

POWERTECH

200W 12VDC Wind Generator

User Manual MG-4520 (12VDC)

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WFD200W 12VDC Wind Generator



1. Safety Precautions

Please follow the instructions and recommendations in the User Manual. This will help assure safe and rewarding use of your new renewable energy system.



WARNING!

It is essential you read the entire contents of the User Manual prior to installation and operation.

Wind generator (or wind turbine) systems present mechanical, electrical and chemical (battery) hazards that can be life threatening. The generator, tower or support structure could fall and cause injury or death and property destruction. A component of the wind generator could become loose if not properly maintained, or if the maximum wind speed of 40m/s (144kph) is exceeded and the necessary steps are not taken to minimise the risk of failure. These conditions could cause injury or death. If the wind generator is connected to a DC to AC power inverter, then high voltages from the inverter could cause injury or electrocution. A burn injury can result from an electrical short. A severe chemical burn, including blinding, can occur from a battery explosion or contact with the sulphuric acid in a lead-acid battery.

These conditions are addressed in the following safety messages:

WARNING! The WFD200W 12VDC 200W Wind Generators (MG-4520) is designed for permanent terrestrial installation and use only.

WARNING! It is your responsibility to obtain all required permits and engineering certifications for your tower, guy wires and tower location. Professional advice should be obtained. Soil and wind conditions vary from area to area and tower foundations, including the tower/ mast configuration, must be designed for dynamic wind loading that is specific to the area. The tower must be positioned so that it can not fall on occupied buildings, neighbour's property or power lines. The manufacturer recommends locating the tower well away from occupied buildings and power lines ie typically 100m minimum. Tower climbing is dangerous and should only be attempted by experienced and qualified personnel using proper safety equipment.

WARNING! If the generator appears to be loose or vibrate in the tower, or is making an unusual sound, the condition must be rectified immediately. A loose generator or component presents an extremely dangerous situation as it may fall from the tower. Never stand in line with a rotating propeller.

WARNING! If excessive wind speeds are anticipated that would exceed the wind generator's maximum wind speed specification, a three phase shorting switch with a suitable electrical rating must be fitted to the generator's three phase output to short the windings of the generator for dynamic braking purposes. The switch must be applied under these atmospheric conditions to minimise the risk of mechanical failure.

WARNING! It is strongly recommended you install protection barriers to prevent unauthorized persons or children climbing the tower. Never allow an untrained person or someone without the proper safety equipment to climb the tower. Choose a calm, dry day for your installation and always stop the propeller before climbing the tower. Falling from the tower or contact with the rotating blades can be lethal.

WARNING! High voltage systems (systems with a DC to AC inverter) can represent a dangerous shock hazard and could be lethal. All high voltage systems must be wired and maintained by a qualified and licensed electrician.

WARNING! Batteries can emit dangerous and explosive gas while charging. Never turn on a light switch or any other electrical connection near a recently charged or charging battery (or battery bank). Never light a match or make any type of spark near a recently charged or charging battery. Use protective gloves and eyeglasses when working with lead-acid batteries. Remove all personal metal items such as rings, bracelets, necklaces, and watches when working with lead-acid batteries. A lead-acid battery can produce short-circuit currents high enough to weld a ring or similar metal, causing a severe burn. Turn off all loads and be extremely careful when making a final battery connection.

WARNING! Never place objects on top of, or near the charge controller, the DC to AC inverter, or any other associated electronics. These devices dissipate heat and require unrestricted airflow as part of normal operation. **FIRE AND FAILURE** may result if airflow is blocked to these devices.

WARNING! To reduce the risk of fire or electric shock, make sure the installed wiring and terminations are in good electrical condition and that all cables are appropriately sized to carry the necessary charge currents.

WARNING! To reduce the risk of electric shock, do not operate the wind turbine without connecting it to an appropriate ground. Grounding procedures must be followed along with any regulatory codes. Grounding the tower is essential for lightning and static protection.

Disclaimer

Unless specifically agreed to in writing, we:

- (a) Make no warranty as to the accuracy, sufficiency or suitability of any technical or other information provided in this manual or other documentation.
- (b) Assume no responsibility or liability for loss or damage, whether direct, indirect, consequential or incidental, which might arise out of the use of such information. The use of any such information will be entirely at the user's risk.

