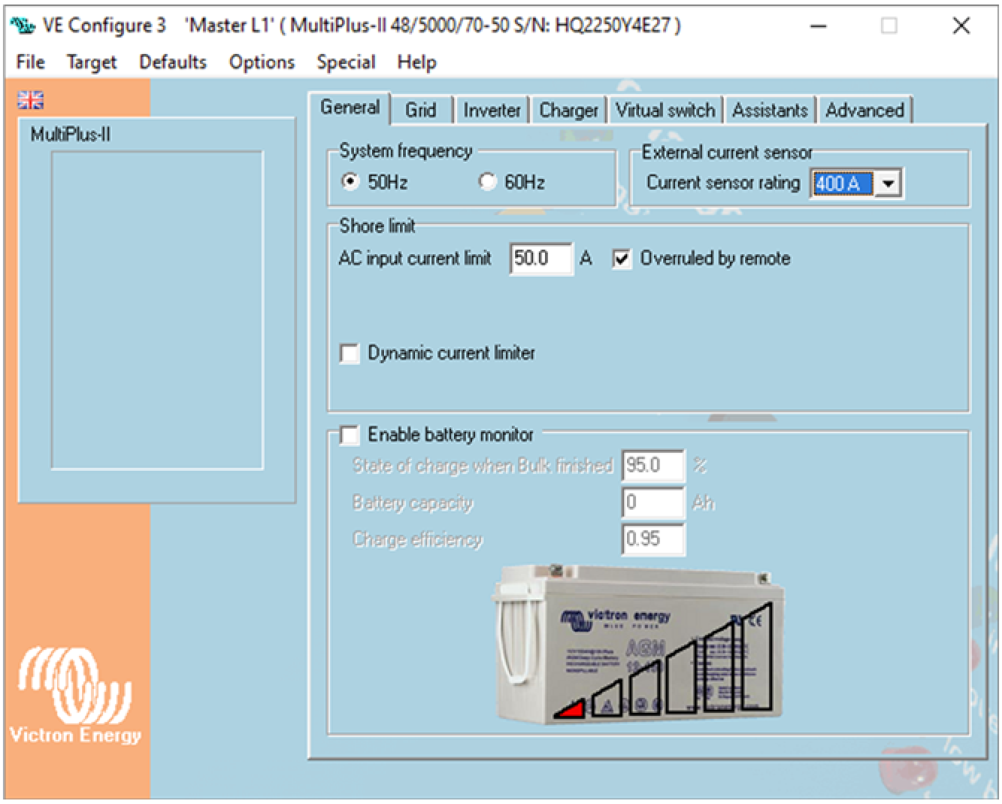


4.3. Inverter/Charger configuration

Use "VEConfigure" to configure each Inverter/Charger unit.

Configuration procedure:

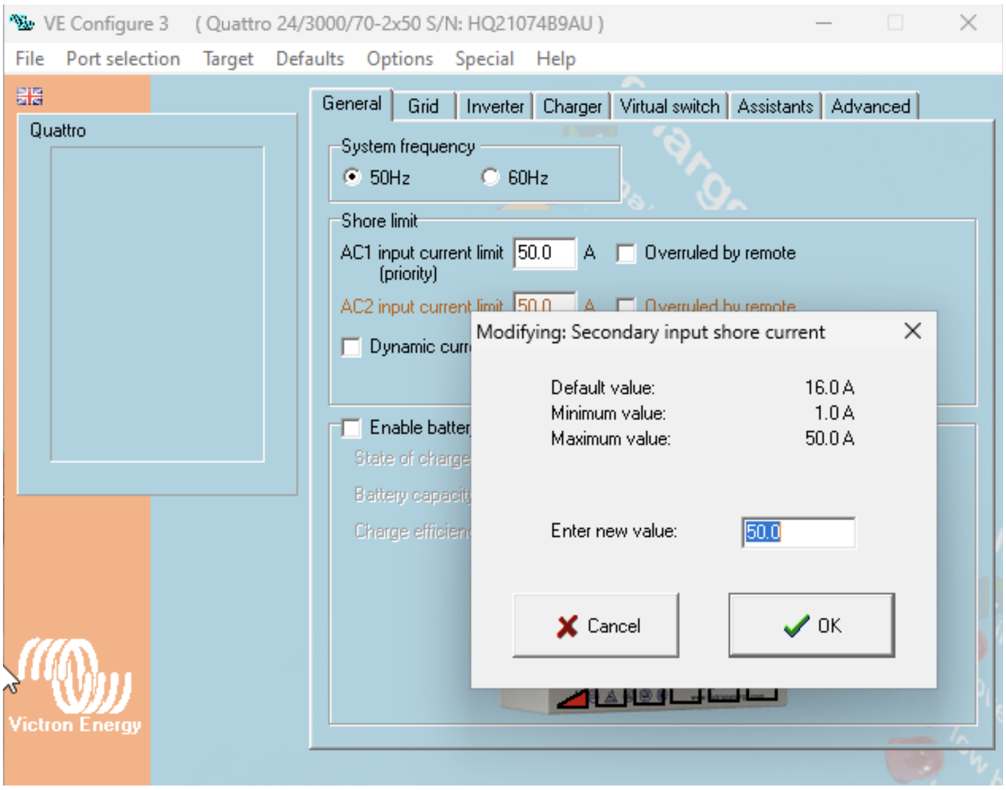
1. Ensure the s97 or s98 firmware version is installed, and all software versions are up to date.
2. Navigate to the “General” tab.
3. In case of an External Transfer Switch setup with the s98 firmware:



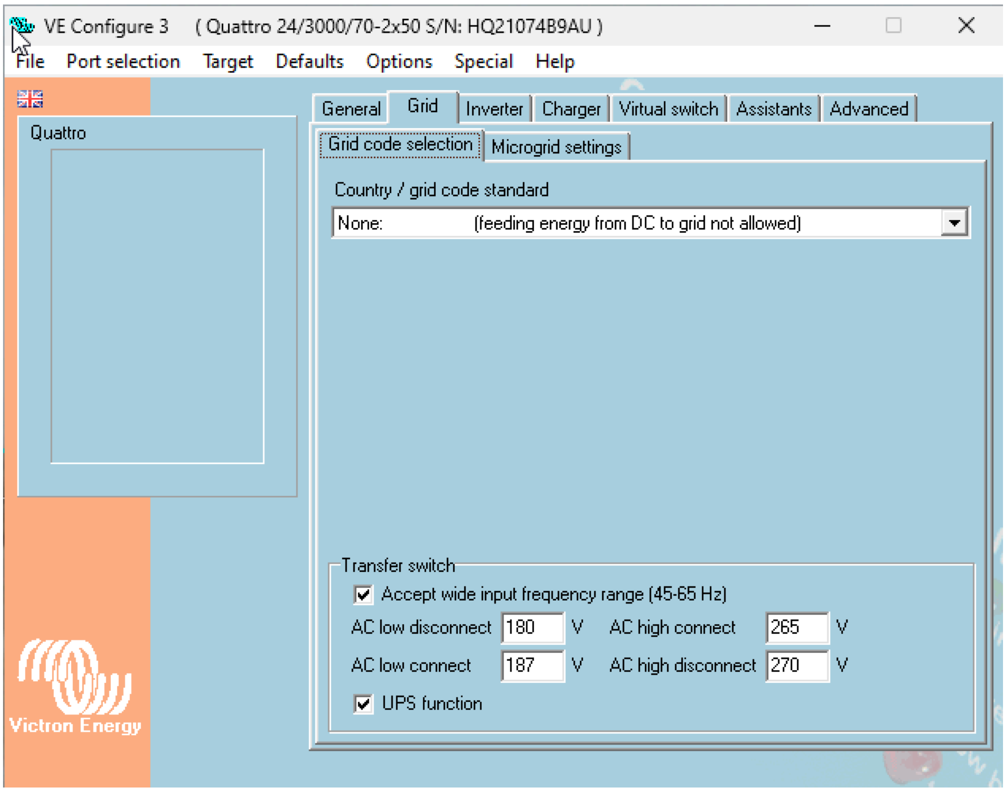
a. For all phase master units, set the "Current sensor rating" to 100 or 400A, matching the current sensor's current rating.

b. For all slave units, set the "Current sensor rating" to 100A, regardless of the current sensor's current rating.

