

Pure Sine Wave Off-grid Power Inverter

INSTRUCTION MANUAL

Pure Sine Wave Off-grid Power Inverter INSTRUCTION MANUAL

Thank you very much for selecting our product. Please read this manual carefully before installing or using the inverter and pay attention to all safety recommendations.



WARNING: Electricity is dangerous!

Never touch bare wires, connectors or terminals. All installation work should be carried out by an appropriately qualified person. Safety measures and precautions should be taken in all cases.

General information and suitable appliances

This inverter converts **12V/24V/48V** battery power into mains power **220V-240V 50Hz**. The inverter can power low energy appliances such as laptops, mobile phone and tablet chargers, low power LED lights, radio etc, and also more powerful household appliances if the inverter power rating (W) is higher. Please make sure that the total continuous power consumption of all your appliances is within the maximum power limit of the inverter. Be careful of appliances with non-constant power consumption, as power spikes may cause overload and shutdown of the inverter.



Note: Do not use this inverter to run any equipment with higher power consumption than the maximum continuous power of the inverter, or appliances that have power spikes exceeding the power rating of the inverter.



Note: This inverter is not suitable for equipment with operating voltage and frequency other than 220V-240V 50Hz. For example, it cannot be used for 110V-120V/60Hz appliances.



CAUTION!

This is an off-grid inverter. Never connect any AC power to AC output of the inverter, otherwise you will damage it immediately.

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The following table provides typical power consumption for major appliances. This table should be used for general guidance only; in all cases please adhere to the appliance specifications to calculate their power consumption. If more than one device is connected to the inverter, the total power consumption should be the sum of all the devices being used.

Equipment	Power consumption ¹	Power rating of inverter (continuous)							
		150W	300W	600W	1000W	1500W	2000W	3000W	6000W
<i>--- Home and kitchen appliances ---</i>									
Table fan*	50W	-	OK	OK	OK	OK	OK	OK	OK
Sewing machine*	100W	-	OK	OK	OK	OK	OK	OK	OK
Halogen light**	100W	-	-	OK	OK	OK	OK	OK	OK
Pedestal fan*	100W	-	OK	OK	OK	OK	OK	OK	OK
Small fridge*	200W	-	-	OK	OK	OK	OK	OK	OK
Blender*	350W	-	-	-	OK	OK	OK	OK	OK
Large fridge*	500W	-	-	-	-	OK	OK	OK	OK
Washing machine* (no heating)	700W	-	-	-	-	-	OK	OK	OK
Microwave oven**	900W	-	-	-	-	OK	OK	OK	OK
Toaster	1200W	-	-	-	-	OK	OK	OK	OK
Coffee maker*	1200W	-	-	-	-	-	OK	OK	OK
Hair dryer*	1200W	-	-	-	-	-	OK	OK	OK
Iron	1500W	-	-	-	-	-	OK	OK	OK
Dishwasher (hot dry)	1500W	-	-	-	-	-	OK	OK	OK
Hob	1500W	-	-	-	-	-	OK	OK	OK
Vacuum cleaner*	2000W	-	-	-	-	-	-	OK	OK
Washing machine* (with heating)	2000W	-	-	-	-	-	-	OK	OK
Air conditioner*	3000W	-	-	-	-	-	-	-	OK
Electric oven	5000W	-	-	-	-	-	-	-	OK
<i>--- Audio and video appliances ---</i>									
		Power rating of inverter (continuous)							
		150W	300W	600W	1000W	1500W	2000W	3000W	6000W
12" colour LCD TV	20W	OK	OK	OK	OK	OK	OK	OK	OK
Satellite TV receiver	30W	OK	OK	OK	OK	OK	OK	OK	OK
HiFi stereo with CD changer **	50W	-	OK	OK	OK	OK	OK	OK	OK
DVD/Blu-ray player	50W	OK	OK	OK	OK	OK	OK	OK	OK

¹ Typical continuous power consumption. Note that some appliances have peak power several times greater than continuous power.

