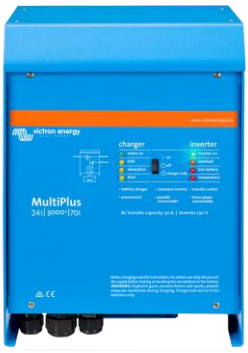
MultiPlus Inverter/Chargers 2 kVA and 3 kVA

www.victronenergy.com

(120 V/60 Hz) Lithium-Ion battery compatible



MultiPlus
24/3000/70

MultiPlus Compact
12/2000/80

Multifunctional, with intelligent power management

The MultiPlus is a powerful true sine wave inverter, a sophisticated battery charger that features adaptive charge technology, and a high-speed AC transfer switch in a single compact enclosure. Next to these primary functions, the MultiPlus has several advanced features, as outlined below.

Two AC Outputs

The main output has no-break functionality. The MultiPlus takes over the supply to the connected loads in the event of a grid failure or when shore-/generator power is disconnected. This happens so fast (less than 20 milliseconds) that computers and other electronic equipment will continue to operate without disruption.
The second output is live only when AC is available on the input of the MultiPlus. Loads that should not discharge the battery, like a water heater for example, can be connected to this output (second output available on models rated at 3kVA and more).

Virtually unlimited power thanks to parallel operation

Up to six Multis can operate in parallel to achieve higher power output. Six 24/3000/70 units, for example, provide 15kW / 18kVA output power with 420 Amps of charging capacity.

Three phase capability

In addition to parallel connection, three units can be configured for three-phase output. But that's not all: with three strings of six parallel units a 45 kW / 54 kVA three phase inverter and 1260 A charger can be built.

Split phase options

Two units can be stacked to provide 120-0-120 V, and additional units can be paralleled up to a total of 6 units per phase, to supply up to 30 kW / 36 kVA of split phase power.
Alternatively, a split phase AC source can be obtained by connecting our autotransformer (see data sheet on www.victronenergy.com) to a 'European' inverter programmed to supply 240 V / 60 Hz.

PowerControl - Dealing with limited generator, shore side or grid power

The MultiPlus is a very powerful battery charger. It will therefore draw a lot of current from the generator or shore side supply (nearly 20 A per 3 kVA MultiPlus at 120 VAC). With the Multi Control Panel a maximum generator or shore current can be set. The MultiPlus will then take account of other AC loads and use whatever is extra for charging, thus preventing the generator or shore supply from being overloaded.

PowerAssist - Boosting the capacity of shore or generator power

This feature takes the principle of PowerControl to a further dimension. It allows the MultiPlus to supplement the capacity of the alternative source. Where peak power is so often required only for a limited period, the MultiPlus will make sure that insufficient shore or generator power is immediately compensated for by power from the battery. When the load reduces, the spare power is used to recharge the battery.

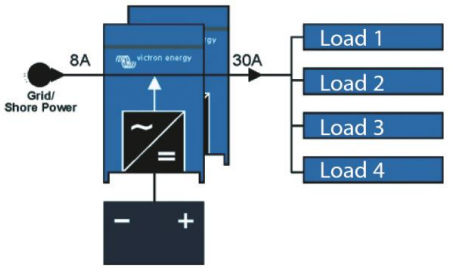
Four stage adaptive charger and dual bank battery charging

The main output provides a powerful charge to the battery system by means of advanced 'adaptive charge' software. The software fine-tunes the three stage automatic process to suit the condition of the battery, and adds a fourth stage for long periods of float charging. The adaptive charge process is described in more detail on the Phoenix Charger datasheet and on our website, under Technical Information. In addition to this, the MultiPlus will charge a second battery using an independent trickle charge output intended for a main engine or generator starter battery.

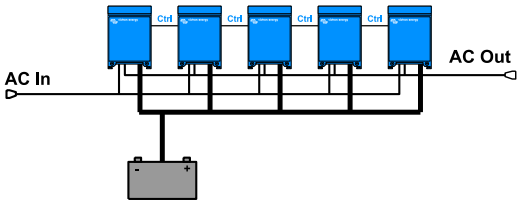
System configuring has never been easier

After installation, the MultiPlus is ready to go.
If settings have to be changed, this can be done in a matter of minutes with a DIP switch setting procedure. Even parallel and 3-phase operation can be programmed with DIP switches: no computer needed!
Alternatively, VE.Net can be used instead of the DIP switches.
And sophisticated software (VE.Bus Quick Configure and VE.Bus System Configurator) is available to configure several new, advanced, features.

PowerAssist with 2x MultiPlus in parallel



Five parallel units: output power 12,5 kW



MultiPlus	12 Volt 24 Volt	12/2000/80 24/2000/50	12/3000/120 24/3000/70
PowerControl		Yes	
PowerAssist		Yes	
Transfer switch (A)		50	
Parallel and 3-phase operation		Yes	
INVERTER			
Input voltage range (V DC)		9,5 – 17 V	19 – 33 V
Output		Output voltage: 120 VAC ± 2%	Frequency: 60 Hz ± 0,1% (1)
Cont. output power at 25°C / 77°F (VA) (3)		2000	3000
Cont. output power at 25°C / 77°F (W)		1600	2400
Cont. output power at 40°C / 104°F (W)		1450	2200
Cont. output power at 65°C / 150°F (W)		1100	1700
Peak power (W)		4000	6000
Maximum efficiency (%)		92 / 94	93 / 94
Zero load power (W)		9 / 11	20 / 20
Zero load power in AES mode (W)		7 / 8	15 / 15
Zero load power in Search mode (W)		3 / 4	8 / 10
CHARGER			
AC Input		Input voltage range: 95-140 VAC	Input frequency: 45 – 65 Hz Power factor: 1
Charge voltage 'absorption' (V DC)		14,4 / 28,8	
Charge voltage 'float' (V DC)		13,8 / 27,6	
Storage mode (V DC)		13,2 / 26,4	
Charge current house battery (A) (4)		80 / 50	120 / 70
Charge current starter battery (A)		4	
Battery temperature sensor		yes	
GENERAL			
Auxiliary output (5)		n. a.	Yes (32A)
Programmable relay (6)		Yes (1x)	Yes (3x)
Protection (2)		a - g	
VE.Bus communication port		For parallel and three phase operation, remote monitoring and system integration	
General purpose com. port (7)		n. a.	Yes (2x)
Remote on-off		Yes	
Common Characteristics		Operating temp. range: -40 - +65°C / -40 to 150°F (fan assisted cooling)	Humidity (non-condensing): max 95%
ENCLOSURE			
Common Characteristics		Material & Colour: aluminium (blue RAL 5012)	Protection category: IP 21
Battery-connection		M8 bolts	M8 bolts (2 plus and 2 minus connections)
120 V AC-connection		Screw-terminal 6 AWG (13 mm²)	Screw-terminal 6 AWG (13mm²)
Weight		13 kg 25 lbs.	19kg 40 lbs.
Dimensions (hxwxd in mm and inches)		520x255x125 mm 20.5x10.0x5.0 inch	362x258x218 mm 14.3x10.2x8.6 inch
STANDARDS			
Safety		EN-IEC 60335-1, EN-IEC 60335-2-29	UL 1741, UL 458, EN-IEC 60335-1, EN-IEC 60335-2-29
Emission and Immunity		EN-IEC 61000-3-2/3-3/, EN-IEC 61000-6-1/6-2/6-3	EN-IEC 61000-3-2/3-3/, EN-IEC 61000-6-1/6-2/6-3

1) Can be adjusted to 60 HZ; 120 V 60 Hz on request
2) Protection key:
a) output short circuit
b) overload
c) battery voltage too high
d) battery voltage too low
e) temperature too high
f) 230 VAC on inverter output
g) input voltage ripple too high
3) Non-linear load, crest factor 3:1
4) At 75˚F ambient
5) Switches off when no external AC source available
6) Programmable relay that can a.o. be set for general alarm,
DC under voltage or genset start/stop function
AC rating: 230V/4 A
DC rating: 4 A up to 35 VDC, 1 A up to 60 VDC
7) A.o. to communicate with a Lithium Ion battery BMS

Digital Multi Control

A convenient and low cost solution for remote monitoring, with a rotary knob to set PowerControl and PowerAssist levels.

Computer controlled operation and monitoring

Several interfaces are available:

Color Control GX and other GX devices

Provides monitor and control. Locally, and also remotely on the VRM Portal.

BMV-712 Smart Battery Monitor

Use a smartphone or other Bluetooth enabled device to:
- customize settings,
- monitor all important data on single screen,
- view historical data, and to
- update the software when new features become available.

VE.Bus Smart Dongle

Measures battery voltage and temperature and allows monitoring and control of Multis and Quattros with a smartphone or other

Bluetooth enabled device.

MK3-USB VE.Bus to USB interface

Connects to a USB port (see 'A guide to VEConfigure')

VE.Bus to NMEA 2000 interface

Connects the device to a NMEA2000 marine electronics network. See the NMEA2000 & MFD integration guide

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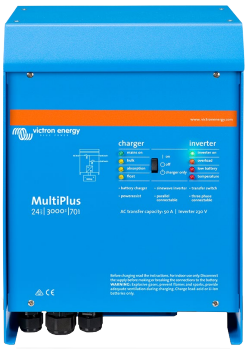
General phone: +31 (0)36 535 97 00 | E-mail: sales@victronenergy.com
www.victronenergy.com

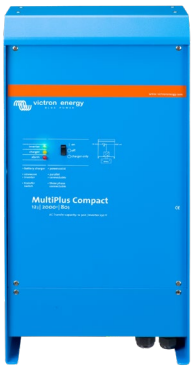
MultiPlus Inverter/Charger

800 VA – 5 kVA Lithium Ion battery compatible

www.victronenergy.com



MultiPlus
24/3000/70



MultiPlus Compact
12/2000/80

Two AC Outputs

The main output has no break functionality. The MultiPlus takes over the supply to the connected loads in the event of a grid failure or when shore/generator power is disconnected. This happens so fast (less than 20 milliseconds) that computers and other electronic equipment will continue to operate without disruption. The second output is live only when AC is available on the input of the MultiPlus. Loads that should not discharge the battery, like a water heater for example can be connected to this output (second output available on models rated at 3 kVA and more).

Virtually unlimited power thanks to parallel operation

Up to 6 Multis can operate in parallel to achieve higher power output. Six 24/5000/120 units, for example, will provide 25 kW / 30 kVA output power with 720 Amps charging capacity.

Three phase capability

In addition to parallel connection, three units of the same model can be configured for three phase output. But that's not all: up to 6 sets of three units can be parallel connected for a huge 75 kW / 90 kVA inverter and more than 2000 Amps charging capacity.

PowerControl - Dealing with limited generator, shore side or grid power

The MultiPlus is a very powerful battery charger. It will therefore draw a lot of current from the generator or shore side supply (nearly 10 A per 5 kVA Multi at 230 VAC). With the Multi Control Panel a maximum generator or shore current can be set. The MultiPlus will then take account of other AC loads and use whatever is extra for charging, thus preventing the generator or shore supply from being overloaded.

PowerAssist - Boosting the capacity of shore or generator power

This feature takes the principle of PowerControl to a further dimension. It allows the MultiPlus to supplement the capacity of the alternative source. Where peak power is so often required only for a limited period, the MultiPlus will make sure that insufficient shore or generator power is immediately compensated for by power from the battery. When the load reduces, the spare power is used to recharge the battery.

Solar energy: AC power available even during a grid failure

The MultiPlus can be used in off grid as well as grid connected PV and other alternative energy systems. Loss of mains detection software is available.

System configuring

- In case of a stand-alone application, if settings have to be changed, this can be done in a matter of minutes with a DIP switch setting procedure.
- Parallel and three phase applications can be configured with VE.Bus Quick Configure and VE.Bus System Configurator software.
- Off grid, grid interactive and self-consumption applications, involving grid-tie inverters and/or MPPT Solar Chargers can be configured with Assistants (dedicated software for specific applications).

On-site Monitoring and control

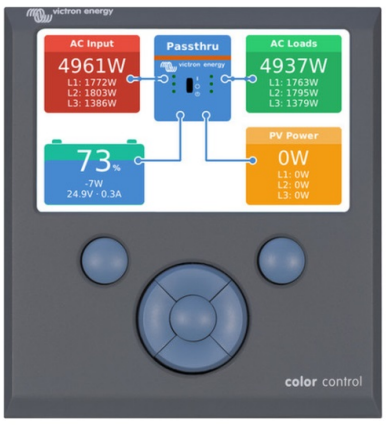
Several options are available: Battery Monitor, Multi Control Panel, Color Control GX or other GX devices, smartphone or tablet (Bluetooth Smart), laptop or computer (USB or RS232).

Remote Monitoring and control

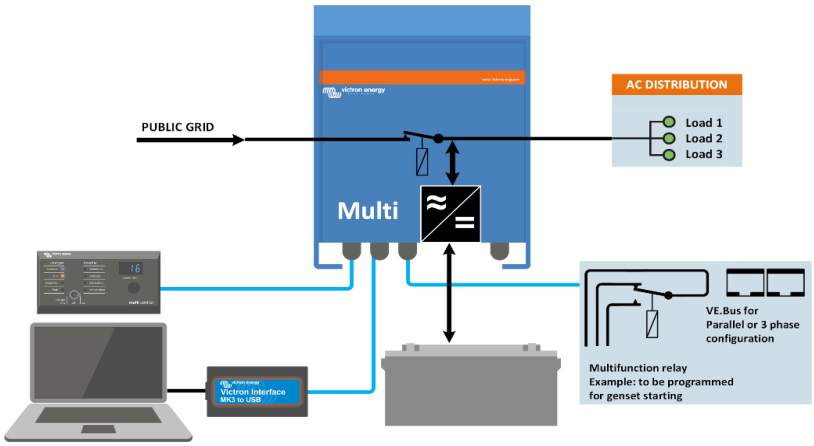
Color Control GX or other GX devices.
Data can be stored and displayed on our VRM (Victron Remote Management) website, free of charge.

Remote configuring

When connected to the Ethernet, systems with a Color Control GX or other GX device can be accessed and settings can be changed remotely.



Color Control GX, showing a PV application



MultiPlus 12 Volt / 24 Volt / 48 Volt	C 12/800/35 C 24/ 800/16	C 12/1200/50 C 24/1200/25	C 12/1600/70 C 24/1600/40	C 12/2000/80 C 24/2000/50	12/3000/120 24/3000/70 48/3000/35	24/5000/120 48/5000/70
PowerControl	Yes	Yes	Yes	Yes	Yes	Yes
PowerAssist	Yes	Yes	Yes	Yes	Yes	Yes
Transfer switch (A)	16	16	16	30	16 or 50	100
INVERTER						
Input voltage range (V DC)	9,5 – 17 V 19 – 33 V 38 – 66 V					
Output	Output voltage: 230 VAC ± 2% Frequency: 50 Hz ± 0,1% (1)					
Cont. output power at 25°C (VA) (3)	800	1200	1600	2000	3000	5000
Cont. output power at 25°C (W)	700	1000	1300	1600	2400	4000
Cont. output power at 40°C (W)	650	900	1200	1400	2200	3700
Cont. output power at 65°C (W)	400	600	800	1000	1700	3000
Peak power (W)	1600	2400	3000	4000	6000	10.000
Maximum efficiency (%)	92 / 94	93 / 94	93 / 94	93 / 94	93 / 94 / 95	94 / 95
Zero load power (W)	8 / 10	8 / 10	8 / 10	9 / 11	20 / 20 / 25	30 / 35
Zero load power in AES mode (W)	5 / 8	5 / 8	5 / 8	7 / 9	15 / 15 / 20	25 / 30
Zero load power in Search mode (W)	2 / 3	2 / 3	2 / 3	3 / 4	8 / 10 / 12	10 / 15
CHARGER						
AC Input	Input voltage range: 187-265 VAC Input frequency: 45 – 65 Hz Power factor: 1					
Charge voltage 'absorption' (V DC)	14,4 / 28,8 / 57,6					
Charge voltage 'float' (V DC)	13,8 / 27,6 / 55,2					
Storage mode (V DC)	13,2 / 26,4 / 52,8					
Charge current house battery (A) (4)	35 / 16	50 / 25	70 / 40	80 / 50	120 / 70 / 35	120 / 70
Charge current starter battery (A)	4 (12 V and 24 V models only)					
Battery temperature sensor	yes					
GENERAL						
Auxiliary output (5)	n. a.	n. a.	n. a.	n. a.	Yes (16A)	Yes (50A)
Programmable relay (6)	Yes					
Protection (2)	a - g					
VE.Bus communication port	For parallel and three phase operation, remote monitoring and system integration					
General purpose com. port	n. a.	n. a.	n. a.	n. a.	Yes	Yes
Remote on-off	Yes					
Common Characteristics	Operating temp. range: -40 to +65°C (fan assisted cooling) Humidity (non-condensing): max 95%					
ENCLOSURE						
Common Characteristics	Material & Colour: aluminium (blue RAL 5012) Protection category: IP 21					
Battery-connection	battery cables of 1.5 meter			M8 bolts	Four M8 bolts (2 plus and 2 minus connections)	
230 V AC-connection	G-ST18i connector			Spring-clamp	Screw terminals 13 mm² (6 AWG)	M6 bolts
Weight (kg)	10	10	10	12	18	30
Dimensions (hxwxd in mm)	375x214x110			520x255x125	362x258x218	444x328x240
STANDARDS						
Safety	EN-IEC 60335-1, EN-IEC 60335-2-29, IEC 62109-1					
Emission, Immunity	EN 55014-1, EN 55014-2, EN-IEC 61000-3-2, EN-IEC 61000-3-3, IEC 61000-6-1, IEC 61000-6-2, IEC 61000-6-3					
Road vehicles	12V and 24V models: ECE R10-4					
Anti-islanding	See our website					

1) Can be adjusted to 60 HZ; 120 V 60 Hz on request
2) Protection key:
a) output short circuit
b) overload
c) battery voltage too high
d) battery voltage too low
e) temperature too high
f) 230 VAC on inverter output
g) input voltage ripple too high
3) Non-linear load, crest factor 3:1
4) At 25˚C ambient
5) Switches off when no external AC source available
6) Programmable relay that can a.o. be set for general alarm,
DC under voltage or genset start/stop function
AC rating: 230 V/4A
DC rating: 4 A up to 35 VDC, 1 A up to 60 VDC

Digital Multi Control Panel

A convenient and low cost solution for remote monitoring, with a rotary knob to set PowerControl and PowerAssist levels.

Computer controlled operation and monitoring

Several interfaces are available:

Color Control GX or other GX device

Provides monitor and control. Locally, and also remotely on the VRM Portal.

MK3-USB VE.Bus to USB interface

Connects to a USB port (see 'A guide to VEConfigure')

VE.Bus Smart Dongle

Measures battery voltage and temperature and allows monitoring and control of Multis and Quattros with a smartphone or other

Bluetooth enabled device.

