

Kestrel e300i

With Conditional Two Year Warranty



Installation and Maintenance Manual

To report errors, omissions or improvements please write to:
kestrel.technical@eveready.co.za or kestrel.admin@eveready.co.za

Warranty Registration

Please complete and return this page within three months after the product delivery date or within one month following the commissioning date.

Name of Product: _____
Product Serial Number _____ Pitch Control Serial Number _____ Blade Serial No. (1) _____ (2) _____ (3) _____
Delivery Date _____ or Commissioning Date _____
Name and Address of Owner _____ _____ _____
Telephone: _____ Email: _____
Installation / Site Address (GPS co-ordinates are appreciated) _____ _____ _____

Commissioning Check List

Section	Operation / Procedure	Verified
4.2	All tail assembly M6 fasteners torqued to 10Nm (7.5ft lb)	
4.3	8 x M8 x 25 Hex bolts H.T 8.8 torqued to 35Nm (25.8ft lb)	
4.4	1 xM10 x 40 Main hub bolt torqued to 60N.m (44.3ft lb)	
4.5	3 xM8 Nylocks torqued to 20N.m (15ft lb)	
4.5	4 x M8 bolt sets torqued to 20N.m (15ft lb)	
4.6	6 x M12 Blade bolts torqued to 50N.m (37ft lb)	
4.7	M6 nylocks tightened to 4N.m (3ft lb)	
4.7	M5 valance screws tightened to 3 N.m (2.2lb ft)	

Type of Tower	Installation Engineer	Comissioned Date

GENERAL COMMENTS:

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Revision History

Revision	Date	Comments	Author
1.4	12/12	Corrections and updates	J. Carpy
1.3	12/12	Revised technical specification	B.Singh
1.2	06/12	Revised contact details for warranty	B. Singh
1.1	06/10	Full Revision	J. Carpy

Disclaimer

Kestrel Wind Turbines makes every effort to give accurate information in this manual and is in no way liable for any error or omission. The user of this manual assumes full responsibility and risk

We appeal to your common sense to read and apply the safety notes. Consult a professional engineer and take advice if you are unsure.

1. Safety and Warning Notes

Accidents can easily occur and there are always inherent dangers associated with any type of machine. Tower installations pose their own dangers. Always work carefully and have an assistant wherever possible. All installation work should be completed at ground level wherever possible. Be very aware of the blades during installation. Consult a civil engineer or reputable builder if you are unsure.

Maintain a healthy respect for this wind turbine. Use good handling methods and take precautions to avoid physical injury. The Kestrel e300i output voltage can become dangerous and even lethal when running on open circuit. Always short the output wires together when the turbine is disconnected. Do not work on the system when the turbine is running or when lightning is possible.

Disconnecting any wire may result in a spark. The presence of explosive hydrogen from battery charging is always a possibility. Adequate ventilation must be provided for battery installations. Wire sizes must be correct for the powers supplied. Fire can result from shorts created on a battery. Respect the system and use common sense. Consult a qualified electrician if you are unsure.

Slack bolts, poor workmanship and loose electrical connections must be avoided. The turbine blades are dangerous. Respect a rotating turbine. Always shut the turbine down before approaching by operating the brake switch on the controller or shorting the generator output. Preventative maintenance is always the best. Checks are best carried out in calm weather conditions. Avoid any maintenance or inspection during windy weather.

