



**FORTIS**  
WIND ENERGY  
GREAT IN SMALL TURBINES

# FORTIS Wind Energy

## Passaat Wind Turbine

### Instruction Manual





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WIND ENERGY  
GREAT IN SMALL TURBINES

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## 1. Introduction

**Thank you for choosing this FORTIS energy systems.**

Your choice means proven reliability, no maintenance costs (only a regular check is recommended) and the convenience of an independent power supply.

FORTIS wind turbines are in operation all over the world and can withstand almost every environment imaginable. Even arctic expeditions have benefited from the reliable power the FORTIS wind turbine produces. FORTIS tests their systems under the worst possible weather conditions.

FORTIS wind turbines are installed all over the earth. Therefore the FORTIS products are designed on such a way that they can be installed and erected successfully with a minimum of tools and technical know-how. Also unskilled people are capable of maintaining the system with a minimum of tools and knowledge.

A FORTIS-system is almost always composed of various components: the wind turbine itself is only one component of this system. We can supply controllers for battery charging and for grid connection. For hybrid systems, controllers are available to couple a photovoltaic solar generator or to a diesel or petrol generator together to a FORTIS Wind turbine. In other words, the possibilities with an FORTIS wind turbine are endless in the sense that they can be adapted to suit almost every conceivable application.

Sincerely,

Fortis Wind Energy



### **Important security notice**

This Instruction Manual contains important operational guidelines and security considerations that require your attention. Before installation, it is essential that the user first studies this user's manual in detail and keeps in mind the safety matters that need attention. During user installation and operation one must refer to this handbook's documentation. If you are unfamiliar with installation as shown below, **DO NOT CONTINUE** and let a qualified Technical Engineer proceed with correct installation. Failure to comply with the guidelines and instructions will void your warranty.



Do not change anything of the wind turbine parts or do not paint the blades. If you do so you lose the right of warranty. Any change can have effect in the behaviour of the wind turbine.

## 2. Assembling the power head

The FORTIS PASSAAT (1.4 kW) power head consists of the following parts;

- Frame/generator
- Rotor blades/hub
- Tail with tail vane
- High-Wind speed Protection (Side Furling)
- Mast top
- Nose cone

### 2.1 Frame/ generator

When you first open the box, check the contents carefully starting with the generator and its support-frame. First make a visual check to determine any existing scratches, dents or cracks.

The generator is packed in a box. Type, voltage and serial number are written down on the box. Unpack the generator and check it. Rotate the generator shaft by hand. This must rotate smoothly ( $<5.0\text{N/m}$ ). If it does not, check whether there is no short-circuit in one of the phases. (out coming wires might be connected somehow).

The generator can be assembled to the support frame according instruction and pictures. The generator has to be assembled to the support frame in such a way that the cable gland is in “south” position ( see picture in fig.1). First fit the clamps to the M10 bolts on top and second at the bottom with the M12 nuts. The M12 nuts on the clamp are tightened with a specified torque (appendix 7.1). Don't forget the Norlock rings to lock the nuts. Check if the generator is in position as shown in picture fig 2 and 3.

After you have completed the assembling check the shaft of the generator of it rotates as smooth as before. If not, you fixed the M12 nuts to strong.



*Fig. 1 Cable gland*



*Fig. 2 Generator position front*



*Fig. 3 Generator position side*

## 2.2 Rotor blades/hub

The large cardboard box contains the rotor blades and parts of the tail frame. Sometimes also the dump load is packed with the rotor blades. Unpack the rotor blades and make a visual check for any existing cracks or scratches. When nothing is visible at all, the blades can be mounted between the two hub plates with the 12 x M8 bolts and with self locking nuts. Every set of 3 blades is selected on weight and centre of gravity. Therefore the rotor blades are in balance when assembled to the hub plates. Don't mix the blades with other sets. Unbalance can easily destroy a wind turbine. There is only one way to fix the blade to the hub. You can't position the blade in wrong position. The flat side of the blades should face the wind and is the front side of the hub.



#### **WARNING**

Be careful with assembling the 12 x M8 bolts. The bolts fit very narrow in the holes. For assembling turn the bolts only into the holes. Don't use a hammer or drill the holes. Only in this way the rotor blades get the same position when they were balanced in the factory.

Be careful with any damage to the thread on the bolts because it can give problems when you fit the nuts to the bolts. Stainless steel is sensitive for damaged thread.

### **2.3 Tail with tail vane**

The tail assembly is composed of 5 parts: the tail vane, the upper section and 2 steel bars. The lower section is already assembled to the frame. The steel bars are packed with the rotor blades. The tail vane with tail upper section and steel bars can be assembled with M8 bolts according to the pictures on chapter 9.0. Tail Assembly and appendix 7.1 Torque specifications. The complete tail can be assembled to the frame by 3 x M8 bolts.

There is only one way to assemble the tail parts. In another way the pieces do not fit.

### **2.4 High-Wind speed Protection (Side Furling)**

The High-Wind speed Protection system will protect the wind turbine automatically during high wind speeds. When furling, the rotor will turn away from the wind direction. When the rotor speed is reduced, the power output of the wind turbine will be significantly reduced. Side Furling is an easy method to provide high wind speed protection. It is based on a basic physical relationship between aerodynamics, rotor, gravity, the specially designed tail shape and weight balance of the PASSAAT. Side Furling is completely passive and very reliable.

### **2.5 Mast top**

The mast top is fit into the support frame of PASSAAT (1.4 kW) wind turbine. Do not remove the mast top from the frame. Inside are Teflon coated vertical thrust bearing and radial glider bearings. Further they are greased with copper grease. Before you bolt it on top of the mast, make sure that it fits well in the support frame and can be rotated by hand in this position.

### **2.6 Nose cone**

Further you will find in the packing, a box with the nose cone and all the bolts and nuts for assembling. Also the voltage controller with dump load is packed with the generator. In some cases the dump load is packed in the box with the rotor blades.



#### **WARNING**

When any parts of the wind Turbine show damage that might have occurred during transportation, inform your local supplier or FORTIS directly about this. If you do not report such damage or the turbine is already in operation, you lose the right to your warranty !

### **3 Instructions Mast**

- 3.1 Producing a Mast yourself
- 3.2 Foundations
- 3.3 Installation preparations

#### **3.1 Producing a mast yourself**

Producing a mast for your FORTIS wind turbine is relatively simple. Various constructions are possible but in most cases a steel tubular mast with guy wires is used. It is also possible to use wooden poles, free standing steel tubular masts or free standing lattice masts. Even concrete masts are a possible option.

However, before you start to construct your mast, you have to consider where you are going to place the wind turbine and mast. For a good performance, it is necessary to install the wind turbine in such a way that the wind has an uninterrupted flow from all directions to the wind-rotor. Any obstructions such as trees, hills or buildings, even if they are somewhat lower than the wind-rotor, will cause turbulent air currents to arise which seriously decrease the generator output. Turbulent air has lost a large part of its original power and continually shifts from one direction to another, also upwards and downwards. This causes the wind turbine to vibrate to some extent. All of these factors should be considered when selecting a satisfactory location for the wind turbine. The higher the wind turbine is situated the better since the air currents are smoother and steadier further from the ground.

**For a good operation, the wind turbine should be mounted at least 5 metres above any obstruction within 200 metres!**

In order to keep electrical losses caused by long transmission lines to a minimum: Install the wind turbine as close to the application as possible without disturbing an unobstructed sweep from the wind. The dimensions of transmission lines are described under the chapter heading "Transmission lines 4.1".



#### **WARNING**

**Be sure that the tower tube is in a right vertical level. Use a bubble level to check the pole position.**

This is very important for the side furling function of the tail.

In most cases FORTIS advises the use of the guyed steel tubular mast as it is inexpensive, easy to build, easy to erect and FORTIS can provide all the required calculations. These calculations can be very important when planning permission has to be obtained.

The drawings for a guyed steel tubular mast are provided in this manual. The masts are designed according to a modular system with 3m modules, guyed every 6m. (Appendix 13).

## 3.2 Foundations

As there is such a wide variety of masts possible, we only describe here the foundations for the standard guyed steel tubular mast according to the standard FORTIS design. There are three ways to make a proper foundation for the mast and guy wires:

1] The first type of foundation is for very soft and unstable ground: for this type, concrete blocks of a certain weight have to be used. Drawings for this type of foundation are provided in appendix 7.6 / 7.7.

2] The second type of foundation is for rocky ground: this type requires the use of rock-bolt's for the tower and the guy wires. Make sure that the rocks are heavy enough. FORTIS can provide and specify the rock-bolts on request. The size and weight of the rocks must be about the same as the concrete blocks described in the foundation drawings.

3] The third type of foundation is for medium soft but stable ground: for the guy wires, earth-screw-anchors are used and for the mast, a small concrete block will be sufficient. The earth-screw-anchors can be specified and provided by FORTIS. The concrete block is the same as in appendix 7.6 / 7.7 or a standard block for roads can be used in the size of 2m x 2m x 0,12 cm. The base plate can be fit with chemical bolts.

## 3.3 Installation preparations

Before the mast is placed in a horizontal position, bolted to the base-plate, make sure the mast will be lifted towards the main wind direction. Lift and support the top of the mast in such a way that it is possible to slide the support frame over the mast top.

**However, before you do this, it is necessary to pull the wires through the mast.**

For your FORTIS PASSAAT (1.4 kW) machine, 3 flexible wires of 6 or 10 mm<sup>2</sup> will be sufficient in most cases. Only for 48V systems 10 mm<sup>2</sup> or 16 mm<sup>2</sup> is required. They must be pulled through the support frame first, and then through the mast. Now you can slide the support frame over the mast top. The connecting wires must not get stuck anywhere on any part of the wind turbine. Make sure the three wires can move and rotate freely inside the mast. Any possible problems in this area can cause a short circuit.

On top of the support frame, a knot or loop in the connecting wires must act as pull relief. Use three wires with the same colour to indicate the three similar phases. These three wires must be connected to the three wires coming from the generator, the connector block can be found in the white box that is attached to the generator. The order of connection is not important since all three lines are equal at both sides.

At the basement of the tower the 3 wires are connected to a plug and socket. This plug and socket can be used to retwist the cable in the tower. In some lace the wind can change from direction regular and the turbine rotated 360 degrees. When you have installed the turbine check every month the twisting. If you did not retwist after 6 month you can check the wires ones a year. If the cables are twisted disconnect the plug and socket when the wind speed is very low. Retwist the cables and plug in again It take only a few minutes.



**WARNING**

**Never disconnect the plug and socket at moderate or high wind speeds. The open circuit voltage can reach to a very high level and results in damage of the electronics when assembling the plug and socket.**

The lower section of the tail with spindle is assembled to the frame. There is no need to change it but in case you have to replace it follow the procedure.

The tail uses a 18mm stainless steel pin as spindle. This is fit to the frame. Note in which way the spindle shaft is assembled into the frame. The pin must slide into the tubular section of the tail frame where it passes through two Teflon bearings. When assembling the lower tail section to the frame, you put the spindle shaft from the lower position upward into the tail section and final into the top frame section. In principle, the tail bearings should not need any additional lubrication; however, applying grease extends the life of the bearings to some extent. The spindle is fixed at the top with a M12 self locking nut and washer

Next to be assembled are the rotor blades: the assembly of rotor blades (3) and 2 hub plates are bolted together with the 12x M8 bolts.



Hub plates

One hub plate is the front which has connections for the nose cone. The other hub plate can be used only in one position. Don't drill the holes because the blades get only in this way in the right position and therefore are balanced. Because the bolts are made of stainless steel you must be careful not to damage the thread. If the thread of the bolt is damaged it is impossible to get the nut on it.

After the 3 blades are assembled together you can fix the complete rotor to the generator shaft. On the shaft you fit the clamp ring, move rotor hub to the shaft and fix it with one M12 bolt with washer. See picture in fig 4. Finally assemble the nose cone with 3 x M6 bolts.



*Fig.4 Generator shaft. **Note: washer directly behind nut.***

The next stage involves the guy wires: a standard FORTIS PASSAAT (1.4 kW) mast according to FORTIS specifications is guyed every 6m, in four directions. Make a rough calculation of the length of each individual guy wire and then connect it to the mast and to its foundation. The only guy wire that cannot be connected is the one directly opposite the direction in which the mast is pointing. This guy wire should be connected when the mast is in the upright position. All guy wires are connected to the mast with a bow shackle, to the foundation with a rigging screw and twin cable clamps. Both cable clamps must be fully tightened before lifting the mast.

## 4 Electric Installations

- 4.1 Transmission lines
- 4.2 Voltage control/ dumpload
- 4.3 Grid connection
- 4.4 Batteries

### 4.1 Transmission lines

The FORTIS PASSAAT (1.4 kW) generator is a 3 phase generator and 3 electric wires are needed to connect the generator with the rectifier bridge which is inside the voltage control box. The maximum rectified current is 60 A and peak voltage is 600 VDC. The working temperature of the components is - 40°C to + 50°C.