VE.Bus to NMEA 2000 interface

Connects the device to a NMEA2000 marine electronics network. See the NMEA2000 & MFD integration guide

BMV-712 Smart Battery Monitor

Use a smartphone or other Bluetooth enabled device to:

- customize settings,
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Achieving the impossible

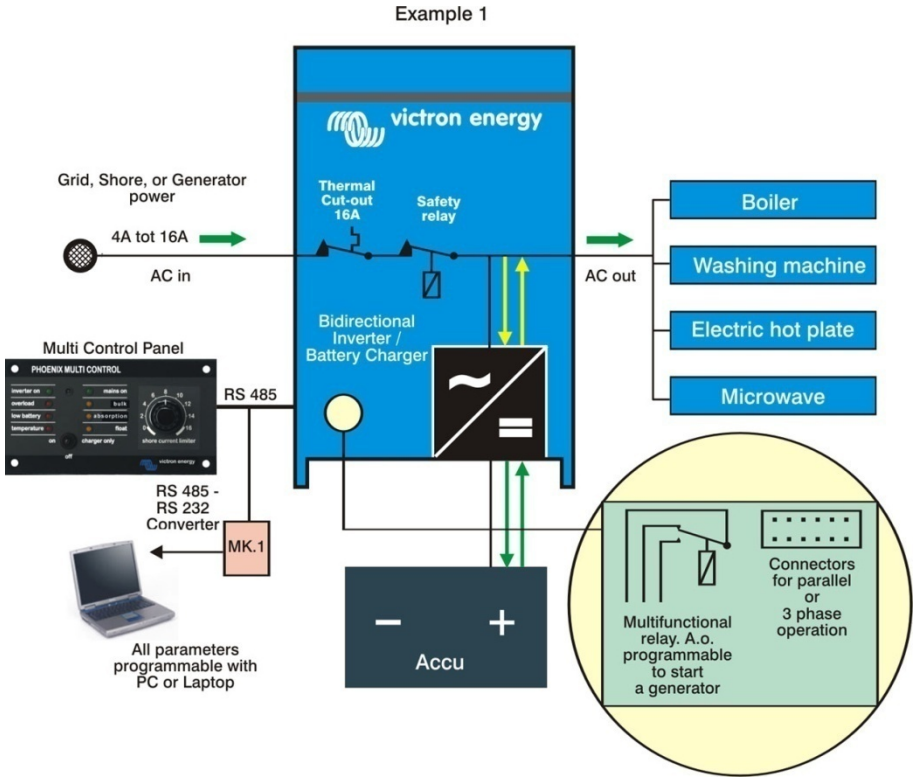
Taking control of shore power with the Phoenix Multi/MultiPlus fromVictron Energy

Sometimes the features of a new product are so unique that the benefits are difficult to understand or simply denied. The Phoenix MultiPlus is such a product.

The purpose of this paper is to step by step clarify the many features of the Phoenix Multi/MultiPlus.
Think of a situation where electricity from the grid or a generator is not available or limited in power. Think of boats, mobile homes, trucks, service vans, remote communication systems or off-grid houses. All too often shore power in the marina or on the camping ground is limited. All too often small gensets are a headache because of premature failure or frequent maintenance.
The Phoenix Multi/MultiPlus solves these problems.

1. The block diagram of the Phoenix Multi and MultiPlus (M/M+)

The most important components and features:



1.1 The bidirectional converter

The M/M+ is built around a bidirectional converter, that operates as an inverter or as a battery charger.
The converter of the M+ does more than a conventional bidirectional converter: it operates in parallel with the grid, with shore power or with a genset. It can add power to AC supply (with energy from the battery) and it will use surplus power to recharge. In most cases the M+ will also reduce the harmonic distortion of the genset voltage (this can be important for certain sensitive loads such as an induction cooker)

1.2 A multifunctional relay
This relay can a. o. be programmed to start a generator based on power demand and / or battery voltage.

1.3 A RS485 port
All parameters of the M/M+ are programmable.
The most important parameters can be programmed with a push button code, but it is much more convenient to use the MK.1 RS485 to RS232 converter, VEConfigure software (downloadable from our website) and a PC Notebook computer.
Examples of programmable parameters:
- inverter DC voltage cut out
- charge curve
- maximum charge current
- parallel operation and 3 phase operation
- programming the multifunctional relay

1.4 Connector for parallel operation and 3 phase operation
Up to 6 Multis can be parallel-connected to increase power to 15 kW.
In 3 phase configuration up to 18 Multis can be used to build a 45 kW inverter / charger!

1.5 AC input with 16 Amp thermal breaker and safety relay
The maximum AC input current of the M/M+ is 16 A. The safety relay makes sure that no dangerous AC voltage will be present on for example the shore power plug when disconnected.

1.6 The Multi Control Panel (16 A or 30 A)
The rotary knob on this panel is crucial: with this knob the maximum AC input current can be set, to a maximum of 16 A or 32 A.

1.7 AC output
To connect the AC appliances

1.8 The drawbacks of a conventional combined inverter / charger
A conventional "combi" will operate as an inverter when there is no AC input voltage present, and as a battery charger when AC is available. That's it.
When AC is available the input current will be the current drawn by the battery charger **plus** the current taken by the connected AC appliances. A powerful battery charger draws a lot of current: a 24 V 70 A charger for example will take nearly 10 A from the AC supply. When connected to a 16 A socket only 6 A will be left for the remaining AC equipment on board.
The result is that a powerful combi will trip a 16 A circuit breaker as soon as some household equipment is switched on
(a high output battery charger will have the same effect)

1.9 PowerControl: how the Phoenix Multi solves the problem described in par. 1.8.
The Phoenix Multi measures the AC input current and gives priority to the connected AC equipment. The PowerControl function makes sure that only whatever current is "left over" is used to charge the batteries. This will be explained below with several examples.

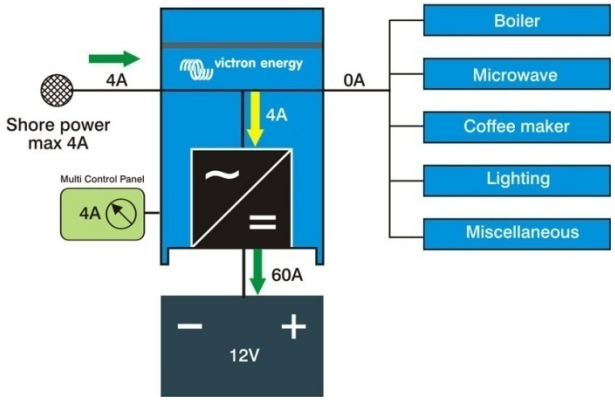
1.10 PowerAssist: this function, unique to the MultiPlus, takes PowerControl to a further dimension, allowing the MultiPlus to supplement the capacity of the AC source.
This is where we "achieved the impossible": the bidirectional converter of the MultiPlus operates in parallel with the AC input and will add current (with energy from the battery) whenever demand exceeds the capacity of the supply!

More power needed than the AC supply permits? The MultiPlus will supply the difference with power taken from the battery.
Has the load been reduced? The MultiPlus will use any surplus power to recharge the battery.

2. How it works in practice

Below are several examples to clarify the benefit of PowerControl (available on both the Multi and the MultiPlus) and of PowerAssist (MultiPlus only).
For the first examples we assume an AC supply limited to max. 4 A.
To make it work the input current limit should be set at 4 A on the Multi Control Panel.

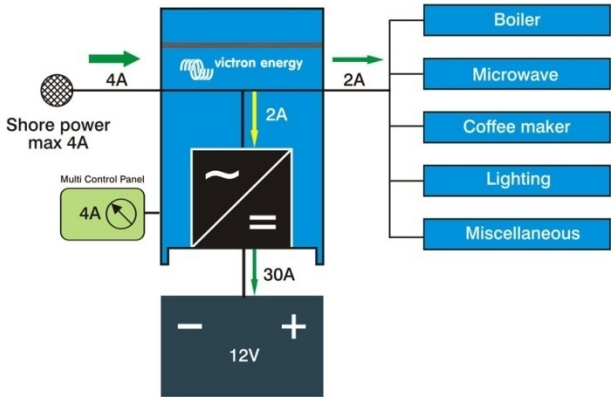
Example 2.1



Example 2.1

In this example all AC loads are off. With the Multi Control Panel set at 4 A the converter will not take more than 4 A, which limits the battery charge current to about 60 A.

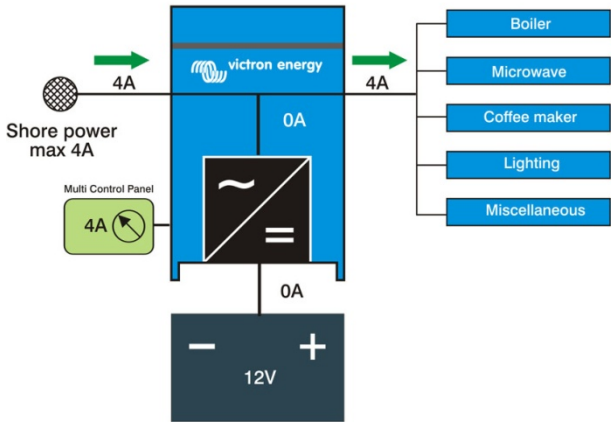
Example 2.2



Example 2.2

Now some small loads are switched on and the load increases to 2 A. Only 4 – 2 = 2 A is left to charge the batteries and the charge current is reduced to about. 30 A. Shore current is automatically limited to 4 A and the circuit breaker will not trip!

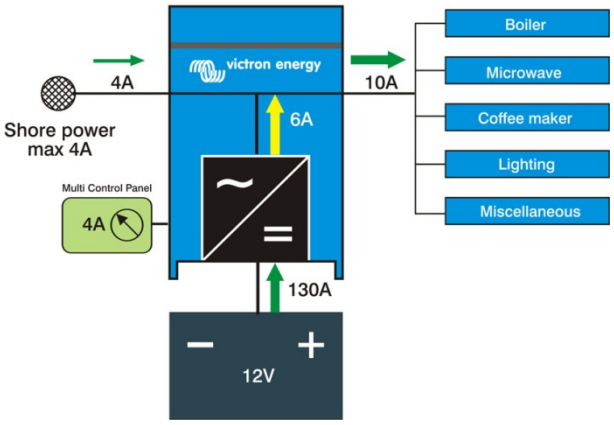
Example 2.3



Example 2.3

The coffee machine is switched on and current consumption increases to 4 A. Nothing is left to charge the batteries: the charge current is automatically reduced to 0. And again: the shore current circuit breaker does not trip!

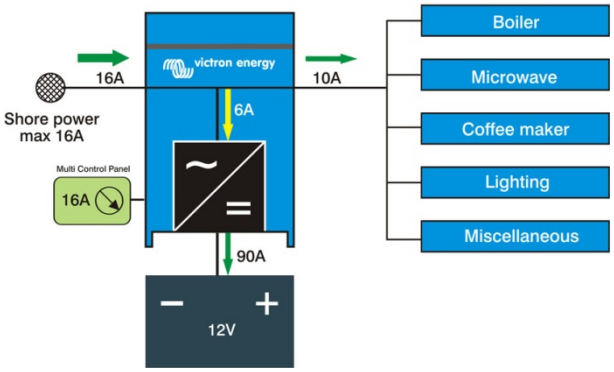
Example 2.4



Example 2.4

And now the impossible happens: the water heater switches on and the current increases to 10 A.
This is where PowerAssist (available on the MultiPlus only) is needed. The bidirectional converter starts operating as inverter to add 6 A to the 4 A that is available from the shore-side: total 6 + 4 = 10 A, and no overload on the AC supply!
As soon as the load reduces to less than 4 A any current that is left over will be used to recharge the battery.

Example 2.5



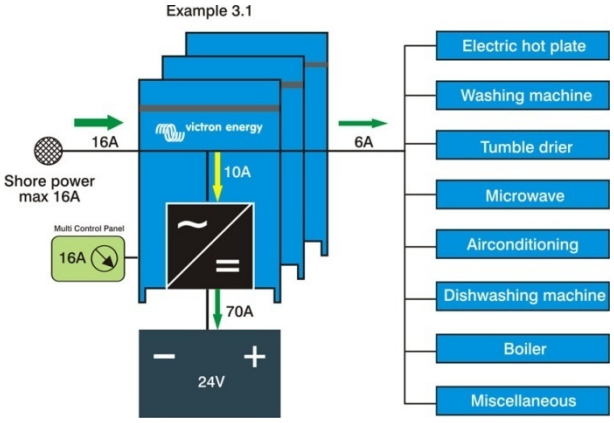
Example 2.5

In this example a 16 A supply is assumed. On the Multi Control Panel the current limit can now be set at 16 A.
The logic remains the same: with 16 A available and 10 A load, 6 – 10 = 6 A is left over, which results in a maximum charge current of 90 A.

3. More power needed: parallel operation

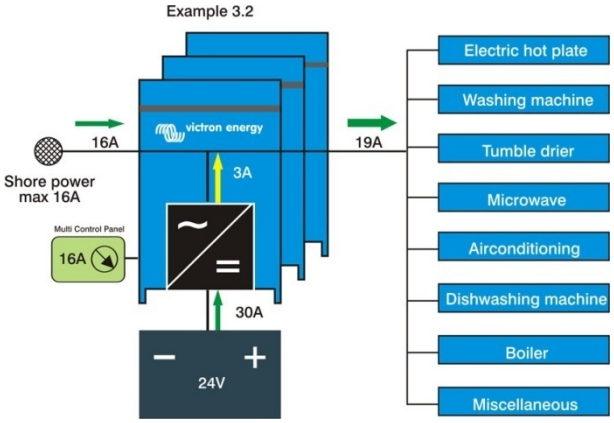
With a washing machine on board (and possibly also a dishwasher, electric cooker, oven and air conditioning) the current needed will increase to much more than 16 A.
What to do?
One solution is a stronger AC power supply. But more than 16 A shore power is not always easy to find, and berths for mega yachts are expensive!

Why not installing a set of parallel Multi's as shown in the examples below?



Example 3.1

In this example 3 Multis 24/3000/70 are operating in parallel. The AC supply is rated at 16 A and therefore the Multi Control Panel is also set at 16 A.
When power demand is low (during the night for ex.) the batteries will be charged. With 6 A needed for different loads, 16 – 6 = 10 A is left over. Therefore the batteries will be charged at max. 70 A. This is much less than the maximum charge current of 3 x 70 = 210 A the 3 Multis are capable of, but then the shore side circuit breaker would trip immediately!



Example 3.2

Turning on the washing machine (current 13 A) will, during a short period, increase the load to 6 + 13 = 19 A. PowerAssist is now needed to supply the missing 3 A. This is made possible by installing 1 MultiPlus (as Master) and 2 Multis (as Slave). The complete set of 3 units will then have PowerAssist functionality.
And again: the load is 19 A but the supply is only 16 !

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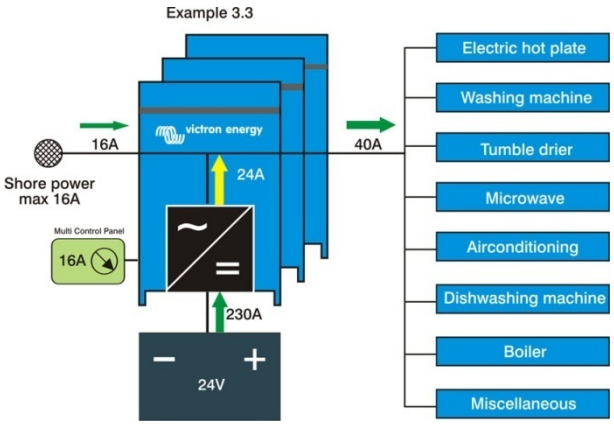
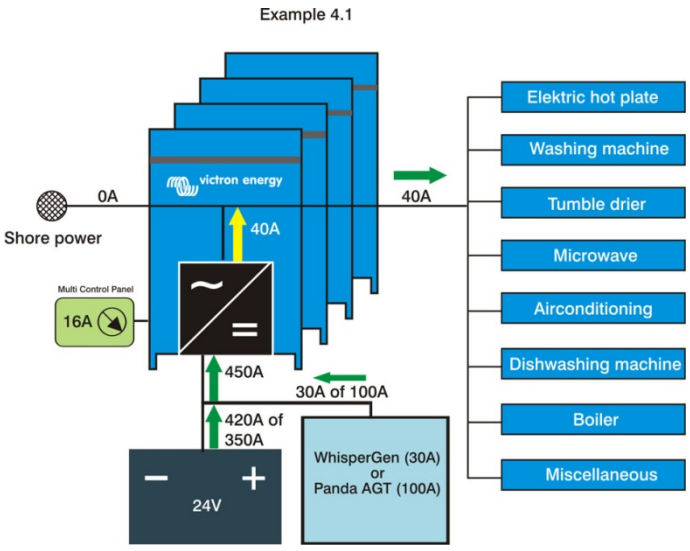


Example 3.3

The power needed will increase dramatically as soon as more household equipment is switched on, or when the electric cooker is in use. The AC current will peak to 40 A or more. Now the Multis must supply an additional 40 – 16 = 24 A to the AC source and the batteries will be discharged at a rate of some 230 A. It may be hard to believe but the total discharge of the batteries, measured in Ampere-hours (Ah), will nevertheless be limited. This is because a cooker or washing machine does need a lot of power during only a short period. Practice has shown that 16 A shore current is, on average, more than sufficient for big yachts and or luxury mobile homes. It is only when continuous power requirement increases (due for ex. to air conditioning) that a more powerful supply will be needed.
Please refer to our book "Electricity on Board" for detailed battery capacity calculations.

4. A DC genset on board

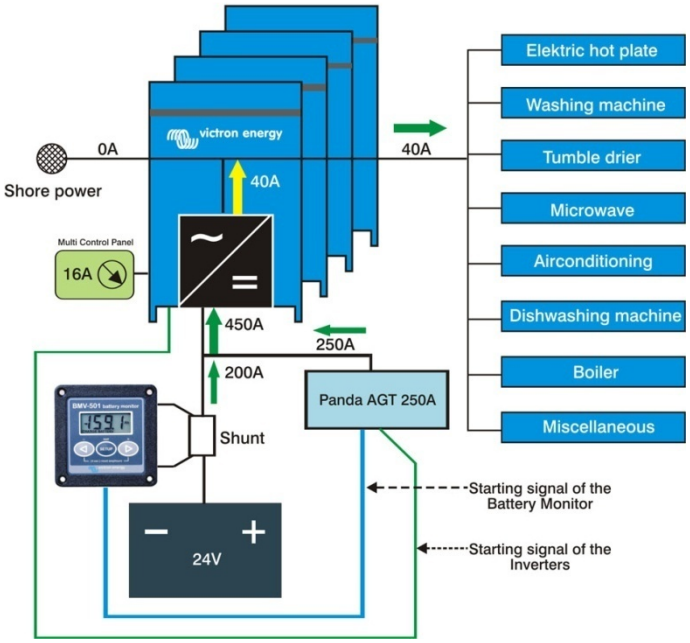
When no AC supply is available (no shore current, because the yacht is sailing) the Multis will operate as inverters and the DC genset will charge the batteries.



Example 4.1: maximum power required 7 kW, average load 700 W

If a lot of power is required for a short period only, a WhisperGen or a small Fischer Panda DC generator will easily supply the average load. Please refer to our book "Electricity on Board" for more examples

Example 4.2

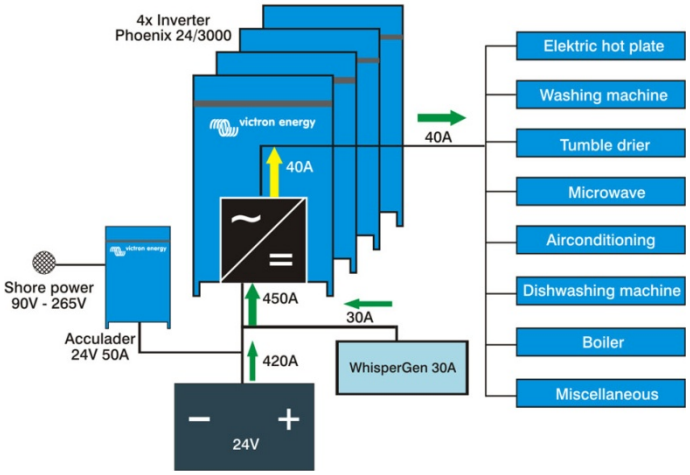


Example 4.2: maximum power required 7 kW, average load 2 kW

Intensive use of air conditioning will raise power consumption beyond the capacity of the WhisperGen. A powerful DC generator will be needed to keep running hours and noise within acceptable limits.
The multifunctional relay of the Multi can be used to automatically start the generator in case of high power demand. In addition our BMV-501 battery monitor may be used to start the generator once the batteries have been discharged to a pre-set percentage.
Complete wiring diagrams can be found on our website www.victronenergy.com.