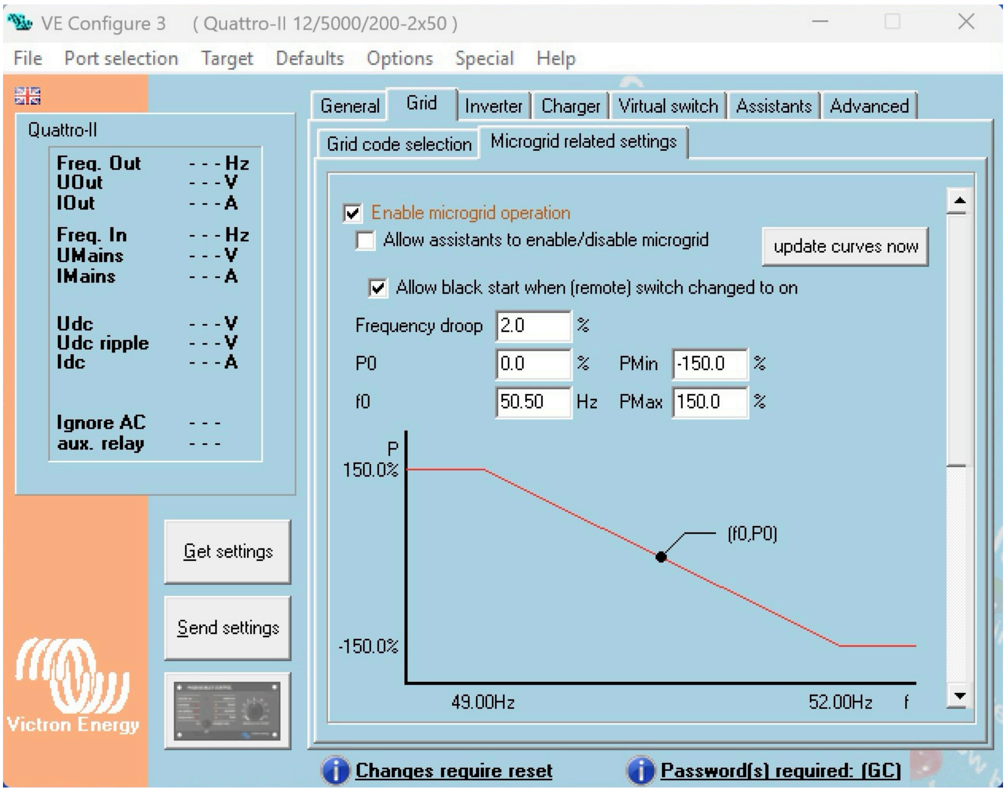
4. Set the "Shore limit" on the connected AC input to the maximum allowed value.



5. Navigate to the "Grid" tab.



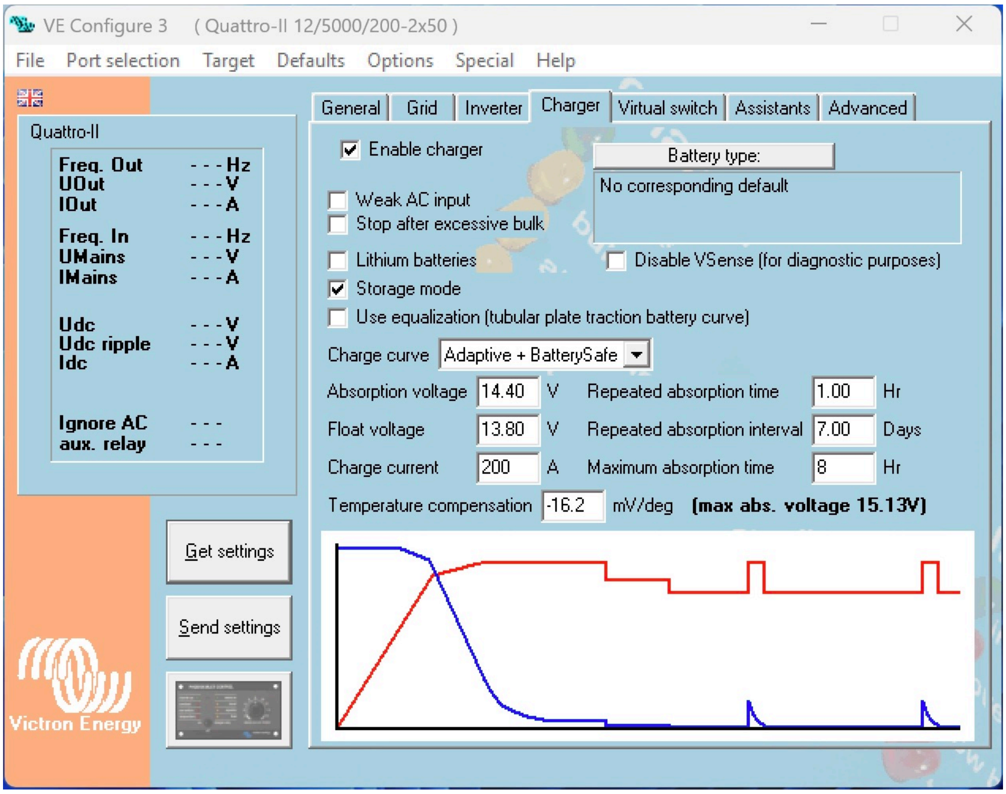
6. In "Grid code selection" sub-tab, set the grid code to "None".
7. In "Microgrid settings" sub-tab, enable the "Enable Microgrid operation" checkbox.



Victron grid code password is required to enable the "Enable microgrid operation". Contact your Victron dealer for the necessary training to obtain this password.

8. If desired, also enable the "Allow this system to initiate a black start" checkbox (see notes below).

9. Navigate to the "Charger" tab



10. Make sure that "Enable charger" is enabled

11. Configure "Charge current" to the maximum allowed value.

12. Configure all other battery charging parameters as required.

> The Microgrid feature is designed exclusively for off-grid applications and therefore does not provide support for Grid codes. However as AC-input behaviour is modified, a grid code password is required from your Victron dealer.

Explanation of the Microgrid settings:

- With "Enable Microgrid operation" disabled, the inverter/charger operates according to the standard firmware behaviour.
- With “Enable Microgrid operation” enabled, the inverter/charger is configured for Hybrid Droop mode, enabling participation in load sharing on the Microgrid AC bus.
- The “Allow assistants to enable/disable microgrid” setting is intended for a feature that will be introduced in a future release.
- With “Allow black start when (remote) switch changed to on” disabled, the unit will not energize the AC bus on its own. It will wait for another Power Bank to energize the Microgrid AC bus, then synchronize and connect.
- With “Allow black start when (remote) switch changed to on” enabled, the unit is permitted to energize the Microgrid AC bus by generating AC voltage on its configured AC input. This permission remains valid only until the Power Bank has successfully closed the transfer switch and connected to an energized AC bus for the first time — regardless of whether the AC bus was energized by another Power Bank or by this unit itself. Following this, black-start capability must be restored manually (see details below).

Black start behaviour

To prevent repeated and uncontrolled restart attempts, black-start capability is limited as follows:

If a Power Bank has “Allow black start when (remote) switch changed to on” enabled, it may initiate a black start only until it has, for the first time established connected to an energized AC bus (either by joining an already energized bus, or by energizing it itself).

If a shutdown event later occurs (for example due to high AC bus voltage, overload, or other protection conditions), the Power Bank:

- Can still synchronize with and join an already active Microgrid AC bus.

- Cannot initiate a new black start independently.

To restore black-start capability, the Power Bank must be restarted:

1. Switching all Inverter/Charger in that Power Bank off and then switching all units on again
2. On a remote monitoring device, like a GX device, or via VRM: Setting Inverter/Charger Mode to "Inverter-only" or "Off" and then to "On" again

> Even if “Allow black start when (remote) switch changed to on” is disabled, once the inverter/charger has synchronized to an active Microgrid AC bus, it will keep its transfer switch closed and continue supplying voltage to the bus – even if other Power Banks are disconnected.

Black start requirement

At least one Power Bank must have black-start capability available in order to energize and start the Microgrid AC bus. If no unit has active black-start permission (for example after a previous successful start without restart), the Microgrid cannot be initiated until a system restart is performed.

4.4. Hybrid droop parameters

Hybrid Droop control defines how each Victron Power Bank reacts to deviations in frequency and voltage on the Microgrid AC bus. Two independent droop mechanisms are implemented:

- **P–f Droop** (Active power vs. frequency)
- **Q–U Droop** (Reactive power vs. voltage)

Together, they determine how active and reactive power are shared between Power Banks and how the AC bus behaves under load.