The electric wires have to be flexible and should not consist of a single solid copper core. Furthermore, the isolation wrapping of the wires should be UV-resistant (PVC-isolation cannot stand UV light).

Prevent the damaging of the electric wires by sharp edges. Any damage to the electric wires will lead to short-circuiting and the rotor will stop rotating, or even worse, the rectifier bridge might be destroyed because of too many amperes. Never let the wires hang with their full weight on the cable terminals. If the cable is long and heavy use steel wire inside the tower and tape the electric wires to this steel wire every 4 –6 m.

For the wire-gauge see the chapter 7.8 -8.0.

### Passaat battery charging system 24 or 48VDC

| System voltage    | 24V | 24V | 48V | 48V  |
|-------------------|-----|-----|-----|------|
| Power losse       | 5%  | 10% | 5%  | 10%  |
| 6 mm <sup>2</sup> | 5 m | 10m | 17m | 34m  |
| 10mm <sup>2</sup> | 8m  | 16m | 29m | 58m  |
| 16mm <sup>2</sup> | 12m | 24m | 46m | 92m  |
| 25mm <sup>2</sup> | 18m | 36m | 72m | 144m |

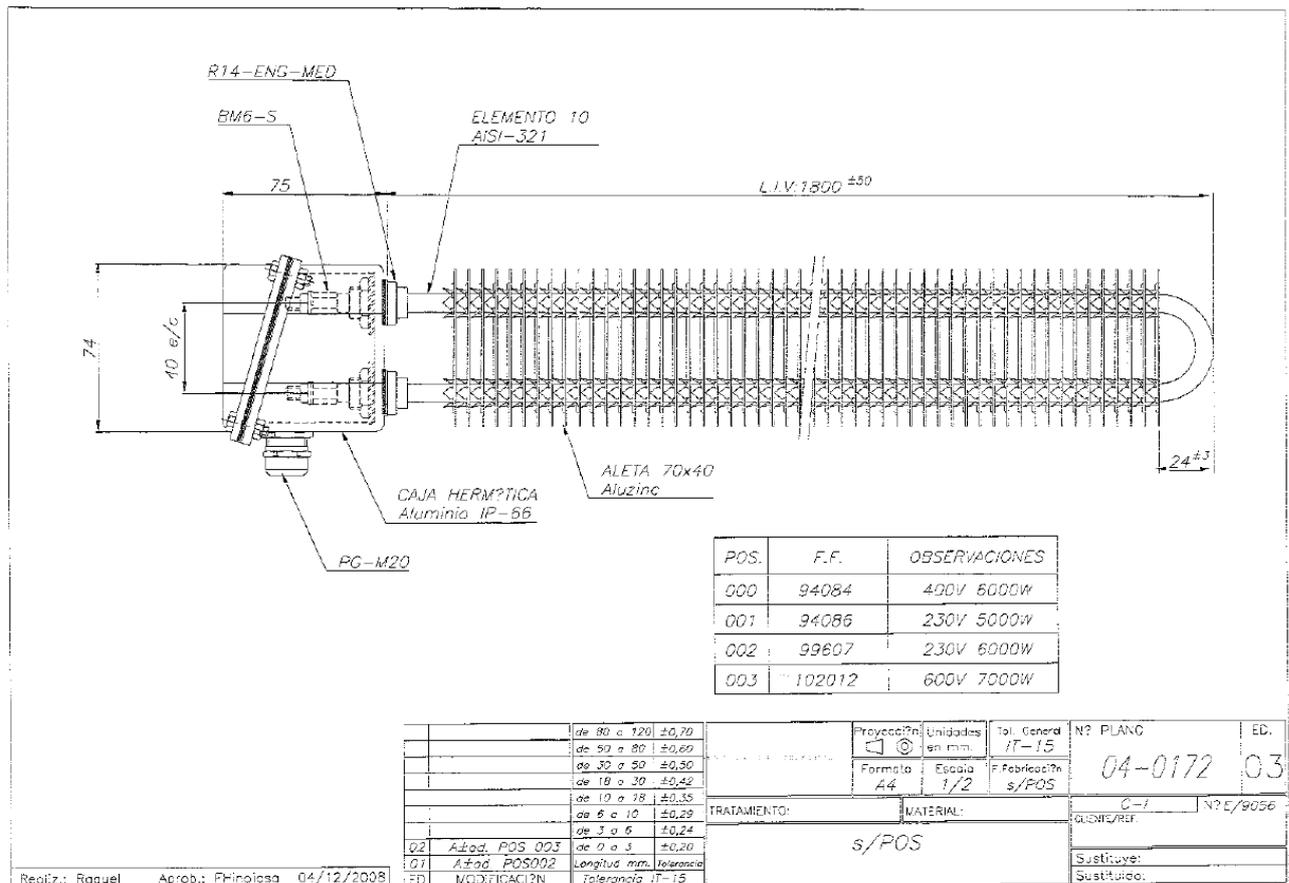
Max allowed cable length compared to power losses and system voltage

## 4.2 Connection of the Dump load(s)

The electronic voltage control prevents over-charging of the batteries. When the batteries reach a threshold value, or the grid is not available the current from the generator is proportionally directed to a dump load. The dump load can either be a coil for water heating or for air heating. For Battery charging at 24VDC the dump load connection is different compared to 48VDC if the dump loads are 750 Watt each. For grid connected mostly the dump load is one type.

### Dump load matrix for Passaat wind turbine:

| Passaat           | Battery charging 24VDC    | Battery charging 48VDC    | Single Phase 230V/50Hz                                 |
|-------------------|---------------------------|---------------------------|--|
| Dump load:        | 2x 750 W / 28V            | 2x 750 W / 28V            | 1x 1500W / 250V  |
| Connection:       | Parallel                  | Serial                    |  |
| Cable connection: | terminal block MP-60A-24V | terminal block MP-30A-48V | Connection to Fortis Voltage Controller:<br>IN_350V_5A |



### Dump load grid connected

### 4.3 Voltage control for battery charging

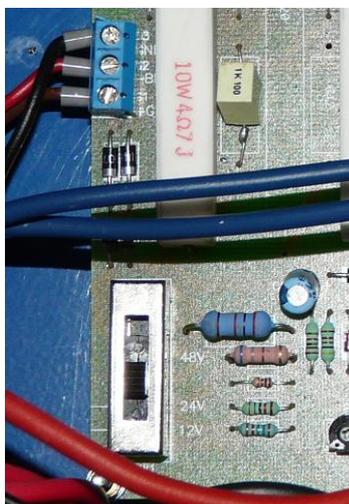
The box of the voltage control unit is made according to international standard IP 44 and is not 100% weather resistant. Every voltage controller is supplied with an air-heating coil which functions as dump load. Water heating is optional. To prevent any problems with heat dissipation, mount the dump load above or at some distance away from the controller. It is advisable to mount the controller as close to the batteries as possible to minimize electrical losses. When the controller is housed in the same room as the batteries and dump load, the room must be well ventilated.

There are two possible voltage controller types for the FORTIS PASSAAT (1.4 kW);

- 1] MP-60A-24V Over Voltage controller / Battery charger / Dump load for Off\_Grid
- 2] MP-30A-48V / Over Voltage controller / Battery charger / Dump load for Off\_Grid



Fortis Voltage controller / Battery charger / dump load



Switch for voltage selection: 12 / 24 / 48V

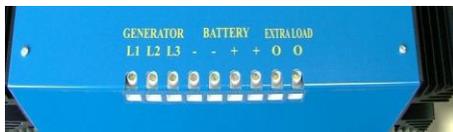
When mounting the voltage controller, it is very important to choose a wall or surface which is non-conductive. Cooling blocks are mounted on both sides of the controller to cool the rectifier bridge and the MOSFET's of the electronic part. When the wind turbine is operating at full power, there is a heat generated in these blocks. The dumpload can get very hot. Both controller and dumpload should therefore be mounted in such a way that the risk of getting scorched is minimal.

The wires of the dumpload must be connected to the 18 and 19. The dumpload is not sensitive to plus and minus, so the order of connection is not important. The same applies for connecting the three phases of the generator: these must be connected to the three contacts 10, 11 and 12.

Again, the order in which they are connected is unimportant. The last component to connect is the consumption circuit. The consumption circuit can either be a battery-bank, an inverter for grid connection or a Pump controller for water pumping. Connect the battery bank to terminal no.; 16 and 17 for + and 14 and 15 for - .

#### **Terminal connections (16mm<sup>2</sup>):**

- Connect the dump load to terminal no.; 18 and 19
- Connect the battery bank to terminal no.; 16 and 17 for + and 14 and 15 for -
- Connect the 3 phases of the generator to terminal no.; 10, 11 and 12



#### **IMPORTANT!**

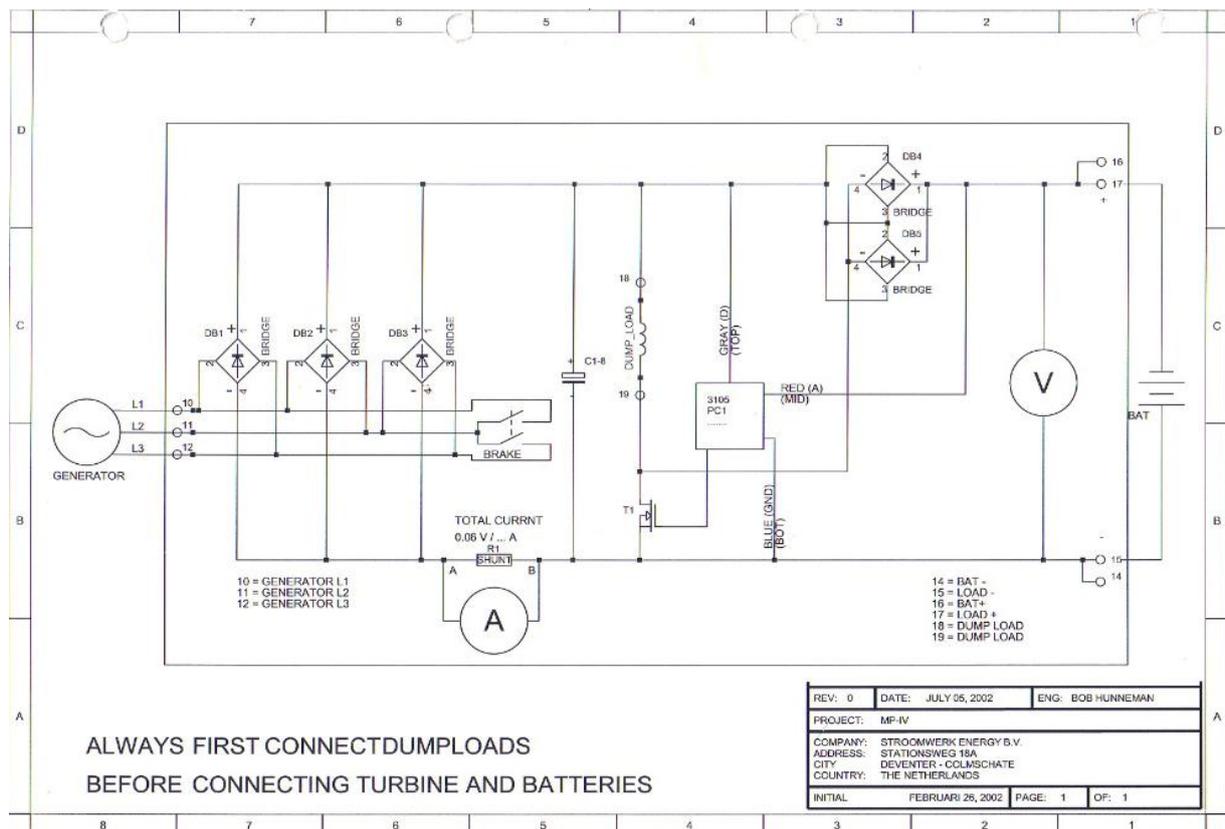
**There is, however, a specific sequence in which all the above mentioned connections must be made. This is very important as if the connections are not made in this order, the generator or controller can be damaged during the installation procedure.**

- 1] The brake switch has to be set on STOP
- 2] The dump load must always be the first component to be connected
- 3] The consumption circuit or inverters must always be the next component to be connected; beware of the difference between + and -
- 4] The 3 wires of the generator are the next component to be connected
- 5] The batteries are the last component to be connected



## Electrical drawing of MP-30A-48V or MP-60A-24V

For Instruction Manual see document: Overvoltage-/Battery charge Controller for Passaat 1.4 kW wind turbine. Type: MP-30A-48V / MP-60A-24V.