A remark about 3 phase electric motors to drive pumps, a diving compressor or air conditioning:
Three phase motors of up to 3 kW can be connected to a single phase supply by adding a 3 phase motor drive with single phase input. The motor drive then takes care of 3 phase to 1 phase conversion and will also reduce start-up current.

Example 4.3



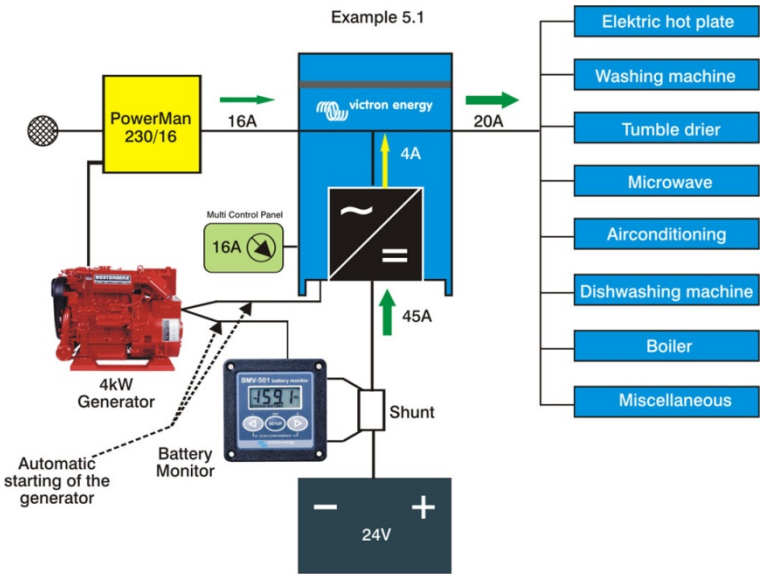
Example 4.3: An alternative solution, using inverters and battery chargers

The maximum AC supply current can also be controlled when only battery chargers are connected to it. All AC equipment should then be supplied by the inverters and the batteries are again used to absorb periods of high power demand.
Using battery chargers with universal 90 to 265 V input capability will make sure that a yacht can connect to any shore power supply anywhere in the world.

5. **How it works with an AC generator**

PowerAssist can also be used to boost the output of an AC genset. Next to reducing size and weight of the genset this also has the following advantages:

- In most cases the harmonic distortion of the genset output will be reduced (this can be important for certain sensitive loads such as an induction cooker)
- Because the generator can be reduced in size the load in % of its rated power will increase. This will improve efficiency and increase service life.



Example 5.1: maximum power required 2.5 kW

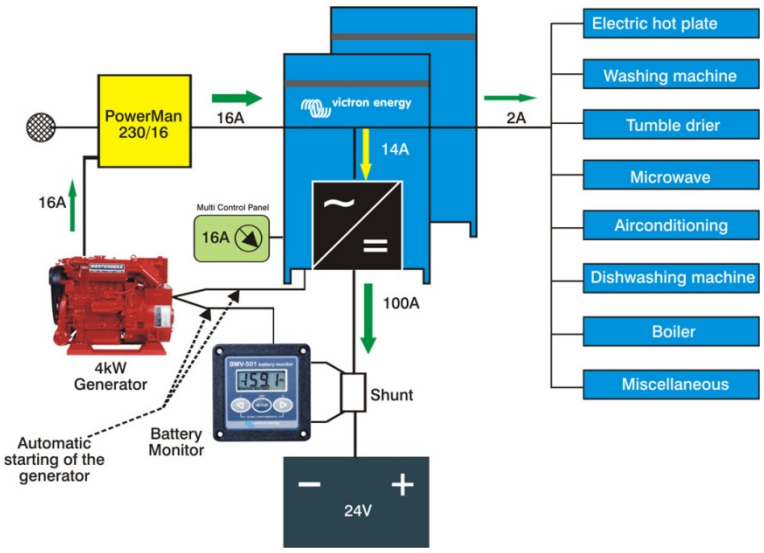
A lot can be achieved with a simple and compact system. As long as either the shore supply is available or the generator is running, the system can supply up to 26 A of AC current, which amounts to 6 kW. (the shore or genset supplies up to 16 A, to which the Phoenix MultiPlus will add up to 10 A)
And the batteries will be recharged as soon the load reduces to less 16 A.

Important building blocks of the system:

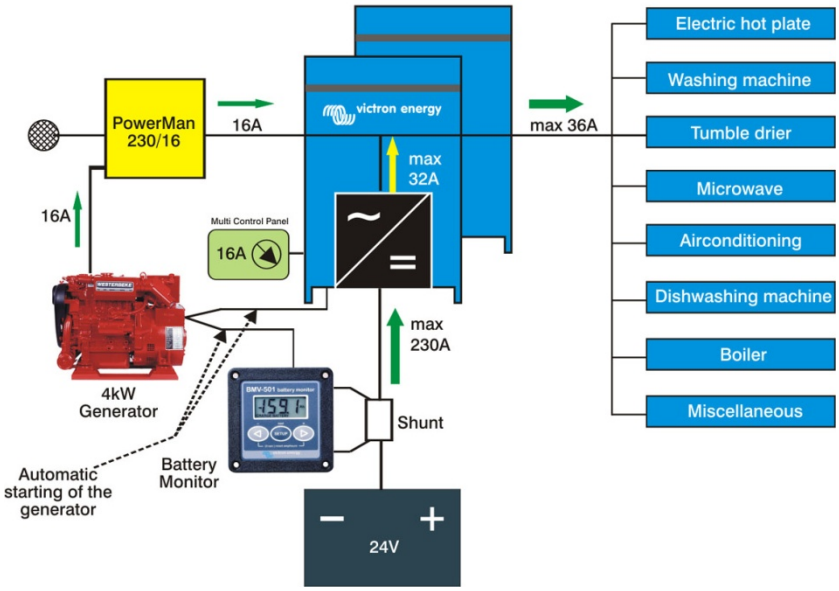
a) PowerMan 230/16-0
An automatic 16 A transfer switch.

b) Battery Monitor BMV 501
The BMV 501 keeps track of the state of charge of the battery. The BMV 501 can be programmed to generate a generator start signal when the batteries have been discharged to a pre-set percentage. Together with the start signal from the Multi the generator will start both in case of a high power requirement and when the batteries have been discharged to a pre-set percentage.

Example 5.2 a

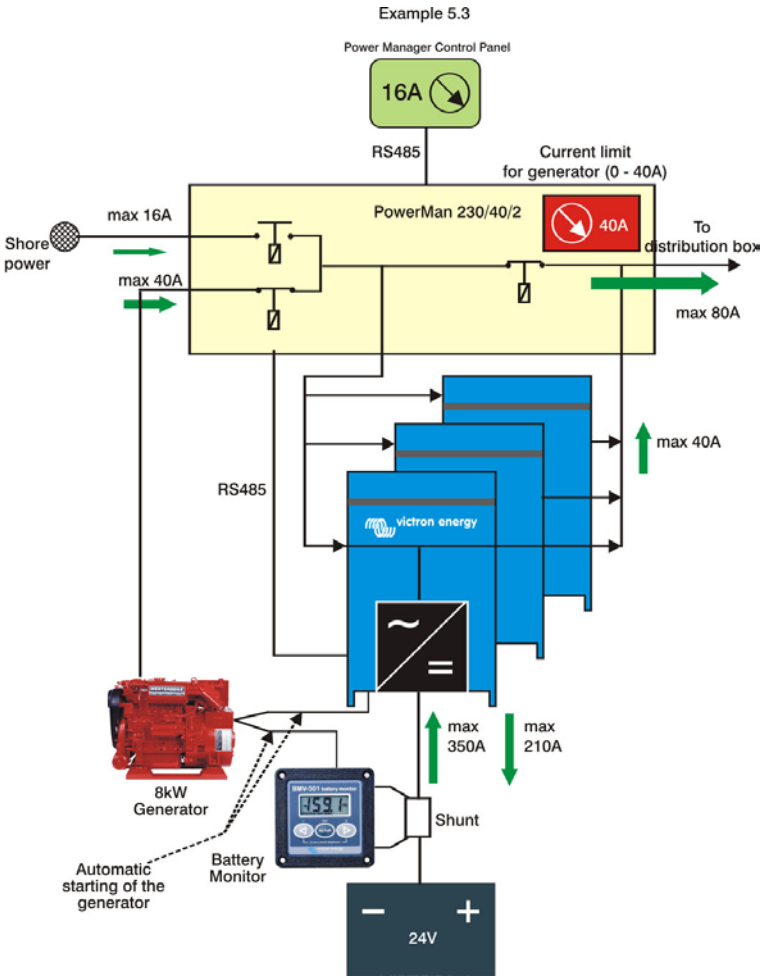


Example 5.2b



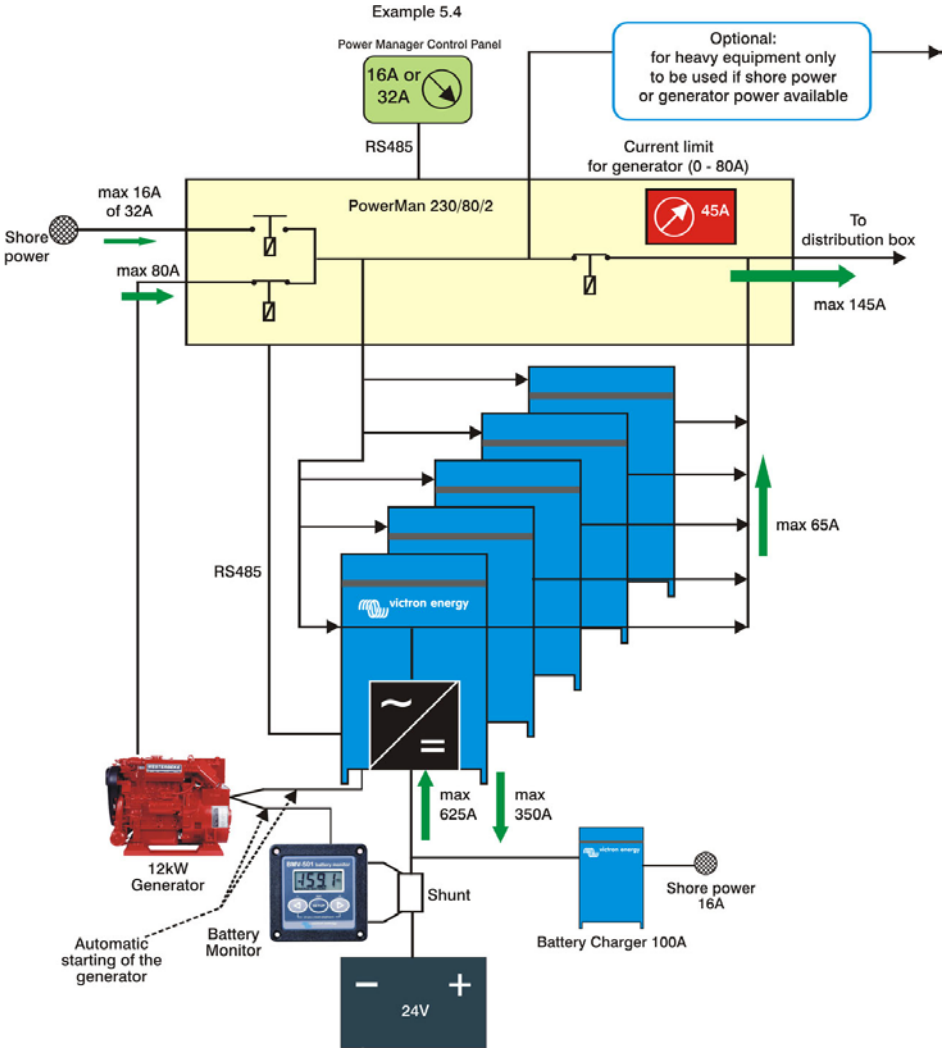
Example 5.2a and 5.2b: maximum power required 5 kW

A much more robust system is obtained by installing 2 Multis. The 2 Multis (of which 1 unit should be a MultiPlus to have PowerAssist functionality) can supply sufficient power even when several AC loads are switched on simultaneously. And once the generator is running the system will supply up to 16 + 2 x 10 = 36 A. Moreover the 2 Multis will easily absorb all available power from the generator when recharging the batteries, reducing running hours of the genset to the bare minimum.
Please note that a small 3000 rpm genset has limited service life and is in general not made to run at full load for long periods of time. (reduce output to 70 % of full load with the Multi Control Panel!). A 1500 rpm model is the better choice if intensive use is expected



Example 5.3: maximum power required 7 kW, and average power 2 kW (intensive use of air conditioning)

It is now time to install a bigger genset, unless a substantial generator free period is not required.
In this example transfer switch model PowerMan 230/40-2 has been used. This transfer switch will accept up to 40 A of AC input current. The genset current limit can be set inside the cubicle (indicated in red in the schematic diagram above) and is independent from the shore current setting on the PowerMan Control Panel (indicated in green in the schematic diagram above). The PowerMan Control Panel is similar but not identical to the Multi Control Panel.
Up to 3 Multis can be connected directly to the PowerManager.



Example 5.4: maximum power required 12 kW, and average power 4 kW (intensive use of air conditioning)

By connecting to 2 shore outlets of 16 A each, up to 32 A (7 kW) of shore current is available. The trick is to connect the AC system to one outlet, and a 100 A battery charger to the other. The transfer switch is a PowerMan 230/80-2, suitable for up to 80 A input.
Up to 6 Phoenix Multis can be connected to this Power Manager.

3 phase systems
Phoenix Multis and Phoenix inverters can also be configured for 3 phase operation. We will be pleased to make a proposal for a 3 phase system.

Data communication with Victron Energy products

Matthijs Vader

www.victronenergy.com

Introduction

Many of our customers integrate our products into their own systems, using data communication protocols. There are several options to establish data communication. The purpose of this document is to explain the different options, and help you choose one.

Communicating to a complete system? Use Modbus-TCP

Rather than going for direct communication with Inverters, battery monitors or Solar chargers, consider using ModbusTCP. This has two advantages:

1. ModbusTCP is easier than most other protocols
2. Retrieve precalculated system, as available on the Color Control GX

Looking for internet related protocols? Use the JSON API or MQTT

Once uploaded to the VRM Portal by a Color Control GX, or another device running our Venus OS, the data can be requested via our VRM JSON API:
https://vrmapi.victronenergy.com/v2/docs

Besides that API, MQTT is also available. More information here: https://github.com/victronenergy/dbus-mqtt/blob/master/README.md

Integrating into a Marine NMEA 2000 network? See our integration guide:
https://www.victronenergy.com/live/ve.can:nmea-2000:start

More information

As a developer, make sure to also have a look at these two pages:
https://www.victronenergy.com/live/open_source:start
https://github.com/victronenergy/venus/wiki

Products with data communication

The following product lines have a data communication port, with protocol information available for 3rd parties:

Product range	Products in that range	Onboard comm. port	3rd party protocol	How to connect
Color Control GX	Gateway to almost all Victron products that have a data communication port	Ethernet	Modbus-TCP	Modbus-TCP
Battery monitoring	BMV-600S, BMV-602S and BMV-600HS	BMV-60xS Text (TTL)	CAN and BMV Text	Via interface
	BMV-700 and BMV-700H	VE.Direct	VE.Direct	Direct or via interface
Inverters	Phoenix Inverter models from 1200 to 5000VA	VE.Bus	CAN and MK2/MK3	Via interface
	Phoenix Inverter 250, 375 and 500VA	VE.Direct	VE.Direct	Direct of via interface
Multi Inverter/chargers	Complete range: all Multis and Multi compacts	VE.Bus	CAN and MK2/MK3	Via interface
Quattro's	Complete range	VE.Bus	CAN and MK2/MK3	Via interface
Skylla-i/-IP44 battery chargers	Complete range	VE.Can	CAN	Direct
BlueSolar Chargers	BlueSolar MPPT 150/70 and 150/85 (VE.Can)	VE.Can	CAN	Direct
	BlueSolar MPPT 75/10 to 150/100 (VE.Direct)	VE.Direct	VE.Direct	Direct or via interface
Lynx Ion (Lithium Ion BMS)	Lynx Ion, Lynx Ion + Shunt and Lynx Ion BMS	VE.Can	CAN	Direct
Lynx Shunt 1000A VE.Can	Only the Canbus version.	VE.Can	CAN	Direct
Peak Power Pack	Complete range	VE.Direct	VE.Direct	Direct or via interface

Protocol overview

At Victron Energy we have the following protocols:

Protocol	3rd party connections allowed	Topology	Physical	International standard	More information
Modbus-TCP	Yes (preferred)		TCP/IP	Modbus-TCP	Further down in this document
VE.Direct	Yes (preferred)	Point to point	RS232 / TTL	Proprietary	On our website, see next page for link
VE.Can / NMEA2000	Yes	Drop cables / Daisy chain	CANBUS	J1939 & NMEA2000	http://www.victronenergy.com/ http://www.nmea.org/
VE.Bus	No	Daisy chain	RS485	Proprietary	See MK2/MK3 protocol
MK2/MK3 Protocol	Yes	Point to point	RS232	Proprietary	On request
BMV Text	Yes	Point to point	RS232	Proprietary	On our website, see next page for link
VE9bit RS485	No	Point to point	RS485	Proprietary	Deprecated

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VE.Net	No	Daisy chain	RS485	Proprietary	Deprecated

And then there are JSON and MQTT, see introduction.

NMEA2000 Certified products

This table lists all Victron products that have an NMEA2000 or VE.Can communication port, and the status of NMEA2000 certification. Note that the mentioned NMEA2000 database version number is the database version used by the latest firmware of each product.

Part number	Product	NMEA2000 Certified?	NMEA2000 DB
ASS030520000	BMV-60xS to NMEA2000 interface	Yes	v1.301
ASS030520100	VE.Bus to NMEA2000 interface	Pending a firmware update due to the new AC PGN's	
LYN040102100	Lynx Shunt VE.Can	Yes	v1.301
LYN040301000	Lynx Ion	No	
LYN010100100	Ion Control	No	v1.301
SCC010070000	BlueSolar MPPT 150/70 (12/24/36/48V-70A)	No	v2.000
SKI024080000	Skylla-i battery charger 24V/80A (1+1)	Yes	v2.000
SKI024080002	Skylla-i battery charger 24V/80A (3)	No	v2.000
SKI024100000	Skylla-i battery charger 24V/100A (1+1)	Yes	v2.000
SKI024100002	Skylla-i battery charger 24V/100A (3)	No	v2.000

Make sure to read our NMEA 2000 & MFD integration guide: https://www.victronenergy.com/live/ve.can:nmea-2000:start

Staying up-to-date

Send an email to mvader@victronenergy.com, asking to be on the protocol-mailing-list. If you have received protocol documentation from us by email, you are on this list automatically.

Details per protocol

VE.Can / NMEA2000

Canbus is the preferred protocol for third parties to communicate with our products. Our CANbus protocol is based on the NMEA2000 and J1939 protocols.

Further down in this document is a list per product with supported NMEA2000 PGNs. All data and settings that are not covered by the NMEA2000 standard PGNs are available through proprietary PGNs. More information is in the manuals of the Canbus-enabled products on our website, and in the document "VE.Can registers - public.docx". Look for it on the Whitepapers page on our website.

Detailed information on the NMEA2000 PGN's is available for purchase on the NMEA website (www.nmea.org). See the NMEA 2000® Appendix B POWER SUBSET.