> It is strongly recommended to keep Hybrid Droop parameters at their default values. Parameters do not need to be changed under normal operation.

> All percentage-based power values refer to the nominal active power of the inverter/charger system, which equals 80 to 90 percent of its VA rating, depending on the device model.
>
> This scaling also applies to relative reactive power parameters.

4.4.1. P–f Droop (Active Power vs. Frequency)

The P–f droop defines how active power output changes as a function of frequency deviation.

Configurable parameters

- Frequency droop [%] (default: 2.0)
- P_0 [%] (default: 0.00)
- f_0 [Hz] (default: 50.50)
- P_{min} [%] (default: -150.00)
- P_{max} [%] (default: 150.00)

Operating principle

The parameter f_0 defines the reference frequency. At this frequency, the inverter delivers the active power defined by P_0.

If the measured bus frequency deviates from f_0:

- A decrease in frequency causes the inverter to increase active power output.
- An increase in frequency causes the inverter to decrease active power output.

The slope of this relationship is defined by the Frequency droop setting.

In a Microgrid with multiple Power Banks:

- Identical droop settings result in proportional active power sharing.
- Different droop slopes or offsets (P_0, f_0) shift load distribution and dynamic behavior.

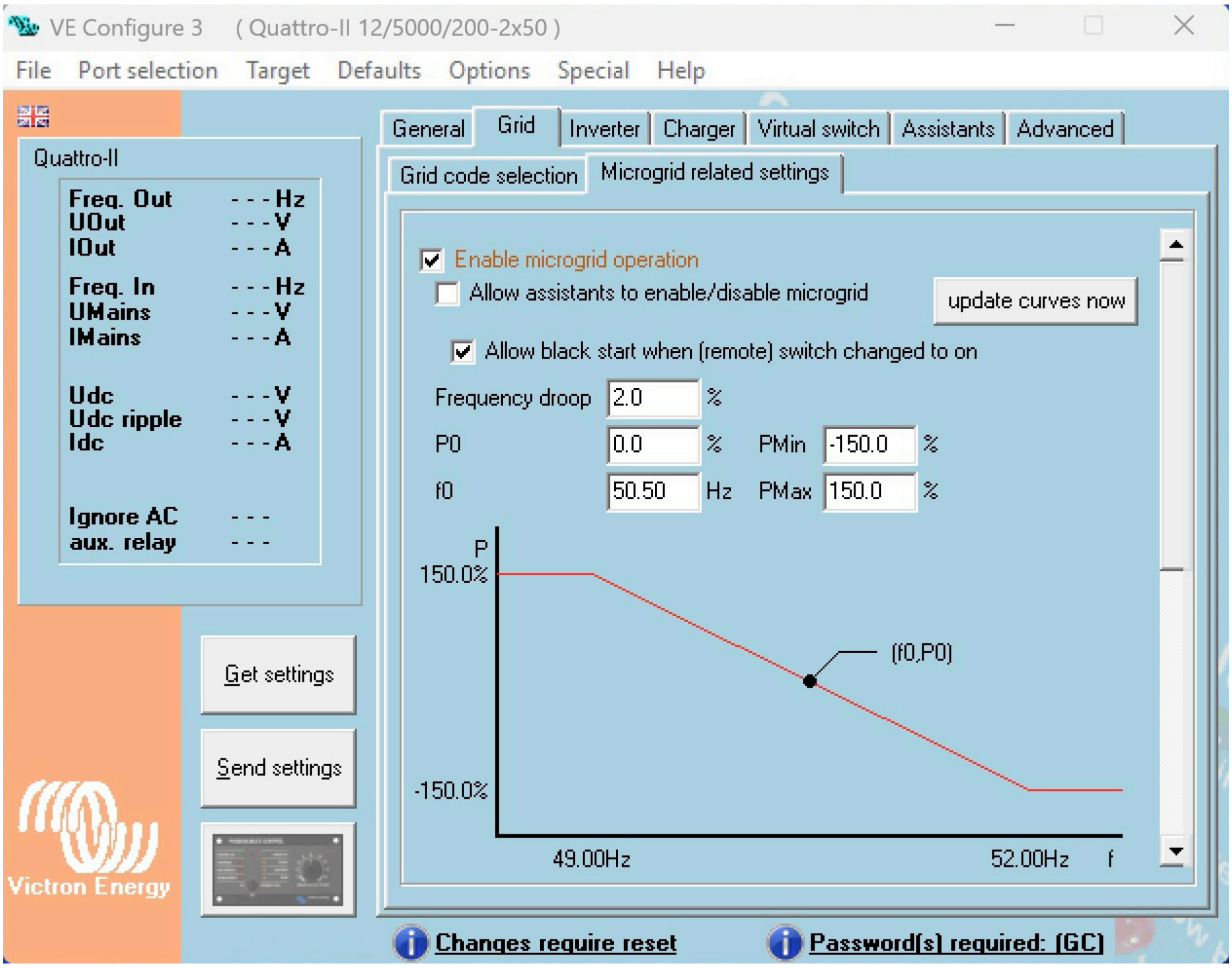
Power limits

Active power contribution is bounded by:

- P_{min}
- P_{max}

These limits define the allowed active power range relative to nominal inverter power.

Refer to the following screenshot.



4.4.2. Q–U Droop (Reactive Power vs. Voltage)

The Q–U droop defines how reactive power output changes as a function of voltage deviation.

Configurable parameters

- Voltage droop [%] (default: 8.7)
- Q_0 [%] (default: 0.00)
- U_0 [V] (default: 230.00)
- Q_{min} [%] (default: -50.0)
- Q_{max} [%] (default: 50.0)

Operating principle

The parameter U_0 defines the reference voltage. At this voltage, the inverter delivers the reactive power defined by Q_0.

If the measured bus voltage deviates from U_0:

- A voltage drop results in increased reactive power injection (supporting voltage).
- A voltage rise results in reduced or absorbing reactive power.

The Voltage droop parameter defines the slope of the Q–U characteristic.

As with P–f droop:

- Identical Q–U settings across all Power Banks result in proportional reactive power sharing.
- Modified slopes or offsets influence voltage stiffness and reactive power distribution.

Reactive power limits

Reactive power output is bounded by:

- Q_{min}
- Q_{max}

These limits restrict reactive power contribution relative to nominal inverter power.

Reactive power capability

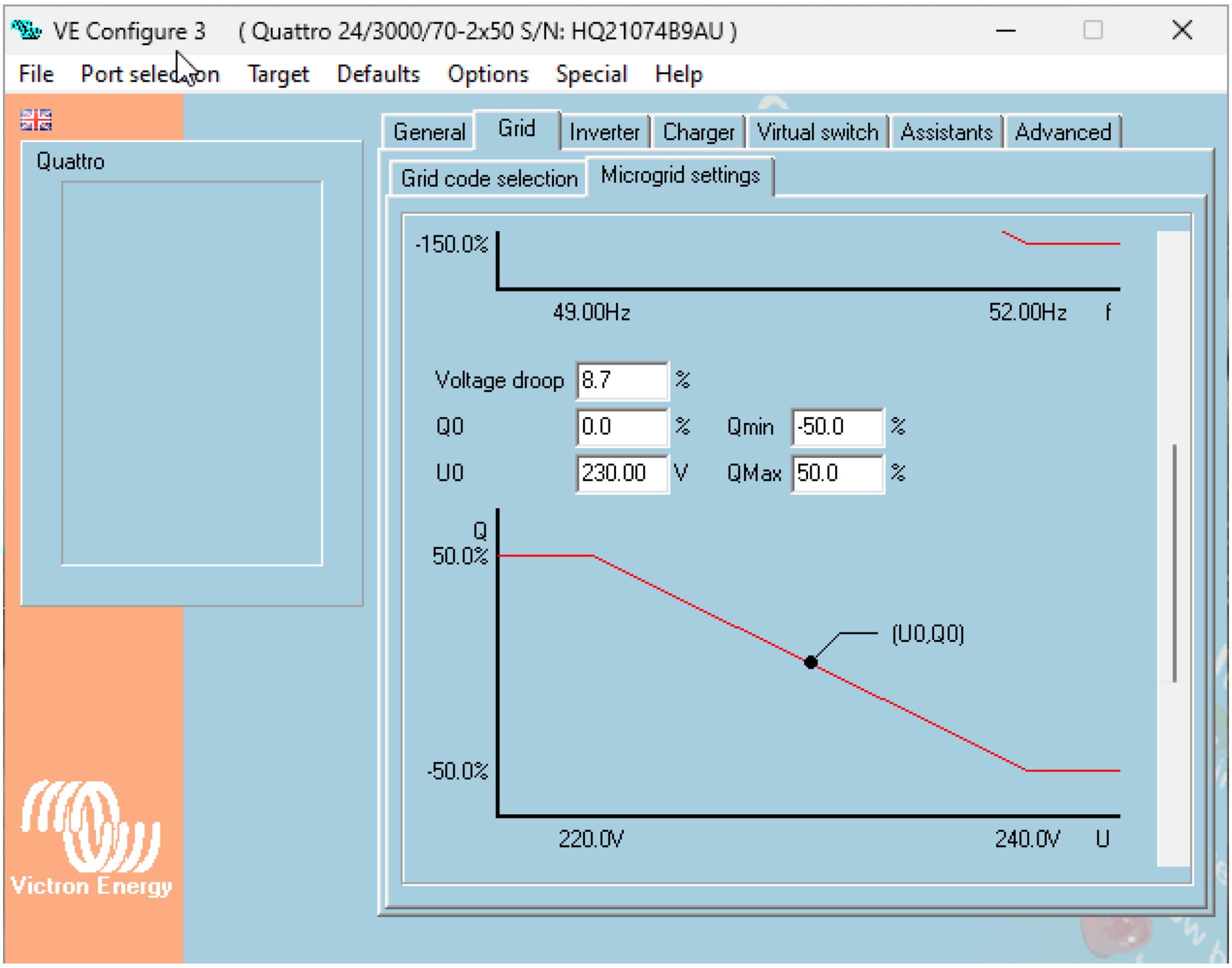
When the inverter/charger delivers more than 30% of its nominal active power, the minimum achievable power factor (cosφ) is limited to 0.7.