*Electric wiring scheme*

## 4.4 Batteries

Batteries need to be kept in a place with sufficient ventilation and no risk of freezing. Charged batteries can stand temperatures of up to minus 20°C, but uncharged batteries cannot withstand frost at all. Place the batteries underneath the voltage control in the same room if possible as this minimizes energy loss in the wires. A battery is normally 12 V so you need two batteries connected in series for 24 VDC or 4 for 48V or 10 for 120VDC. Connect the minus terminal of one battery with the plus terminal of the other battery. The remaining terminals are the plus and minus of the battery group. For a FORTIS PASSAAT (1.4 kW) 24V we advise a minimum battery capacity of 300 Ah (C= 10 h), but a capacity of 500 Ah is even better. For lead/acid batteries the charging/discharging current should not exceed 20% of the capacity (preferable 10%).

## 4.5 Voltage Controller & Inverter for Grid connection

Grid connection is one of many options with a FORTIS system. In a grid-connected FORTIS PASSAAT (1.4 kW) system, a Fortis Voltage Controller IN\_350\_5A incl. On/Off Switch with LED status, Automatic Brake Switch, GCI-1.5K-2G-W Inverter with front panel display, dump load and Power Curve programming (Optional: Wifi & Internet connection) Output: 230VAC, 1-phase + N + PE

The voltage controller / Brake Switch is needed to protect the inverter against peak voltages when the load is disconnected.



Installation Manual Grid Tie Inverter see chapter 4.6  
GCI-1.5K-2G-W Inverter



Voltage Controller IN\_350V\_5A, Brake Switch and Main Switch



Dump Load

### 4.5.1 Fortis Overvoltage Controller IN\_350V\_5A

This overvoltage controller can only be used for the Fortis-Passaat wind turbine with the 300 V generator and 1.4 kW rated power.

The system for safe operation comprises of:

- this over voltage controller
- the 230 V, 1.5 kW ballast resistor that is delivered with the over voltage controller properly connected
- the grid-tie converter
- the Fortis -Passaat wind turbine

Under no circumstances operate the wind turbine without this over voltage controller and without ballast resistors connected.

Wrongly dimensioned cables, improper connections, etc. bear a high risk of sparks and fire, injuries, damage of the wind turbine!

Please read this manual and the installation and operation manual of the wind turbine and grid-tie converter before starting the installation.

The rated current is 5 A, the rated DC voltage is 300 V, please use appropriate cables and switchgear especially for the DC output.

Do not short circuit the “+” and “-“ or “R+” and “R-“ or “L+” and “L-“ terminals.

For connection to the “R+” and “R-“ terminals only use the ballast resistors delivered with the overvoltage controller, do not install any fuse or switch in between this controller and the ballast resistor.

The main switch of this controller does not replace an external main switch for the wind turbine.

The combination of this overvoltage controller, the wind turbine and the grid-tie converters have to be explicitly tested and approved by the wind turbine manufacturer.

## 4.5.2 Overview of functions

The over-voltage controller has two main functions:

- 1] Rectifying the generator voltage for the input of grid-tie inverters
- 2] Control of the external ballast resistors in case of over voltage supplied to the grid-tie inverter.  
This puts load on the wind turbine and therefore reduces the risk of over-rotational speed.
- 3] Short circuit of the generator in case of problems with the ballast or this controller

The three functional units are internally decoupled via separate rectifiers and do not interfere with each other.

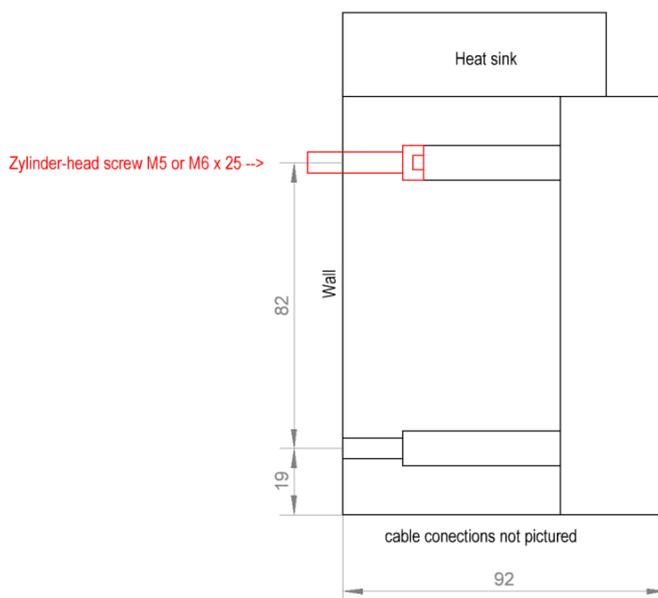
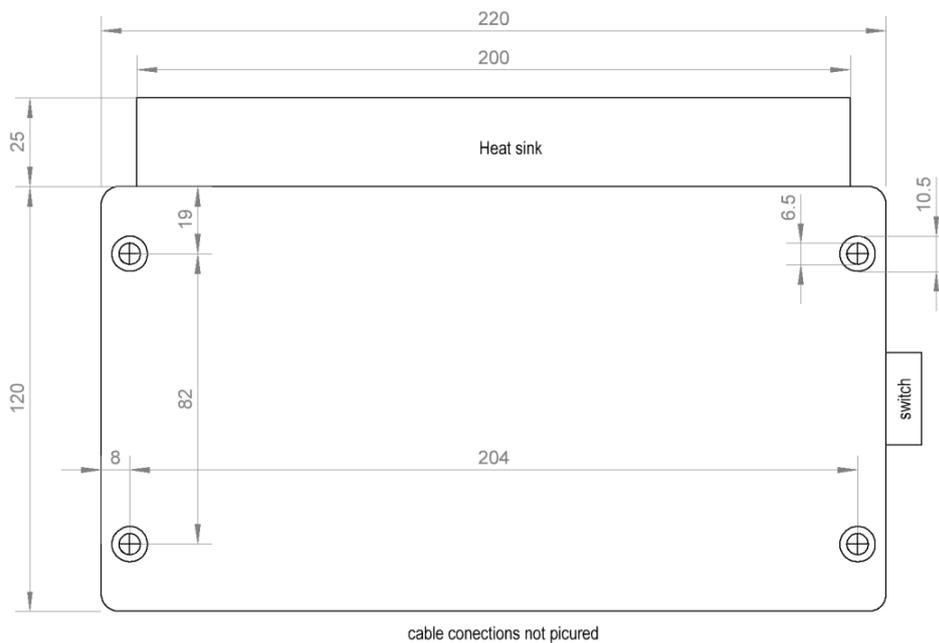
The ballast resistor is PWM controlled. If the voltage at the DC-output is below 340 VDC, there will be no load supplied to the ballast resistors. Above that voltage the power supplied to the ballast resistor is ramped up to 100 %.

The controller and the display are active whenever the voltage is above 40 VDC. The display shows the rectified generator voltage.

## 4.5.3 Installation and commissioning

The controller is for wall-mounting only; the heat sink has to face upright. Sufficient cooling has to be provided allowing adequate space for natural air ventilation around the controller.

Remove the lid to access the drillings for 4 cylinder headed screws up to 10 mm shrew head diameter or 6 mm thread diameter.



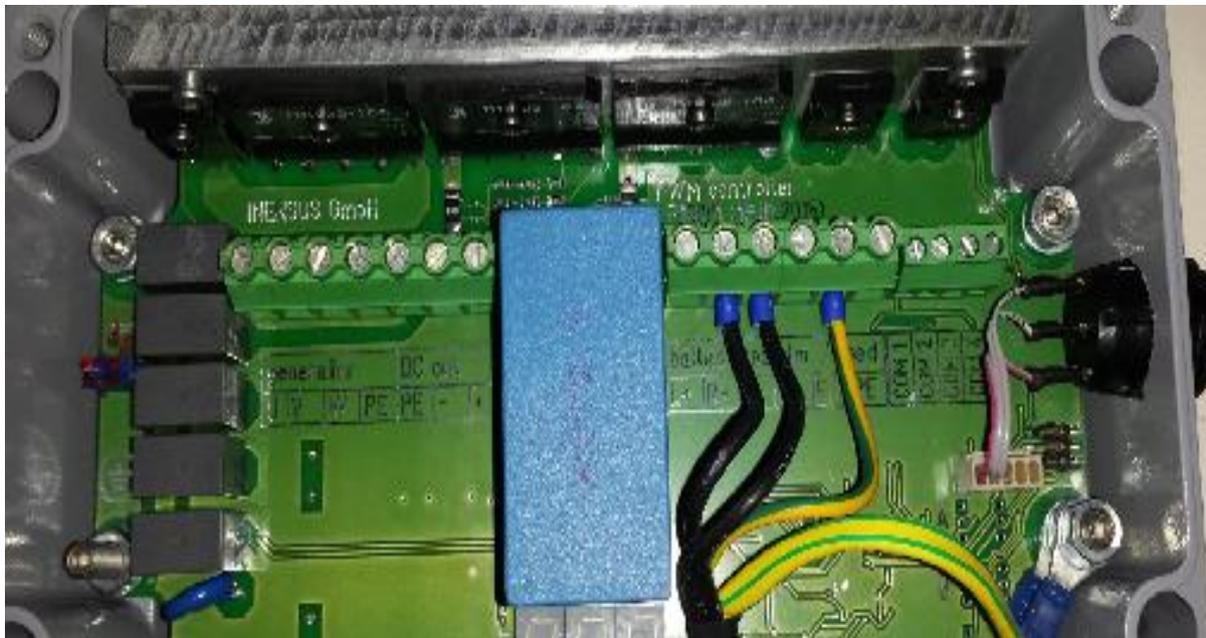
Install the ballast resistor close to this controller in a minimum height of 1.8 m above ground that children cannot get hurt at the hot surface. Ensure that the ballast resistor is installed on a non-inflammable surface and that there is sufficient space around. Above the ballast resistor 0.8 m is the recommended distance to the roof or any other object. The maximum cable length of the shielded cable should be less than 3 m.

Install the grid-tie converter and the wind turbine according to the manufacturer recommendations. Install a separate main switch or basic safety controller for the wind turbine; ensure that from switching of the generator no voltage spikes are on the generator cable.

#### 4.5.4 Electrical connections

Most connections are with screw terminals up to 6 mm<sup>2</sup> solid copper conductors or 4 mm<sup>2</sup> flexible conductors with end-sleeves. Main ground terminal for the housing is via M6 ring terminal.

1. Connect the metal housing to ground, preferably with one M6 ring terminal at the ground terminal screw on the left or any free PE terminal
2. Connect the ballast resistor to “R+”, “R-”, and “PE” with a shielded cable, connect the shielding to a separate “PE” or directly to the housing
3. Connect the grid-tie converter to “+”, “-”, and “PE”, observe correct polarity!
4. Switch off the generator at its external main switch; ensure that there is no voltage from the generator. Connect the windings to “U”, “V”, “W”, and “PE”



#### 4.5.5 Commissioning

Ensure that the grid-tie converter is fully operational and especially the ballast resistor is properly connected. Start the wind turbine for the first time only at low or moderate wind. Put the main switch of this overvoltage controller in the ON position. Start the wind turbine as described in the manufacturer documentation, usually with the external main switch. After the rotor has started to turn and the green light of the main switch of this overvoltage controller starts flashing, put its main switch in the OFF position to test the braking function preferably several times. If this works successfully, restart the wind turbine with the main switch in the ON position. Usually, the grid-tie converter has to monitor mains before being able to feed in and load the generator. During this time, the overvoltage controller has to load the generator to limit rotor speed and generator voltage. If there is enough wind, the voltage will rise to 340 VDC and the load on ballast is increased gradually. The green LED in the switch is permanently on when the ballast is in use.

#### 4.5.6 Operation

The controller works fully automatically. AC power from the generator is rectified for an external grid tie-converter. Rectified voltage is monitored and limited to 350 VDC by increasing the load on the external ballast resistor. In case the voltage should rise to 395 VDC, a direct short circuit of the generator is engaged. The main switch can be used to stop the wind turbine manually by increasing the load on the ballast resistor to the maximum. At high wind speed, the rotor may stop with delay. Restart of the wind turbine is prevented as soon as the controller is powered from the generator again. The LED in the main switch flashes slowly when the controller is powered and no power is dissipated to the ballast. The LED is on continuously when the ballast resistor is activated.

Only skilled electrical technicians are allowed to work with the controller when the lid is open.

#### 4.5.7 Maintenance

The controller does not need special maintenance. Please ensure that the heat sink on top of the housing and the ballast resistor are clean from dust and dirt. Cooling of the controller and the ballast resistor must not be obstructed. Test the stop function for the wind turbine from time to time. The inside of the housing has to be kept clean and free from water.