VE.Direct

VE.Direct is a combination of what we used to call the HEX protocol and the BMV text protocol. It combines the advantages of both: in text-mode the products automatically transmit all important parameters every second. To implement code which reads and interprets this data is extremely simple. If more functionality is needed, such as changing settings, one can switch to the HEX protocol. Communication ports on new Victron products will always be either VE.Can or VE.Direct ports. The VE.Direct port is for products where a full Canbus connection adds to much cost. VE.Direct documentation is available on our website. Look for the VE.Direct Protocol document on: http://www.victronenergy.com/support-and-downloads/whitepapers/. And see also the VE.Direct FAQ: https://www.victronenergy.com/live/vedirect_protocol:faq.

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Modbus TCP

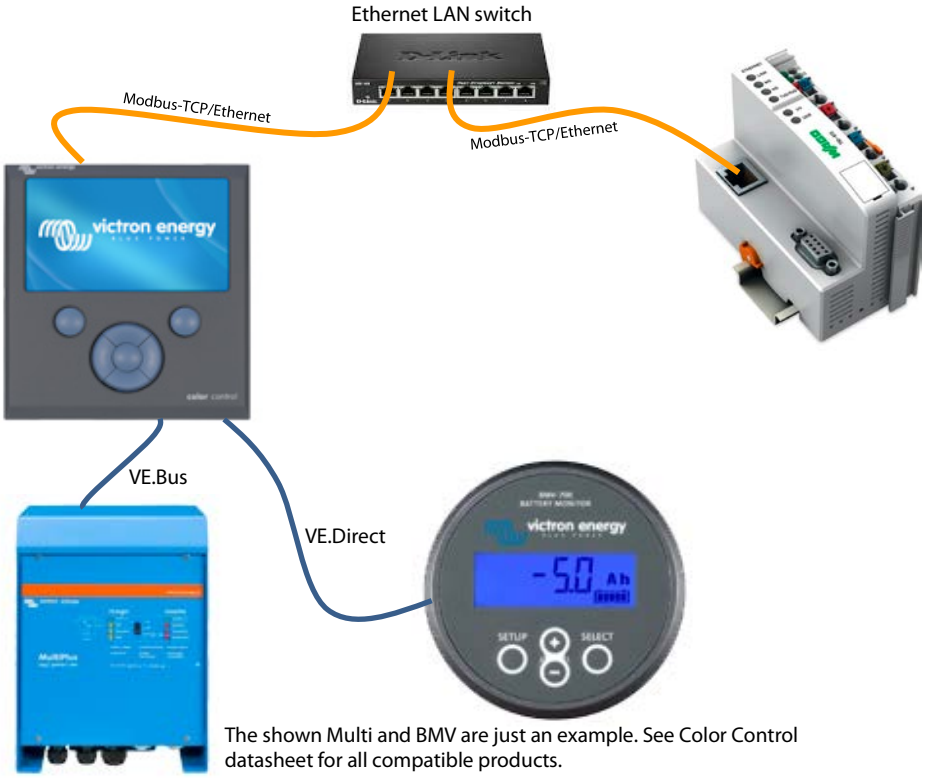
The industry standard Modbus TCP is a well-known and open communication protocol, used in many PLCs and SCADA systems. The Victron Color Control GX acts as a Modbus-TCP gateway. Connect it to the Victron products that you want to monitor, and then communicate from your PLC to the Ethernet LAN port on the Color Control GX. It allows reading information, and writing operational parameters, such as Multi on/off and input current limiter settings. Changing configuration settings, such as battery capacity or float or absorption voltages, is not yet possible.

Check the Color Control GX Datasheet to find out which products are supported by the Color Control GX.

We use the default Modbus TCP port number, which is 502. The unit id, sometimes called 'slave address', specifies what product connected to the CCGX needs to be addressed. See the tab 'Unit ID mapping' in the Modbus-TCP excel sheet. The register addresses are listed on the first tab of the excel sheet, in column C. There are two data types, uint16 and int16. After receiving the value, divide it by the Scale factor to get the value in the unit as specified in column G.

Download the list of registers from our website, look for the CCGX Modbus-TCP register list on http://www.victronenergy.com/support-and-downloads/whitepapers/.

The FAQ page as well as a commenting system to put questions is available on Victron Live: http://www.victronenergy.com/live/ccgx:modbustcp_faq



The shown Multi and BMV are just an example. See Color Control datasheet for all compatible products.

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VE.Bus

VE.Bus is our proprietary protocol used by the Inverters to synchronize their AC outputs. There are VE.Bus communication ports on our Inverters, Multi's and Quattro's. The synchronization feature is mission-critical. Direct third-party connections are not allowed. All interfacing has to be done via Modbus TCP (preferred), "VE.Bus to CANbus/NMEA2000 interface", or via the MK2/MK3:

MK2/MK3 Protocol

The MK2.2 and MK3 provide a galvanically isolated connection to VE.Bus, and it translates the VE.Bus protocol into the "MK2/MK3 Protocol". The MK2/MK3 Protocol allows reading information, turning the device on and off, changing the current limits and configuring a device. To download the document, look for the 'Interfacing with VE.Bus products – MK2/MK3 protocol' on: http://www.victronenergy.com/support-and-downloads/whitepapers/

Note that implementing the MK2/MK3 protocol is a task which is not to be underestimated. It is a complicated protocol, and unless there is a huge commercial interest, we cannot give any support or help during the implementation(!). Make sure to have a look at Appendix 2 in that document, which is an annotated example for a typical UI.

Note that there is no difference in protocol between the MK2 and MK3 interfaces.

BMV-60xS Text Protocol (deprecated)

All of our BMV-600's feature a serial communication interface which allows simple access to detailed battery status information. This protocol only allows reading information from the battery monitor. Setting parameters or 'synchronizing' the BMV is not possible. Documentation is available on our website, look for the BMV60xS Text protocol: http://www.victronenergy.com/support-and-downloads/whitepapers/. Note that this Text protocol is now part of the VE.Direct protocol. The successor of the BMV-600, the BMV-700, works with the VE.Direct protocol. See earlier in this document for more information on the VE.Direct protocol.

VE.Net (deprecated)

VE.Net is a proprietary protocol used by some of our control panels. Third party connections are not possible. New products will not be equipped with VE.Net. They are equipped with VE.Can or VE.Direct instead.

VE 9bit RS485 (deprecated)

This protocol was used to communicate to our Multi's and Quattro's before they had paralleling and three phase capabilities. This protocol is no longer maintained. Documentation is not available.

Accessories to communicate with VE.Bus (Inverter, Multi, Quattro)

Partnumber	Product name	RS-232	Canbus	SMS	Web	Ethernet	SNMP
ASS030120200	Victron Interface MK2.2b – RS232	X					
ASS030130000	Victron Interface MK2-USB	X[1]					
ASS030140000	Victron Interface MK3-USB	X[2]					
ASS030520100	VE.Bus to NMEA2000 interface		X				
ASS030520105	VE.Bus to VE.Can interface		X[3]				
BPP000300100R	Color Control GX		X		X	X	
VGR000200000	Victron Global Remote 2			X	X		
VGR200100000	Victron Ethernet Remote			X	X	X	X

Accessories to communicate with a VE.Direct product

Partnumber	Product name	RS-232	Canbus	SMS	Web	Ethernet	SNMP
ASS030530000	VE.Direct to USB interface						
ASS030520500	VE.Direct to RS232	X					
ASS030520300	VE.Direct to NMEA2000 interface		X				
ASS030520400	VE.Direct to VE.Can interface		X[4]				
BPP000300100R	Color Control GX		X		X[5]	X	

1 The Victron Interface MK2-USB is an MK2.2b with built-in RS232 to USB Converter.
2 The Victron interface MK3-USB also has a built-in RS232 to USB Converter. There is no RS232 version of the MK3 available.
3 The VE.Bus to VE.Can interface is the same as the VE.Bus to NMEA2000 interface. The only difference is the canbus connection. The VE.Bus to VE.Can interface has two RJ-45 sockets; the other one has the NMEA2000 Micro-c plug.
4 The VE.Direct to VE.Can interface is the same as the VE.Direct to NMEA2000 interface. The only difference is the canbus connection. The VE.Direct to VE.Can interface has two RJ-45 sockets; the other one has the NMEA2000 Micro-c plug.
5 Data, including historic data, can be accessed via https://vrm.victronenergy.com. All data is stored in our database. Logs can be downloaded, see chapter "Getting the data from VRM".

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Accessories to communicate with a BMV-60xS battery monitor

Partnumber	Product name	RS-232	Canbus	SMS	Web	Ethernet	SNMP
ASS030071000	BMV Data Link RS232	X					
ASS030520000	BMV-60xS to NMEA2000 interface		X				
ASS030520020	BMV-60xS to VE.Can interface		X				
VGR000200000	Victron Global Remote 2[6]			X	X		
VGR200100000	Victron Ethernet Remote[7]			X	X	X[8]	X

FAQ – General

Q1: Do I need an MK2 or MK3 for each product in a system with multiple VE.Bus products in parallel or three-phase?
No. Per VE.Bus system you need only one of those interfaces.

Q2: Do I need a VE.Bus to NMEA2000 interface for each product in a system with multiple VE.Bus products in parallel or three-phase?
No. Per VE.Bus system you need only one of those interfaces.

Q3. Why is it not possible that my application directly communicates with the Victron via VE.Bus messages?
VE.Bus is our proprietary protocol used by the Inverters to synchronize their AC outputs. It is not possible to connect directly because as soon as other people are on that bus we cannot guarantee the proper working of paralleled and three-phase operations. Note that even in all our own display and control products that talk to VE.Bus, for example the Color Control GX and the VE.Bus to NMEA2000 interface, we have an MK2/MK3 IC. So even at Victron we are not talking directly to VE.Bus.

FAQ – Canbus communication

Q10: Which version of J1939 is actually implemented (J1939/11, J1939/15, J1939/14...)?
We are using the NMEA2000 protocol, which is based on ISO 11783-3 (Datalink Layer) and ISO 11783-5 (Network management). ISO 11783-3 is virtually identical to the SAE data link layer SAE J1939-21. The network layer (ISO 1183-5) is based on SAE J1939-81. For more information, see also http://www.nmea.org/content/nmea_standards/white_papers.asp.

Q11: Is the bus speed 250kbps?
Yes, the bus speed is 250kpbs

Q12: Is the identifier extended (29-bits)?
Yes, the ISO11783 standard defines the use of the extended identifier (29-bits).

Q13: Are the data fields always 8 bytes long?
Yes, the data fields are always 8 bytes long.

Q14: Can you send us the PGN definition?
This detailed documentation has to be bought from the NMEA website. You can buy the Power PGN's at http://www.nmea.org/store/index.asp?show=pdet&pid=322&cid=7. The product name is "NMEA 2000® Appendix B POWER SUBSET PGN (NMEA Network Messages) – Electronic", USD 500,= for non-members. Note that for the VE.Bus AC messages you need some SAE documentation as well. More information on the used PGN's is further down below in this document.

Q15: Are all the messages broadcasted or do they have to be requested/polled?
The important messages (AC status, Battery status, etc.) are broadcasted. Others have to be polled.

Q16: Do I need to terminate the canbus?
Yes you do. Use one 120Ohm 0,25W 5% resistor at both ends of the canbus. Connect it between CAN-H and CAN-L. Victron Energy sells a set of VE.Can terminators with part number ASS030700000.

[6] The Victron Global Remote has two communication ports. It can connect to a BMV and a VE.Bus product or system at the same time.
[7] The Victron Ethernet Remote has only one communication port, it can connect to one device.
[8] Data can be accessed via a local, password secured, website, running on a web server in the Victron Ethernet Remote. Note that only the current values can be accessed. Historic data is not available on the local web server.

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Q17: Do I need to power the canbus?
That differs per product. Some products power the canbus themselves others don`t. To power the canbus, supply anywhere between 9 and 36Volts to V+ and V-. See also the pin outs below. A small list at the time of writing:

Skylla-i	Powers the canbus, isolated
Skylla-IP44	Powers the canbus, non-isolated
Lynx Shunt VE.Can	Powers the canbus, isolated
Lynx Ion BMS	Powers the canbus, isolated
Lynx Ion + Shunt	Powers the canbus, isolated
Lynx Ion	Does not power the canbus, depends on the Lynx Shunt VE.Can to power both the VE.Can and the BMS canbus
Color Control GX	Does not power the canbus, and needs a powered canbus to operate
VE.Bus to NMEA2000 interface	Does not power the canbus, and needs a powered canbus to operate
VE.Bus to VE.Can interface	Does not power the canbus, and needs a powered canbus to operate
BMV-60xS to NMEA2000 interface	Does not power the canbus, and needs a powered canbus to operate
VE.Direct to NMEA2000 interface	Does not power the canbus, and needs a powered canbus to operate
VE.Direct to VE.Can interface	Does not power the canbus, and needs a powered canbus to operate
BlueSolar MPPT 150/70	Does power the canbus, not isolated. See manual for info on a resistor that is mounted to prevent ground loops.

The mentioned 9 to 36Volt is conform the NMEA2000 standards. Most of our products accept an input voltage from 7 to 70VDC, see the datasheets.

Q18: What is the difference between NMEA2000 and VE.Can?
The only difference is in the physical connection and the isolation:

	VE.Can	**NMEA2000**
Physical connector	RJ-45	Micro-C
Isolation	Differs per product, see Q17 above and/or datasheet	Always

Q19: What is the pin out of VE.Can?
The two RJ-45 sockets on each product that has VE.Can are paralleled. Note that we use RJ-45 also for VE.Bus or VE.Net connections, see the datasheet to make sure that your product has a VE.Can connection.

1	Not connected
2	Not connected
3	NET-C (V-)
4	Not connected
5	Not connected
6	NET-S (V+)
7	CAN-H
8	CAN-L

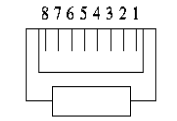


Figure 1:
End view of RJ45 Plug

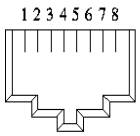
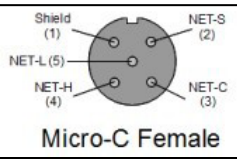


Figure 2:
Looking into an RJ45 Jack

Q20: What is the pin out of NMEA-2000?

1(brown):	Shield
2(red):	NET-S (V+)
3(black):	NET-C (V-)
4(white):	NET-H (CAN-H)
5(blue):	NET-L (CAN-L)



Q21: I do not want to implement the full ACL procedure, what fixed source address shall I use?
Address 0xFE is reserved for when you cannot perform an ACL (Address Claim) procedure. You are free to use this address. See also Q24.

Q22: What is Victron's NMEA2000 manufacturer code?
It is 358 (0x166)

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Q23: Instances: I have multiple BMV's (or another canbus product) in the same network, how do I address them?
You need to use instances to differentiate between multiple similar products in the same network. There are different types of instances within NMEA2000:

Device instance
The device instance is sent in PGN 0xEE00, ISO Address Claim, as a combined field of Device Instance Lower (ISO ECU Instance) and Device Instance Upper (ISO Function Instance).
The Device instance is used by Victron chargers (Skylla-i/-IP44, VE.Can MPPTs) to configure them in the same group and synchronize them.

Data instances (Battery Instance, DC Detailed Instance, Switch bank instance, etc.)
These instances are embedded in the different PGN's. All Victron products support changing these instances through a complex write, PGN 0x1ED00, Complex Request Group Function Code 5, write fields.

System instance
The system instance is also sent in PGN 0xEE00, field 8. It is not used. All Victron products do support changing this instance by sending a complex command.

Instance conflicts
If you have connected multiple products sending out the same PGN with the same data instance number, you might encounter a data instance conflict. Typically this can be seen on display's showing an alternating value. E.g. The VE.Direct to NMEA2000 interface and VE.Bus to NMEA2000 interface are both sending out PGN 127508 with Battery instance 0. To solve this issue one of the Battery instances needs to be changed to another (unique) number. We recommend to change the Battery instance of the VE.Bus to NMEA2000 instance to 5.

More information about changing instances is here: http://www.victronenergy.com/documentation/ve.can:changing_nmea2000_instances.

Display manufacturers
The display manufacturers use different types of instances to show data for multiple batteries, inverters or chargers:

Garmin needs the data-instances to be different.

Raymarine needs the device instance to be different in order to show information for (for example) multiple batteries. They use the data-instance to connect multiple products, for example gps-es, as a way of redundancy.

Maretron sometimes needs the data-instances to be different, and some other times they need to device instance to be different.
Note: this information about other manufacturers is mostly learned by experience. If you have more information about this, which could be useful to others, please let us know via mvader@victronenergy.com.

Q24: Do the Victron VE.Can and NMEA2000 products used fixed network address or do they support NMEA address claim ISO 602928?
All our products have implemented the address claim procedure. See also Q21.

Q25: I want to read the State of Charge (0 to 100%) as calculated by the Multis and Quattros. I do understand that this SOC is only reliable if there are no DC loads or other battery chargers in the system (almost impossible on a boat, but in a self-consumption system this is very possible). And I cannot find the SOC in the PGNs.
Correct, the information is in PGN 127506, but transmission of that PGN is disabled by default, because it is not valid in all systems. To enable transmission of this PGN, change the transmission interval. To do this at protocol level, see NMEA2000 documentation, PGN 126208 - NMEA - Request group function (field 1 = 0x00). And then field 3, transmission interval. To do this at PC level, use Actisense NMEA Reader or other PC software that has this functionality.

Q26: Which products have a bag of VE.Can RJ-45 terminators included?
These products are shipped with two pieces of VE.Can RJ-45 terminators:

- Color Control GX
- MPPT 150/70 and MPPT 150/85 Solar Charge Controllers
- Lynx Ion + Shunt all models
- Lynx Ion BMS all models
- Lynx Shunt VE.Can
- VE.Bus to VE.Can interface
- VE.Direct to VE.Can interface
- Skylla-i control
- CANUSB

These products are shipped without:

- Ion Control (not necessary since terminators *are* included with the Lynx Ion + Shunt)
- BMV-60xS to VE.Can interface
- VE.Can to NMEA2000 Micro-C male cable
- VE.Can resistive tank sensor (not necessary, terminators are included with the CCGX)

Note that it will normally not be necessary to purchase the terminators separately.

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Canbus PGN overview per product

Use below tables to see where to find what data. There is a freely available PDF file on the NMEA2000 website that also gives a good overview. Go to http://www.nmea.org/content/nmea_standards/downloads.asp, and then the link called "NMEA2000 Parameter Group Descriptions (Messages) with Field Description". To get the detailed information in order to decode the PGNs, see Q14 in the FAQs.

VE.Bus products (Multi's, Quattro and Inverters)

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery voltage	Battery Status	127508	0x1F214	2	
Battery current	Battery Status	127508	0x1F214	3	
State of Charge (%)	DC Detailed Status	127506	0x1F212	4	This PGN is disabled by default, since the reported value is only valid in systems with no other chargers or dc loads. Use the proper NMEA method to enable it, which is a complex request.
Battery temperature	Battery Status	127508	0x1F214	4	
Charger on/off switch	Charger Status	127507	0x1F213	5	
Charge state	Charger Status	127507	0x1F213	3	Off, bulk, absorption, float etcetera.
Inverter on/off switch	Inverter Status	127509	0x1F215	5	
Inverter Operating State	Inverter Status	127509	0x1F215	4	Off, inverting, etcetera.
L1 AC input voltage	J1939-75 PGN	65014	0xFDF6		AC input information is sent from a different network address than all other PGNs. To distinguish, use the device function code from the ACL PGN, which is "154 AC Input monitor" for the AC input information. All other PGN's are sent with device function code "153 Inverter". See manual for more information.
L1 AC input current	J1939-75 PGN	65014	0xFDF6		
L1 AC input frequency	J1939-75 PGN	65014	0xFDF6		
L1 AC input power	J1939-75 PGN	65013	0xFDF5		
L1 AC output voltage	J1939-75 PGN	65014	0xFDF6		These parameters are sent per phase, see manual for information about all phases.
L1 AC output current	J1939-75 PGN	65014	0xFDF6		
L1 AC output frequency	J1939-75 PGN	65014	0xFDF6		
L1 AC output power	J1939-75 PGN	65013	0xFDF5		
Warnings and alarms	Binary Switch Bank Status	127501	0x1F20D		Switch bank instance 0
LED states	Binary Switch Bank Status	127501	0x1F20D		Switch bank instance 1. This message is by default not enabled, see manual on how to enable it.