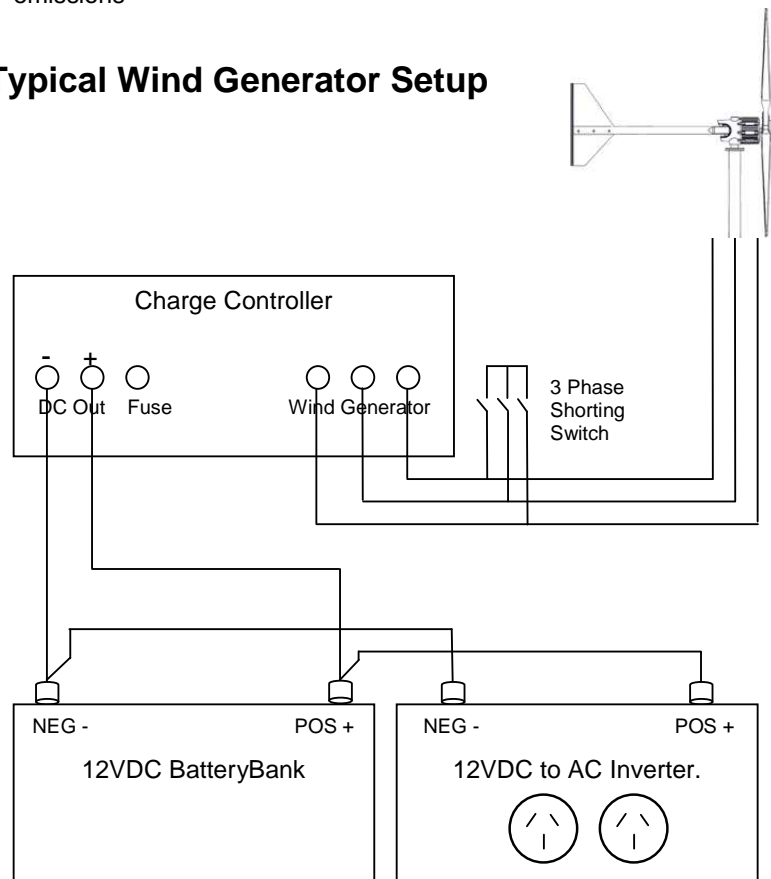
2. Preliminary Overview & Features

The WFD200W Wind Generator is an advanced 200W alternator/ charge controller system designed to charge batteries and supply electrical power in a 12VDC system. When used in conjunction with a suitable DC to AC sine-wave inverter and battery bank, the generator can also provide high voltage AC for powering mains type AC appliances.

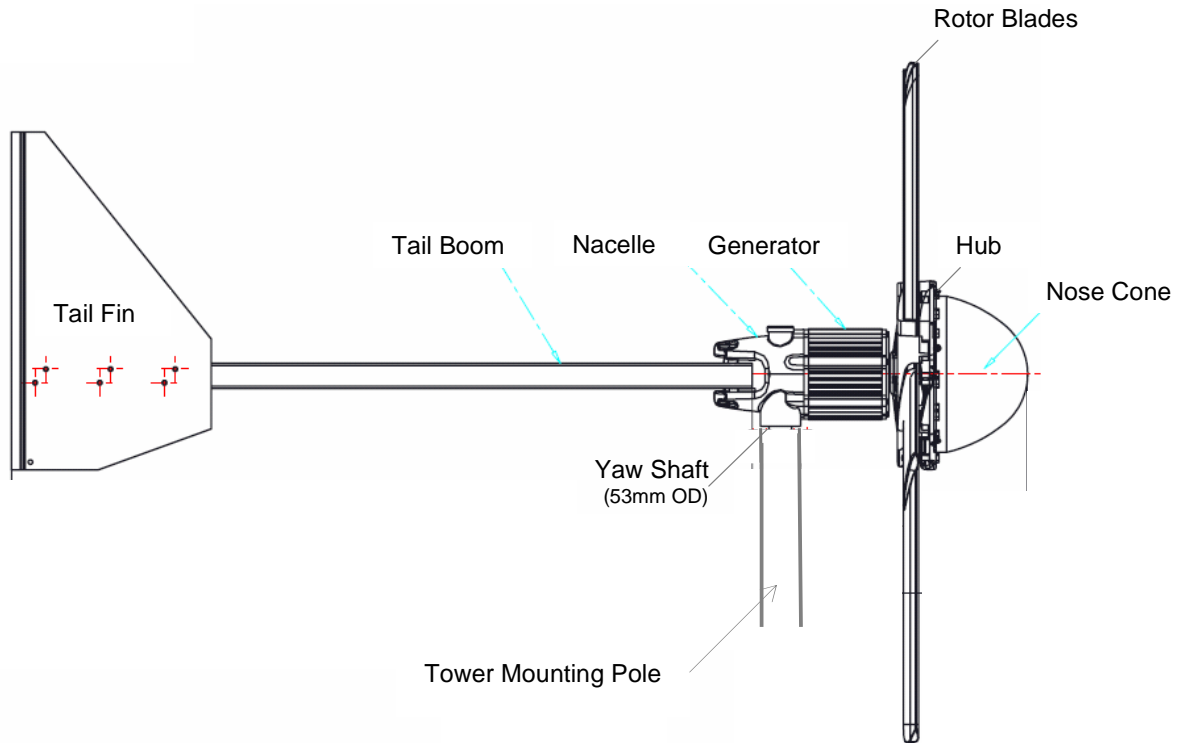
The 200W Wind Generator features:

- Powder coated aluminium body, fasteners and a water tight housing
- Reliable passive self-furling
- Iron Boron Neodymium magnet alternator
- Finned housing for efficient heat dissipation
- Aluminium alloy blades
- External charge controller that provides the necessary voltage regulation to charge the batteries, and autobrake which slow the blades when the battery bank is fully charged
- Simple to install, easy to use and minimal maintenance
- Superior low wind speed performance, very high system efficiency, and low noise emissions

Typical Wind Generator Setup



2.1 What you should have with the 200W Wind Generator



- 1 Generator with output cables
(including 1 flat washer, 1 split washer, and 1 large split pin for securing the hub; and 2 M10 Bolts for securing the generator to the tower mounting pole)
- 1 Tail Fin (including 6 bolts and flat washers)
- 1 Tail Boom (including 1 hex head bolt, 1 flat washer, 1 nut and 1 small split pin)
- 3 Aluminium Rotor Blades
- 1 Hub for mounting Rotor Blades (including 3 clamps, 12 bolts, 12 split washers, 12 flat washers, and 12 nuts)
- 1 Nose Cone (including 3 truss head screws)
- 1 Charge Controller
- 1 User Manual

3. System Description

The major components of the wind generator are listed below.