1.1 Safety Symbols

The symbols shown are used throughout this manual to highlight safety points

General caution warning



Danger of hand injury



Danger of electrical shock



Injury from blades

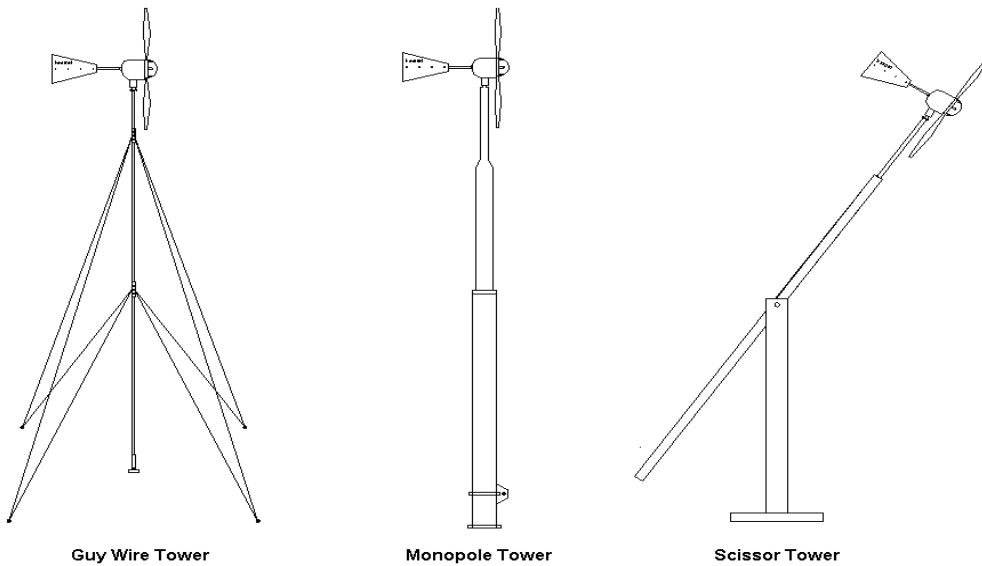


Work Instructions

* Asterisk denotes a special instruction or reminder.

► Arrow head denotes an assembly/build instruction.

2. The Tower



Three possible tower types are shown above. The most affordable erection is a guyed tower that is raised and lowered with a jin pole. The guyed tower can be constructed to great heights using a lattice frame as the pole section. It requires the largest footprint and more maintenance checks.

A scissor tower is usually the most expensive erection and is cost restricted in height. It gives the safest and most convenient installation. The turbine can be simply raised and lowered for inspection and maintenance with all work being done at ground level. Once again the footprint is small and the ground area required to lower the tower is less than other towers.

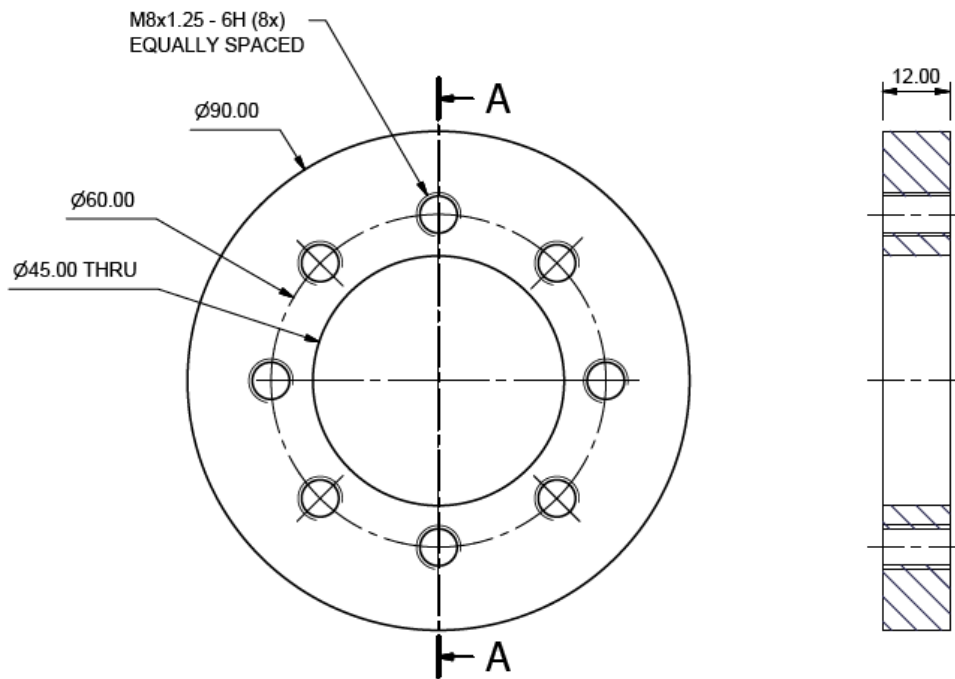
The straight monopole tower is the latest edition to the Kestrel range. This tower uses large bore diameter pipe sections to increase rigidity and strength but decrease the total tower weight. This tower is also the easiest to assemble and install due to its simple design and optional hydraulic lifting pack.

Other tower types include lattice construction and monopole taper towers. Kestrel supplies standard approved towers and can provide the turbine characteristics and parameters for tower design.

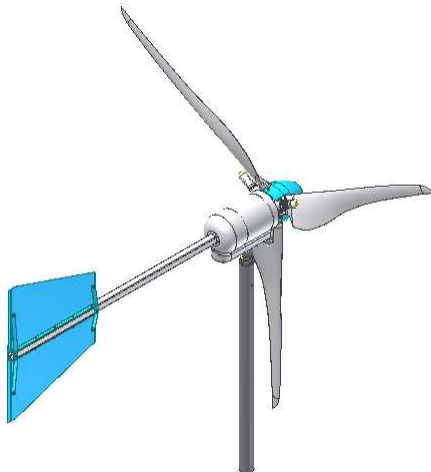
The e300i has a tower top mass of approximately 75kg

2.1 Mounting Flange and Tower Top

The Kestrel e300i is mounted on the tower with a circular flange. Dimensions are shown below.