The Battery instance from PGNs 127508 (field 1), DC Instance from PGN 127506 (field 2) and PGN 127509 (field 3) and Charger Instance from PGN 127507 (field 1) are the same number. Changing one of the instances will change all of the mentioned instances.
See the VE.Bus to NMEA2000 interface manual for more details (https://www.victronenergy.com/accessories/ve-bus-to-nmea2000-interface).

Skylla-i/-IP44 battery charger family

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery voltage	Battery Status	127508	0x1F214	2	The 3-output model has 3 instances of PGN 0x1F214, one for each output. Field 1 of this PGN, Battery Instance is used to distinguish between them.
Battery current	Battery Status	127508	0x1F214	3	
Battery temperature	Battery Status	127508	0x1F214	4	
Relay and alarms	Binary Switch Bank Status	127501	0x1F20D		
Charger state	Converter Status	127750	0x1F306	3	Off, bulk, absorption, float etcetera.
AC input current	AC Power / Current Phase	127744	0x1F300	3	AC RMS Current
Charger on/off	Charger Status	127507	0x1F213	5	DEPRECATED: PGNs 127507 and 127503 are deprecated in favor of 127750 and 127744 They are not being transmitted by default. They can still be requested though, and also they can be configured to be transmitted on an interval.
Charge state	Charger Status	127507	0x1F213	3	
AC input current[9]	AC Input Status	127503	0x1F20F	7	
Equalization pending	Charger Status	127507	0x1F213	6	
Equal. time remaining	Charger Status	127507	0x1F213	8	

Note that the Skylla-i/-IP44 will switch off when there is no mains available. It will therefore also stop sending and responding to Canbus messages.

[9] The AC Input Status PGN 127503 is not present on the Skylla-IP44

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BlueSolar MPPT 150/70 and 150/85

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery voltage	Battery Status	127508	0x1F214	2	Battery instance 0
Battery current	Battery Status	127508	0x1F214	3	Battery instance 0
Battery temperature	Battery Status	127508	0x1F214	4	Battery instance 0
PV voltage	Battery Status	127508	0x1F214	2	Battery instance 1
PV current	Battery Status	127508	0x1F214	3	Battery instance 1
Relay and alarms	Binary Switch Bank Status	127501	0x1F20D		
Charger state	Converter Status	127750	0x1F306	3	Off, bulk, absorption, float etcetera.
Charger on/off	Charger Status	127507	0x1F213	5	DEPRECATED: PGN 127507 is deprecated in favor of 127750. They are not being transmitted by default. They can still be requested though, and also they can be configured to be transmitted on an interval
Charge state	Charger Status	127507	0x1F213	3	
Equalization pending	Charger Status	127507	0x1F213	6	
Equal. time remaining	Charger Status	127507	0x1F213	8	

The Battery instance for PGNs 127508 can be changed. After you did that, you can still distinguish between the Battery and PV information by looking at the DC detailed status PGN, 127506 0x1F212. It will report the DC Type, field 3, as Battery or Solar Cell. Field 2, DC Instance, equals the Battery instance in the Battery Status PGN for battery and solar information.

BMV-60xS and BMV-700 Battery Monitors

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery voltage	Battery Status	127508	0x1F214	2	Battery Instance 0
Battery current	Battery Status	127508	0x1F214	3	Battery Instance 0
State of Charge (%)	DC Detailed Status	127506	0x1F212	4	DC instance 0
Time Remaining	DC Detailed Status	127506	0x1F212	6	DC instance 0
Consumed Ah	Proprietary VREG 0xEEFF	61439	0xEFFF		Is also broadcasted at 1.5 seconds interval, see manual.
Starter battery voltage	Battery Status	127508	0x1F214	2	Battery Instance 1. Only sent for BMV-602.
Relay and alarms	Binary Switch Bank Status	127501	0x1F20D		See manual for more information

Notes:

- Battery instance 0 and DC Instance 0 are the same instance number, only the name is different in the NMEA2000 documentation.
- Above table is valid for the latest firmware version of the BMV to NMEA2000 interface cable, v1.06. Previous firmware versions used PGN 127502 instead of 127501 to report relay and alarm status.

See the manual of the BMV to NMEA2000 Interface for more details (https://www.victronenergy.com/accessories/ve-direct-to-nmea2000-interface).

Lynx Shunt VE.Can

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery voltage	Battery Status	127508	0x1F214	2	Battery instance 0. This voltage is measured before the main fuse.
Fused voltage	Battery Status	127508	0x1F214	2	Battery instance 1. This voltage is measured after the main fuse.
Battery current	Battery Status	127508	0x1F214	3	Battery instance 0
Battery temperature	Battery Status	127508	0x1F214	4	Battery instance 0
State of Charge (%)	DC Detailed Status	127506	0x1F212	4	DC instance 0
Time Remaining	DC Detailed Status	127506	0x1F212	6	DC instance 0
Consumed Ah	Proprietary VREG 0xEEFF	61439	0xEFFF		Is also broadcasted at 1.5 seconds interval.
Relay and alarms	Binary Switch Bank Status	127501	0x1F20D		Switch instance 0

Note that Battery instance 0 and DC Instance 0 are the same instance number, only the name is different in the NMEA2000 documentation.

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Lynx Ion, Lynx Ion + Shunt and Lynx Ion BMS

Data	PGN Name	PGN dec	PGN hex	Field	Remarks
Battery pack voltage	Battery Status	127508	0x1F214	2	Battery instance 0
Battery pack current	Battery Status	127508	0x1F214	3	Battery instance 0
Battery pack highest temperature	Battery Status	127508	0x1F214	4	Battery instance 0
State-Of-Charge (SOC)	DC detailed Status	127506	0x1F212	4	DC instance 0
Time-To-Go (TTG)	DC detailed Status	127506	0x1F212	6	DC instance 0
Lowest cell voltage in pack	Battery Status	127508	0x1F214	2	Battery instance 1
Highest cell voltage in pack	Battery Status	127508	0x1F214	2	Battery instance 2
Battery voltage	Battery Status	127508	0x1F214	2	Battery instance 10 t/m 25
Battery temperature	Battery Status	127508	0x1F214	4	Battery instance 10 t/m 25

Notes:

- Both the Lynx Ion and the Lynx Shunt VE.Can are sending Battery pack voltage and Battery pack current. Distinction can only be made on product id.
- Battery instance 0 and DC Instance 0 are the same
- One or more 24V 180Ah batteries together in one system are a Battery pack.
- One 24V 180Ah battery, consisting of 8 cells is a Battery.

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DEPRECATED: Getting data from VRM with wget

Use the JSON API for this, instead of wget. See: https://vrmapi.victronenergy.com/v2/docs

DEPRECATED: VRM Juice API

Use the new JSON VRM API, instead of Juice. See https://vrmapi.victronenergy.com/v2/docs

Links to interesting products

Note that we have not tested all these products, and they are not affiliated to Victron Energy in any way. We do not take any responsibility.

Consider using our own Color Control GX as the Victron to ModbusTCP converter, instead of below products.

1. NMEA2000 to Modbus RS485 converter by Offshore Systems (UK) Ltd:
   http://www.osukl.com/3155.htm

2. Converters from NMEA2000 to a variety of protocols, one of them is Modbus:
   http://www.adfweb.com/home/products/NMEA2000_Conveters.asp?frompg=nav14_2

3. RS232 to Ethernet/LAN Converter. Works well with the BMV Text Protocol. With the MK2/MK3 Protocol it is not very stable. The ATOP SE5001-S2
   http://www.atop.com.tw/en/productList2.php?pl1_id=2

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Document History

Rev.	Date	Name	Details
1		Matthijs Vader	Initial version
2		Matthijs Vader	Changed 9bit protocol from Daisy Chain to point to point.
3		Matthijs Vader	Added FAQ section for the Canbus communication.
4	2012-jan-24	Matthijs Vader	Added names of the VE.Bus and BMV protocol documents. And added link to Canbus manuals on our website.
5	2012-may-3	Matthijs Vader	Canbus is the preferred protocol. Added list of products, and how to connect via Canbus. Added information on the HEX protocol. BMV Protocol is now available on our website. Various rewording and layout changes. Added 'Staying-up-to-date'. Added several items to the FAQ.
6	2012-june-29	Matthijs Vader	Added Q3 to the FAQ (29 bits identifier) Changed Q7 (termination resistors) Inserted Q8 (powering the Canbus)
7	2012-nov-19	Matthijs Vader	Added Q12 (network address without ACL procedure) Added chapter "Canbus PGN overview per product" Renumbered Canbus FAQ
8	2012-nov-21	Matthijs Vader	Added NMEA2000 to Modbus RS485 converter by Offshore Systems (UK) Ltd
9	2013-feb-2	Matthijs Vader	Changed the colors mentioned at Q20, NMEA 2000 cable pin out Added PGN DC Detailed Status 127506 0x1F212 to the VE.Bus PGNs Changed PGN Number 127502 to 127501 in the VE.Bus PGNs Added 7 to 70VDC to Q17 Remarked that VE.Bus Switch bank instance 1 is by default not enabled. Added column to product table: onboard comm. Port Added PGN 127501 to list of Skylla-i and BlueSolar MPPT 150/70 PGNs Added information about instances, Q23 Changed the information in Getting the data from VRM with information for the new VRM website Replaced HEX with VE.Direct
10	2013-apr-20	Matthijs Vader	Added comment about Consumed Ah for BMV-60xs and Lynx Shunt VE.Can Added Q24 Added table on certified products.
11	2013-july-7	Matthijs Vader	Added note that Battery instance and DC instance are the same to BMV-60xS, Lynx Ion and Lynx Shunt VE.Can Updated BMV Canbus table, binary switch bank status instead of control.
12	2013-august-7	Matthijs Vader	Added note that Battery instance and DC instance are the same to BMV-60xS, Lynx Ion and Lynx Shunt VE.Can Updated BMV Canbus table, binary switch bank status instead of control. Fixed typo: a VE.Net to BMV2000 interface was mentioned. Should have been BMV-60xS to NMEA2000.
13	2013-august-13	Matthijs Vader	Added info to Q16, termination
14	2014-february-3	Matthijs Vader	Added part number of our terminators to Q16 Updated VE.Can/NMEA2000 protocol section Added new interfaces (…. to VE.Can interface) Added NMEA2000 database version numbers Added new interfaces such as VE.Direct to RS232 interface Added Modbus-TCP
15	2014-March-24	Matthijs Vader	Updated getting data from VRM with wget section Added VRM JSON API link
16	2014-May-30	Matthijs Vader	Added (JUICE) on page 10. Updated Modbus-TCP: available Added new solar chargers
17	2014-May-31	Matthijs Vader	Added more information and example on Modbus-TCP
18	2014-Sept.-26	Matthijs Vader	Modbustcp now also supports writing values (multi on/off and input current limit) Added Q25 on VE.Bus SOC Added link to changing NMEA2000 instances information on Victron Live.
19	2014-Dec-04	Matthijs Vader	Changed ModbusTCP text: it still said that it was read only in some places. Moved ModbusTCP FAQ to Victron Live.
20	2015-Jan-27	Matthijs Vader	Updated download links, almost all documents are now downloadable from our website instead of needing to ask us by email for one. Added link to Juice API page on Victron Live.
21	2015-Aug-27	Matthijs Vader	Chapter 'Getting data from VRM with wget': changed download link for 'Template to retrieve data'
22	2016-Feb-1	Matthijs Vader	Added Q26; products that are shipped with or without VE.Can RJ-45 terminators
23	2016-Apr-13	Matthijs Vader	Added Phoenix Inverters 250, 3675 and 500VA VE.Direct inverters

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			Added link to VE.Direct protocol FAQ as well as VE.Direct RS232 interface More small cleanups and updates left and right
24	2016-Nov-18	Matthijs Vader	Skylla-i and Solar Charger with VE.Can connection: 127503 and 127507 are deprecated in favor of 127750 and 127744
25	2016-Nov-30	Matthijs Vader	Reworded introduction, putting more focus on ModbusTCP Deprecated the Juice and wget methods of getting data from vrm.
26	2017-May-10	Matthijs Vader	Added info on MK3-USB
27	2017-Sept.-21	Martin Bosma	Added info about battery instances for VE.Bus to NMEA 2000/VE.Can interface Added Skylla-IP44 and Lynx Ion BMS Updated text of Q23 and added text about instance conflicts

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Operating a MultiPlus or Quattro in parallel with an Engine Driven Inverter System

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Engine Driven Inverter System or Variable speed AC Generator

A variable speed AC generator, like for instance a Dynawatt or a Dometic Travelpower generator, will produce a constant voltage of 230VAC when mounted to the engine of a vehicle or boat. Due to a DC-AC converter mounted to the generator both value and frequency of the generated voltage are (within limits) independent of the engine's speed. A major drawback using this concept is that the power output of these units depends on the engine's speed. In case the engine is running idle or at low speed, the alternator just does not generate power at all *(RPM<3000)* or performs at a fraction of its maximum rating *(3000<RPM<7000)*. So, when a large load is switched on while the engine is at low speed, there just may not be enough power available.
Due to the resulting power shortage, these alternator systems may stall or even get damaged beyond repair.
Another issue within mobile applications is the charging of the DC battery in case the original DC alternator was replaced by an AC alternator. One would then need additional equipment to provide solid DC power to charge the vehicle's battery and/or feed other DC loads aboard. This equipment will draw power from the AC alternator as well and using such equipment will therefore have a negative effect on the alternators performance.

A solution for these issues is to install one or more Victron MultiPlus *(or Quattro)* inverter/chargers in between of alternator and load. A unique feature, found only on the MultiPlus and Quattro models, called *'PowerAssist'* enables them to charge the batteries whenever the alternator generates a surplus of energy and is able to generate additional AC power whenever the alternator does not generate enough to feed the full AC load.
This means that when the engine is at moderately high speed, the installed batteries will be charged by the MultiPlus *(or Quattro)* using the optimum procedure. On the other hand, when the engine is at low speed and the alternator just cannot generate sufficient power by itself, the MultiPlus *(or Quattro)* will generate the additional AC power required to supply the existing AC load.

The most important requirement for the installation to perform as described is to have knowledge of the engine's actual speed *(the alternator's speed)*. In theory, this could be done by measuring the alternator's AC output but practice has shown that this method is not reliable enough. Being aware of this problem, Victron Energy engineered and created an interface module to measure the actual alternator's speed. Connecting the output of this interface to the MultiPlus *(or Quattro)* enables the MultiPlus to precisely calculate the power available from the alternator. As a result, the MultiPlus can adjust its own performance to generate the extra AC power needed. No more, no less. This will ensure a power system to perform as expected. At any rpm, with any load.

The graph below globally illustrates the performance of an installation consisting of a Travelpower 3,5kW alternator and a MultiPlus 24/3000/70 inverter/charger. Together they provide enough power for heavy loads up to 6500 Watts if needed, but whenever alternator power becomes low, the MultiPlus alone will still provide enough power to feed a 3000 Watt load. As a rule of thumb, the maximum load installed is usually limited by the alternator's maximum performance, so now sufficient AC power will be available all the time!

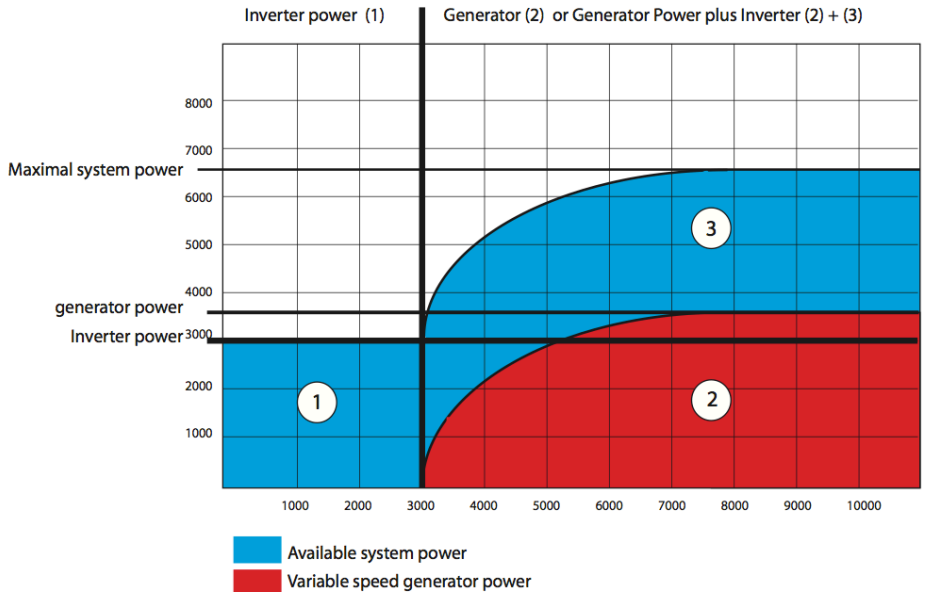

Figure 1:
Increased power performance, showing allowable load (Watt) versus alternator speed (RPM).

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Brief installation instructions

Required:

- One or more Victron Energy MultiPlus inverter/charger(s) with firmware 19xx008 or newer.
- A Victron Energy 16A transfer switch (optional).
- A Victron Energy INTERFACE 1140 module (tachometer).
- A remote panel with generator support (a VE.Bus Multi Control or a VE.Bus Digital Multi Control). Note: firmware 1120119 or newer is required when using an external relay as a transfer switch.
- An UTP cable, available from Victron Energy as well.

Steps to perform:

- Connect one end of a color-coded twin-wire cable to the tacho connections on the generator and connect the other end to the input of the INTERFACE 1140 module.

  Warning:
  Very high voltage may be present on these wires that can be hazardous for humans and animals. Be sure to make solid connections. Cable or wires used may never be subject to mechanical stress.

- Connect an UTP cable between the INTERFACE 1140 output and the MultiPlus.
- When using an external relay as transfer switch, be sure to connect the Remote Panel as shown.

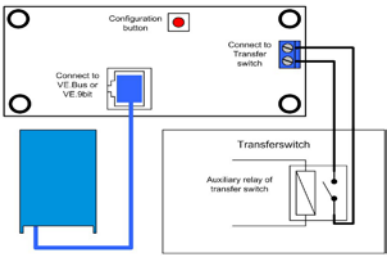


Figure 2: *Using an auxiliary relay*
The auxiliary relay contact must be closed whenever the engine's generator is selected.

Remarks:

- In case a Remote Panel is connected and AC power is drawn from shore, the shore current setting as specified by the Remote Panel is used and measured values from INTERFACE 1140 are ignored.
- When no Remote Panel is connected, the MultiPlus will always use the shore current set point as derived from the INTERFACE 1140 measurements.

The '*Dynamic Current Limiter*' setting must be unchecked and the '*Overruled by Remote*' setting must be checked (both settings are preset this way by default). The value of the '*AC Input Current Limit*' setting will be ignored.