3.1 Rotor and Blade System

The rotor and blade system consists of three Aluminium alloy engineered blades fastened to a hub. The rotor blades convert the energy of the wind into rotational forces that drive the generator. The Aluminium blades are exceptionally strong, however, they may be damaged if they come in contact with a solid object i.e. a bird or flying debris. If this occurs, the blades must be inspected and replaced as necessary. Note: the blades are supplied in a balanced set of three, so if one or more are damaged, all three must be replaced.

3.2 Alternator

The WFD200W wind generator is a horizontal axis wind generator that mounts to a vertical pole/ tower. The wind generator consists of an alternator that utilises extremely strong permanent magnets to produce 3 phase electricity.

The alternator produces a three-phase alternating current (AC) output which is rectified and regulated into direct current (DC) by the external charge controller. Note, since the alternator uses permanent magnets, it will generate electricity/ voltage whenever the rotor is turning.



3.3 Nacelle

The nacelle is the aluminium housing that surrounds the main body of the wind generator. It contains the main structural backbone of the generator (called the mainframe), the yaw bearings, and the yaw shaft or tower mount. The yaw bearings allow the wind generator to freely pivot around the top of the tower so that the rotor faces the wind at all times.

3.4 Tail Assembly and AutoFurl Operation

The tail assembly, which comprise a tail boom and tail fin, keep the rotor blades aligned into the wind at speeds below approximately 12m/s. At about 12m/s the AutoFurl action turns the rotor away from the wind to limit its rotational speed. The tail appears to fold, but in reality the tail stays stationary, as the rotor/ alternator angles away from the wind. The rotor does not furl completely, as this allows the generator to continue to produce power in high wind speeds. When the high winds subside, the AutoFurl system automatically restores the generator to the normal unfolded or straight configuration.

3.5 Charge Controller

The charge controller serves as the central connection device for the electrical components of the system. The charge controller has three primary functions:

- rectifies the three-phase AC output from the alternator into DC
- regulates the DC output and charges the battery bank
- provides a load to the alternator when the batteries are fully charged

The controller continually monitors the battery voltage and compares it to the regulation set point. The regulation set point is factory set. When the battery voltage rises above the set point, it automatically stops charging the batteries and applies a load to the generator. It then waits for the battery voltage to drop slightly before normal charging resumes.

WARNING! Bad connections and terminations, undersized cables, excessive cable lengths and in-line isolation diodes (blocking diodes) will prevent the charge controller from working properly.

3.6 Battery Bank Capacity

The battery bank should be lead-acid batteries with a capacity of at least 200Ah at 12VDC ie one 12V 200Ahr battery or two 12V 100Ahr batteries in parallel.

3.7 Generator to Charge Controller Cable Size

Measure the cable run length from the generator to the charge controller, and then select a cable with the appropriate cross sectional area from the table below:

Cable Run (m)	Up to 8m	8 to 12	12 to 18	18 to 30
Cable Size (mm ²)	2.5	4	6	10

4. System Operation

4.1 Normal Operation

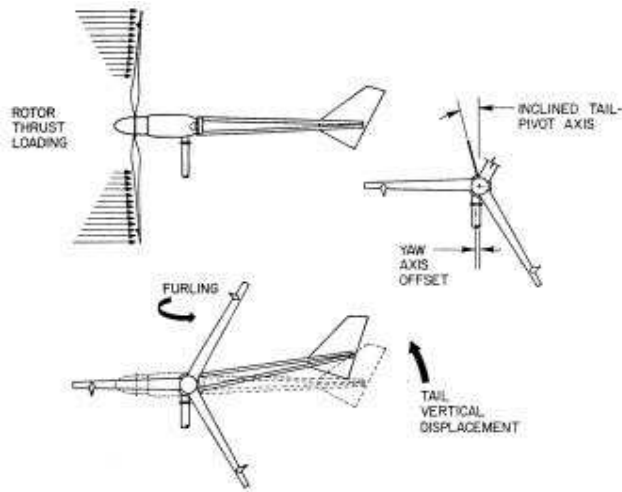
The rotor blade assembly of the WFD200W wind generator should begin to rotate when the wind speed reaches approximately 3m/s. For the first several weeks of operation, the start-up wind speed will be slightly higher because the bearing seals take a short period of time to wear in. Battery charging should commence shortly after the rotor spins up to speed. Once the rotor assembly is turning, it will continue to do so in lower wind speeds.

Rotor speed increases with increased wind speed. This results in the wind generator providing a higher output. The output increases rapidly because the energy available in the wind is a function of the third power (cubed power) of the wind speed. For example, if the wind speed doubles from 5m/s to 10m/s, the energy in the wind increases by a factor of eight ie $2^3 = 2 \times 2 \times 2 = 8$. One result of this relationship is that there is very little energy available in low wind speeds.

4.2 High Winds - AutoFurl

During periods of high wind speeds, the AutoFurl system will protect the wind generator. When furled, the power output of the generator will reduce. In winds between approximately 12m/s and 18m/s it is normal for the wind generator to repeatedly furl, unfurl, and furl again. In winds above 18m/s the wind generator should remain continuously furled.

AutoFurl is a simple and elegant method of providing high wind speed protection. The AutoFurl system is based on aerodynamic forces on the rotor, gravity, and the carefully engineered geometry of the wind generator. As shown below, the aerodynamic forces acting on the blades cause a thrust force pushing back on the rotor. This force increases with increasing wind speeds. The thrust force acts through the centreline of the rotor, which is offset from the centreline of the tower pivot/ axis (yaw axis). Therefore, the thrust force on the rotor is always trying to push the rotor over to the side, away from the wind. But the rotor blade assembly is kept facing the wind at speeds less than 12m/s by the tail assembly. The tail is kept straight by its own weight, and because the pivot point at the back of the nacelle is inclined. So the weight of the tail holds it against a rubber bumper and the tail holds the rotor into the wind.