This means that at higher active power levels, the available reactive power is reduced in order to remain within the inverter's apparent power (VA) capability.

As active power increases, the maximum allowed reactive power decreases accordingly. This limitation is inherent to the inverter's power stage and must be considered when configuring Q–U droop parameters in Microgrid applications.

Above 30% active power, the minimum power factor is limited to cosφ = 0.7, reducing available reactive power.

Refer to the following screenshot.



4.4.3. Applying Hybrid droop parameters

The Hybrid droop curve parameters are handled using two internal storage mechanisms:

- **Default parameter storage** (non-volatile)
- **Active runtime storage** (volatile)

Understanding the difference between these two is important when modifying droop curves or related settings.

Default Parameter Storage

When pressing “Send settings”, the configured curve data is written to the non-volatile default parameter storage. However, the new curve will not become active immediately. The updated curve will only take effect after a system reset.

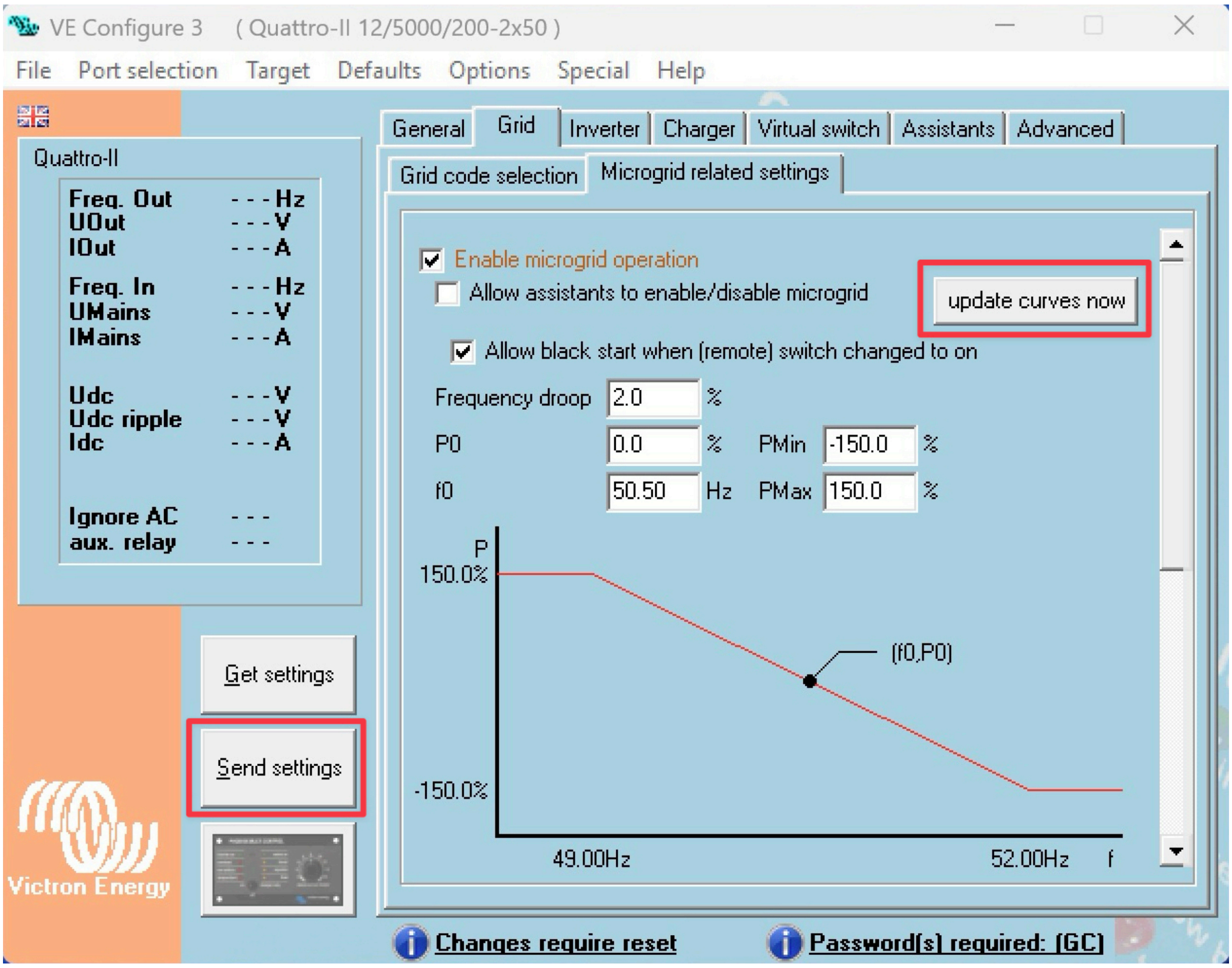
This mechanism ensures that permanent configuration changes are applied in a controlled manner.

Active Runtime Storage

When pressing “Update curves now”, the new curve data is sent directly to the Power Bank and written to the active runtime storage. In this case the updated curves become effective immediately and no system reset is required.

This function is intended for temporary adjustments or tuning during commissioning and testing.

The changes remain active until the next reset. After such an event, the system will revert to the curve stored in the non-volatile default parameter storage.



4.4.4. Hybrid droop parameter behaviour reference

The following table summarises all configurable Hybrid Droop parameters and describes the effect of adjusting each one.

P–f droop : Active Power (P) vs Frequency (f)

Parameter	Controls	Effect when changed
Frequency droop [%]	Slope of the P–f characteristic curve	A lower percentage produces a steeper slope, resulting in less frequency deviation under load and a stiffer system response. A higher percentage produces a flatter slope, allowing more frequency deviation but softer load transitions.
f_0	Reference frequency	Shifts the operating point along the frequency axis. At this frequency, the inverter delivers the active power defined by P_0.

Parameter	Controls	Effect when changed
P_0	Active power output at f_0	Shifts the droop curve vertically. Increasing P_0 biases more active load toward this Power Bank at the reference frequency. Decreasing P_0 reduces its share.
P_max / P_min	Active power output limits	Clamps the active power contribution regardless of droop calculation. Prevents overload at the upper limit and reverse power flow at the lower limit. Values are expressed as a percentage of nominal inverter power.