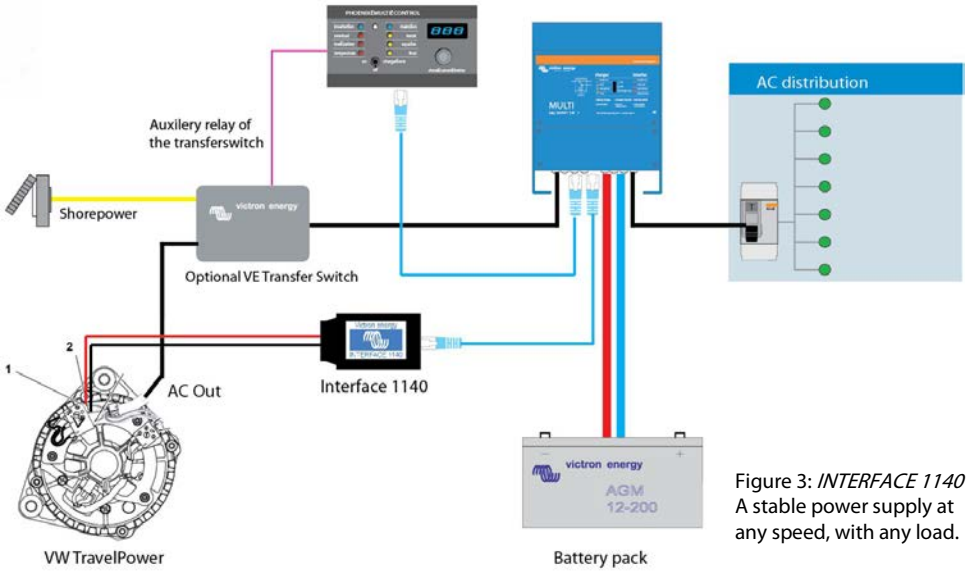


Figure 3: *INTERFACE 1140*
A stable power supply at any speed, with any load.

Telecom white paper

How to reduce the cost of supplying power to an off-grid BTS (and simultaneously increase up time)

1. Conventional solution

Off-grid BTS supplied by 1 or 2 generators, each rated at 7,5 kVA

1.1 Load and fuel consumption

	Duration (hr)	Load (W)	Energy (kWh)		Generator load (%)	Fuel (l/hr)	Duration (hr)	l/day
Day								
BTS + MW	12	1000	12.0					
Air-conditioning	12	836	10.0					
			1836	22.0	24%	1	12	12
Night								
BTS + MW	12	700						
			700	8.4	9%	0.9	12	10.8
Total per day				**30.4**				**22.8**

1.2 Capital and operational expenses (1 generator 7,5 kVA)

Capital Expenditures (Capex):
Generator 7,5 kVA 3 phase **$6,500.00**

Operating Expenditures (Opex) + equipment replacement costs:

Generator replacement every 2 years, costs per year (replacement after 18.000 running hours)			$3,250.00
Fuel consumption, liters per day		22.8	
Cost of 1 liter of diesel (including delivery)		$1.00	
Cost per day		$22.80	
Cost per year			$8,322.00
Periodic maintenance (24/24 operation)			
Every 250 hr:	oil change (3 liter)	$15.00	
	oil filter	$10.00	
	travel and work	$100.00	
Costs per year (site visit every 10 days, 32x per year)			$4,500.00
Every 500 hr:	fuel filter and other maintenance	$25.00	
Cost per year			$450.00
Opex per year			**$16,522.00**

1.3 Capital and operational expenses (2 generators 7,5 kVA)

For reasons of reliability, often 2 generators are installed.
Capex roughly doubles in comparison with 1.2.
Opex is similar to 1.2.

2. A Hybrid solution consisting of a generator, a MultiPlus and a battery

This configuration consists out of: one generator, a 3 Phase MultiPlus inverter/charger system and a battery. By using this configuration you can reduce the running hours of the generator by a factor 2 or more. Typically the generator would supply the load and recharge the battery during day time. The inverter/charger would take over during the night; when the air-conditioning is off. In order not to over stress the battery, the calculation below is based on a generator run time of 8 hr per day.

During the night the load is 700 Watt. This will be supplied by the inverter/charger. In addition, the inverter/charger will also supply the load during 4 hours of day time. In case of a 24 V battery, the discharge current would be:

Idn = 700/20 = 35 A during night time (12 hr), and
Idd = 1836/20 = 91 A during day time (4 hr)

For this example we are using a rather low discharge voltage (20 V) in order to take into account efficiency losses in the inverter/charger and cabling.

Total discharge: Cd = 12 x Idn + 4 x Idd = 420 + 364 = 784 Ah.

During the day the generator will supply the load and recharge the battery.
The average recharge current during the 8 hours available will be:

Cd / 8 = 98 A.

And the average power required by the inverter/charger:
Pm = 98 x 28 = 2744 W.

We are using a rather high average recharge voltage in order to take into account efficiency losses of the battery, cabling and inverter/charger.

Battery capacity needed: 1600 Ah (the reserve capacity will also allow for approximately 8 hours MTTR in case of generator failure).

Battery type: we recommend flooded tubular plate lead acid for the best price/performance comparison (this the battery used in electric vehicles such as fork lift trucks).

2.1. Load and fuel consumption

	Duration (hr)	Load (W)	Energy (kWh)		Generator load (%)	Fuel (l/hr)	Duration (hr)	l/day
Day								
BTS + MW	8	1000	8.0					
Air-conditioning	8	836	6.7					
Inverter/charger	8	2744	22.0					
			4580	36.6	61%	1.6	8	12.8
Night:	Generator	off						
Total per day				**36.6**				**12.8**

The amazing result is that although the total energy consumption has increased from 30,4 to 36,6 kWh, fuel consumption has decreased from 22,8 to 12,8 liter.
The increased energy consumption is due to efficiency losses in the battery, cabling and inverter/charger.
The dramatically improved fuel efficiency is due to better fuel efficiency of the generator at higher load.

2.2. Capital and operational expenses, hybrid solution

Capex:				
Generator 7,5 kVA 3 phase	$6,500.00			
Tubular plate battery 24V/1600Ah (including automatic watering system)	$3,500.00			
3x MultiPlus 24/1600/40	$2,424.00	(see note 1)		
VE.Net control and monitoring	$500.00	(see note 2)		
Total	**$12,924.00**			
Opex + equipment replacement costs:				
Generator replacement every 6 years, costs per year (replacement after 18.000 running hours, 8 hours per day)			$1,083.33	
Battery replacement every 4 years, costs per year			$875.00	(see note 3)
Multi replacement every 8 years, costs per year			$303.00	
VE.Net replacement every 8 years, costs per year			$62.50	
Fuel consumption, liters per day		12.8		
Costs of 1 liter of diesel (including delivery)		$1.00		
Costs per day		$12.80		
Costs per year			$4,672.00	
Periodic generator maintenance (8/24 operation)				
Every 250 hr:	oil change (3 liter)	$15.00		
	oil filter	$10.00		
	travel and work	$100.00		
Costs per year (site visit every month, 12x per year)			$1,500.00	
Every 500 hr: fuel filter and other maintenance		$25.00		
Costs per year			$150.00	
Opex per year			**$8,645.83**	
10% capex costs over additional Investment		$6,424.00	$642.40	
Total			**$9,288.23**	
Yearly costs advantage of hybrid solution			**$7,233.77**	
Total cost has been reduced by more than 40%!				

3. Additional advantages of the hybrid system

3.1. Increased reliability compared to the 1 generator solution

In case of generator failure the system will operate on battery for at least 8 hours (800 Ah battery reserve capacity, discharge current 91 A).

3.2. Longer generator engine life due to higher load

When operating at low load, the engine will suffer bore glazing, reducing service life. Replacement intervals therefore may even exceed 6 years in case of the hybrid solution.

3.3. Less pollution

Less pollution is the result of lower fuel consumption and better combustion.

3.4. Possibility to add solar or wind power

The battery is already there!

3.5. Improved control and monitoring with VE.Net

VE.Net enables remote control and monitoring of the inverter/chargers and the generator.

4. DC solution

Supplying the BTS directly with the DC from the battery. The inverter/chargers would be replaced by battery chargers.
This would eliminate the capex for 3x Multi 24/1600/40 ($2.240,00). They would be replaced by 2x Skylla 24/80 ($1.846,00).
The costs reduction is not impressive.
The DC supply voltage would range from 20 V (battery discharged) to 34 V (absorption charge). If the BTS needs a better stabilized voltage, the additional costs of a DC-DC converter would result in the DC solution being more expensive than the hybrid solution.

Alternatively, a 48 V battery could be used, if the DC voltage required for the BTS is 48 V.

Notes

1. MultiPlus 24/1600/40
Three units are needed, to create a 3 phase AC supply.
Continuous AC output at 25°C: 3 x 1600 = 4800 VA.
Continuous AC output at 45°C: 3300 VA.
Peak output: 9600 VA.
AC transfer switch included in the Multi's.
When the generator is running, the Multi's will automatically reduce battery charge current if needed to prevent an overload of the generator during periods of peak demand by the BTS.

2. VE.Net
Needed for timing (8/24 operation of the generator) and monitoring of battery state of charge.
VE.Net can also be used to monitor and control both the Victron equipment and the generator from a central control room.

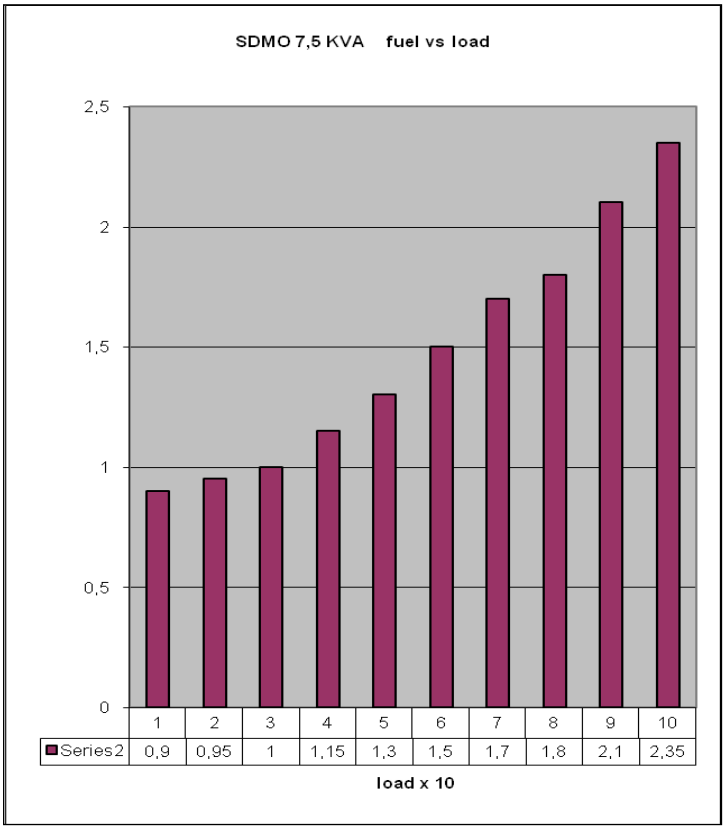
3. Battery
The tubular plate lead-acid battery offers the best price performance (that is why it is the standard battery for forklifts).

Cycle life
Battery manufacturers claim 1500 - 2000 charge/discharge cycles of 80%, in forklift applications.
This is equivalent to 2400 - 3200 cycles of 50%, which is well in excess of 4 years (4 x 365 = 1460 cycles) service life as assumed under 2.2.
Cycle life is not much affected by temperature.

Float life
Float life is reduced by 50% for every 10°C temperature increase.
Manufacturers claim 10 to 20 years float life for flooded tubular plate batteries, at 20°C ambient temperature.
This would reduce to 5 - 10 years at 30°C ambient and 3,5 - 7 years at 35°C (average temperature)

Service life
End of life is reached when either the max # of cycles is reached, or when the end of float life is reached, whichever comes first.
Battery manufacturers experience and guarantee conditions (and possibly local field experience with electric forklifts) is needed to obtain reasonable certainty that 4 years service life is realistic.

4. Fuel consumption of generator: see table



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1. The traditional AC generator system

Per Watt ac-power, an inverter is generally more expensive than a generator. So why would one add an inverter to an ac-generator system?

Apart from the obvious advantage of "silent ac-power", there are other major considerations why it is attractive to add a Multi inverter/charger to a system with ac-generator:

- Fuel savings
- Cost and time savings as a result of reduced maintenance
- Extended generator life
- 24/7 availability of ac power

Figure 1. shows a typical ac-power requirement schedule. In this example, there is a morning peak of 3 kW for two hours, a 3 kW peak around noon and the evening peak of 6 kW. Between morning- and noon peak and between noon- and evening peak, ac requirement is relatively low, around 500 W on average. After the evening peak, the average requirement is about 1 kW for some hours.

With a 7.5 kW ac-generator as the only source of ac-power, the generator needs to run for 17 hours per day. 70% of the time the generator is loaded to less than 15% of its full capacity.

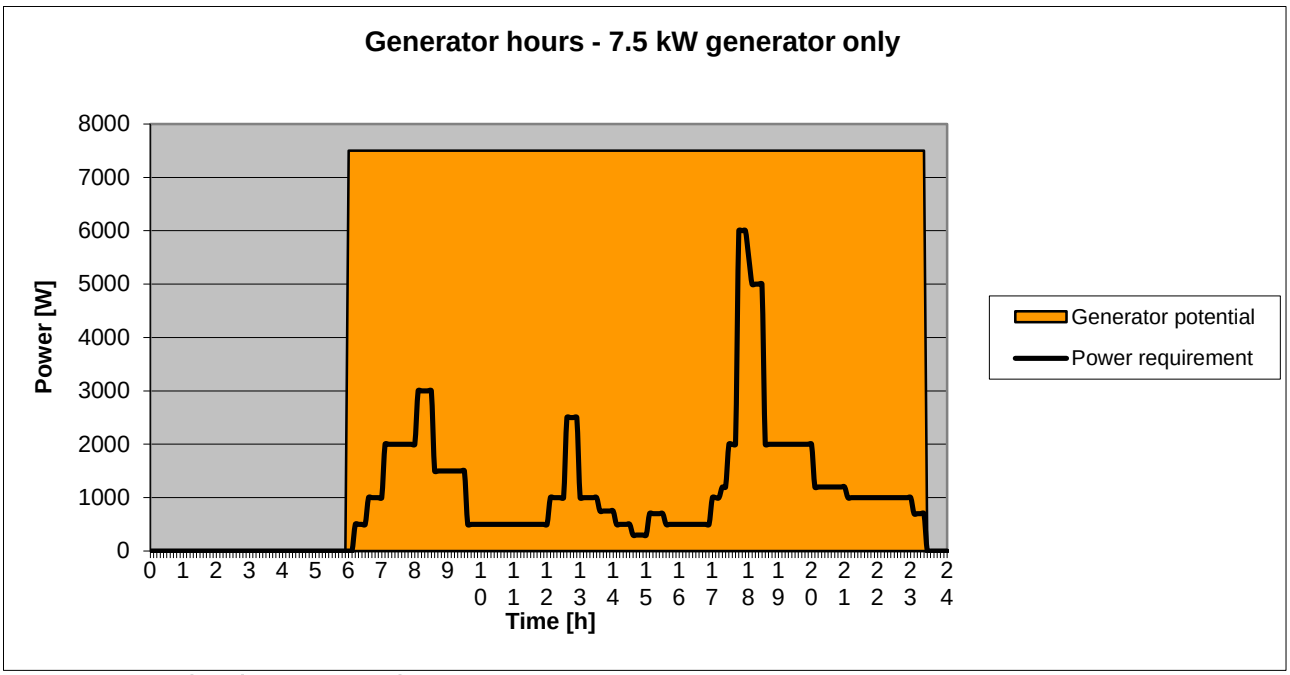


Figure 1. System with 7.5 kW generator only

2. Adding a Victron MultiPlus to the system

We now introduce a Victron MultiPlus 24/3000/70 inverter/charger and a battery bank to the system. (see appendix for MultiPlus schematic) The inverter can supply the required ac-power most of the time. During the peak ac-requirement, the generator is started (preferably automatically by the Multi and/or a battery monitor) to supply peak ac demand. At the same time, the MultiPlus will use any ac-power from the generator which is not required by the ac-loads, to re-charge the batteries.

Figure 2 shows the same system now with the Victron MultiPlus added. Generator running hours can be reduced to 5 hours/day, while 12 hours of ac-consumption are enjoyed in silence. Whenever the generator is running, it is loaded up to 70% of its capacity.

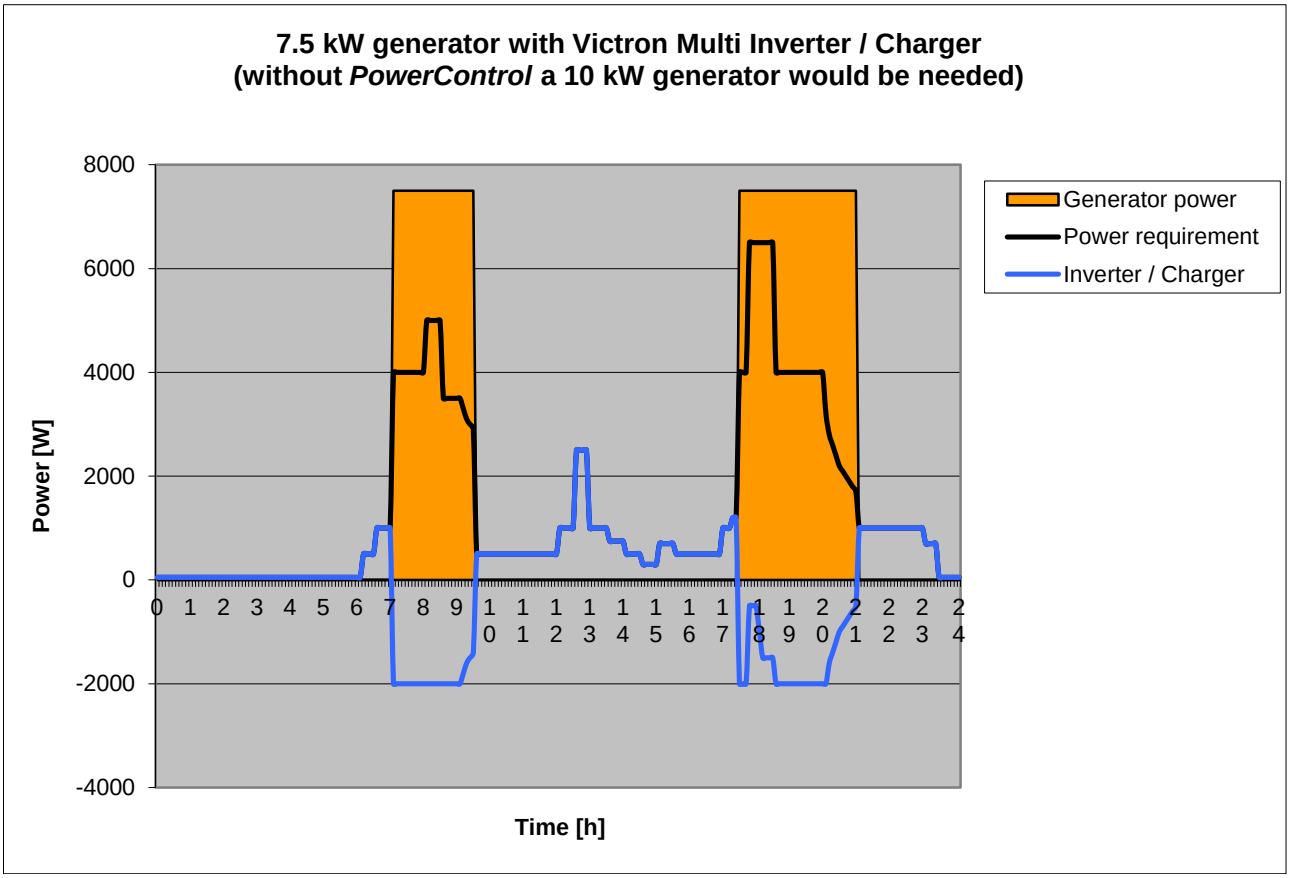


Figure 2. System with 7.5 kW generator and Victron MultiPlus. The blue line shows the power through the Victron Multi. When the blue line is above 0, the inverter of the Multi takes power from the batteries to supply ac-power to the ac-loads. When the blue line is below 0, the charger of the Multi takes ac-power from the generator to re-charge the batteries.