For service and maintenance, please follow the procedure below:

- 1] Stop the wind turbine as described in its operation manual, secure it against self-restarting.
- 2] Wait for 3 minutes until the internal capacitor is discharged
- 3] Open the cover, measure the voltage at the terminals and the large capacitor to ensure that the remaining voltage is low enough to start working on the inside of the overvoltage protection. The voltage of the capacitor can be measured in between "R+" and "COM1".

In this position it is safe to remove the cables of the grid inverter since no current can flow from the generator.

After finishing the work inside of the overvoltage protection, close the cover and restart the wind turbine. Test the wind turbine stop with the main switch of this controller after every service.

#### 4.6 Installation Manual Grid Tie Inverter:

**Installation Manual for GCI-2K-2G-W GCI-2G-W Single Phase Inverter see separate document**

**For USA:**

**Installation Manual for GCI-1-5K-2G-W-US-V2 Single Phase Inverter see separate document**



## 5 Technical Data Overvoltage controller (Grid connected);

|  |                               |
|--|-------------------------------|
| Wind turbine permanent magnet generator input:                                 |                               |
| Rated power  | 1500 W                        |
| Rated rectified voltage  | 300 VDC                       |
| Rated rectified current  | 5 ADC                         |
| Type of generator input  | 3~                            |
| Voltage limitation:  |                               |
| Increase of load on ballast resistor   | 340 ... 350 VDC               |
| Short circuit of generator   | 395 VDC                       |
| Integrated varistor for short voltage peaks, protected by a 500 mA/1000 V fuse | 470 VDC                       |
| External ballast resistor:   |                               |
| Minimum resistance for the ballast resistor                                    | 24 $\Omega$                   |
| Recommended resistor   | 1500 W @ 230 V (35 $\Omega$ ) |
| Switching frequency (PWM control)  | 16 kHz                        |
| Maximum shielded cable length for the ballast resistor                         | 3 m                           |
| Maximum cable cross section solid  | 6 mm <sup>2</sup>             |
| Housing:   |                               |
| Colour   | RAL 7001                      |
| Material   | aluminium                     |
| Dimensions (width x height x depth)  | 230 x 145 x 91 mm             |
| Weight   | approx. 2.5 kg                |
| Ambient temperature  | -10 ... 35 °C                 |
| International protection   | IP 54                         |



**WARNING**

**Be aware that step 1 and 2 are made properly before you start with step 3 and 4. If the generator has been connected first it is possible that a high voltage is generated which can damage the transistors. Be also aware of static electricity on your clothes or wires because they can damage the transistors too.**

Before the wind turbine is erected and during the process of erection the three phases of the generator should be short-circuited. If an MP-controller is used, this can be done by using the **STOP SWITCH** inside the controller. Any other (temporary) way of short-circuiting the three phases is allowed. It is not necessary to disconnect the batteries as they are protected from short-circuiting by the rectifier bridge. In addition to this, the batteries and any other consumption circuit should be properly fused. FORTIS advises to fuse all other consumption circuits in accord with their specifications as required.

**Check that all your connections are tightly and correctly connected.**



**WARNING**

**Never connect the wires from the generator to the controller when the wind turbine is in operation. The open circuit voltage can be 10x the nominal voltage. This voltage can destroy the electronics.**

## **6 Erecting the turbine in the upright position**

- 6.1 Safety first
- 6.2 Conditions during installation
- 6.3 The installation
- 6.4 Guy wire tensioning
- 6.5 Start-up procedure

### **6.1 Safety first!**

Safety becomes very important when you consider the amount of serious damage and injuries that can be caused if a wind turbine topples over. Firstly, therefore, make sure that all the nuts and bolts of the wind turbine are tightened securely. We advise you to make one person responsible for the final overall check of all the nuts and bolts. Then let the same person check all the guy wires, rigging screws and foundations.



**WARNING**

**During hoisting of the mast and wind turbine, everybody who is not directly involved with the process must keep a distance of (at least) mast height to the base plate!**

When a gin-pole with a cable-jack or cable-winch is used to erect the mast and wind turbine, only 2 men are necessary for the process; one for the actual lifting (jacking) and one to check the guy wires during erection. This person should make sure that the wires do not get stuck somehow or work themselves loose.

## **6.2 Conditions during installation**

It is not absolutely necessary to wait for a windless day to erect the mast of an FORTIS PASSAAT (1.4 kW) wind turbine. The maximum wind speed for erection of the mast and wind turbine must not exceed 8 m/sec. Only an FORTIS specialist who is present during installation and erection can decide to proceed during higher wind speeds. Snowfall during installation is not necessarily a problem provided the snow is not sticking to the blades in large amounts. Snow or ice can cause rotor unbalance and thus damage the bearings of the generator.

### 6.3 The installation (erection) procedure

The simplest way to erect an FORTIS-mast is to use a gin-pole. It is also the method most often used owing to the fact that it is usable under a wide range of circumstances. The length of the gin-pole must be somewhere between 1/2 and 1/3 of the length of the mast and a set of guy wires are required to prevent the mast from toppling to one side. If only one set of guy wires is used, connect this one guy wire to the top section of the gin-pole. When several sets of guy wires (at different levels) are used, a guy wire of every set must be connected to the top section of the gin-pole. The last attachment point of the gin-pole is used for the cable of the winch or cable-jack. The gin-pole is now held in place by at least four cables.

If it is possible to climb the mast when it is in a vertical position, we advise you to fix a rope to one of the blades to prevent the turbine from rotating. Even when it is possible to fix one of the blades with a rope, the three phases of the generator must always be connected (short-circuited).

**Be very careful with short circuiting the three phases when the rotor blades are moving, the voltage can easily reach dangerous levels !**

The mast and wind turbine can now be erected!

### 6.4 Guy wire tensioning

FORTIS has developed and recommends a method for setting the pretension on guy wires for all guyed towers. This simple procedure utilizes the relationship between cable tension and the rate of cable vibration to give a preload which is proportional to cable size. It is based on the time required for the guy cable to complete 20 oscillations at the fundamental natural frequency.

The approximate desired preloads for the various cable sizes are given below:

| EHS Cable size | Preload  |
|----------------|----------|
| 1/2"(12mm)     | 900 kg   |
| 7/16"          | 675 kg   |
| 3/8"(10mm)     | 450 kg   |
| 5/16"(8mm)     | 337.5 kg |
| 1/4"(6mm)      | 225 kg   |

### 6.4.1 Determining the proper frequency of the cable

- 1] Determine the length of the cable in metres from the guy bracket to the ground.
- 2] Divide this length by 3.
- 3] This gives the number of seconds which are required for the cable to make 20 complete cycles.
- 4.] The process is very sensitive to this time period. Doubling the time required to make the 20 oscillations will result in 1/4 of the desired guy tension. We recommend therefore that the tension be adjusted until the time period is within 1 second of the recommended value.

**Calculation example:**

assume the following geometry,

Height of guy fixing point = 12m

Distance mast-foundation point = 6m

This gives a total cable length of 13.4m.

Dividing by 3 gives 4.5 seconds to complete the 20 oscillations.

### 6.4.2 How to oscillate the cable

Any cable under tension will tend to oscillate at a certain natural or fundamental frequency which is dependent upon its tension, weight per meter and length. It is very important that the cable be moved back and forth at this frequency. The cable should trace out the pattern shown below in a regular, consistent way without whipping or distorting into other shapes.

**IMPORTANT: the frequency of oscillation is independent of the magnitude of oscillation.**

The idea is then to vary the tension of the cable until the proper frequency of oscillation is observed.

### **6.4.3 Procedure for tensioning the cable**

- 1] Stand at one anchor and move the guy wire back and forth at its natural frequency.
- 2] Measure the number of seconds required for the cable to make 20 complete cycles.
- 3] Compare this time period with the recommended value.
- 4] If necessary, adjust the tension and go back to point 1.

### **6.4.4 Cautions, hints and suggestions**

- 1] Use your common sense. If the guy wires start making noises something like a guitar, they may well be too tight, so stop tensioning. You may be doing something incorrectly.
- 2] This procedure cannot be used under all wind conditions. If the wind speed is above 7m/sec., then your readings will not be accurate owing to the additional forces on the tower caused by the wind. Furling the wind turbine and stopping the rotor will reduce these additional forces and allow the use of this procedure in winds of up to 10 m/sec.
- 3] Do not use this procedure if the cable size is different from that recommended by FORTIS. For example, if the cable is larger, the result will be tension forces which are much greater than the recommended value.
- 4] On an FORTIS tilt-up tubular mast with 4 anchor points the cables which are at the same height but opposite to one another will tend to develop the same pretension. Both cables may require adjustment, however, for the tower to remain straight.
- 5] Do not attempt this procedure if ice is present on the cable. The extra weight of the ice will give incorrect results.

## 6.5 Start-up procedure

Provided the wind turbine and mast are in the final position and there is some wind (more than 3 m/sec.), the start-up procedure can take place.

Provided the wire connections are correct. If there is sufficient wind, the turbine will start to rotate and power will be produced. A multi meter can be used to check the system; even the slightest increase in voltage indicates power coming from the turbine. Do not be disappointed when the wind turbine does not start up in winds slightly above 3 m/sec., as it sometimes needs a short running-in period.

When lifted the wind turbine with generator short circuit, the wind turbine will start to rotate very slowly if there is sufficient wind, (less than 5 m/sec.). A final check can be made when the turbine is producing some power; check the voltage over a period of several hours. If all the connections are made correctly, the voltage will increase slightly although the difference may be minimal.

To replace a controller, first set the short circuit switch on STOP.

Prepare 3 copper wires without isolation and at one site connected with each other. Unplug the plug and socket at the tower base and put the 3 copper wires around the 3 pins of the plug. You can use also a second socket which is short circuit internal and plug this one in the plug.

If this has been made properly the turbine is short circuit and runs only very slow.

Disconnect the wires from the wind turbine and other wires but as final the wires of the dump load. If you assemble the controller again take first the dump load wires to be connected.

## 7 Appendix:

### 7.1 Torque specifications

| Specification bolt/nut | Description                | Torque (N/m) |
|------------------------|----------------------------|--------------|
| M12*45                 | Main shaft                 | 40 Nm        |
| M8                     | Generator housing          | 5 Nm         |
| M12*60                 | Mast top and mast flanges  | 40 Nm        |
| M12 nut                | Tail hinge pin             | 40 Nm        |
| M 12*30                | Tail hinge pin             | 20 Nm        |
| M 12                   | Generator-chassis mounting | 10 Nm        |
| M8*45                  | Tail boom                  | 20 Nm        |
| M8*40                  | Tail boom                  | 20 Nm        |
| M8*70                  | Rotor blades               | 30 Nm        |
| M5*20                  | Fixed connector frame      | 10 Nm        |
|                        |                            |              |

### 7.2 Required tools

The following tools are the minimum that required for successful installation:

|                                       |                   |
|---------------------------------------|-------------------|
| Spanner                               | 8,10,13 and 19 mm |
| Screw driver for electrical terminals |                   |
| Rubber hammer 0,5 kg                  |                   |
| Multimeter (AC/DC voltages 0-500V)    |                   |
| Ratchet                               |                   |
| Socket                                | 13 and 19 mm      |

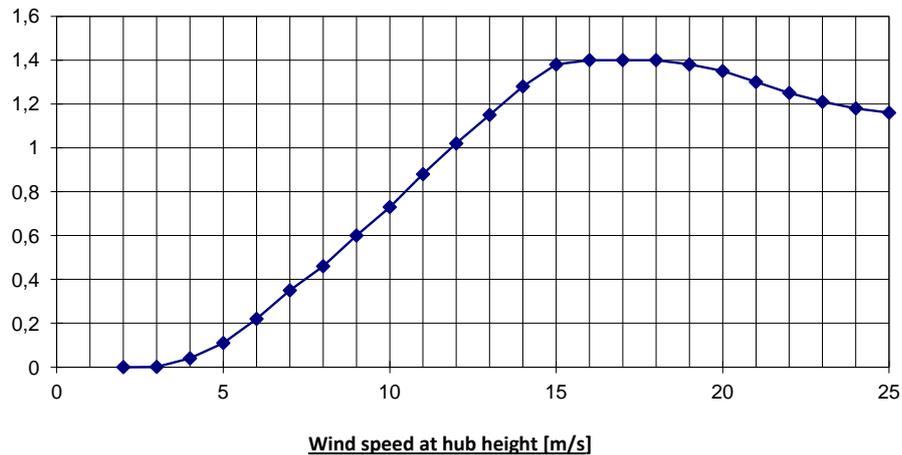


### 7.3 Technical data PASSAAT (1.4 kW)

|                     |   |
|---------------------|---|
| Max. output         | 1400Watt  |
| Output @ 11m/sec    | 900Watt   |
| Wind speed:         |   |
| cut in              | 2.5 m/sec.  |
| rated               | 16 m/sec.   |
| survival            | 60 m/sec.   |
| Rotor blades:       |   |
| number              | 3   |
| diameter            | 3.12 m  |
| area                | 7.64m <sup>2</sup>                                |
| airfoil             | E387  |
| tip speed ratio     | 6.9   |
| material            | glass-fibre reinforced epoxy                      |
| Generator:          |   |
| type                | Permanent Ne-Fe-Br magnets producing 3 phase AC   |
| RPM operation range | 180 - 775   |
| voltage             | 24V- 350VDC standard<br>other voltages on request |
| frequency           | 0-70 Hz   |
| Other:              |   |
| gearbox             | none  |
| braking mechanism   | none  |
| rotor speed control | Inclined hinged vane                              |
| output control      | voltage control with dump load                    |
| rectifiers          | built inside controller                           |
| hub type            | rigid   |
| yaw system          | tail vane   |
| rotor position      | Upwind rotor with fixed pitch                     |
| tower               | guyed steel tubular (height: 12 - 24m)            |
| tower               | free standing tube mast (height: 12 - 18m)        |
| Head weight         | 75 kg   |