Q–U droop : Reactive Power (Q) vs Voltage (U)

Parameter	Controls	Effect when changed
Voltage droop [%]	Slope of the Q–U characteristic curve	A lower percentage produces a steeper slope, resulting in stiffer voltage regulation and less voltage deviation under reactive load. A higher percentage produces a flatter slope, allowing more voltage deviation.
U_0	Reference voltage	Shifts the operating point along the voltage axis. At this voltage, the inverter delivers the reactive power defined by Q_0.
Q_0	Reactive power output at U_0	Shifts the droop curve vertically. Increasing Q_0 causes the Power Bank to inject more reactive power at the reference voltage. Decreasing Q_0 reduces its reactive contribution.
Q_max / Q_min	Reactive power output limits	Clamps the reactive power contribution regardless of droop calculation. Must be configured within the inverter's apparent power (VA) capability. Values are expressed as a percentage of nominal inverter power.

All percentage-based power values refer to the nominal active power of the inverter/charger system, which equals 80 to 90 percent of its VA rating (depending on the device model). This scaling also applies to reactive power.

Above 30% nominal active power, the minimum achievable power factor is limited to cosφ = 0.7. This means available reactive power decreases as active power increases. The Q–U droop limits must be configured with this constraint in mind to avoid requesting reactive power the inverter cannot deliver.

4.5. GX user interface and VRM monitoring

This chapter covers three layers of monitoring and visibility: the GX device local user interface, the VRM portal for individual Power Bank monitoring, and VRM Installation Groups for aggregated Microgrid-wide monitoring.

Each Power Bank in a Microgrid operates independently, and each may have its own GX device connected via VE.Bus to its inverter/charger system. While a GX device is not mandatory, it is strongly recommended. It provides local visibility into the Power Bank's operating state and, when connected to the internet, enables remote monitoring through the Victron Remote Management (VRM) portal.

Venus OS v3.70 or later is required for Microgrid support on the GX device.

Ensure the GX device firmware is updated before commissioning. Refer to the Venus OS version guidance in the [Configuration] chapter, Section 4.5.

4.5.1. GX Device role in the Microgrid

Each GX device monitors a single Power Bank. It connects to the inverter/charger system (MultiPlus, Quattro, MultiPlus-II, or Quattro-II) via VE.Bus and, optionally, to DC charging sources (MPPT solar chargers, battery monitors) via VE.Direct or VE.Can.

In a Microgrid with multiple Power Banks, there is no direct communication between GX devices. Each GX device sees only its own Power Bank. Microgrid-wide visibility is achieved through VRM Installation Groups, described in Section 4.

The GX device provides two categories of information relevant to Microgrid:

1. **Operational data.** Real-time readings from the VE.Bus device detail page: AC input voltage and frequency, AC power, DC bus voltage, battery SoC, inverter/charger state, and active AC input.

2. **Microgrid parameters.** A dedicated Microgrid submenu displaying the active Hybrid Droop control mode and its configured parameters. These values are read from the inverter/charger firmware settings and displayed for verification.

4.5.2. GX Local User Interface

VE.Bus Device detail page

Navigate to the VE.Bus device detail page from the GX device overview. Select the inverter/charger device from the device list (e.g. "MultiPlus 12/2000/80-32").

The page displays the following fields:

Table 1. Available information

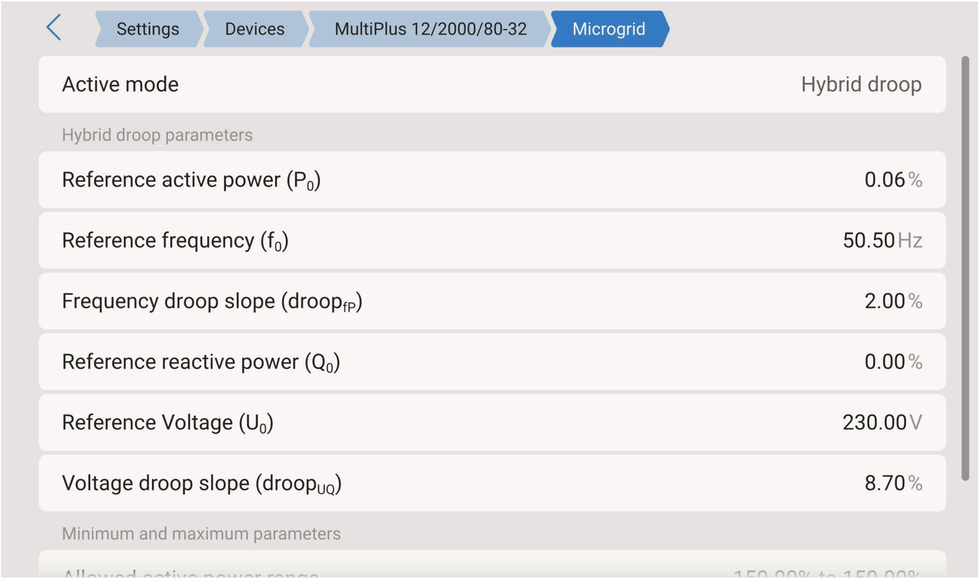
Field	Description	Microgrid relevance
Mode	Current operating mode of the inverter/charger.	Must read **On**. If set to Charger-only or Inverter-only, the Power Bank cannot participate in Hybrid Droop control.
State	Operational state (e.g. Assisting, Bulk, Absorption, Float, Inverting).	**Assisting** indicates the Power Bank is synchronised to the Microgrid AC bus and actively participating.
Grid current limit	Maximum AC input current setting.	Set to the maximum allowed value per the [Configuration] chapter, Section 4.3.
AC In	Power (W), voltage (V), current (A), and frequency (Hz) on the AC input, which in a Microgrid is the shared AC bus connected to AC-IN (MultiPlus / MultiPlus-II) or AC-IN-2 (Quattro / Quattro-II).	Frequency is the primary diagnostic value. In a Microgrid operating under Hybrid Droop, AC bus frequency reflects aggregate active power load via the P–f droop relationship. A frequency of f0 (default 50.50 Hz) indicates the Power Bank is at its reference active power (P0). Frequency below f0 indicates the bus is loaded above P0; frequency above f0 indicates it is loaded below P0.
AC Out	Power (W), voltage (V), current (A), and frequency (Hz) on the AC output terminals.	In a Microgrid, AC-OUT-1 and AC-OUT-2 are not used and must remain disconnected. The AC Out readings may show small residual values but are not operationally relevant.
Active AC Input	Indicates which AC input terminal is in use.	Confirms the Power Bank is connected to the Microgrid AC bus via the correct input terminal.
DC	Power (W), voltage (V), current (A), and battery SoC (%).	SoC is critical for operational awareness. The lowest Power Bank SoC in the Microgrid drives load-shedding and shutdown decisions, per the [Operation] chapter.

The "AC In" frequency reading is the single most important value for Microgrid monitoring at the local GX level.

It serves as a real-time proxy for aggregate percentage load on the Microgrid AC bus. An installer or operator observing bus frequency can immediately assess whether the Microgrid is lightly loaded (frequency near or above f0), moderately loaded (frequency noticeably below f0), or approaching capacity (frequency near the lower droop limit).

Microgrid submenu

Navigate to the Microgrid submenu via Settings → Devices → [VE.Bus device name] → Microgrid.



This page displays the Hybrid Droop parameters currently configured in the inverter/charger firmware.

These values are read-only on the GX device, they are configured using VEConfigure 3 and VE.Bus System Configurator, per the [Configuration] chapter, Section 4.4.

The Microgrid submenu displays:

Table 2. Microgrid submenu

Parameter	Value	Description
Active mode	Hybrid Droop	Confirms the inverter/charger is operating in Microgrid Hybrid Droop mode.
Reference active power (P_0)	0.06%	The active power setpoint at the reference frequency f0. Expressed as a percentage of nominal active power.
Reference frequency (f_0)	50.50 Hz	The AC bus frequency at which the Power Bank delivers P0.
Frequency droop slope ($droop_{fP}$)	2.00%	The P–f droop slope. Determines how much the Power Bank adjusts its active power output per unit of frequency deviation.
Reference reactive power (Q_0)	0.00%	The reactive power setpoint at the reference voltage U0.
Reference Voltage (U_0)	230.00 V	The AC bus voltage at which the Power Bank delivers Q0.
Voltage droop slope ($droop_{UQ}$)	8.70%	The Q–U droop slope. Determines how much the Power Bank adjusts its reactive power output per unit of voltage deviation.

Below the droop parameters, the submenu displays the allowed operating range:

Parameter	Default value
Allowed active power range	−150.00% to 150.00%
Allowed reactive power range	−50.00% to 50.00%

Use this page to verify that the Hybrid Droop parameters match the intended design.