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20" colour LCD TV	100W	OK	OK	OK	OK	OK	OK	OK	OK
42" colour LCD TV	200W	-	OK	OK	OK	OK	OK	OK	OK
100W Stereo amplifier **	200W	-	-	OK	OK	OK	OK	OK	OK
Home theatre system **	500W	-	-	-	OK	OK	OK	OK	OK
Active speakers 250W RMS**	500W	-	-	-	-	OK	OK	OK	OK
Active speakers 500W RMS**	1000W	-	-	-	-	-	-	OK	OK
--- Computers and home office ---		Power rating of inverter (continuous)							
		150W	300W	600W	1000W	1500W	2000W	3000W	6000W
Mobile phone charger	5W	OK	OK	OK	OK	OK	OK	OK	OK
Small inkjet printer	40W	OK	OK	OK	OK	OK	OK	OK	OK
Laptop	50W	OK	OK	OK	OK	OK	OK	OK	OK
Fax machine	50W	OK	OK	OK	OK	OK	OK	OK	OK
Desk lamp	50W	OK	OK	OK	OK	OK	OK	OK	OK
Desktop computer (with 17" monitor)	400W	-	-	OK	OK	OK	OK	OK	OK
Large laser printer*	800W	-	-	-	-	OK	OK	OK	OK
--- Power tools and other equipment ---		Power rating of inverter (continuous)							
		150W	300W	600W	1000W	1500W	2000W	3000W	6000W
Drill*	800W	-	-	-	-	-	OK	OK	OK
Electric Chainsaw*	1000W	-	-	-	-	-	OK	OK	OK
Electric Lawn Mower*	1000W	-	-	-	-	-	-	OK	OK
Pressure washer*	1000W	-	-	-	-	-	-	OK	OK
Grinder*	2000W	-	-	-	-	-	OK	OK	OK
Air compressor*	2000W	-	-	-	-	-	-	OK	OK

*** These appliances are likely to have electric motors inside. The starting power required by most motors is several times greater than the normal working power. This should be taken into account when choosing the size of inverter. For example, even though electric lawn mowers have normal working power 1000W, their starting power is higher than 4000W, so inverters with continuous power 2000W are not suitable because their peak power is limited by 4000W.**

Always take into account starting power requirements of equipment with electric motors when sizing the inverter.

**** These appliances do not have an electric motor, but still have variable power consumption with power spikes. This requires a larger inverter than other appliances with similar nominal power.**

Installation

Make sure you choose the correct battery voltage in line with the nominal input voltage of the inverter. Although this manual refers to three types of input voltages (12V, 24V and 48V), your inverter has one fixed input voltage. For example, if you purchased 12V inverter, you should always use it with 12V battery, and never connect it to 24V or 48V battery.

Connection / installation order:

- 1) If the inverter is supplied with cables, connect the red cable to “+” battery terminal of the inverter (red or brown), and the black cable to “-” battery terminal of the inverter (black). If two identical cables are supplied for “+” (red) and “-” (black), do not connect them in a chain. Connect the cables with the same colour in parallel for an increased cross-section.

CAUTION!



Only use the original cables supplied with the product. Longer cables or cables with thinner cross-sections will create resistance between the inverter and battery. Less power will reach the inverter due to cable losses and may result in “low battery condition” status, even if the battery is fully charged. Thinner cables may warm up quickly, increasing the risk of fire.

- 2) For vehicles, boats or other mobile systems with negative common ground, use the earth cable (yellow/green if supplied with the inverter) to connect the inverter case and the negative common ground of your system. For stationary systems, use a suitable ground connection for earthing the inverter case.



Note: this inverter cannot be used in positive common ground systems.

- 3) Connect the inverter cables to your battery:
Red cable should connect “+” battery terminal of the inverter (red / brown) and “+” of your battery; the black cable should connect “-” to the battery terminal of the inverter (black) and “-” of your battery. Make sure the connection polarity is correct. Incorrect polarity will damage the inverter.

300W / 600W inverters

If you bought a 300W or 600W inverter, it might have come with cables with crocodile clips on the end. Use them for temporary connection only and replace by secure battery clamps or eyelet/ring terminals as soon as permanent connection is required. Do not leave the inverter connected by crocodile clips unattended, as the connections might not be secure enough in an unstable environment.



CAUTION!

Do not use crocodile clips to connect powerful 1000W-3000W inverters to your battery. Only use battery clamps (for stud terminals) or eyelet connectors (for bolt terminals).



CAUTION!

Inverters work under extreme pressure of high voltage and high power. If you choose to leave the working inverter unattended, take additional precautions for electrical and fire safety:

- install a fuse or DC circuit breaker between the inverter and the battery bank. The current rating of such fuse / circuit breaker depends on the input voltage of your inverter and the power of your load. For example, if the inverter is running 700W load from 24V battery, the fuse / circuit breaker should have the current rating slightly higher than $700W/24V = 29A$. Or, if the inverter is running 1500W load from 12V battery, the fuse / circuit breaker should have the rating slightly higher than $1500W/12V = 125A$.