The geometries in the systems are carefully balanced so that at a wind speed of 13m/s the rotor force acting on the yaw-offset is large enough to overcome the preset force holding the tail assembly straight. At this point the rotor will start turning away from the wind, or furl, and the tail will stay aligned with the wind direction. The speed of furling depends on the severity of the wind gusts and whether the wind generator stays furled, really depends on the wind speed.

As the wind generator furls, the geometry of the tail pivot causes the tail to lift slightly. When the high winds subside, the weight of the tail assembly returns the generator to the straight position.

WARNING! There is one situation in the field, however, that can disrupt the operation of AutoFurl. If the wind generator is installed on a steep hill or next to a cliff so that the wind can come up through the rotor on an incline (eg from below; as opposed to horizontally) it will effect the furling action and can produce higher peak outputs. We strongly recommend avoiding this situation.

WARNING! The wind generator is designed to survive in wind speeds of up to 40m/s (144km/hr).

WARNING! If wind speeds are anticipated that would exceed the wind generator's maximum wind speed specification, a three phase shorting switch with a minimum rating of 30A per phase must be connected to the three generator input terminals on the side of the charge controller. The purpose of the switch is to short the three phase windings of the generator for dynamic braking purposes. The switch must be applied when necessary to minimise the risk of mechanical failure in the event of excessive winds.

5. Wind Generator Installation

When installing the WFD200W wind generator, exercise care at all times. The generator head weighs typically 10kg and can be awkward to handle. It is best to plan the installation carefully in advance and use qualified personnel when erecting the machine and tower to avoid accidents.

NOTE: Complete as much of the installation as possible at ground level.

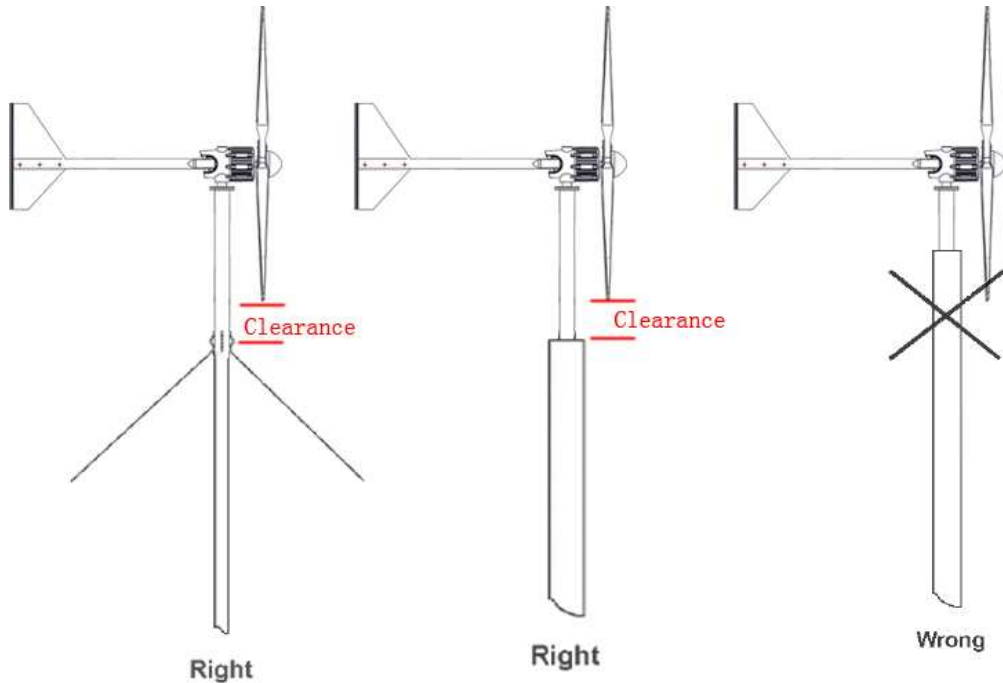
NOTE: Choose a calm, dry day for your installation.

The generator is robustly engineered, but contains high-energy permanent magnets that can be easily damaged from impacts if the machine is dropped or heavily handled.

CAUTION! Make sure the generator and charge controller are disconnected from the batteries during installation.

5.1 Blade to Tower Clearance

Make sure the wind generator blades have adequate clearance from the tower. A minimum clearance of 90mm must be allowed for between the blade tips and the tower or associated rigging. Refer illustration below.



Proper Blade to Tower Clearance

5.2 Installation

Selection of tower and rigging materials is important. Avoid connecting, or joining different metals together ie copper and aluminium as this will create an electrochemical reaction or galvanic cell that will eventually erode one of the metals. Corrosion resistant materials should be used to prevent an electrochemical reaction.

NOTE: All external electrical cables should be protected to prevent damage from wildlife. Run all wires inside conduit for protection.

The powerhead yaw shaft has a diameter of typically 53mm for mounting to the tower. The tower mounting pole should be made of steel and have a thickness of at least 3mm. The two M10 mounting holes in the yaw shaft are approximately 80mm apart. The yaw shaft diameter and hole spacing should be measured accurately prior to steel pole selection and drilling.