2.1 The Battery

The battery size needed is smaller than what may be expected.
In our example a 24 V battery would be discharged to 166 Ah just before the generator is started in the morning, and to 285 Ah just before the generator is started in the evening.
A 24 V / 600 Ah battery would therefore be a good choice, with ample reserve capacity.
If a 48 V system is chosen, 300 Ah will be needed.
The most rugged battery for the purpose is the type used in forklift trucks.

2.2. Fuel consumption

The typical 7.5 kW generator will consume about 1.5 l/h diesel at low load and 2.3 l/h at 75% load. So the generator only configuration requires 25.5 liters diesel per day, whereas the generator with the Victron Multi requires 11.5 l/day to provide the same ac power. A savings of 5110 liters diesel per year. At Euro 0.50 per liter, this equates to a savings of about Euro 2555 per year (not counting time and money saved on re-fuelling).

2.3. Periodic maintenance

Typical recommendation by the manufacturers is to change oil every 150 h of operation. For the generator-only scenario with 6205 running hours, this equates to 41 oil changes per year.
When the Multi inverter / charger is added to the system, running time is reduced to 1825 hours, this equates to 12 oil changes per year. A savings of 29 oil changes per year.
At a typical lube oil volume of 5 l, 145 liter of lube oil is saved each year. At Euro 5.00 per liter, this equates to a savings of Euro 725 per year (not counting time involved in performing the oil change and parts such as oil filters).

2.4. Generator life

Generators based on a fixed speed diesel engine will last longer when they are run under load compared to being run at no- or low load. Some manufacturers recommend operation at a minimum of 30% load to prevent premature failure.
By adding the Multi inverter/charger in our example, the load on the generator went up from less than 15% for 70% of the time, to a loading of 70%. A considerable longer generator life may be expected.

2.5. Summary

	Generator Only	**Generator with Multi**	**Savings**
Running hours/day	17 h	5 h	12 h (silence)
Diesel consumption/day	25.5 l/day	11.5 l/day	14 l/day
Diesel consumption/yr (Euro 0,50 per liter)	9307 l/yr	4197 l/yr	5110 l/yr 2555 Euro/yr
Oil changes/yr	41	12	29
Lube oil consumption/yr (Euro 5,00 per liter)	205 l/yr	60 l/yr	145 l/yr 725 Euro/yr
Generator loading	15% load for 70% of running hours	70% load	
Annual savings in fuel and lube oil **(3x longer service life of the generator not included)**			**3.280 Euro/yr**
Savings after 5 years			**16.400 Euro**

2.6. Conclusion

Apart from the obvious benefit of availability of “silent” ac-power, the fuel savings and cut-down in maintenance are significant when a Multi inverter/charger is added to the generator system. Also, not covered in this brief, the environmental impact as a result of reduction in harmful exhaust and oil waste will be significant.
Actual gain will vary per generator and actual power requirement profile. In general, the benefits will be larger when the ac-requirement profile shows a pattern of a few high peaks with significantly lower average power requirements between the peaks, which is a common profile for most ac generator systems.

3. Why should the inverter/charger be a Victron MultiPlus?

In the previous section we saw that there are potentially huge benefits and cost savings to be made when an inverter/charger is added to a system with ac-generator. There are many inverter/chargers on the market that cost a lot less than a Victron MultiPlus. In this section we will show that, to take full advantage of the potential benefits, the inverter/charger must be a Victron MultiPlus.

Apart from obvious benefits such as the clean pure sine wave output, ultra-fast ac-transfer switch, marinized construction, high quality built and an organization behind the product which has been committed to R&D and customer support for over 30 years, there are five specific features of the MultiPlus that are essential in achieving cost savings when using the inverter/charger with the ac-generator.

3.1. AC input power manager

Unique to the Victron MultiPlus is the ability to set a power level that the unit will try to maintain at its ac-input terminals. The MultiPlus has 2 levels of ac power management. The first level is PowerControl.

PowerControl

The **PowerControl** functionality enables the MultiPlus to automatically increase and decrease the charge rate of its charger depending on the power demand at the ac-output of the Multi. The **PowerControl** functionality of the input power manager is best understood by looking more closely at fig. 2.
The blue line shows the power through the Victron Multi. When the blue line is above 0, the inverter of the Multi takes power from the batteries to supply ac-power to the ac-loads. When the blue line is below 0, the charger of the Multi takes ac-power from the generator to re-charge the batteries. This ac-power is an additional load of 2.2 kW for the generator. As can be concluded from fig. 1, this additional load would result in an overload of the generator between 18 hours and 19 hours, because the other ac loads do increase to 6 kW during that period (see fig. 1). Adding the 2.2 kW load of the charger would increase the load to 6 + 2.2 = 8.2 kW. This overload would stall the 7.5 kW generator.
To prevent this, the input power manager of the MultiPlus will automatically reduce its charge rate in order to limit the total load on the generator to the set maximum power level, 6.5 kW in this example.

If you are still reading, you are either an enthusiast or professionally involved with power systems. In that case we will let you in on one of our best-kept secrets.

PowerAssist: the secret of the MultiPlus
Figure 3 shows again our example power schedule with the 6 kW peak in the evening.
But now the generator has been downsized to 5 kW.
Choosing a smaller generator will of course reduce noise, size, weight, fuel consumption and initial investment.
The 5 kW generator will however not be able to supply the peak load of 6 kW, even if the charge current of the MultiPlus is reduced to zero during that period.
Now **PowerAssis**t, the second level of ac power management is needed. With PowerAssist the MultiPlus can temporarily supplement the generator ac-power with power from the battery. In figure 3 this is visible between 18 hours and 19 hours: even though the generator is running, the MultiPlus is inverting (blue line above 0) instead of charging, thus providing the additional ac-power that is required on top of the generator output.
With one MultiPlus 24/3000/70 an additional 3 kW can be added to the generator output!

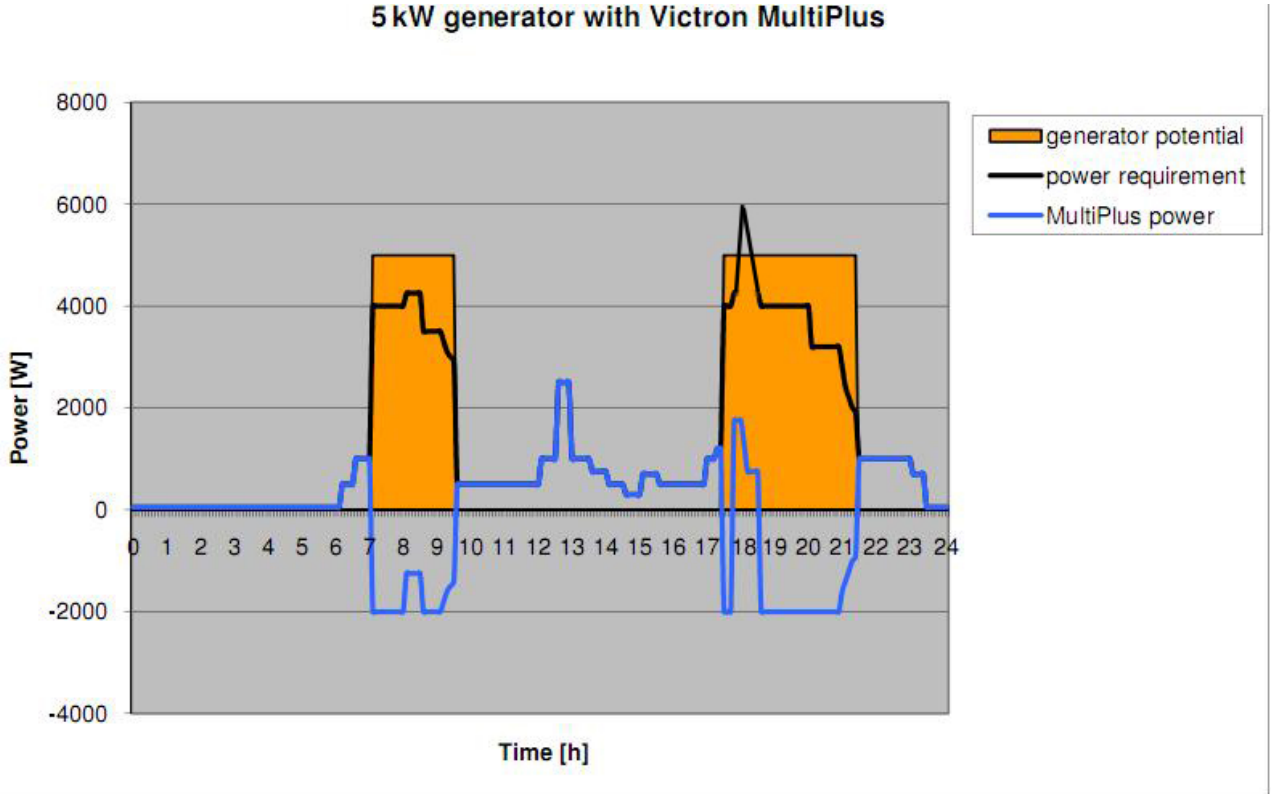


Figure 3. System with 5 kW generator and MultiPlus inverter/charger. When the blue line (MultiPlus) is below 0, energy is put into the battery bank (charging), when the blue line is above 0, the MultiPlus is generating ac from the battery bank (inverting).

Dynamic range of ac power regulation

In the previous sections, we saw that the key to achieving savings by adding an inverter/charger to a generator system was the ability of the inverter/charger to dynamically control the ac power taken from the generator.
With the MultiPlus, 24/3000/70 the dynamic range of ac power regulation is more than 5 kW:
The first level of dynamic ac power regulation is PowerControl, which enables control of the ac power needed for battery charging between zero and a maximum power draw of about 2.3 kW. (= 70 A charge current times 30 V charge voltage at 90% efficiency)
On top of that PowerAssist, the second level of dynamic ac power regulation, extends power regulation with an additional 3kW (per unit), which may be above the maximum power of the generator. This implies that using a MultiPlus is particularly useful when the ac-power requirement profile shows large variations (high peaks short in duration, low average), that require a wide dynamic range of ac-power regulation.

3.2 Unity power factor

Simply said, the power factor of an ac-load is an indication of how much power needs to be supplied to the load relative to the power that the load consumes. The power consumed by the load is indicated in Watts, the power that needs to be supplied is indicated in VA. If the Power factor is PF, the following relationship exists:
PW = PF x PVA. The power in VA is equal to the product of rms voltage and rms current.

The power factor of some battery chargers can be as low as 0.7. This means that a charger that consumes 2 kW, requires about 2.8 kVA from the generator to make it work. If the generator voltage is 230 V, the generator must be able to supply 12.2 A to this charger. The generator would only need to supply 8.6 A for the same charge result if the power factor were to be 1.
One cause of non-unity power factor is that load current is not in phase with the voltage. The other major cause of non-unity power factor is a load current that is not sinusoidal. A non-sinusoidal load current will cause harmonic distortion in the ac system. Harmonic distortion can cause generator windings to burn out.
To cope with the negative effects of non-unity power factor and non-sinusoidal current of most chargers, generator suppliers will recommend to oversize the generator by as much as a factor of 2 (note that only the generator needs to be oversized, not the diesel engine driving it).
The Victron MultiPlus inverter/charger has a unity power factor (PF = 1). A system with Multis does not require over sizing to cope with the chargers. It furthermore will not introduce harmonic distortion into the system. These are very important considerations when planning to add an inverter/charger to a generator system.

3.3 Scaling

Third reason to choose a Victron Multi, is because this is the only inverter/charger on the market that allows easy scaling of the system. A single 3 kW inverter/charger will have little impact on a 40 kW generator system. Because the Victron Multi is a modular unit, systems of up to 15 kW single phase or 45 kW 3-phase can easily be built by adding more units. The total system can easily be scaled for optimum performance / savings. (see fig. 4)

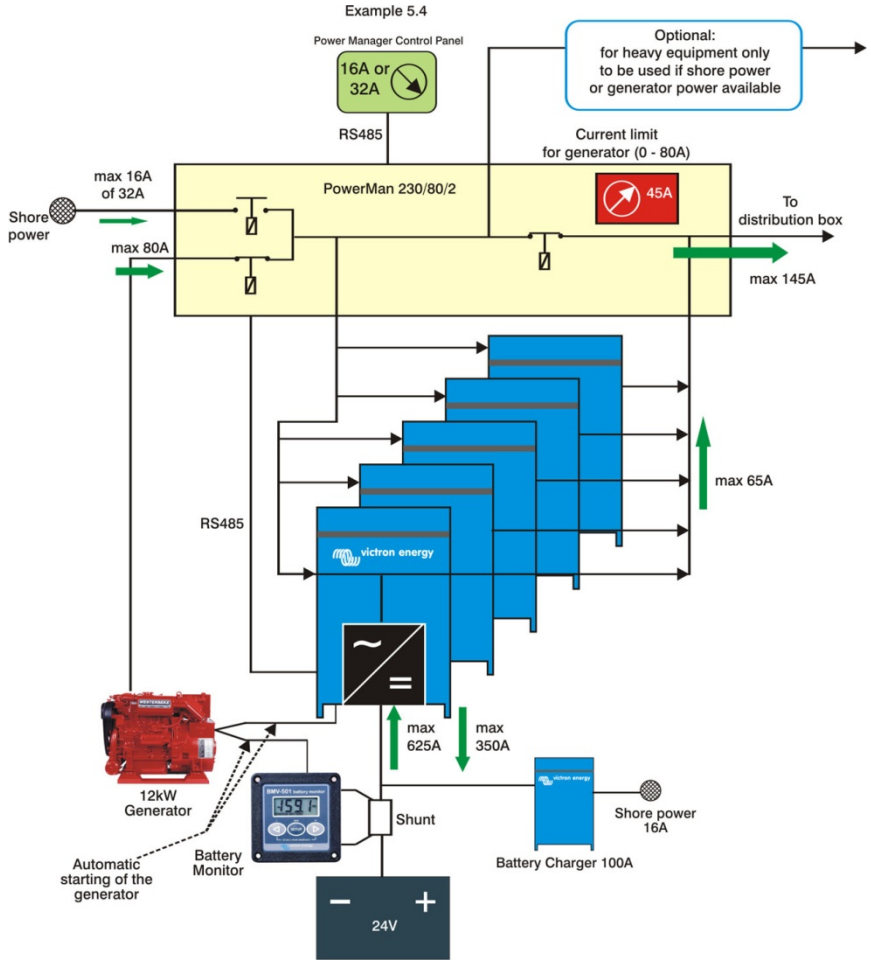


Figure 4: System with 5 Multis in parallel, a generator and an alternative supply.

Note:
At the other side of the power spectrum, A MultiPlus can also be used to boost the output of small gensets like the Honda "I" range for example. (The "I" range starts at 1 kVA)

3.4 External ac power management module

In the examples of fig. 2 and fig. 3 generators with 7.5 kW and 5 kW output power were used.
In case of larger systems (see fig. 4) with multiple paralleled Multis, it becomes unpractical to use the internal ac power management module of the Multis.
For larger systems an external current measuring system has been built in the PowerManager, and soon an even more sophisticated ac power management module will become available.

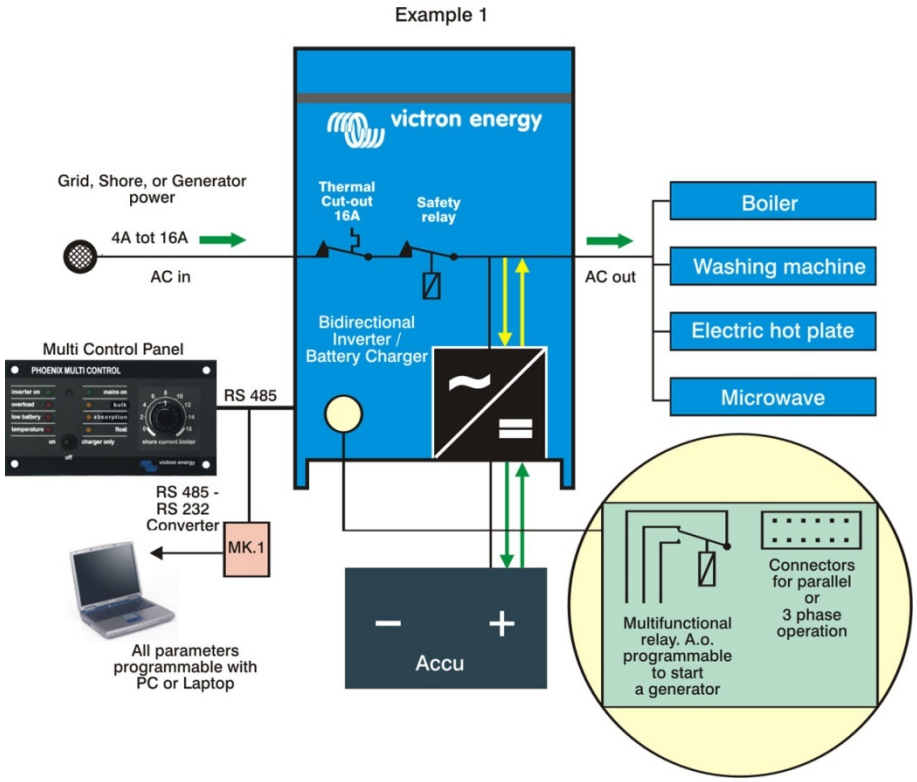
3.5 Connectivity: a continuously increasing array of monitoring and control facilities

Next to the Multi Control panel and VEConfigure, VE.Bus and VE.Net connectivity will soon make any requirement regarding remote control (including mobile phone and satellite) a reality.

4. Conclusion

In the second section, we showed that adding an inverter charger to an ac-generator system could have huge potential benefits such as silent ac supply, fuel savings, maintenance reduction and extended generator life.
In the third section we saw that to be able to achieve these potential benefits, the inverter/charger must have certain specific features that are found only on the Victron MultiPlus: automatic ac input power control, unity power factor and modularity for scaling.

Appendix : schematic diagram of the MultiPlus



The bidirectional converter
The M/M+ is built around a bidirectional converter, that operates as an inverter or as a battery charger.
The converter of the M+ does more than a conventional bidirectional converter: it operates in parallel with the grid, with shore power or with a genset. It can add power to AC supply (with energy from the battery) and it will use surplus power to recharge. In most cases the M+ will also reduce the harmonic distortion of the genset output (this can be important for certain sensitive loads such as an induction cooker)

A multifunctional relay
This relay can a. o. be programmed to start a generator based on power demand and / or battery voltage.

A RS485 port
All parameters of the M/M+ are programmable.
The most important parameters can be programmed with a push button code, but it is much more convenient to use the MK.1b RS485 to RS232 converter, VEConfigure software (downloadable from our website) and a PC Notebook computer.
Examples of programmable parameters:
- inverter DC voltage cut out
- charge curve
- maximum charge current
- parallel operation, split phase operation and 3 phase operation
- programming the multifunctional relay

Connector for parallel operation and 3 phase operation
Up to 6 Multis can be parallel connected to increase power to 15 kW.
In 3 phase configuration up to 18 Multis can be used to build a 45 kW inverter / charger!