When commissioning a Microgrid with multiple Power Banks, check that all Power Banks display identical droop parameters, unless intentional asymmetric load sharing has been designed, per the [Configuration] chapter, Section 4.4.

If the Microgrid submenu does not appear in the device menu, verify that the inverter/charger is running firmware with S97 or S98 subversion and that the GX device is running Venus OS v3.70 or later.

4.5.3. VRM portal, individual Power Bank monitoring

Each GX device in the Microgrid registers as a separate installation on the VRM portal (vrm.victronenergy.com). When a GX device is connected to the internet and registered to a VRM account, it continuously uploads system data.

Each Power Bank's VRM installation provides:

- **Dashboard.** Real-time overview of battery SoC, solar yield, AC power flows, and system state.
- **Advanced page.** Detailed historical graphs and data logging for all monitored parameters, including AC input frequency, voltage, power, and battery SoC over time.
- **Remote Console.** Full remote access to the GX device local user interface described in Section 2, including the Microgrid submenu.
- **Alarm logging and notifications.** Historical alarm records and configurable email/push notifications for alarm conditions.

For Microgrid monitoring, the most valuable VRM data points per installation are:

- **Battery State of Charge trend.** Track each Power Bank's SoC over time to identify imbalances between Power Banks. Because there is no automatic SoC balancing between Power Banks, diverging SoC trends may indicate unequal DC charging capacity or load distribution.
- **AC input frequency trend.** The bus frequency logged by each Power Bank provides a historical view of Microgrid loading. Since all Power Banks are on the same AC bus, their frequency readings should be consistent.
- **Inverter/charger state transitions.** State changes (Assisting, Bulk, Absorption, Float) indicate when a Power Bank is contributing to the Microgrid, or disconnected.

Use consistent, descriptive installation names for each Power Bank (e.g. "Site Name PB1", "Site Name PB2") to simplify identification when working with multiple installations.

4.5.4. VRM portal, Microgrid monitoring with Installation groups

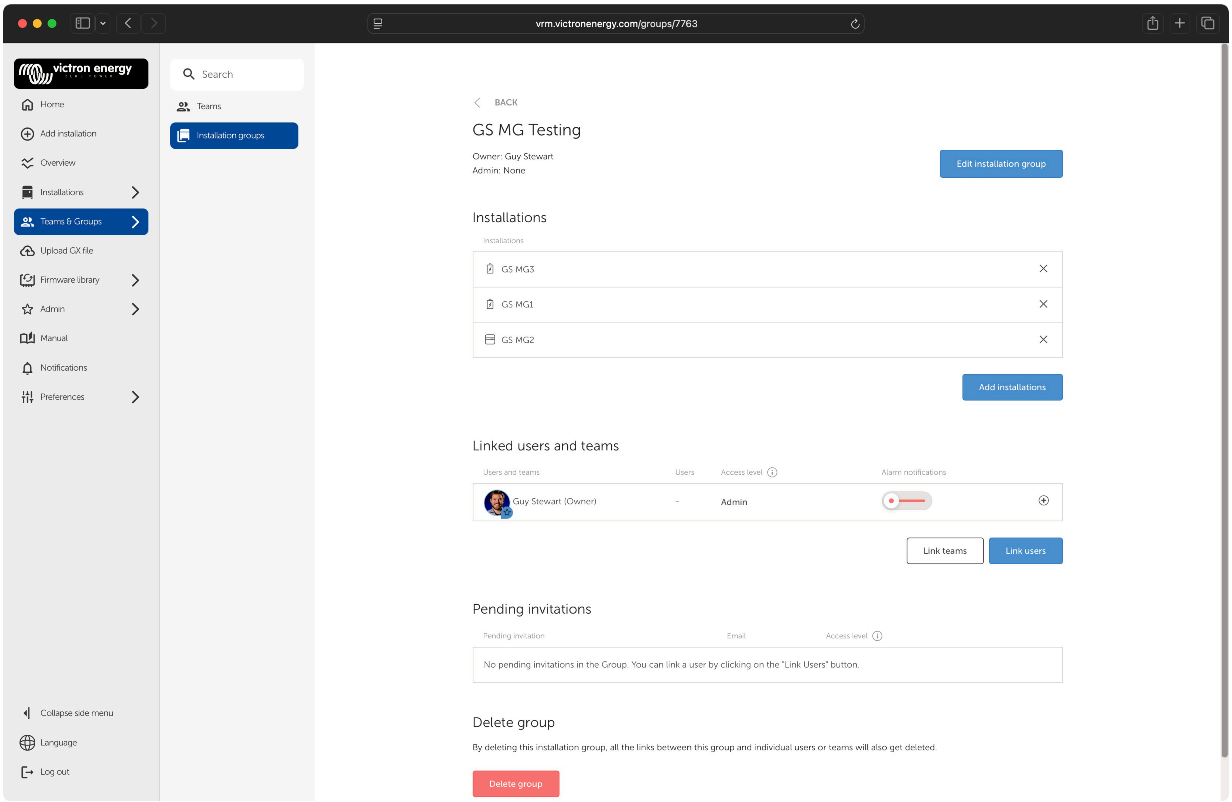
When a Microgrid contains multiple Power Banks, each with its own GX device and VRM installation, it's possible to monitor them individually and collectively.

VRM Installation Groups provide a mechanism to view all Power Banks belonging to a single Microgrid in a unified list with aggregated totals.

Creating an Installation Group

1. Log in to the VRM portal.
2. Navigate to **Teams & Groups** in the left sidebar.
3. Select **Installation groups.**
4. Click **Create installation group** in the upper right.
5. Enter a descriptive group name that identifies the Microgrid site.
6. Click **Create installation group** to confirm.

A VRM account can contain multiple Installation Groups. Only installations to which the account has full access can be added to a group.



Adding Power Banks to the Group

After creating the group:

1. Open the group by clicking its name in the Installation groups list.
2. Click **Add installations**
3. Select each GX device installation that belongs to the Microgrid (e.g. "GS MG1", "GS MG2", "GS MG3").
4. Confirm the selection.

All Power Banks in the Microgrid should be added to the same group. The group detail page displays the list of included installations and allows adding or removing installations at any time.

Linking Users and Teams

The Installation group detail page also allows access management.

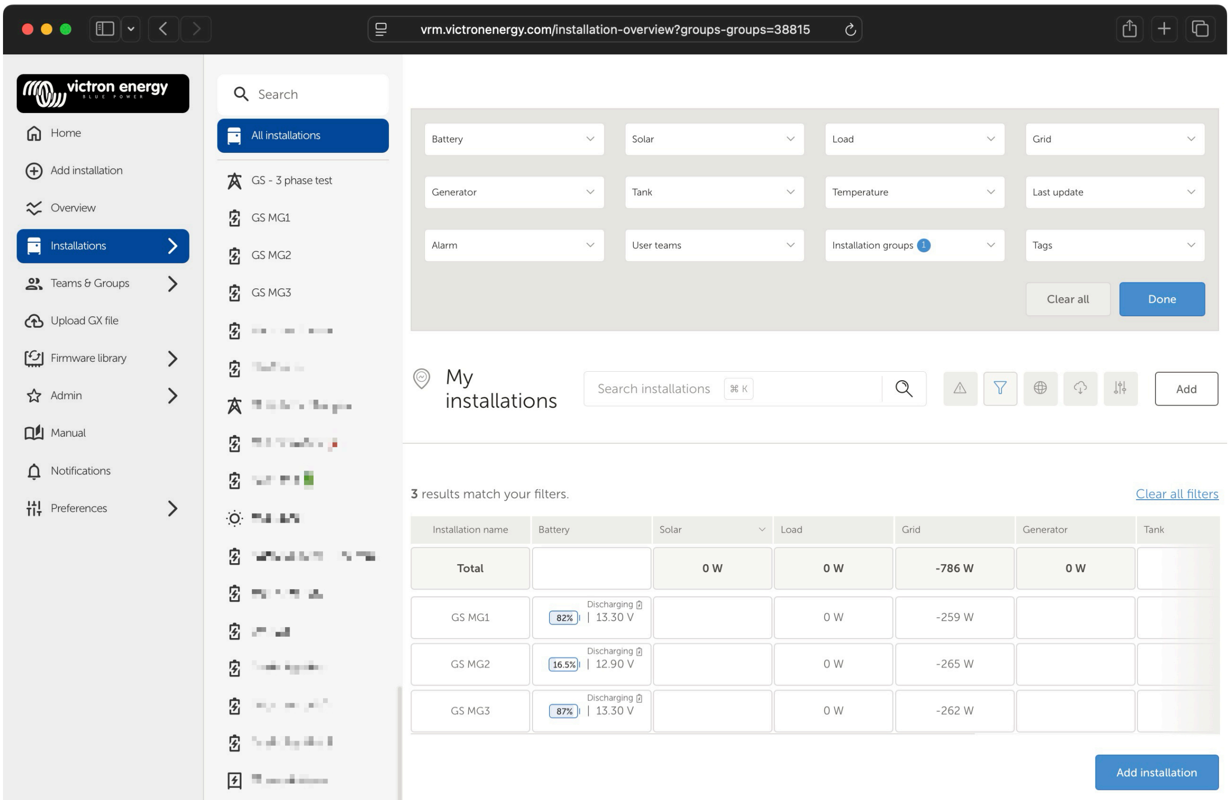
Under **Linked users and teams**, link additional VRM users or teams who need visibility into the Microgrid. Each linked user or team is assigned an access level (e.g. Admin) and can optionally receive alarm notifications.