WARNING: FIRE HAZARD

If you choose to connect the inverter to a DC socket rather than directly to the battery, make sure that such socket and cable connections between the socket and the battery have the required power/current rating. Do not use cigarette lighter sockets as they are only suitable for low power devices. Do not use any sockets if you are not confident that the wiring which connects the socket to your battery and the socket itself can handle the power and current drawn by the inverter.

WARNING: FIRE HAZARD

Even if the inverter is switched off, there might be a spark when



connected to a battery (powerful 1000W-3000W inverters create a strong spark). This is normal and caused by capacitors in the inverter circuit which require initial charging at connection. Once charged, reconnection of the inverter within a short time frame should not cause a spark again. To avoid this spark, an external heavy duty isolator switch between the inverter and the battery is recommended.

WARNING: EXPLOSION HAZARD



Keep the inverter away from any flammable substance. Do not use the inverter in an enclosure containing automotive-type lead-acid batteries as they might vent explosive gases which can be ignited by sparks.

- 4) Plug your appliances into the 240V mains socket of the inverter. You can use a suitable fused mains extension lead / adapter if you need to have more sockets, but you need to make sure that the total power consumption of all appliances plugged into the inverter is within the power rating of the inverter. Use the same principle if the inverter has two built-in mains sockets – they are connected internally, and are not two independent outputs.
- 5) Turn the inverter power switch ON, and your appliances will start. If your inverter has a green LED power light, it should switch on.



Note: the green power LED light of the inverter might not be visible in bright conditions, and there might be a few seconds delay (possibly with a short beeping sound) before it turns on.

- 6) When mounting the inverter, choose a place on a fire-resistant surface with good air flow and ventilation. Ensure at least 20 cm (8 inches) of air space is maintained on all sides of the inverter. Do not mount the inverter in cavities and places where free air flow might be obstructed.

CAUTION!



***If you choose to leave the working inverter unattended, take additional precautions for electrical and fire safety:
- install the inverter in a metal enclosure appropriate for high***

voltage / high power electrical equipment, with the necessary air space maintained on all sides of the inverter or additional ventilation of the enclosure. Do not put batteries into the same enclosure as they might vent explosive gases.

Operations

- 1) Depending on the power rating and design of your inverter it might have the following LED lights:
 - **Green** is the output power indicator. This light is on whenever the inverter generates AC power to its mains socket. You can run your appliances from the inverter when the green light is on.
 - **Red** a warning light indicating a problem (with the battery power, overload or some other internal protection). Read the section below about protection and troubleshooting to find suitable solutions.
 - **Yellow/orange** is a high temperature warning light which switches on when the temperature inside the inverter is too high. Check the details on overheating protection below.



Note: if your inverter does not have a temperature warning light, it still comes with the automatic thermal shutdown protection to prevent overheating.

- 2) Your inverter is a high power device which works under extreme pressure and dissipates heat while working. Please treat it with extreme caution in the same way as other high power devices and appliances generating heat. Read all the precautions and safety measures in this user manual, including the “SAFETY PRECATIONS” page at the end of the document, and make sure you understand them all. If you do not understand any of them, seek professional advice before using the inverter.
- 3) When the inverter is working, do not leave it unattended. If it is absolutely necessary to leave the inverter unattended, install a suitable inline fuse / or DC circuit breaker between the inverter and your battery, and mount the inverter in a suitable metal enclosure (see more details in the Installation section above).
- 4) When the inverter is not in use, turn it off and disconnect from the battery

completely. Disconnect the cables from the inverter terminals or turn the heavy duty switch off between the inverter and the battery. Remember that the inverter might draw some power from the battery even when it is switched off.

- 5) If the inverter is connected to the starter battery, please disconnect the inverter when starting the engine.



Note: vehicle batteries provide brief periods of very high current needed for starting an engine. They are not designed for constant deep discharge. Regularly operating the inverter from a vehicle battery will shorten the life of your battery very quickly, and it will lose the ability to start the engine. For frequent, extended periods of use, connect the inverter to a special deep-cycle battery (see Appendix I for details).

- 6) If the inverter has a built-in USB port, it is designed to power and charge USB-compatible devices. It is not designed to provide a computer link to the inverter.



Note: USB port current is limited to 500mA, which might not be enough for quick charging of some smartphones and tablets.

Protection features

The inverter has four main protection functions which allow it to automatically shut down to protect itself and the battery:

- Overload protection;
- Overheating protection;
- Low battery voltage protection;
- High battery voltage protection.