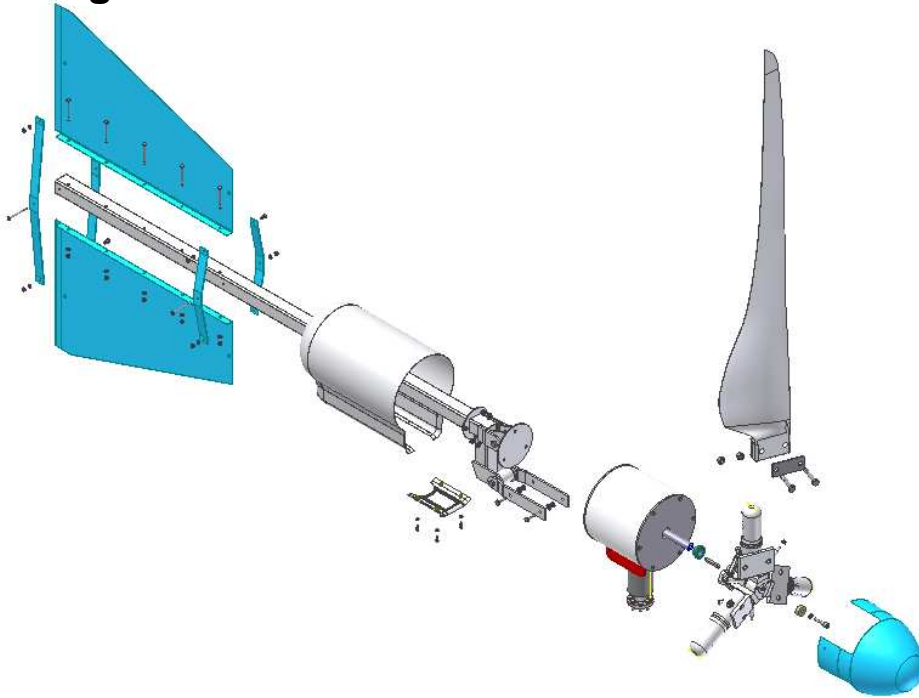
The following specification is recommended for the top pipe section of the tower. Mild steel pipe grade 350WA 80mm (3.5") Nom. bore (OD 88.9mm) SCH 40. and 1.5m long



A standard adapter pipe is available from Kestrel where the turbine will be fitted to an alternative structure. The pole includes a securing point for the tower cable. Consult your dealer for more details.



3. Unpacking the Wind Turbine



A Packing list is packed with the product. Ensure that all parts are present. Notify your dealer of any shortages.

The e300i is package in 3 individual boxes. The pitch control, generator, nose cone, tail plates and nacelle are kept together in one carton while the tail boom and blade set are packaged separately. Any additional controllers will also be packaged separately.

Unpack and check the following parts. Inform your supplier of any defects or shortages.

- ▶ Remove the blades and store safely.
- ▶ Remove the nacelle and nosecone and store safely.
- ▶ Remove the tail boom and store safely
- ▶ Remove the two tail plates.
- ▶ Remove any other accessories that were shipped for you.
- ▶ Locate and remove the fastener pack (assembly grease inc.).
- ▶ Remove the pitch control.
- ▶ Remove the generator.

Note: The fasteners are supplied in marked bags. Each bag contains a set of fasteners for different parts of the turbine. The enclosed grease is used on all nuts from M10 upwards.

Note: One additional fastener pack contains one spare unit of every fastener used on the turbine.

Beware not to damage the output cables below the generator.

4. Turbine Assembly and Installation

* You will need the following hand tools.

- ▶ Trestle, table or other support to support the turbine that is safe for 75kg.
- ▶ Plastic or rubber mallet.
- ▶ Full set of ring spanners from 10mm – 22mm.
- ▶ Metric socket wrench set.
- ▶ Set of standard screwdrivers (plain and Philips).
- ▶ Torque wrench suitable for torques of 0 – 100Nm (132lb ft).
- ▶ Electrical pliers and cutters.