## 7.4 Power curve Passaat

Rated output (kW)



**Type :** FORTIS PASSAAT  
**Manufacturer:** Fortis Wind Energy

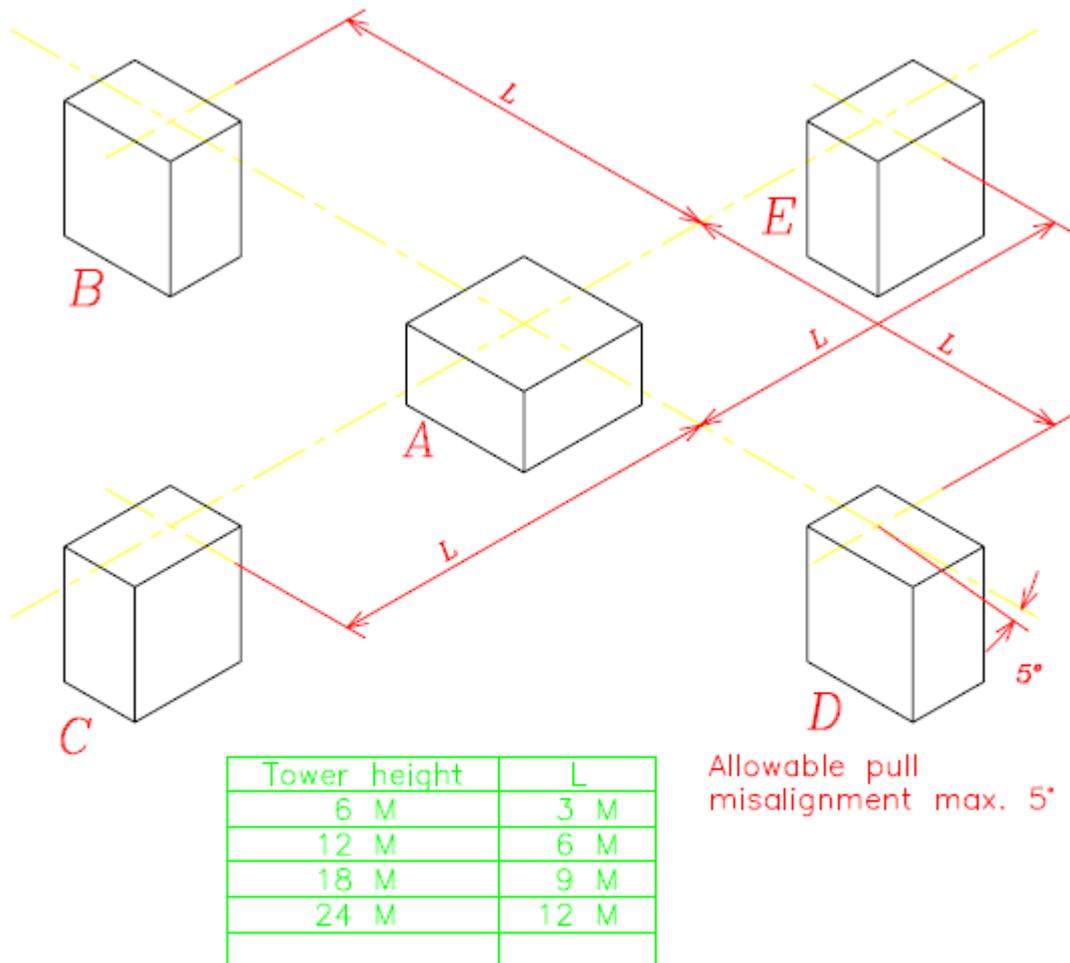
**Rated Power:** 1400 Watt  
**Output (12m/s):** 1000 Watt  
**Rotor Diameter:** 3,12 m  
**Hub height:** 12 –24 m Mast

| Rotor with fixed pitch       |                                       |
|------------------------------|---------------------------------------|
| <b>Type</b>                  | Upwind rotor with fixed pitch control |
| <b>Direction of rotation</b> | Clockwise                             |
| <b>Number of blades</b>      | 3                                     |
| <b>Length of blades</b>      | 1,50 m                                |
| <b>Swept area</b>            | 7,65 m <sup>2</sup>                   |
| <b>Profile</b>               | E387                                  |
| <b>Manufacturer</b>          | Fortis Wind BV                        |
| <b>Blade material</b>        | Fiberglass-reinforced polyester       |
| <b>Rated speed</b>           | variable, 180 – 775 U min-1           |
| <b>Rotor axis angle</b>      | 10 <sup>0</sup>                       |
| <b>Cone angle</b>            | 0 <sup>0</sup>                        |

| Generator with drive train |   |
|----------------------------|---|
| <b>Pitch control</b>       | fixed pitch   |
| <b>Hub</b>                 | Rigid   |
| <b>Generator</b>           | Permanent Magnet Fortis Synchron machine  |
| <b>Grid feeding</b>        | 1 x 230V by inverter  |
| <b>Break systems</b>       | Ecliptic safety system by inclined hinged vane<br>90° setting of tail<br>short circuit of generator |
| <b>Yaw control</b>         | Passive Aligned by Tail Vane  |
| <b>Tower</b>               | Various types of towers designed for different sites  |
| <b>Weight tower head</b>   | 75 kg   |



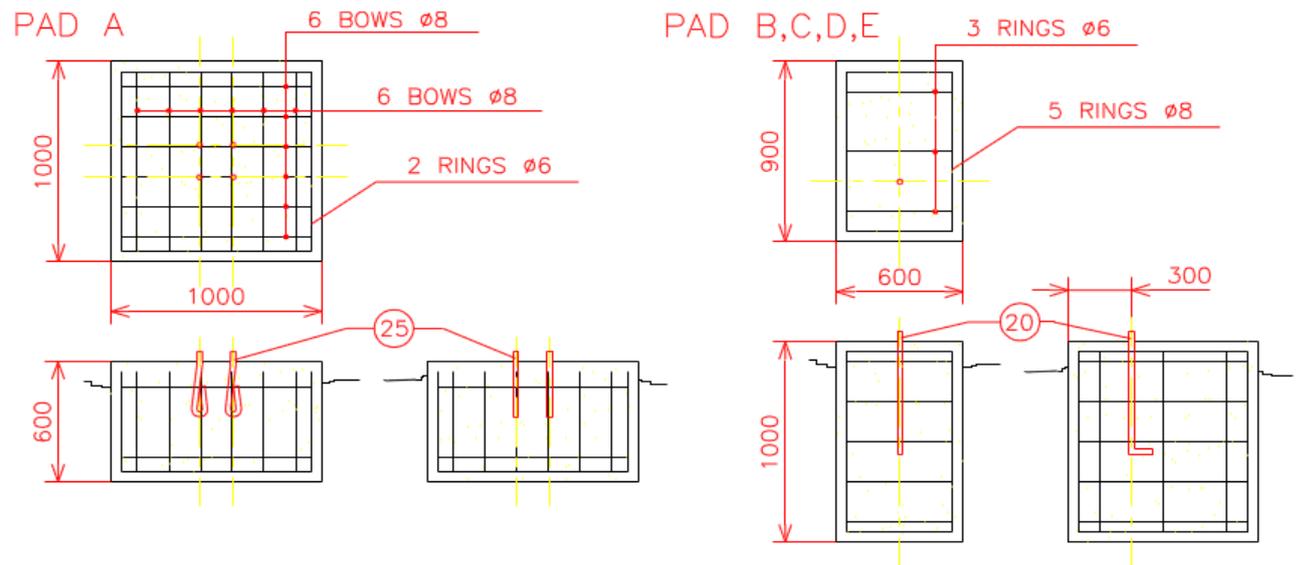
## 8.0 Foundation blocks for guyed tower



|            |                 |               |         |
|------------|-----------------|---------------|---------|
| PROJECTION | SCALE: 1:50     | DRAWN BY: ASW | NOTICE: |
|            | MEASUREMENT: mm | CHECKED:      | :       |
|            | DATE: 04-03-96  | REVISION:     |         |



## 8.1 Anchors and concrete specifications



### notes

- concrete requirements: 2,76 m<sup>3</sup>
  - cement 0,46 m<sup>3</sup>
  - sand 0,92 m<sup>3</sup>
  - gravel 1,38 m<sup>3</sup>
- reinforcement steel FeB360, covered with a minimum of 40 mm concrete
- all pads must be level and be at the same elevation
- guy wire attachments and other fixtures are bolted to the pads using hilti type concrete fasteners

10N = 1kg  
1m<sup>3</sup> concrete = 24000N

PASSAAT

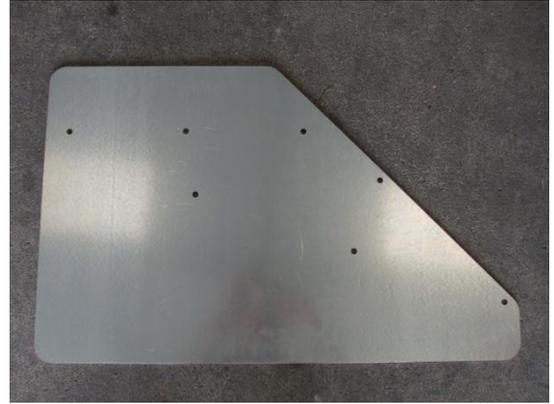
FOUNDATION GUYED TOWER DRAWING 1400-10-4