1) Overload protection

If the nominal or peak power of your load is too high, the inverter will switch the red light on and start making *three consecutive beeps intermittently* - indicating that it has detected an *overload*. Disconnect your load immediately, disconnect

the inverter from the battery and leave it to rest for 30 minutes before using it again. In the future, reduce the load when you use the inverter, otherwise the inverter might get permanently damaged if the overload protection is triggered constantly.



Note: small 300W and 600W inverters also have a red light alarm in case of overload and automatically shut down, but they do not emit a beeping sound.

Overloading is typically detected by the inverter in relation to appliances which have very high starting power consumption (such as devices with electric motors). For such appliances, if their starting power is greater than the inverter's nominal power, they may shut the inverter down. For example, the following appliances might cause the inverter to shut down at start up, even if their nominal power consumption is within the continuous power rating of the inverter:

- 60W heating pump connected to 300W inverter
- 800W microwave oven connected to 1000W inverter
- 1500W vacuum cleaner connected to 2000W inverter



Note: the inverter is designed to handle a small amount of peak power, but only within its maximum peak power limit and for a very short time (fraction of a second). This might not be enough for devices with electric motors or appliances which by design have longer periods of peak power (e.g. active speakers).

2) Overheating protection

The inverter generates heat while it is working. This is not a malfunction. The higher the power of the load that the inverter is running, the higher the temperature inside the inverter.

If the temperature inside the inverter reaches +50°C, the cooling fan will automatically switch on. The fan will stop working when the temperature reduces. However, if the fan is working but the temperature inside continues to rise, the yellow/orange LED will turn on (if available on the inverter) and the inverter will make one beep before automatically shutting itself down.

Even though the inverter can automatically restart when it has cooled down, you should disconnect all loads, disconnect the inverter from the battery and leave it to rest for a minimum of 30 minutes. To avoid overheating in the future, consider

running the inverter with a smaller load or choosing a more powerful inverter.



Note: large inverters might have several fans inside, with one fan working constantly and others switching on when the temperature gets higher.

3) Low battery voltage protection

If the inverter starts beeping once intermittently with the green light on, this is a *low battery warning*. Turn off the inverter switch, disconnect all appliances from the inverter and disconnect it from the battery. If no action is taken, the inverter will automatically turn itself off after some time (green light will be off), and the inverter will beep twice intermittently indicating a *low battery automatic shutdown*.



Note: a low battery shutdown is triggered when the battery voltage goes below a low voltage threshold. With a powerful load connected to the battery, its voltage is always lower than with a small load or with no load at all. Therefore, if the inverter is running powerful appliances, the low voltage threshold will be reached quicker, with more power remaining in the battery after the shutdown. Smaller loads connected to the inverter will allow discharging the battery deeper.

Low battery warning or shutdown might be triggered by the battery getting low, as well as loose / too long / or too thin cables connecting the battery and the inverter. Check tightness and thickness of all cables and connections, check the battery voltage with a digital multimeter and charge the battery if the voltage is below 12.0V (for 12V inverter), 24.0V (for 24V inverter) or 48.0V (for 48V inverter).

Low battery automatic shutdown is designed to protect your battery from excessive discharge, which can permanently damage the battery. Fully charge your battery before using the inverter again.



Note: large inverters working at full power can discharge your battery very quickly. For example, a 12V 100Ah battery has just enough energy to allow 2000W 12V inverter working at full power for about 30 min. Not all of this energy will be used, as the low voltage threshold will be reached very quickly with 2000W load (in probably 10-15 min). Use an appropriately sized battery when running the inverter with powerful loads.

If you occasionally use the inverter and would like the battery to be fully charged by the time when you need to connect the inverter, consider adding a **solar charging kit** to your system. An efficient solar charger will provide free and constant electricity supply to top up your battery in a place where mains electricity is not available. It is silent, clean and convenient, and you do not have to spend money on fuel to recharge the battery from an engine or generator. Modern solar chargers also last very long, typically giving you stable electricity output for decades. See Appendix II for more details.

4) High battery voltage protection

High battery voltage protection is designed to protect the inverter from too high input voltage from the battery which might result from a fault of another component or a short circuit. When the battery voltage is too high, the inverter will start *beeping constantly* and the green light will switch off. Switch the inverter off, disconnect the load and disconnect the inverter from the battery. Check the battery voltage with a digital multimeter to see if it's over 15V (for 12V inverter), 30V (for 24V inverter), 60V (for 48V inverter). Do not use the inverter until the voltage problem has been resolved.



Note: if you have a solar charging kit connected to the same battery alongside the inverter, the solar charge controller might occasionally go into a so called “equalisation” charging stage charging the battery with high voltage. This will trigger an overvoltage shutdown of the inverter. This is more likely to happen in cold weather conditions.