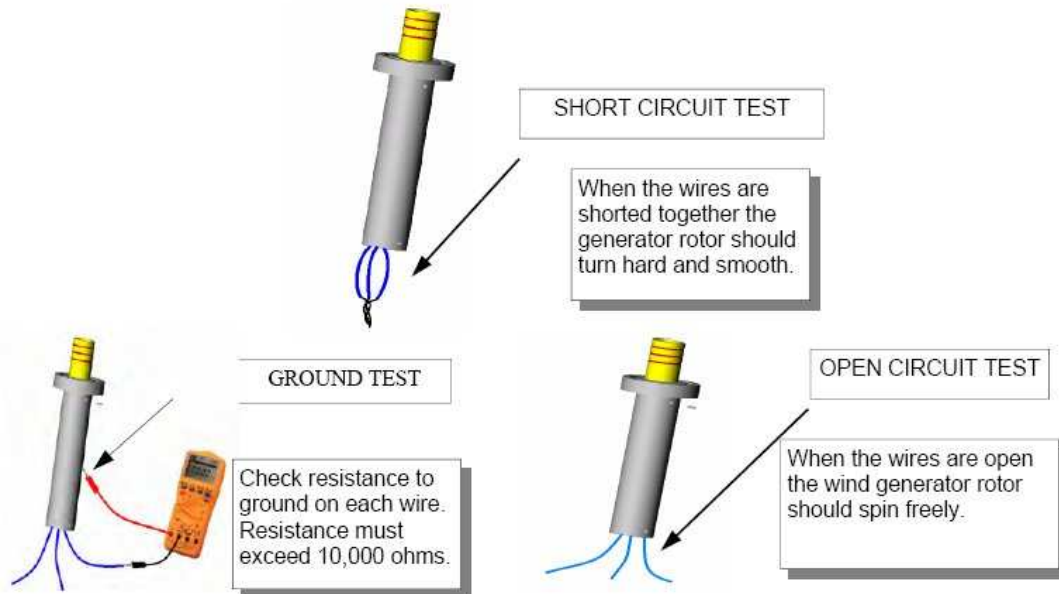
Step 1: With the tower tilted down, place the powerhead of the wind generator near the top end of the tower.

Step 2: Raise the tower about 1 metre off the ground to allow space to assemble the generator. We recommend using a temporary support stand to hold the tower up during generator assembly.

Step 3: If not already done, remove a small amount of insulation from the three generator wires. Then conduct the following electrical tests.

Electrical Tests

Complete these tests before mounting blades to rotor, and before installing turbine to top of tower. These tests confirm that the wind generator is functional and ready to install on the tower.



Step 4: The connecting wires from the generator to the charge controller should be appropriately sized to minimise cable loss (refer Section 3.7). For low voltage machines, transmission losses can be considerable, so try to keep the cable run as short as possible to the charge controller.

Now run three extension wires from the generator down inside the tower to the charge controller location before mounting the powerhead assembly to the tower.

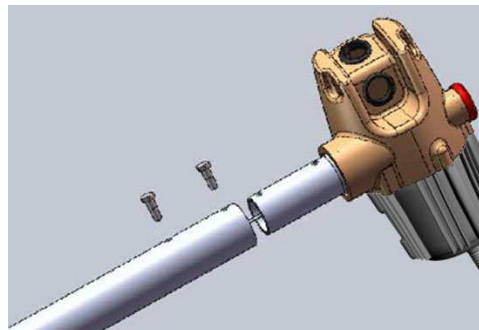
Step 5: Join the generator output wires to the extension wires running inside the tower using high current waterproof connectors or solder. If soldered, use heat-shrink tubing, self amalgamating tape or similar to insulate and protect. The connections must be done properly and made waterproof to minimise the possibility of oxidation and failure.

Step 6: Electrically short all three extension wires at the charge controller end with a small piece of wire to prevent the generator from turning and producing power. Note: the short-circuit wire must be removed during the electrical installation stage later on.

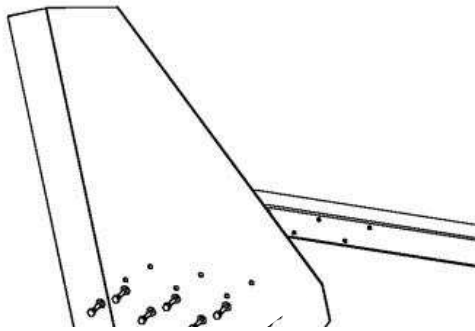
Step 7: Gently pull the three wires down through the tower, being careful not to damage or pinch the cabling.

Step 8: Then mount the powerhead to the top of the tower. Check the powerhead is securely mounted to the tower with the two M10 bolts supplied, as it must hold firmly in high velocity winds. Use an industrial thread lock such as Loctite, or similar to prevent the bolts from working loose.

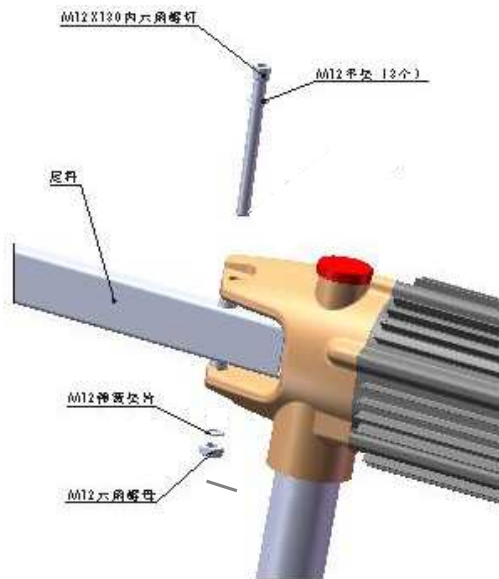
Using a torque wrench, tighten both powerhead/ tower mounting fasteners to 50Nm.