AC input with 16 Amp thermal breaker and safety relay
The maximum AC input current of the M/M+ is 16 A. (optional 32 A).06/12/200406/12/2004 The safety relay makes sure that no dangerous AC voltage will be present on for example the shore power plug when disconnected.

The Multi Control Panel (16 A or 30 A)
The rotary knob on this panel is crucial: with this knob the maximum AC input current can be set, to a maximum of 16 A or 32 A.

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07-05-2019

MultiPlus-II

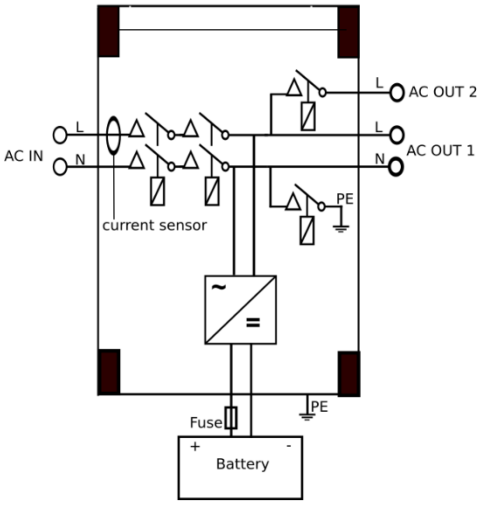
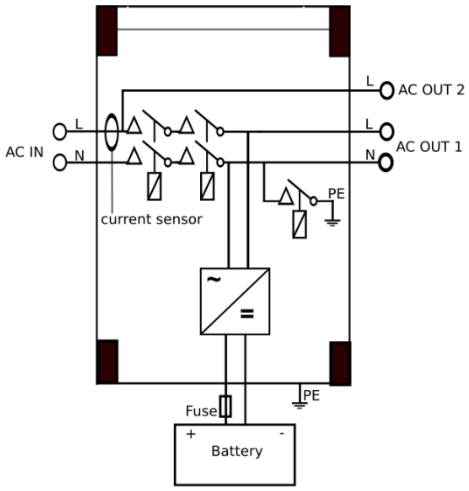
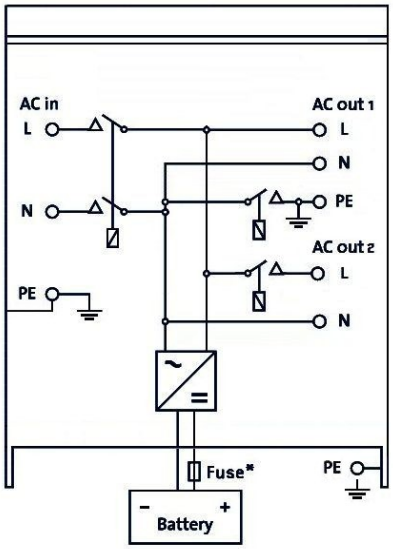
Comparison sheet



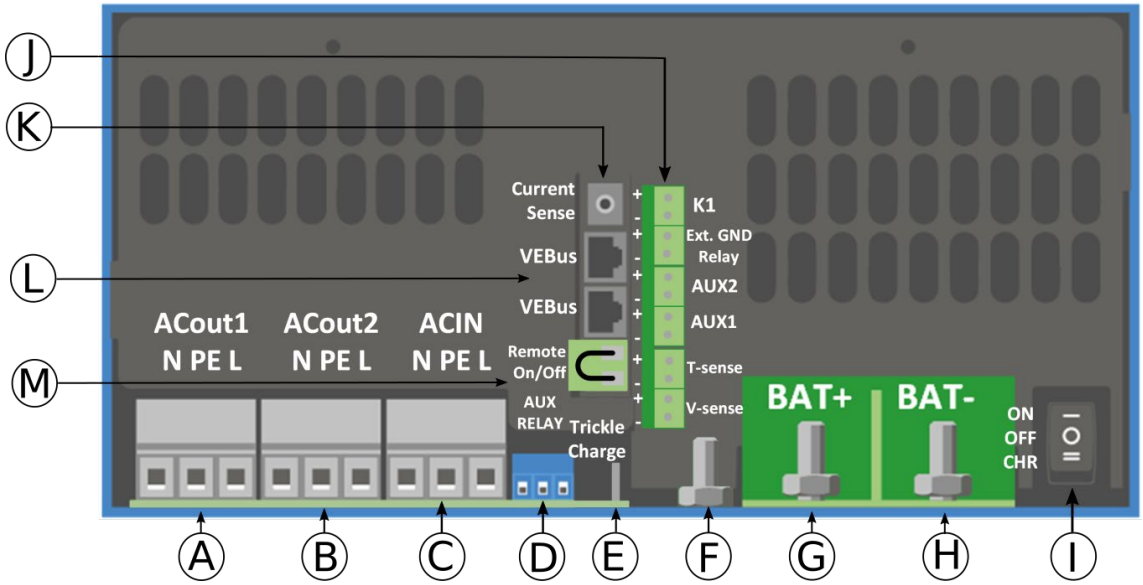
Specifications

	MultiPlus-II 24/3000/70-32 PMP242305010 HW rev. 01 and up	MultiPlus-II 48/3000/35-32 PMP482305010 HW rev. 08 and up	MultiPlus-II 48/5000/70-50 PMP482505010 HW rev. 03 and up	MultiPlus-II 48/3000/35-32 PMP482305000 HW rev. < 08	MultiPlus-II 48/5000/70-50 PMP482505000 HW rev. < 03	MultiGrid 48/3000/35-50	MultiPlus 48/3000/35
PowerControl & PowerAssist	Yes						
Transfer switch	32A	32A	50A	32A	50A	50 A	16A or 50A
	INVERTER						
DC Input voltage range	19 – 33 V	38 – 66 V					
Output	Output voltage: 230 VAC ± 2%			Frequency: 50 Hz ± 0,1% (1)			
Cont. output power at 25°C (3)	3000 VA	3000 VA	5000VA	3000 VA	5000VA	3000 VA	
Cont. output power at 25°C	2400 W	2400 W	4000W	2400 W	4000W	2400 W	
Cont. output power at 40°C	2200 W	2200 W	3700W	2200 W	3700W	2200 W	
Cont. output power at 65°C	1700 W	1700 W	3000W	1700 W	3000W	1700 W	
Maximum apparent feed-in power	2500VA	2500VA	4000VA	2500VA	4000VA	2500VA	
Peak power	5500 W	5500 W	9000W	5500 W	9000W	6000 W	
Maximum efficiency	95 %	95 %	96%	95 %	96%	95 %	
Zero load power	11 W	11 W	18W	11 W	18W	25 W	
Zero load power in AES mode	7 W	7 W	12W	7 W	12W	20 W	
Zero load power in Search mode	2 W	2 W	2W	2 W	2W	12 W	
	CHARGER						
AC Input	Input voltage range: 187-265 VAC			Input frequency: 45 – 65 Hz			
Charge voltage 'absorption'	28,8 V	57,6 V					
Charge voltage 'float'	27,6 V	55,2 V					
Storage mode	26,4 V	52,8 V					
Maximum battery charge current (4)	70 A	35 A	70 A	35 A	70 A	35 A	
Charge current starter battery (A)	4 A	n.a.					
Battery temperature and voltage sensor	Yes	Yes	Yes	VE.Bus Smart dongle (optional)		Yes	
	GENERAL						
Auxiliary output	Yes (32 A) Relay with 2 minutes turn on delay			Yes (32 A) Directly connected to the AC input		Yes (16 A) Relay with 2 minutes turn on delay	
External current sensor (optional)	50A	50A	100A	50A	100A	No	
Programmable relay (5)	Yes						
Protection (2)	a - g						
VE.Bus communication port	For parallel and three phase operation, remote monitoring and system integration						
General purpose com. ports	Yes, 2x						
Remote on-off	Yes, 2 pole					Yes, 3 pole (Incl. remote Charger only)	
Operating temperature range	-40 to +65°C (fan assisted cooling)						
Humidity (non-condensing)	max 95%						
	ENCLOSURE						
Material & Colour	Steel, blue RAL 5012					Aluminium, blue RAL 5012	
Protection category	IP22					IP20	
Battery-connection	M8 Bolts					Four M8 bolts	
230 V AC-connection	Screw terminals 13 mm² (6 AWG)						
Weight	18 kg	18 kg	29 kg	18 kg	29 kg	18 kg	
Dimensions (hxwxd)	506 x 275 x 147 mm	506 x 275 x 147 mm	565 x 323 x 148 mm	499 x 268 x 141 mm	560 x 320 x 141 mm	362 x 258 x 218 mm	

1) Can be adjusted to 60 Hz
2) Protection key:
a) output short circuit b) overload c) battery voltage too high d) battery voltage too low e) temperature too high
f) 230 VAC on inverter output g) input voltage ripple too high
3) Non-linear load, crest factor 3:1
4) At 25°C ambient
5) Programmable relay which can be set for general alarm, DC under voltage or genset start/stop function
AC rating: 230V / 4A, DC rating: 4A up to 35VDC and 1A up to 60VDC

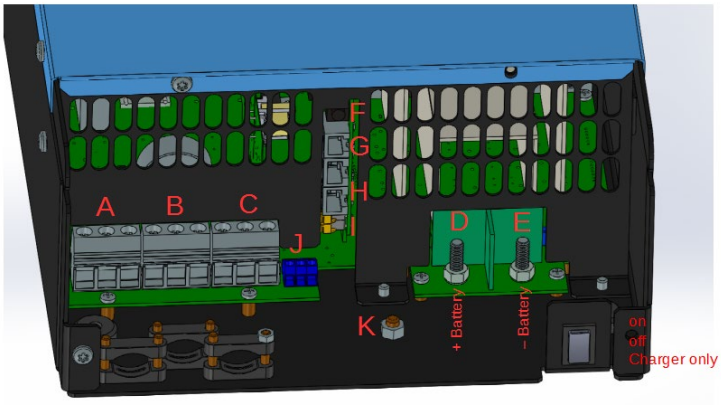
PMP242305010 PMP482305010 PMP482505010	PMP482305000 PMP482505000	MultiGrid MultiPlus
		
AC-out-2 is connected to the AC output	The AC-in current sensor (internal current sensor) of the MultiPlus-II is placed directly on the AC input. AC-out-2 is connected to the AC input, ‘downstream’ of the current sensor.	

MultiPlus-II
PMP242305010 PMP482305010 PMP482505010

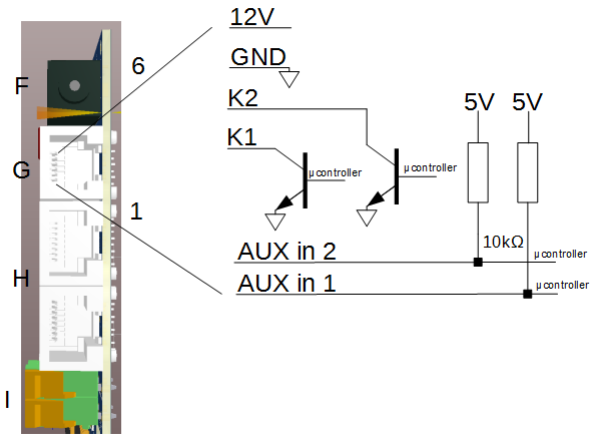


A	Load connection. AC out1. Left to right: N (neutral), PE (earth/ground), L (phase)
B	Load connection. AC out2. Left to right: N (neutral), PE (earth/ground), L (phase)
C	AC input: Left to right: N (neutral), PE (earth/ground), L (phase)
D	Alarm contact: (left to right) NO, NC, COM.
E	Trickle charge (12 and 24V model only)
F	Primary ground connection M6 (PE).
G	M8 battery positive connection.
H	M8 battery minus connection.
I	switch: 1=On, 0=Off, ||=charger only
J	Terminal for: top to bottom: 1. 12V 100mA 2. Programmable contact K1 open collector 70V 100mA 3. External ground relay + 4. External ground relay – 5. Aux input 1 + 6. Aux input 1 – 7. Aux input 2 + 8. Aux input 2 – 9. Temperature sense + 10. Temperature sense – 11. Battery voltage sense + 12. Battery voltage sense -
K	External current sensor
L	2x RJ45 VE-BUS connector for remote control and/or parallel / three-phase operation
M	Connector for remote switch: Short to switch “on”.

MultiPlus-II
PMP482305000 PMP482505000



A	Load connection. AC out1. Left to right: N (neutral), PE (earth/ground), L (phase)
B	AC input: Left to right: N (neutral), PE (earth/ground), L (phase)
C	Load connection. AC out2. Left to right: N (neutral), PE (earth/ground), L (phase)
D	M8 battery positive connection.
E	M8 battery minus connection.
F	External current sensor (not available on MultiGrid)
G	RJ12 additional IO connector (see below)
H	2x RJ45 VE-BUS connector for remote control and/or parallel / three-phase operation (VE.Bus)
I	Connector for remote switch: Short to switch “on”.
J	Programmable relay (left to right) NO, NC, COM.(virtual switch in VE.Configure)
K	Primary ground connection M8 (PE).



Detail of the RJ12 additional IO connector (G)

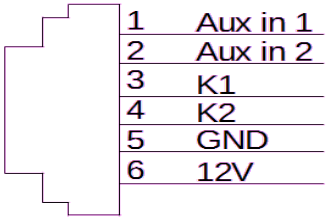
RJ12 additional IO connector

Aux in 1 and Aux in 2: 0 – 5V (same fio as in MultiGrid)

K1, K2: open collector 70V 100mA max (open collector inputs, replaces the programmable relay contacts of the MultiGrid)

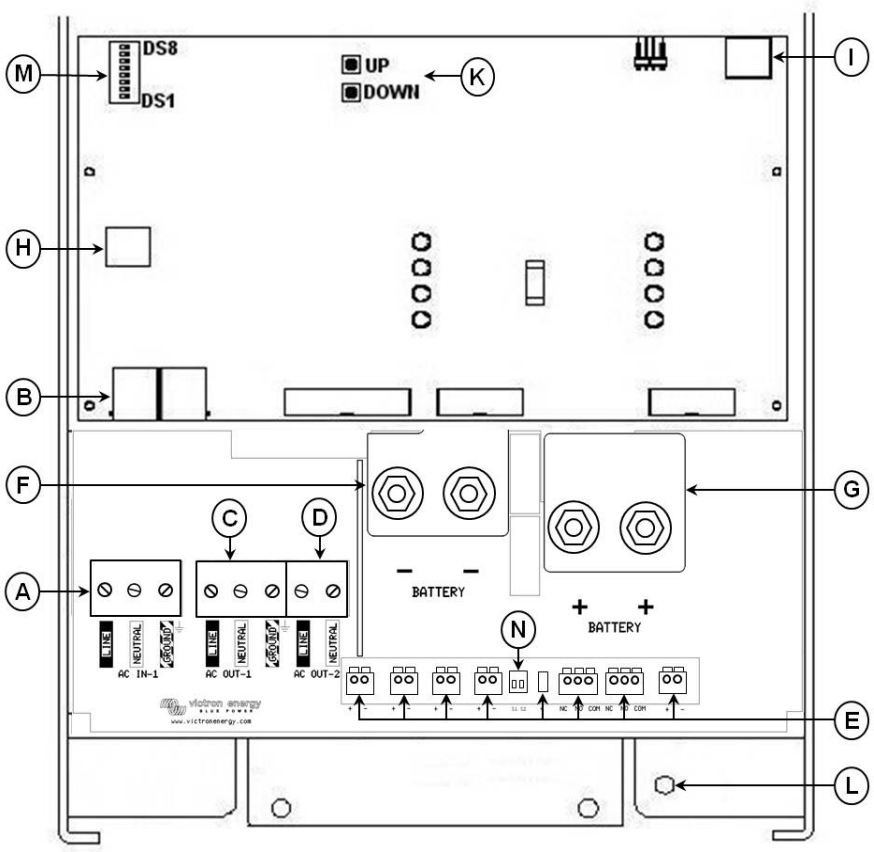
12V: 12V 100mA max power supply

Gnd: common ground



Detail of the RJ12 additional IO connector (G)

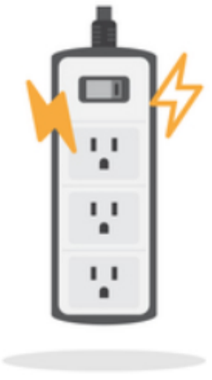
MultiGrid

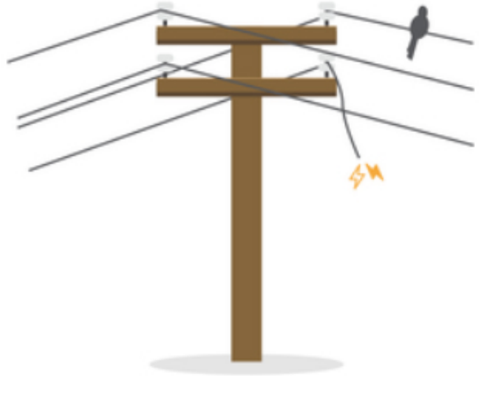


A	AC input: Left to right: L (phase), N (neutral), PE (earth/ground).
B	2x RJ45 connector for remote control and/or parallel / three-phase operation (VE.Bus)
C	Load connection. AC out1. Left to right: L (phase), N (neutral), PE (earth/ground).
D	Load connection. AC out2. Left to right: PE (earth/ground), L (phase), N (neutral).
E	Terminals Temperature sensor (not available on the MultiPlus-II: VE.Bus Smart dongle needed) Aux input 1 (same fio as MultiPlus-II) Aux input 2 (same fio as MultiPlus-II) Starter battery plus + (starter battery minus must be connected to service battery minus) Not available on the MultiPlus-II. Programmable relay contacts K1 Programmable relay contacts K2 Voltage sense (not available on the MultiPlus-II: VE.Bus Smart dongle needed)
F	Double M8 battery minus connection.
G	Double M8 battery positive connection.
H	Connector for remote switch: Short left and middle terminal to switch 'on'. Short right and middle terminal to switch to 'charger only'.(**not available on MultiPlus-II).**
I	Alarm contact: (left to right) NC, NO, COM.
K	Pushbuttons for set-up mode. Not available on MultiPlus-II.
L	Primary ground connection M8 (PE).
M	Dipswitches DS1- DS8 for set-up mode. Not available on MultiPlus-II.
N	Slide switches, factory setting: SW1= down (off) position, SW2 = down (off) position. Not available on MultiPlus-II. SW1: down (off) = internal GND relay selected, up (on) = external GND relay selected (to connect ext GND relay: see E). Not available on MultiPlus-II SW2: No application. To be used for future features. Not available on MultiPlus-II

Unique PowerAssist feature

The MultiPlus will prevent overload of a limited AC source, such as a generator or shore power connection. First, battery charging will automatically be reduced when otherwise an overload would occur. The second level will boost the output of a generator or shore side supply with power taken from the battery.





Uninterrupted AC power (UPS function)

In the event of a grid failure, or when shore or generator power is disconnected, the inverter within the Multi is automatically activated and takes over the supply to the connected loads. This happens so fast (less than 20 milliseconds) that computers and other electronic equipment will continue to operate without disruption.

Virtually unlimited power thanks to parallel operation

Up to 6 Multis can operate in parallel to achieve higher power output. Three phase or split phase operation is also possible. Please check our datasheets to see which models have paralleling, three phase and split phase capabilities.

Remote Monitoring and Control

Monitor and control your MultiPlus and system or systems' locally (LAN) or remotely via the internet from anywhere in the world, using the free VRM app and free VRM portal website. Access can be from a phone, tablet, laptop or PC for multiple operating systems. There is no end to the level of control, via the required Color Control GX or Venus GX, from adjusting your MultiPlus to setting a Geofence for hire vehicles and more...