## 9.0 Tail Assembly



Tail sections Tail frame



Tail vane



Tail connection on frame



## 10 Plug and socket in tower base



### 10.1 Terminal box on frame



Terminal box for generator cable



## 11 Gin pole and winch



Wiring of 18 m guyed tower with gin pole and winch



Fortis Montana guyed tower with gin pole ready for erection



## Guyed tower picture

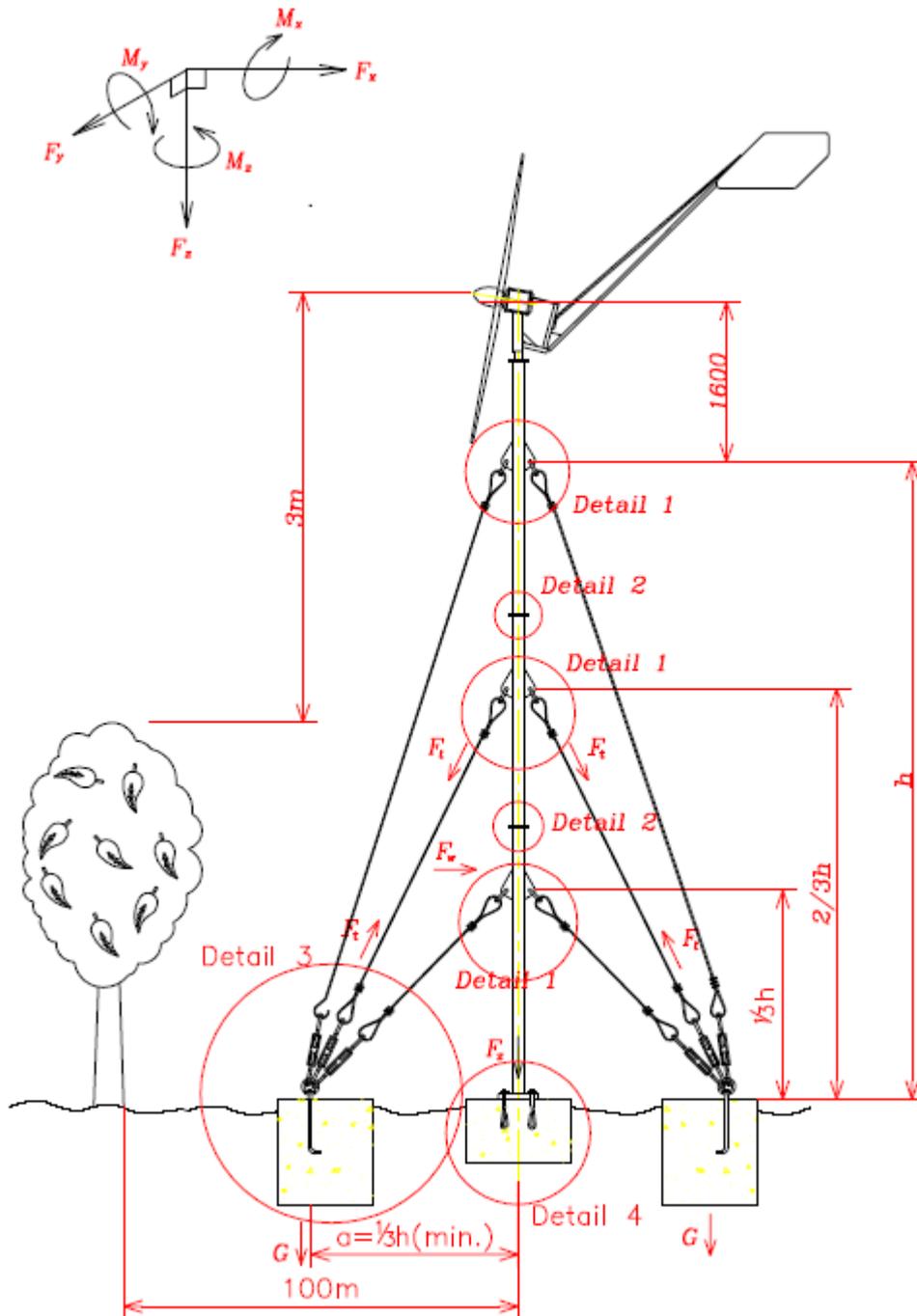


Fortis Passaat at 18 m guyed tower with 4 guy wires





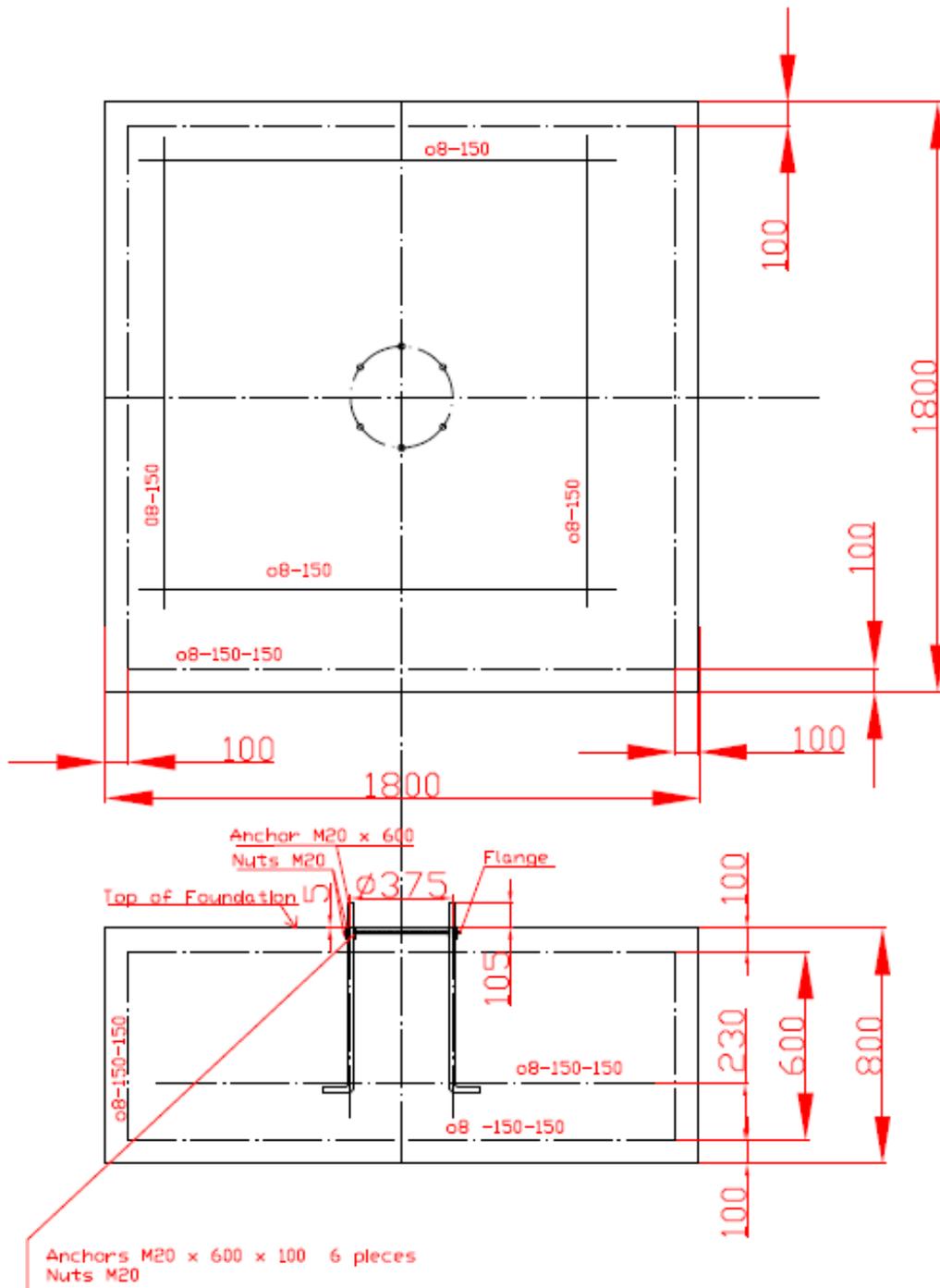
### 12.1 Drawings Guyed Tower:



Guyed Tower Passaat with 18 - 24 meter height



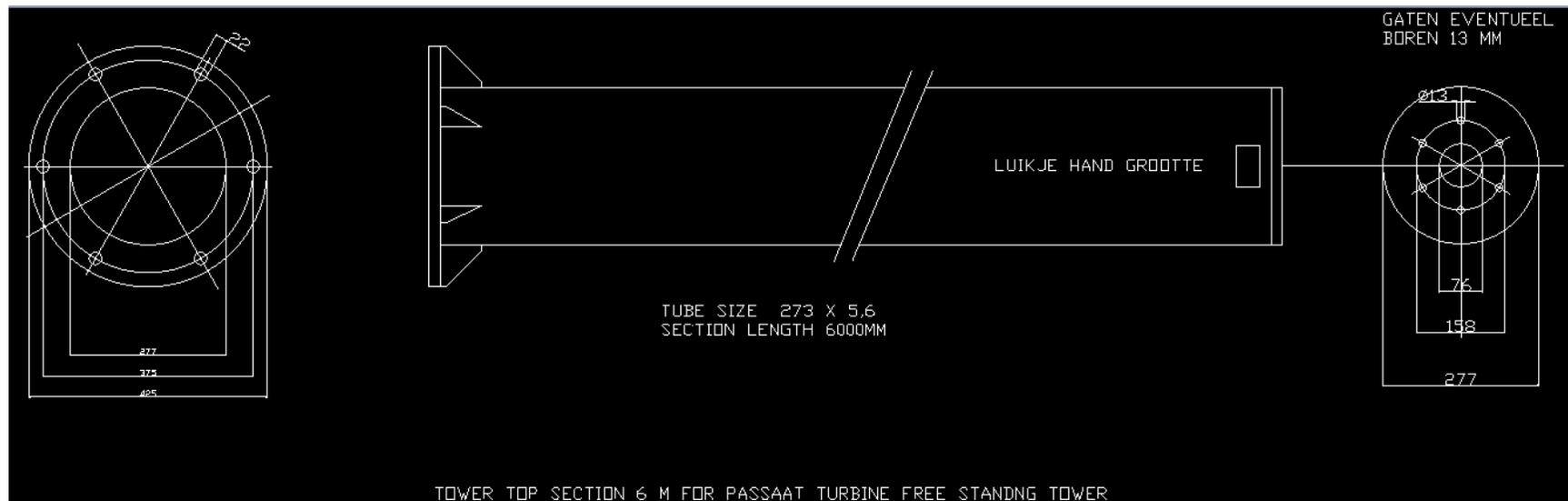
### 13.0 Drawing Foundation Free standing tower



Foundation for single leg tower 15-18 m Fortis Passaat

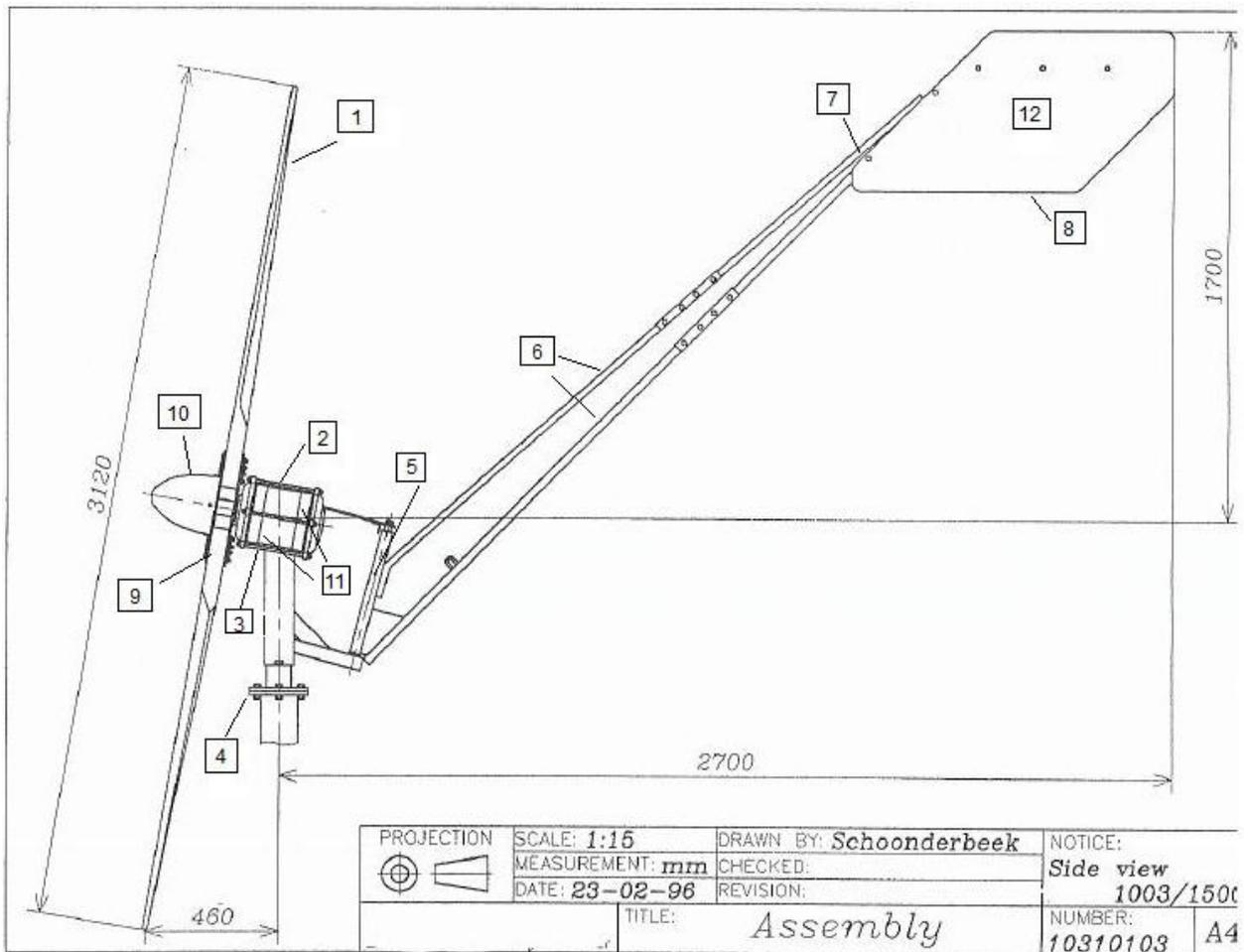


## 14 Passaat Base / Top Section of Free Standing Tower





## 15 Dimensions of Passaat



No: 3 support frame



No: 11 generator clamps



## 15.1 Part number list

| Part Number | Name                     | Material          | Colour        |
|-------------|--------------------------|-------------------|---------------|
| 1           | Rotor blades ( 3 pieces) | Glass fibre Epoxy | Grey          |
| 2           | Generator                | Aluminium         | Blue RAL 5010 |
| 3           | Support Frame            | Steel -Galvanised | Grey          |
| 4           | Mast adapter             | Steel -Galvanised | Grey          |
| 5           | Tail hinge section       | Steel -Galvanised | Grey          |
| 6           | Tail section (2 pieces)  | Steel -Galvanised | Grey          |
| 7           | Tail top section         | Steel -Galvanised | Grey          |
| 8           | Tail vane                | Steel -Galvanised | Grey          |
| 9           | Rotor hub                | Stainless Steel   | Blue RAL 5010 |
| 10          | Nose cone                | Plastic           | Blue RAL 5010 |
| 11          | Generator clamps         | Stainless Steel   | Grey          |
| 12          | Your Company logo/name   | Option            | Option        |
|             |                          |                   |               |