Use this feature to grant monitoring access to site operators, maintenance personnel, or remote support teams without sharing credentials for individual installations.

Viewing the Microgrid as a group

Once the Installation Group is created and populated:

1. Navigate to **Installations** in the left sidebar.
2. Select **All Installations.**
3. Open the filter panel
4. Set the **Installation groups** filter to the Microgrid group name.
5. Click **Done** to apply the filter.



The filter set is stored in the URL, so if you want to create a shortcut to this filtered view, create a bookmark.

The Installations list now shows only the Power Banks belonging to the selected Microgrid. The view includes:

- **A Total row** at the top, displaying the sum of Solar, Load, Grid, and Generator power across all Power Banks in the group. This provides the aggregated Microgrid-wide power flow at a glance.
- Note: In a Microgrid configuration, the inverter operates by pushing power via the AC input. This is reflected as a 'grid export' in the Total row and other elements of the UI. Its normal for the column labeled Load to show zero.
- **Individual Power Bank rows** below the Total, each showing: installation name, battery SoC and voltage, solar yield, load power, and last update timestamp.

This is the primary Microgrid-wide monitoring view. Use it to:

- **Compare SoC across Power Banks.** Significant SoC divergence between Power Banks (e.g. one at 82% while another is at 17%) indicates an imbalance that requires investigation, typically unequal DC charging capacity, different battery sizes, or differing load history.
- **Verify all Power Banks are online.** The "Last update" column confirms each GX device is communicating. A stale timestamp may indicate a GX device has lost internet connectivity or the Power Bank has shut down.
- **Monitor aggregate load.** The Total row provides a quick check on whether the Microgrid is operating within its aggregate continuous rating (P_total = sum of 80% × VA per Power Bank).
- **Check for alarms.** The Alarm column shows whether any Power Bank has active alarms. A count of "0/N" (where N is the number of Power Banks) indicates no active alarms.

Using filters for targeted monitoring

The VRM Installations view provides additional filter dropdowns beyond Installation groups: Battery, Solar, Load, Grid, Generator, Tank, Temperature, Last update, Alarm, User teams, and Tags.

These filters can be combined with the group filter to further narrow the view, for example, filtering for Power Banks with active alarms, or sorting by battery SoC to identify the lowest Power Bank.

4.6. Venus OS version

If a GX device is used, it should be updated to Venus OS version 3.70 or later.

5. Operation

5.1. General

In Microgrid (Hybrid Droop) systems, the AC bus is jointly formed and stabilized by all participating Victron Power Banks.

Unlike grid-connected systems with a stiff utility reference, small variations in frequency and voltage are normal and expected during operation. These variations are part of the droop control mechanism and allow automatic load sharing between Power Banks.

Minor frequency deviations under changing load conditions are therefore a functional characteristic of the system.

Operating mode of Inverter/Chargers

During Microgrid operation, always ensure that all inverter/chargers in all participating Power Banks are set to "On".

No inverter/charger may be set to:

- Charger-only, or
- Inverter-only

Verify the correct operating mode for the physical switch, in VE.Configure, the GX device, and VRM (if applicable).

5.2. Startup & Shutdown procedure

Microgrid startup procedure (from Black Start)

1. **Isolate all loads from the Microgrid AC bus**. Ensure the AC bus is unloaded before energizing the system.
2. **Start all Power Banks one by one.** Power up each Power Bank individually.
3. **Wait for all Power Banks to connect to the Microgrid.** Each Power Bank will either:
   - Detect an existing energized AC bus and synchronize to it, or
   - If permitted, initiate a black start and energize the bus.
4. **Reconnect the loads to the AC bus.**

During startup, each Power Bank checks for voltage at its configured AC input. It determines whether it must synchronize to an existing Microgrid or initiate operation itself.

> ⚠ Do not connect additional Power Banks that are already switched on to an energized Microgrid AC bus. This may cause overload or overcurrent protection devices to trip.

If this occurs unintentionally, no damage will result. Switch the affected Power Bank off and restart it following the procedure above.

Partial startup (adding individual Power Banks to a energised Microgrid)

1. **Ensure the Power Bank's inverter/chargers are switched off**
2. **Close the circuit breaker on the Power Bank** to energise the circuit from the Microgrid to the AC-IN of the Inverter/Charger.
3. **Switch on the inverter/charger(s)**.
4. **Power Bank will detect the energised AC bus**, synchronise, and join the Microgrid automatically.

Planned full shutdown procedure

1. **Turn off all loads connected to the AC bus** before shutting down any individual Power Bank, or the Microgrid as a whole. This reduces the power demand on the remaining Power Banks as they are taken offline and prevents transient overloads during the shutdown process.
2. **Switch off Power Banks one by one.** This can be done remotely via the GX device, or physically via the switch at the inverter/chargers. Each time a Power Bank is taken offline, the remaining units automatically take over the load previously supplied by that Power Bank through Hybrid Droop control. Allow a few seconds between each disconnection for the AC bus to stabilise and minimise any spurious warning or alarm messages.
3. **AC bus is de-energised once the last Power Bank is switched off**

4. **Verify that no voltage is present** on the Microgrid AC bus after all Power Banks have been shut down before performing any maintenance or wiring changes.

Partial shutdown (removing individual Power Banks)

Procedure to take a single Power Bank offline while the Microgrid remains operational

1. **Ensure the remaining Power Banks** have sufficient combined power capacity to sustain the full system load before removing a unit. Removing a Power Bank without adequate remaining capacity will cause the remaining units to overload and shut down the Microgrid.

2. **Switch off the inverter/charger(s)** the remaining Power Banks will automatically take over the load previously supplied by the disconnected Power Bank through Hybrid Droop control.

3. **Open the overcurrent protection device** (circuit breaker) between the Power Bank to be removed and the Microgrid AC bus. This safely isolates the terminals at AC input (from the Microgrid) and allows removal of the Inverter/Charger.

Emergency shutdown

1. **Prioritise de-energising the system**.

   In the event of an equipment fault, safety hazard, or other emergency, switch off all Power Banks as quickly as possible. Do not follow the planned sequential shutdown order.

2. If individual Power Banks cannot be switched off at the unit, open all overcurrent protection devices (circuit breakers) between the Power Banks and the Microgrid AC bus to isolate the system.

3. **After an emergency shutdown, do not restart the Microgrid until the cause of the emergency has been identified and resolved**. Before re-energising, inspect and test all AC and DC wiring, protection devices, and battery systems for signs of damage, overheating, or fault conditions.

4. When restarting after an emergency shutdown, follow the standard startup procedure described in the Startup procedure section. Begin with a single black-start-enabled Power Bank and add remaining units sequentially, monitoring for correct synchronisation and stable AC bus behaviour at each step.

5.3. Recovering from tripped circuit breaker

If the overcurrent protection device between a Power Bank and the Microgrid AC bus trips:

1. **Switch the affected Power Bank off.**

2. **Identify and eliminate the cause of the trip**. Verify that no overload, wiring fault, or configuration issue is present.

3. **Reset the circuit breaker**, restoring the AC connection to the Microgrid AC bus.

4. **Switch the Power Bank on**. The unit will synchronize to the energized AC bus and resume participation in load sharing

If the breaker trips repeatedly, investigate system sizing, protection coordination, and load conditions before attempting another restart.