Troubleshooting other problems

If you have another problem with your inverter, the first thing you should do is to disconnect any load from it, switch the inverter off and disconnect it from the battery. The summary table below should help you to find the cause of the other problem not related to one of the protection functions described above.

Problem	Possible cause	Suggested solution
No AC output - the	Battery is discharged	Check the battery voltage with a digital multimeter, recharge or replace the battery

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green LED light is off	Battery connection or cable problem	Check all connections, cable cross-section, continuity of cables and reconnect the unit to the battery
	Inverter fuses are blown	If the fuses are located outside of the inverter case, replace them by using fuses with the same current rating. If the fuses are located inside the inverter case (large inverters), they can only be replaced by a qualified engineer or electrician.
Voltmeter shows too low AC voltage output of the inverter	Regular type of voltmeter will not show the voltage correctly	Inverters with pure sine wave output require a certain type of voltmeter to measure the voltage correctly, which are sometimes referred to as “True RMS” multimeters.
The inverter discharges my battery too quickly	Battery capacity is not adequate	Large inverters working with powerful loads will discharge your battery very quickly. Consider increasing the capacity of your battery bank and use special deep cycle batteries (see Appendix I for more details).
	Battery is too old	If the battery is old, the capacity might have been reduced. Consider replacing your battery (see Appendix I for more details).

Maintenance

Very little maintenance is required to keep the inverter operating properly. In some cases, fuses might need replacing. If the fuses are located inside the inverter case, they can only be replaced by a qualified electrician.



IMPORTANT! SAFETY PRECAUTIONS!



- ***Electricity can be very dangerous! Never touch bare wires, connectors or terminals.***
- ***Do not open the inverter case, nor should you try to repair it if broken.***
- ***Avoid any contact with water. Never operate the inverter in an environment***

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/ conditions when contact with water is possible or humidity is high.

- ***Avoid any contact with oil or grease.***
- ***Keep the inverter, cables and other components of your system away from children.***
- ***Do not connect the inverter to any other AC power source.***
- ***Do not cover the inverter. Always place it in a well-ventilated environment and allow space around the inverter for airflow.***
- ***If you operate the inverter in a moving vehicle, you need to secure the inverter to prevent it from any movement while the vehicle is in motion.***
- ***Do not place the inverter under direct sunlight or a high temperature environment.***
- ***Keep the inverter away from any flammable substance.***
- ***Do not use the inverter in an enclosure containing automotive-type lead-acid batteries as they might vent explosive gases which can be ignited by sparks.***

Specifications

Parameter	Value						
Input*	12V (10-15V) DC						
Output	220-240V AC						
Output frequency	50Hz						
Output waveform	Pure Sine Wave						
THD	Less than 3%						
Surge power	2 x continuous power for less than ½ of a second ²						
No-load current draw	150W	300W	600W	1000W	1500W	2000W	3000W
	<0.4 A		<0.6 A	<0.8A	<1.0A	<1.5A	<1.8A
Best efficiency	Approx. 90%						
Low battery shutdown*	10.5 +/- 0.5V DC						
High battery shutdown*	15.5 +/- 0.5V DC						
Thermal shutdown	60 +/-5°C						
AC output sockets	UK socket(s)						
Operating temperature	Minimum: 0°C		Maximum: 40°C			Best 15-25°C	

* value for 12V inverters. If your inverter is 24V use 2x, for 48V inverter use 4x

² The higher the surge power consumption, the shorter will be the period for which the inverter can provide surge power.

Appendix I

Battery no longer able to run your inverter for the time you need?

Choose special deep cycle AGM or GEL batteries from **Photonic Universe** for maximum inverter performance and longer discharge time



AGM Batteries

Best for large inverters with power rating starting from 1500W (12V) / 3000W (24V).

- ✓ Absorbed Glass Mat technology
- ✓ Completely sealed, non-spillable and maintenance free
- ✓ Low self-discharge
- ✓ 3-4 years design service life
- ✓ Better recovery from deep discharge
- ✓ Faster charging up to 25A



GEL Batteries

Best for small inverters with power rating less than 1500W (12V) / 3000W (24V).

- ✓ Electrolyte in gel form
- ✓ Completely sealed, non-spillable and maintenance free
- ✓ Very low self-discharge
- ✓ 4-7 years design service life
- ✓ Better recovery from deep discharge

Suitable for outdoor installations and temperatures up to -10°C

Photonic Universe

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Inverter draining your battery?

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