Passaat view rightside

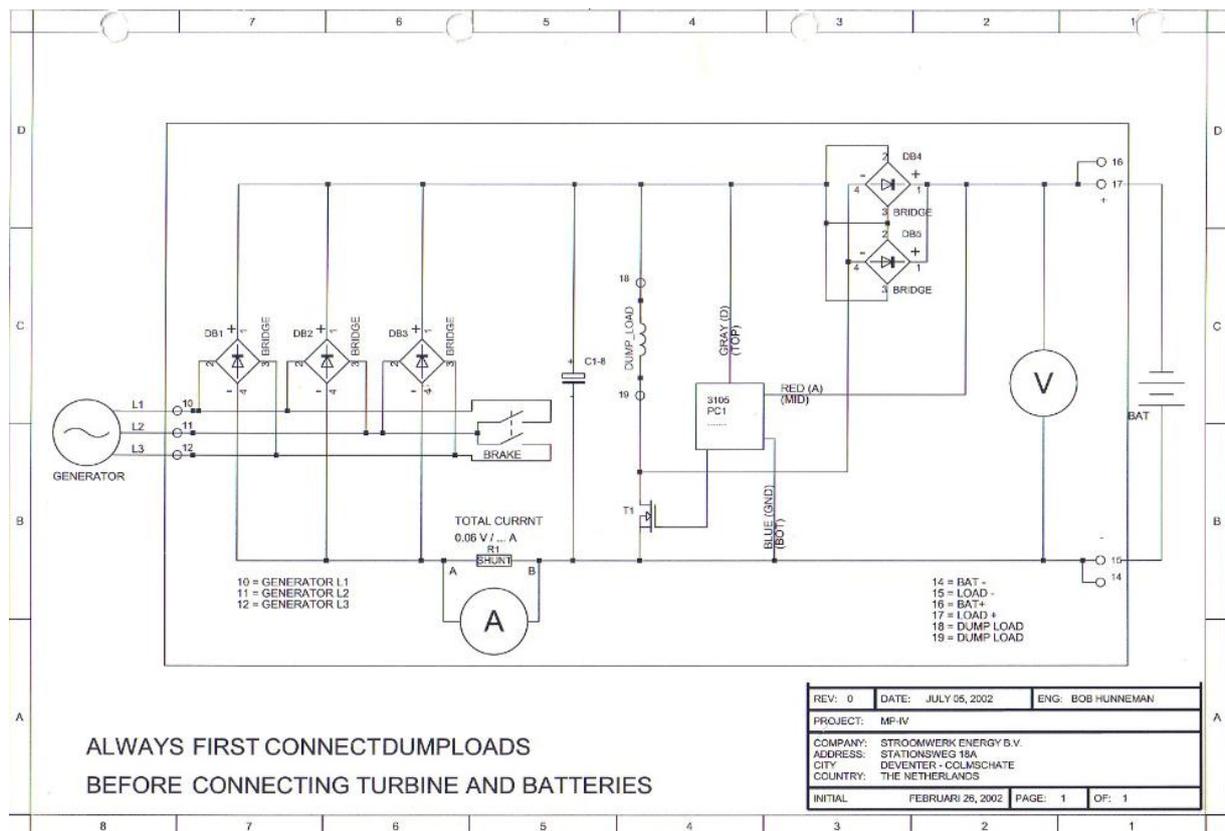


Passaat view leftside



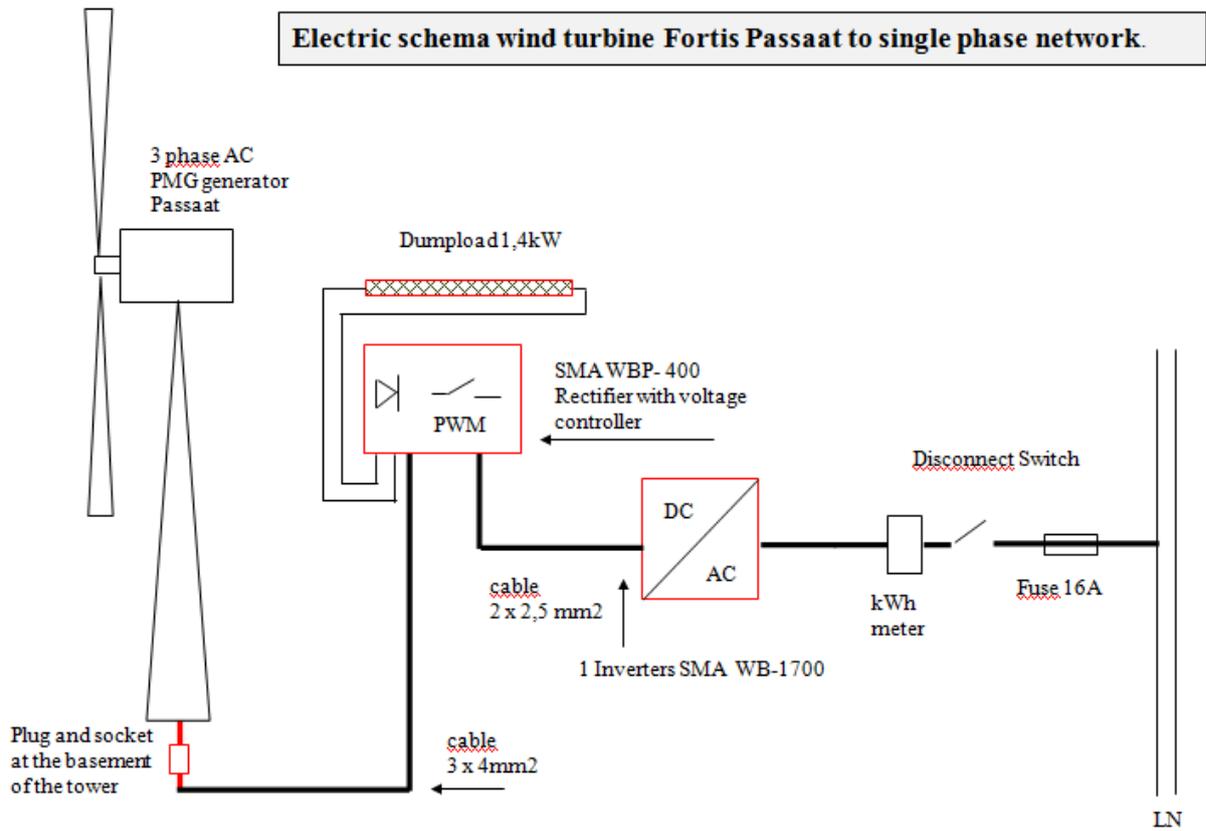
## 16 Electrical drawing of MP-30A-48V or MP-60A-24V

For Instruction Manual see document: Overvoltage-/Battery charge Controller for Passaat 1.4 kW wind turbine. Type: MP-30A-48V / MP-60A-24V.

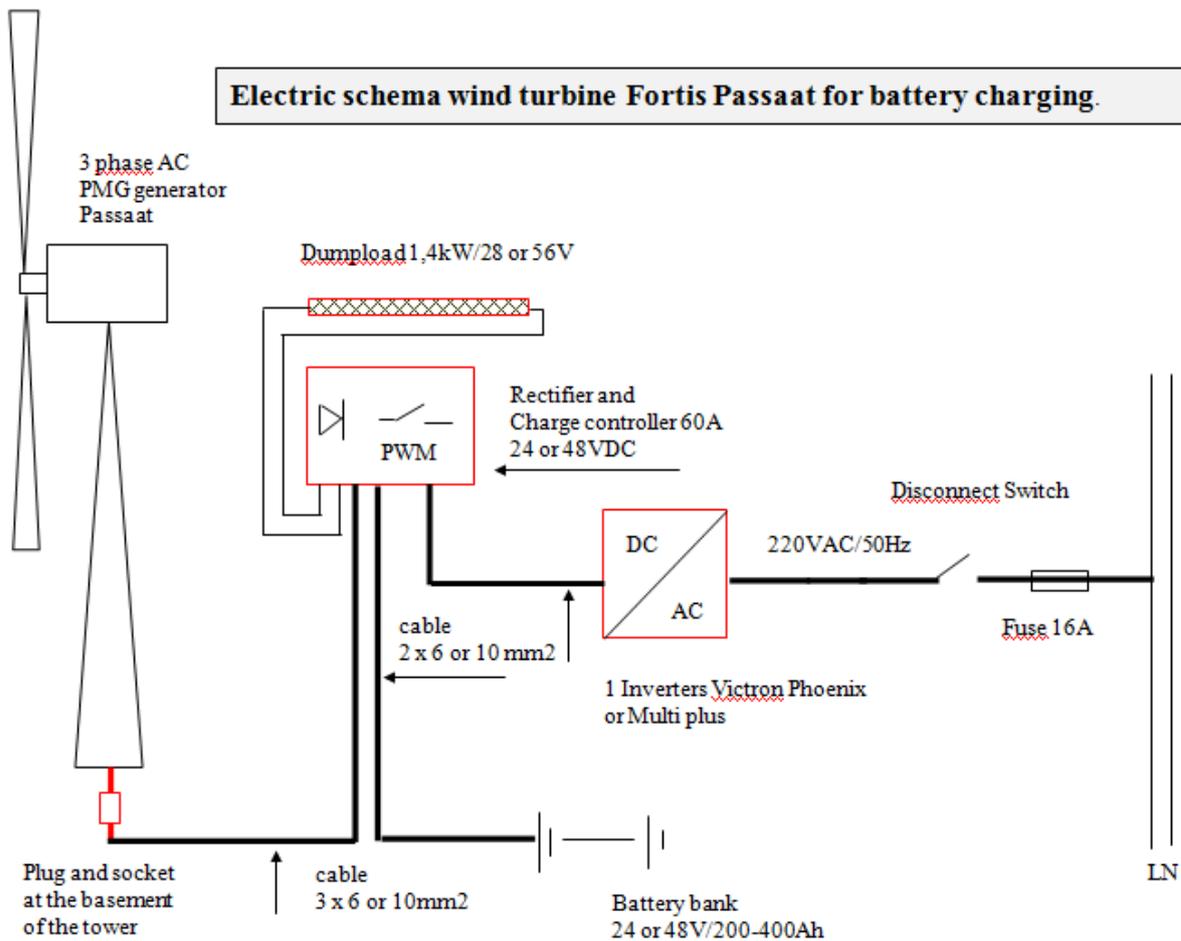


*Electric wiring scheme*

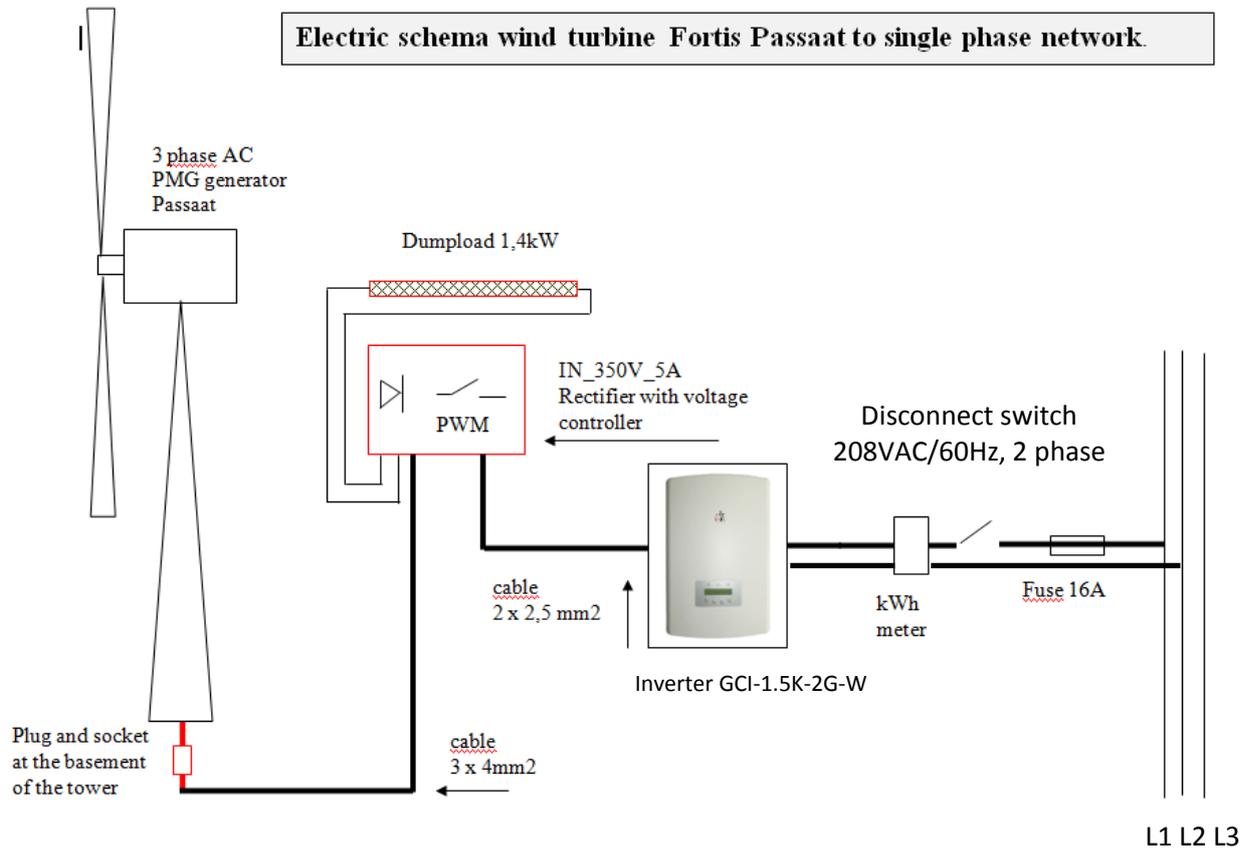
## 17 Electrical scheme for grid connected