Step 9: Bolt the tail fin to the tail boom using the six bolts and flat washers provided. Use Loctite, or similar to prevent the bolts from working loose.

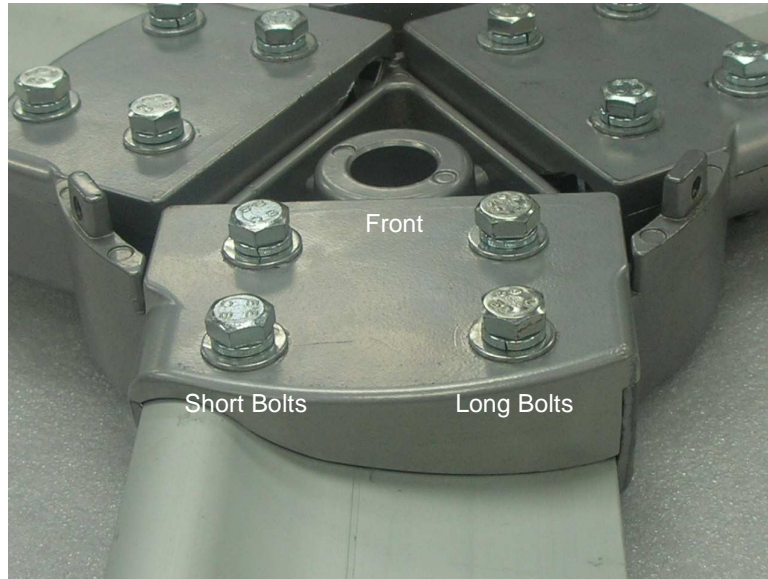


Step 10: Position the tail boom at the rear of the generator powerhead with the narrow part of the tail fin facing up. Insert the tail pivot bolt from the top, and add the flat washer and nut and tighten gently. Secure the tail pivot bolt by inserting the small split pin through the hole, and then bend the legs out.



Step 11: The Aluminium blades can only go one way inside the hub assembly. Carefully attach the rotor blades to the hub using the hardware provided. Note, there are two long bolts (50mm) and two short bolts (45mm), as well as split washers, flat washers and nuts for securing the rotor blades within the hub clamps.

The proper installation is illustrated below.

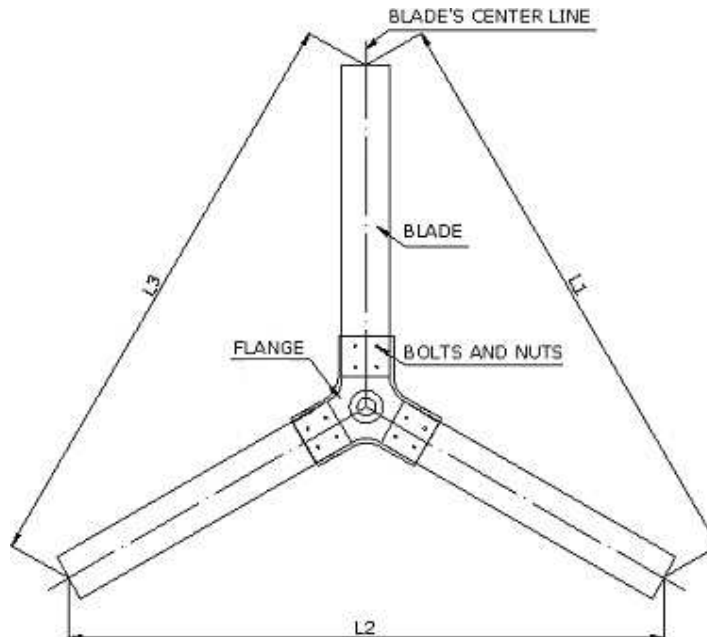


Use an industrial thread lock such as Loctite, or similar to prevent the bolts from working loose. Using a torque wrench, tighten all blade bolts to 14Nm.

Turn the whole hub assembly over. Add Loctite to the extended threads and screw on the twelve nuts. Using a torque wrench, tighten all the nuts to 14Nm.

Step 12: Carefully slide the rotor blade assembly onto the generator shaft. Place the flat washer, then the split washer, then the nut onto the generator shaft and tighten with a torque wrench to 68 to 88Nm. Insert the split pin and bend the ends to prevent the nut from becoming loose.

Step 13: Accurately check the tip-to-tip blade distance and make sure they are all reasonably equal so the blade assembly is well balanced.