5.4. Battery Recharging

In a Victron Microgrid system, each Power Bank manages and charges its own battery independently.

While all Power Banks share the AC bus for load supply via Hybrid Droop control, the Microgrid AC bus is not intended for coordinated battery charging between Power Banks.

Each Power Bank must therefore be equipped with its own DC-side charging source, such as:

- DC-coupled PV (MPPT charge controllers)
- DC genset
- Dedicated AC charger supplied from an external source (e.g. grid or separate genset)

Battery management – including state of charge monitoring, charge control, and protection limits – is handled locally within each Power Bank. There is no automatic state-of-charge balancing between different Power Banks.

> To enable battery charging from the grid or an AC genset, an additional set of inverter/chargers may be operated in “charger-only” mode.
>
> When using VE.Bus inverter/chargers, their separate VE.Bus network can be connected to the GX device of the Power Bank via USB, using an MK3-USB interface.

5.4.1. Important considerations for simultaneously fully charged Power Banks

When multiple Victron Power Banks are connected in Microgrid there are some additional requirements at the end of the battery charge cycle.

For overall system stability, hybrid droop control needs the ability for at least one of the Power Banks to absorb some power, as the system finds equilibrium during adjustments to voltage and frequency.

If all Power Bank batteries are full and charging continues, the surplus energy has nowhere to go. This can cause power to circulate between Power Banks as they try to find equilibrium between demand and supply, and potentially overcharge the batteries (which will cause the Power Bank to disconnect from the AC bus).

To avoid this, apply at least one of the following charging strategies.

1. **Strategy 1: Don't fully charge all Power Banks at the same time.**

   Configure charging so that at least one Power Bank always remains below fully charged at all times.

   This Power Bank then provides charge headroom and can absorb surplus energy. That allows it to keep participating in droop-based load sharing and helps maintain AC bus stability.

2. **Strategy 2: Minimum base load when simultaneously fully charged**

   If all Power Banks are fully charged at the same time, other measures are needed.

   Maintain a minimum AC base load: Keep a continuous load of at least 2% of the combined nominal power of all connected Power Banks on the AC bus. This can be provided by a dedicated dump load or another permanently connected load.

   The base load provides real demand on the AC bus, so droop control can continue to regulate the system correctly.

   > This minimum base load requirement only applies when battery voltage of all Power Banks approaches or exceeds the configured float voltage and there is active charging.
   >
   > There is no base load requirement when the batteries are at less than full states of charge, when the batteries can absorb the power instead.

5.4.2. Why imbalances occur

In a Microgrid system, each Power Bank manages its own battery independently.

Over time, differences in battery state of charge between Power Banks will naturally develop due to variations in DC charging supply (e.g. differing PV array sizes, orientation, or shading conditions), differences in battery capacity or age-related degradation, and individual Power Bank loading history if droop parameters have been intentionally offset.

These imbalances are a normal characteristic of Microgrid operation and must be understood and managed to maintain reliable system operation.

What happens when a Power Bank's battery is depleted

As a Power Bank's battery approaches its low state of charge or low voltage disconnect threshold, the battery management system (BMS) or the inverter/charger's internal protection will reduce and eventually cease discharge.

Specific behaviour depends on the battery type and BMS configuration, but the general sequence is:

Once the battery reaches the disconnect threshold, the inverter/charger shuts down and the Power Bank ceases to contribute to the AC bus.

The internal transfer switch opens, electrically disconnecting the Power Bank from the Microgrid bus.

The remaining Power Banks on the Microgrid AC bus absorb the shortfall through Hybrid Droop control. The bus frequency shifts slightly, causing other units to increase their output proportionally.

A depleted Power Bank does not become a load on the AC bus. The inverter/charger does not draw power from the Microgrid to charge its own battery via the AC input in normal Microgrid operation.

When a Power Bank disconnects due to a depleted battery, the total available inverter capacity on the Microgrid AC bus is reduced.

The remaining Power Banks will automatically absorb the additional load. If the remaining capacity is sufficient, the system continues to operate normally with a slight shift in bus frequency and voltage to trigger the increased per-unit loading.

If the loss of a Power Bank causes the remaining units to exceed their rated capacity, the system may become overloaded. In this case, frequency and voltage will deviate beyond normal operating limits and individual units may trip on overload or overcurrent protection. For this reason, system sizing should account for the possibility of one or more Power Banks dropping out due to battery depletion.

Monitoring and early intervention

Where a GX device is installed in each Power Bank, monitor battery state of charge across the Microgrid with a VRM Portal installation group.

Significant divergence in state of charge between Power Banks is an early indicator that one unit may deplete and shut down before the others.

If monitoring reveals a persistent SOC imbalance, investigate the underlying cause. Common factors include unequal DC charging capacity between Power Banks (e.g. one PV array is undersized or partially shaded), a degraded battery in one Power Bank with reduced usable capacity, and droop parameter offsets that are causing one Power Bank to deliver disproportionately more power than its charging source can sustain.

In systems without GX devices or remote monitoring

Establish a regular inspection schedule to check battery voltage or state of charge on each Power Bank. Address significant imbalances before they result in a Power Bank disconnecting unexpectedly under load.

Power Bank has disconnected due to a depleted battery (low battery voltage)

The Power Bank will automatically rejoin the Microgrid when its battery is recharged (e.g from solar the next morning). The unit does not need to be restarted manually, once the battery voltage is sufficient it will detect the energised AC bus and re-synchronise.

6. Troubleshooting

General troubleshooting

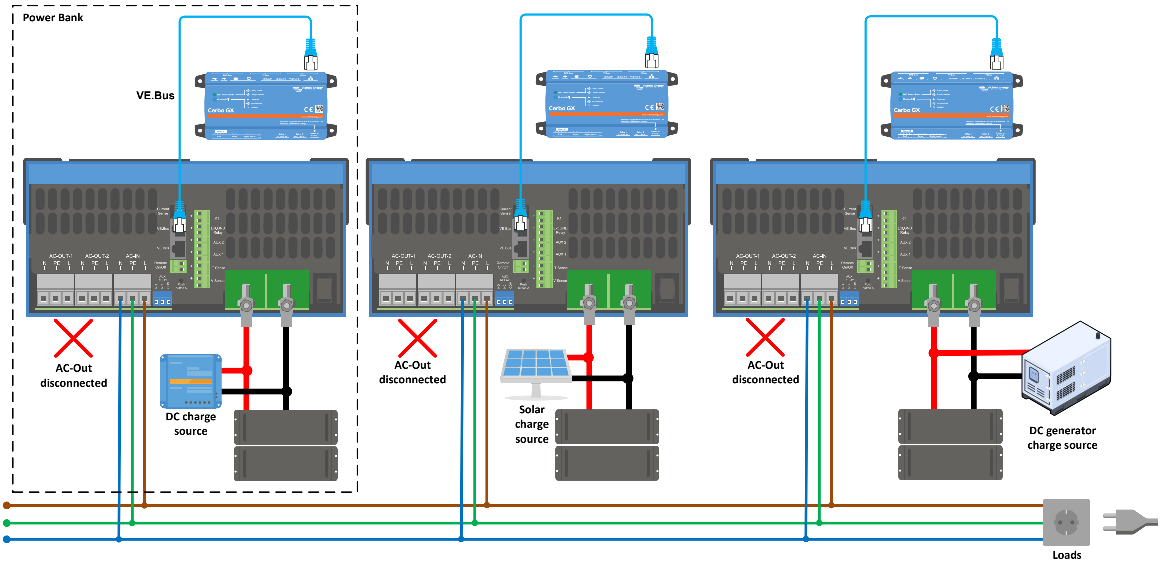
If the system exhibits strange behaviour, please contact your Victron dealer for assistance.

Constraints

- The programmable relays on L2, L3, and all slave units **cannot** be used.
- The VictronConnect app cannot be used for system configuration and current sensor settings. Use **VE.Configure 3** and **VE.Bus System Configurator** software instead.

7. Wiring Diagrams

This diagram shows three Power Banks in a single phase Microgrid system. Each Power Bank is connected to the Microgrid AC bus via the AC input of the inverter/charger, and has an independent DC charge source. AC output is not used, and not connected. VE.Bus is used to connect each Inverter/Charger to its own GX device.



This single line diagram shows nine inverter/chargers with different battery configurations in a three phase Microgrid. In this example, Power Bank 2 utilises an additional MultiPlus that is not configured for Microgrid to charge batteries from an AC source.