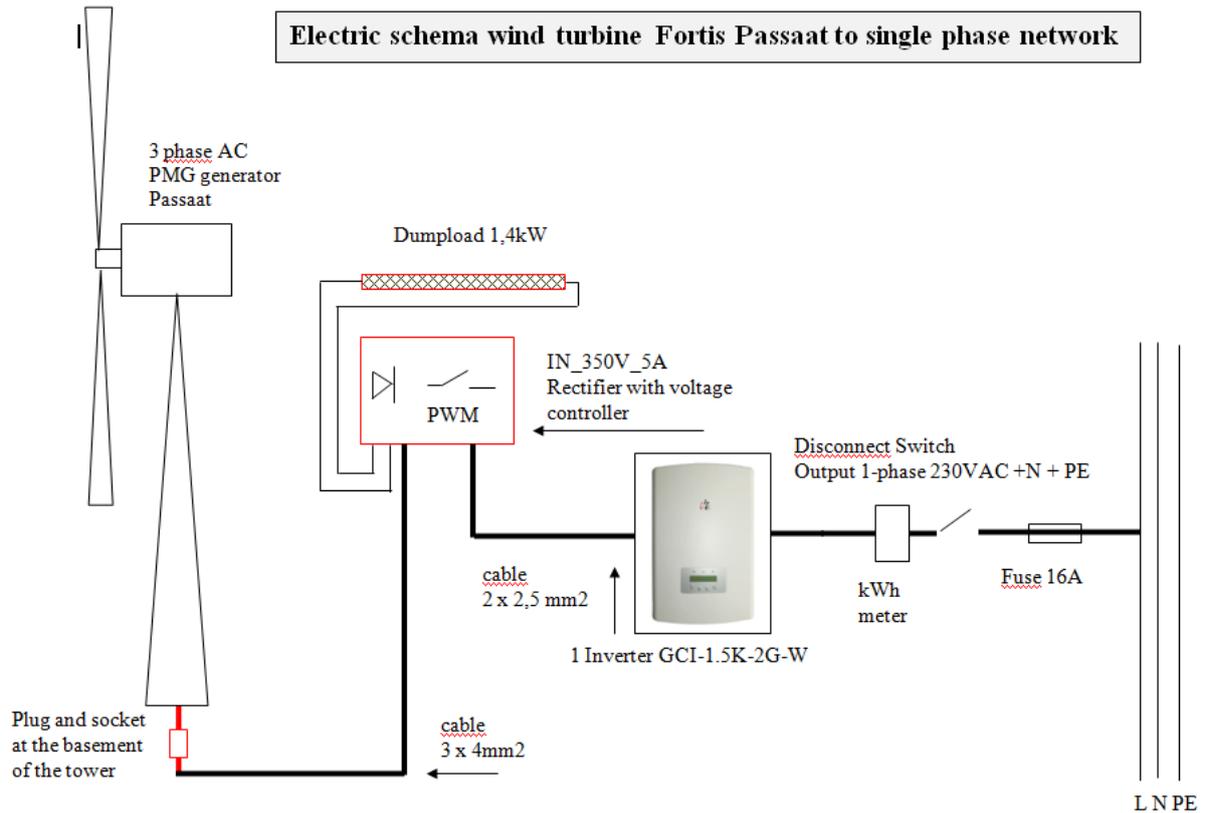
## 18 Electrical scheme for stand alone and battery charging



## 18/1 Electrical scheme for grid connected with GCI-1.5K-2G-W for USA



## 18/2 Electrical scheme for grid connected with GCI-1.5K-2G-W for EU





## 19 Trouble shooting list

| <b>Problem</b>                                  | <b>Possible Cause(s)</b>   | <b>Diagnosis</b>                              | <b>Remedy</b>                          |
|---|--|---|--|
| Fault lights or messages on inverters           | Various  | Various                                       | Refer to Inverter manual               |
| Low output                                      | Low or turbulent wind  | Turbine site                                  | Create more clear space around turbine |
|   | Incorrectly programmed or undersized inverters                         | Check inverter parameters                     | Ensure parameters are as specified     |
| Guy cables loose or tower leaning from vertical | Normal cable slackening following installation                         | Visual check                                  | Tighten to specified pre-tension       |
| Heat dump on                                    | Controller is damaged  | Open controller and check for signs of damage | Replace controller                     |
|   | Mains failure/MCB tripped  | Check MCB and mains supply                    | Restore supply                         |
|   | Incorrectly programmed or undersized inverters                         | Check inverter parameters                     | Ensure parameters are as specified     |
| Pole bends in high winds                        | Normal operation   | Bending like an aeroplane wing is normal      | NA                                     |
| Turbine vibrates or tail shakes                 | Natural frequency  | Vibrations only at a specific speed           | Normal operation                       |
|   | Unbalanced blades  | Vibrations increase as speed increases        | Stop immediately                       |
|   | Rotor blades are not running in the same plane (the hub is misaligned) | Vibrations increase as speed increases        | Stop immediately                       |
|   |  |   |  |



| <b>Problem</b>  | <b>Possible Cause(s)</b>  | <b>Diagnosis</b>   | <b>Remedy</b>  |
|---|---|--|--|
| The rotor blades run very slowly or fail to turn in good wind | Short-circuit in the electrical cable between generator and controller                | Check cable for resistance between phases  | Repair cable   |
|   | The rotor is mounted in the wrong way   | Observe if flat side is to the wind  | Drop the tower and reverse the blades  |
|   | Brake is on   | Check brake switch   | Turn brake off   |
|   | Failed bearings   | All other causes ruled out   | Drop tower and replace generator unit  |
|   | Failed generator/slip ring  | Measure resistance between phases from bottom of tower. Short circuit or variations of resistance means electrical failure | Drop tower and replace generator unit or slip ring                                 |
| Turbine turns too fast and is more noisy than usual           | Cable from generator to controller is disconnected and wind turbine runs without load | Check wires for continuity and loose connections   | Reconnect controller, apply stop switch or insert emergency stop connector in mast |
|   | Controller failure  | Open controller and check for signs of damage  | Replace controller   |
| Clanking noise from tower top                                 | Tail furling  | Use binoculars to see if its the chain clanking  | Normal operation   |
|   | Mechanical failure  | Visual inspection  | Replace worn part  |

## 20 Maintenance / checklist

In principle, FORTIS wind turbines do not require any maintenance at all. On the other hand, it would be unwise not to check the wind turbine occasionally. FORTIS advises that you should check the wind turbine at least once a year.



**Note**

### **The following points should be checked:**

- Check noises; the noise level should not have increased and should sound normal
- Check nuts and bolts; as far as possible. They might have worked themselves loose
- Check the electrical wires that are hanging through the inside of the mast; the tension must not be too high; this can occur if the wires have been wound too far and there is no slip ring used
- Check the leading edge of the blades from the tower basement on a wind less day. Small damages can be caused by small objects carried by the wind; such damages will speed up the process of wear and tear and should be repaired
- Check if the turbine, tail or tower is shaking more than usual. If this shaking occur only at a specific low speed this means own frequency. If it become stronger with higher wind speed, stop wind turbine and contact your dealer or agent or contact Fortis direct
- Check the tension of the guy wires, if you have a guyed tower, in the first 6 months regular

## 21 Safety and control procedures



### **WARNING: What's dangerous!**

1. Spinning Rotor
2. High tension on electric wires
3. Falling from tower
4. Crane drops tower/wind turbine
5. Gin pole/winch fault during erection of guyed tower

For safety and control instruction please check also chapter 19.

Read also section 16 of the book of Paul Gipe "Wind power" Renewable Energy for Home, Farm and Business. Published 2004.

- Choose a supervisor of the team who will be responsible for these procedures
- Do not fix a rope to the rotor blades and tower during erection. It can damage the blades. Only a rope which can move free around the tower is possible
- Before erection check if the generator is on the brake or on short circuit
- Check all bolts and nuts of the wind turbine and tower before erection if they have the right tension
- During erection all persons has to be at a distance from the foundation of more than the height of the tower
- All electrical connections and electronics installation has to be completed before erection. If possible the final connection should be the plug in the tower base
- Check if the earth cables are connected well
- Check if isolation of all cables is made well
- Ask crane drive for their safety and control procedures and their responsibilities
- Do not erect the wind turbine during high winds. The crane driver has always instructions at which max wind speed he can operate safely
- Never climb into the tower when the wind turbine is not set on the brake. This will be very dangerous
- Never disconnect any electrical wire if the wind turbine is not set on the brake
- When climbing in the tower use always position belts and full body harnesses. Follow always the rules. Get aware of the local rules of safe work
- If you use a gin pole for erection read first the special instructions in the manual
- Do you have insurance public liability insurance product warranty and liability professional indemnity erection all risks

## Declaration of Conformity

### Declaration of Conformity

According to type II-A without external approval  
Declaration of approval (according to appendix II-A of the machine guideline)

Manufacturer: Fortis Wind Energy

Address: Botanicuslaan 14, 9751 AC Haren, The Netherlands,

Herewith declare under our sole responsibility that the products:

- Passaat 1.4 kW
- Montana 5 kW
- Alizé 10 kW

to which this declaration is regarded, confirms to the :

- Construction products (89/106/EEG);
- the low voltage electricity (73/23/EEG);
- the EMC (89/336/EEG) and
- the machinery (98/37/EEG)
- IEC 61400-2 "Design requirements for small wind turbines" which has been adopted as European Standard EN 61400-2 guidelines of the EEG.

Instructions for installation, operation and maintenance are according to the Instruction Manuals.

Haren, 2011-08-22

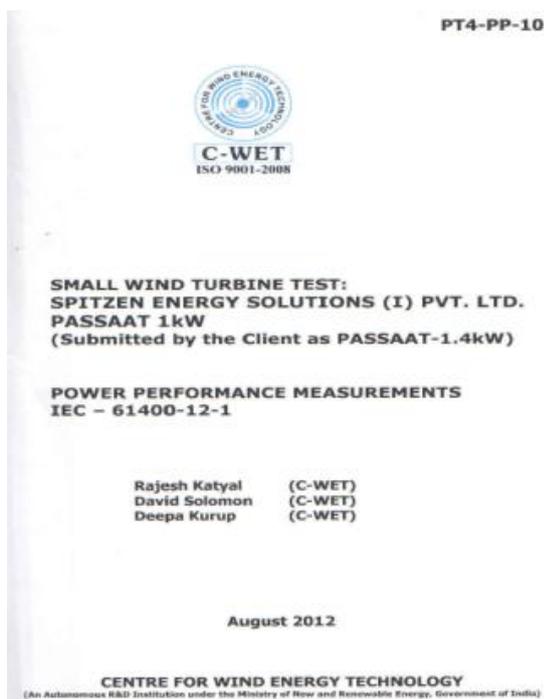


Johan Kuikman  
CEO  
Fortis Wind Energy



**FORTIS**  
WIND ENERGY  
GREAT IN SMALL TURBINES

## Power Performance Measurements IEC – 61400 -12-1



National Institute of Wind Energy (NIWE)