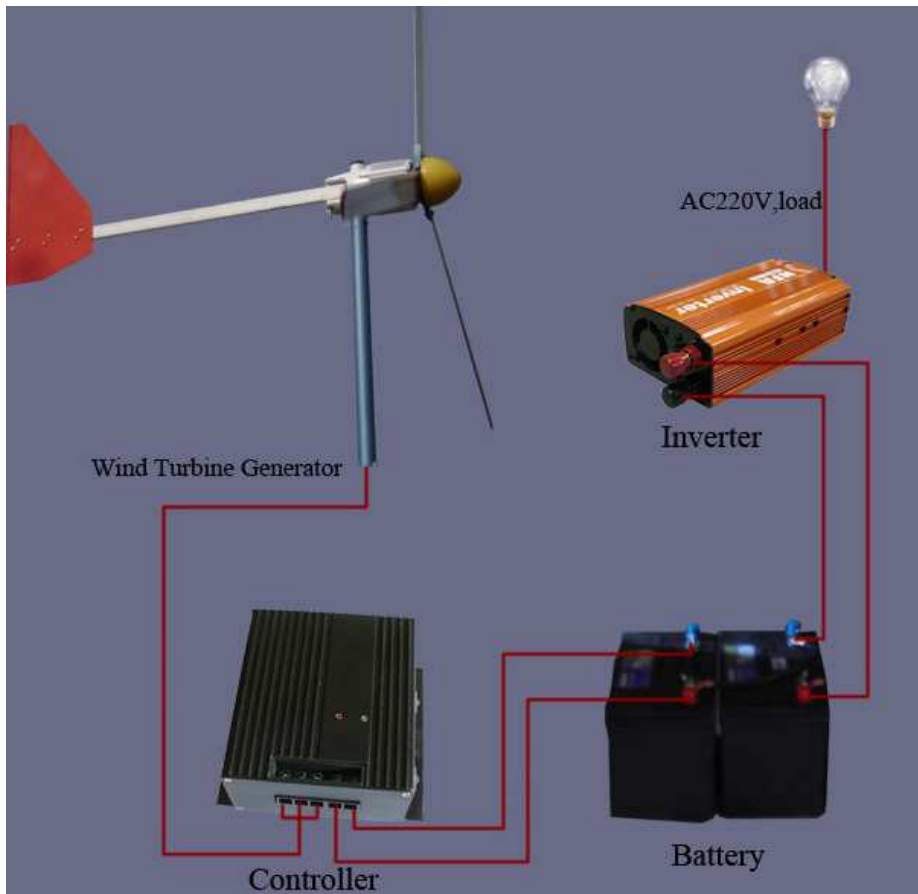


Make sure L1, L2, and L3 tip-to-tip distances do not differ by more than 5mm for smooth and balanced operation.

Step 14: Carefully place the nose cone over the hub and rotor blade assembly. Insert the three screws and tighten. Use Loctite, or similar to prevent the screws from working loose.

Step 15: Carefully raise the tower, making sure not to damage the wind generator; especially the blades and rotor assembly. Secure the tower firmly with guy wires as required.

6. Electrical Connections



The general electrical configuration or setup is illustrated in Section 2 and above. The tower should also be grounded for electrical safety. In most cases the loads will probably be 240VAC/50Hz and will obtain power via an AC inverter connected to the battery bank.

The charge controller must be installed in a ventilated waterproof cabinet or indoors, and should be located relatively close to the battery bank to minimise cable losses.

WARNING! Do not install the charge controller outdoors without protection; it is not waterproof.

WARNING! Never place objects on top of, or near the charge controller. The charge controller dissipates heat and requires unrestricted airflow as part of normal operation. **FIRE AND FAILURE** may result if airflow is blocked.

WARNING! Do not mount the charge controller near anything that is flammable or heat sensitive.

WARNING! Connect the battery first to the charge controller.

Step 1: Connect the battery leads to the charge controller. First connect the negative (-) battery wire to the negative (-) terminal on the charge controller, then connect the positive (+) battery wire to the charge controller. If a very large spark occurs, the connections are reversed. Check wiring configuration if this occurs.

WARNING! You must connect batteries to the wind generator system. Without the batteries connected, the wind generator or charge controller may be damaged after some time!

Step 2: Remove the shorting wire from the three wind generator extension wires. Connect the three wind generator wires to the three terminals on the side of the charge controller. The three wires are interchangeable and therefore are not labelled. Any cable can go to any terminal.

Step 3: If wind speeds are anticipated that would exceed the wind generator's maximum wind speed specification, a three phase shorting switch with a minimum rating of 30A per phase must also be connected to the three generator input terminals on the side of the charge controller. The purpose of the switch is to short the three phase windings of the generator for dynamic braking purposes. The switch must be applied when necessary to minimise the risk of mechanical failure in the event of excessive winds.

The switch should also be applied prior to conducting any maintenance on the generator head.

Note: The switch must be left open under normal operating conditions.

Step 4: If the system includes a DC to AC inverter, connect the inverter DC leads directly to the battery terminals. The controller terminals are not designed to handle high currents that are possible when inverters are fully loaded. Inverters can draw very high currents, hence the reason they must be securely connected to the battery with appropriately sized cables. Refer to the suppliers recommended cable sizes for the inverter connection.

WARNING! Do not connect the wind generator directly to an inverter without batteries. The inverter will not work and may suffer permanent damage.

WARNING! Do not disconnect the batteries while the inverter or the wind generator are running. Permanent damage may occur.

Ensure that you have the correct battery size, voltage and capacity for your system. The MG-4520 utilises a 12VDC battery system.

Ensure that the batteries used are identical types and of identical age. Mixing different types/sizes/ages of battery will cause all the batteries in the bank to fail or age prematurely. If you need to replace batteries, you should replace all at once.

Do not use automotive batteries as they are not designed for wind generation system. They are designed to provide very high currents for a short period to start an engine. True deep cycle batteries should be used as they are designed for much more regular loads and deeper discharge.

WARNING! If it is necessary to disconnect the generator for some reason, do so before disconnecting the battery from the charge controller.

7. Maintenance - Monthly

7.1 Wind Generator

Check the wind generator monthly for mechanical noises, rattles, buzzes or vibration. These conditions can be damaging and must be investigated and addressed. It is essential the rotor blades and hub are balanced and do not wobble.