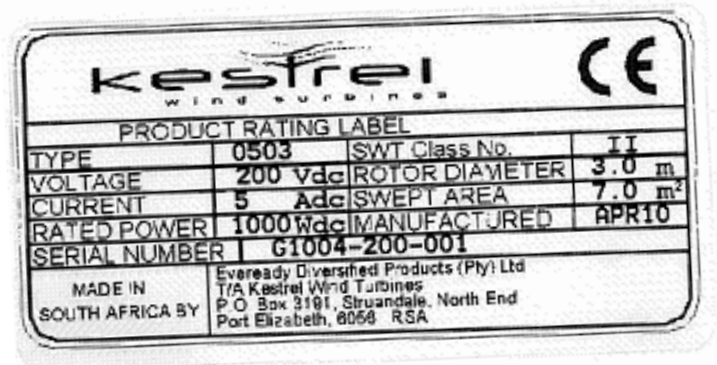
Refer to the diagrams and follow the instructions to assemble the complete wind turbine.

This manual assumes that the support tower is already installed and lowered to ground level ready for turbine installation.

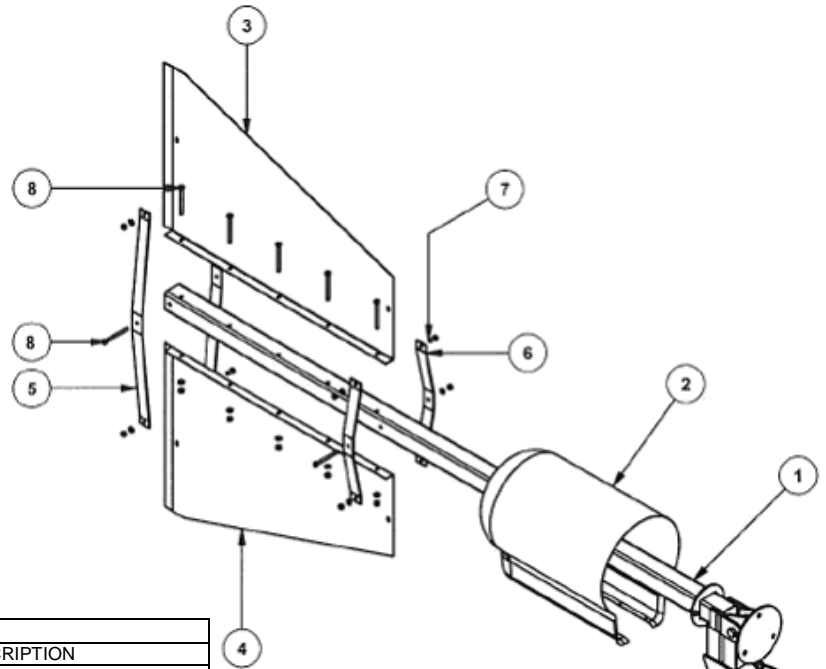
4.1 Identification Marking

The turbine is fitted with a rating label similar to the image.

* Note down your turbine serial number for future reference!



4.2 Tail Assembly



PARTS LIST		
ITEM	QTY	DESCRIPTION
1	1	Tail boom assembly
2	1	e300i Nacelle
3	1	e300i Top Tail Plate
4	1	e300i Bottom Tail plate
5	2	e300i Rear Stiffener
6	2	e300i front stiffener
7	4	Hex Bolt M6 x 16 with nut and washer
8	7	Hex Bolt M6 x 70 with nut and washer

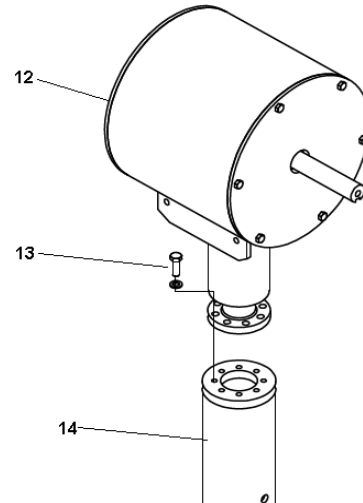
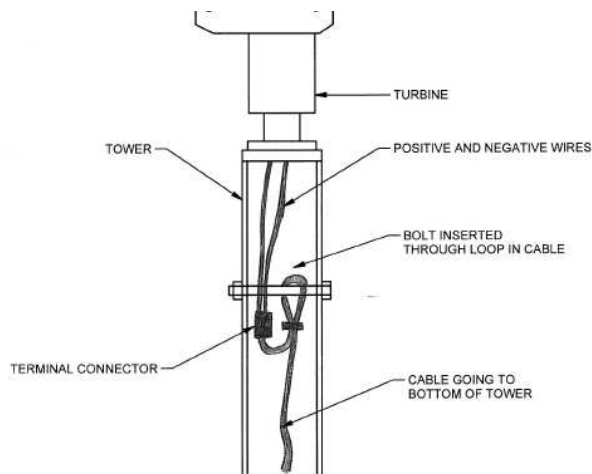
Slide the nacelle (2) over the boom (1) before fitting the tail !