WARNING! If the blades or the wind generator wobble it must be rectified immediately.

WARNING! If the blades appear to be out of alignment or bent they must be replaced immediately.

WARNING! Any maintenance conducted on the wind generator should be conducted on a calm and dry day. The three phase shorting switch must be applied prior to any maintenance. Never approach the wind generator during windy conditions as this is considered extremely dangerous.

Open the three phase shorting switch once the maintenance has been completed.

7.2 Tower

Undertake all maintenance requirements outlined by the tower manufacturer/ supplier. Inspect the tower thoroughly including guy wires and foundations. Tighten all nuts and bolts, especially wire clips. Check for cracks, corrosion, bent or broken parts and inspect the anchors and tower base structure. Check for broken strands and tighten guy wires as necessary.

7.3 Cable Connections and Batteries

Consult the battery manufacturer's maintenance guide and follow the instructions for periodic maintenance. Check and tighten (if necessary) all cable and battery connections as loose terminations can cause localised heating and a reduction in output power. Remove any corrosion and protect the terminals as necessary.

8. Maintenance - Yearly

8.1 Wind Generator and Tower

WARNING! Any maintenance conducted on the wind generator should be conducted on a calm and dry day. The three phase shorting switch must be applied prior to any maintenance. Never approach the wind generator during windy conditions as this is considered extremely dangerous.

Lower the tower and thoroughly inspect the wind generator. Fix or replace any worn, damaged or loose parts. Check and tighten (if necessary) all mounting nuts and bolts. Check and tighten (if necessary) all rotor blade mounting bolts. Check the bearings for 'play'. Just perceptible 'play' is acceptable. Clean the blades with a mild detergent to remove all dirt and debris. Avoid scratching the surface.

Replace rotor blades if they are cracked, bent or damaged in any way. Note: the Aluminium blades are supplied in a balanced set of three, so if one or more are damaged, all three must be replaced.

Open the three phase shorting switch once the maintenance has been completed.

9. Trouble Shooting

The following table should be used as a guide to pinpoint the cause of any operational problems.

Problem	Cause(s)	Diagnosis	Remedy
Battery voltage gets too high.	Charge controller output voltage regulation too high.	Excessive battery gassing. Use a precision DC voltmeter to check battery voltages. Use a hydrometer to check the specific gravity of the battery acid if applicable. Compare results to battery manufacturer's recommendations.	Contact factory or distributor for repair.
Batteries do not reach full state of charge.	Charge controller output voltage regulation too low.	Battery not providing enough power. Use a precision DC voltmeter to check battery voltages. Use a hydrometer to check the specific gravity of the battery acid if applicable. Compare to battery manufacturer's recommendations.	Contact factory or distributor for repair.
	Cable losses too high.	Check cable sizes (ie gauge size) and cable runs. Cable sizes too small or cable runs too long. This can result in excessive voltage drops.	Increase cable size (ie reduce gauge) or shorten cable runs.
	Connector or termination losses too high	Check connectors and terminations. Loose connectors and terminations can cause voltage drops, as well as localised heating.	Properly secure connectors and cable terminations.
	Loads are too large.	Remove largest load and check if the battery bank now reaches full state of charge. If so, the system was overloaded.	Reduce loads
Insufficient wind power		System not providing enough power.	No remedy
Rotor spins, but the system does not charge batteries at all.	Possible damaged stator winding, or damaged charge controller	Check the three phase AC output voltage from the generator with a True RMS voltmeter. They should be very similar if measured at same wind speed. Measure the AC output current from generator with a True RMS AC Clamp Meter. Also check DC output voltage from the charge controller with a DC voltmeter. Make sure the battery is connected.	Replace charge controller, or wind generator powerhead as necessary.
Rotor is unbalanced, causing the generator to vibrate or move back and forth as it spins.	Blade tips not evenly spaced or out of alignment ie blades are out of balance for some reason	Accurately check the blade tip-to-tip distances. The tip-to-tip distances should all be equal. Make sure the blades are not damaged or bent.	Replace the three blades if necessary.

10. Limited Warranty

We provide free replacement cover for all defects with respect to parts and workmanship for a period of two years from the date of purchase; life expectancy typically 10 years. Our obligation is limited to replacing parts which have been promptly reported to the seller as having been in his opinion defective, and are so, found by us upon inspection.

Defective parts must be returned to us as soon as possible, or to an authorised agent.

This warranty is void in the event of damage due to improper installation, failure to comply with required regulations and certificates, owner neglect, blade damage resulting from flying objects, or natural disasters such as lightning, extreme winds, and does not extend to any additional devices connected to the system. This warranty is also void if any modifications are carried out on the wind generator.

No responsibility is assumed for incidental or consequential damage, or damage caused by the use of any unauthorised components.

11. Specifications

Model No.	MG-4520 WFD200W
Rated Power	200W
Maximum Power	300W
Rated DC Output Voltage	12VDC
Start-up Wind Speed	2.5-3m/s
Rated Wind Speed	12m/s
Maximum Wind Speed	40m/s
Cut-Out Wind Speed	Typically 12m/s
Over Speed Protection	Auto Furl
Temperature Range	-40 to +60 Deg. C
Rotor/ Blade Diameter	1.77m
Rotor speed	450rpm
Blade material	Engineered Aluminium alloy
Height of tower (Recommended)	4.5m
Generator	3 phase Iron Boron Neodymium magnet alternator
Turbine Weight	10kg
Hub & Blade Weight	4kg