ASSEMBLE EXACTLY AS SHOWN IN THE DIAGRAM. FIT ALL THE FASTENERS BEFORE TIGHTENING.

- * The tails will be in the middle line of the boom
- * You need the fastener bag marked "Tail Assembly" for this work.
- ▶ Slide the nacelle over the boom
- ▶ Assemble the top (3) and bottom (4) tail plates to the boom (1) in the order shown. Use the M6 x 70 long bolt set (8) for this work and tighten lightly
- ▶ Assemble two rear stiffeners (5) to boom (1) with one stainless bolt set (8).
- ▶ Assemble two front stiffeners (6) to boom (1) with one stainless bolt set (8).
- ▶ Bolt all stiffeners (5) and (6) to top and bottom tail plates (3) and (4) with four off bolt set (7).
- ▶ All tail fasteners are M6. Torque all fitted bolts to **10Nm (7.5 lb ft)**.



4.3 Generator to the Tower



PARTS LIST		
ITEM	QTY	DESCRIPTION
12	1	Generator
13	8	M8 x 25 H.T Hex Bolt and spring washer
14	1	Tower top

(See Annexure 5 if fitting a resilient mounting kit)

- * The already installed tower is lowered to ground level before mounting the generator. The power cable is also fitted. The eight fixing bolts must be HT 8,8 (High Tensile grade 8,8).
- * Secure the tower cable at the top of the tower. This can be done by fastening a loop in the cable and placing a bolt through the loop to take up the tension in the cable. The tower cable must not hang or pull on the generator cables. Leave enough tower cable to make the connection to the generator.
- * Do not “spin” the generator by hand. Short the red (+ve) and black (-ve) generator output cables until wiring is to be done.
- * Avoid damage to any paint finishes by protecting with suitable sundry material (HD foam, carpet tiles, cloth rags etc).
- * Make all power cables ends safe by insulation before installing the generator.
- * You need the fastener bag marked “Generator Mounting”.
- Support the lowered tower at a suitable height to receive the generator. Be sure that the support can bear the weight after the generator is mounted Allow for 75kg.



► Support the generator at a similar height with the mounting flange in line with the tower flange.

* Observe polarity on electrical connections. Connect +ve (red) and -ve (black) generator output cables correctly. Reverse polarity will damage the generator and any connected equipment.

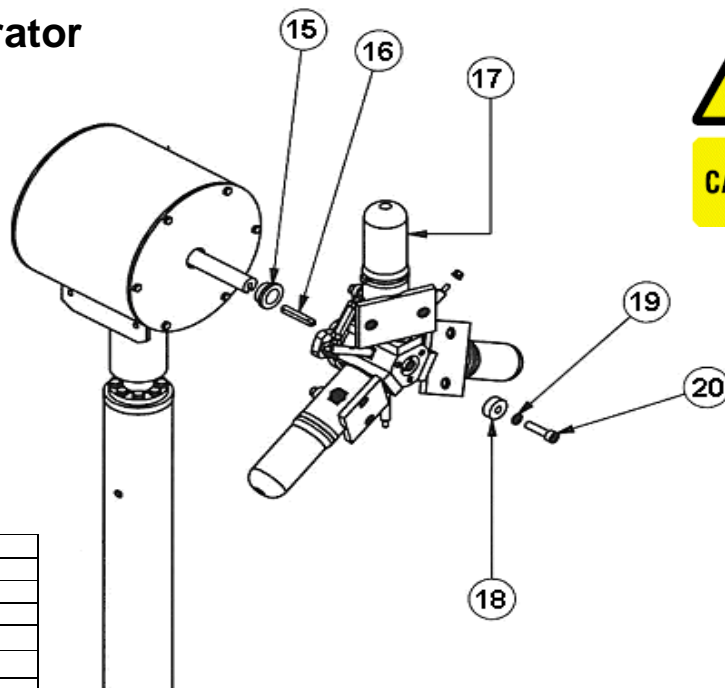


► Remove the short across the generator wires. Make and complete the electrical connection between the generator and the tower cable. Use connectors rated for at least 25A for the 200V unit and 80A connectors for the 12/24/36/48V versions. It is very important to ensure that this connection is good, secure and completely watertight.



► Fit the generator to the tower while storing the cable and connector down the inside of the tower. Fit the eight M8 HT bolts and spring washers (13) and tighten to 35Nm (25,8 lb ft). Ensure that the cable is not damaged during this operation. (For a resilient kit, see Annexure 5).

4.4 Pitch Control to Generator

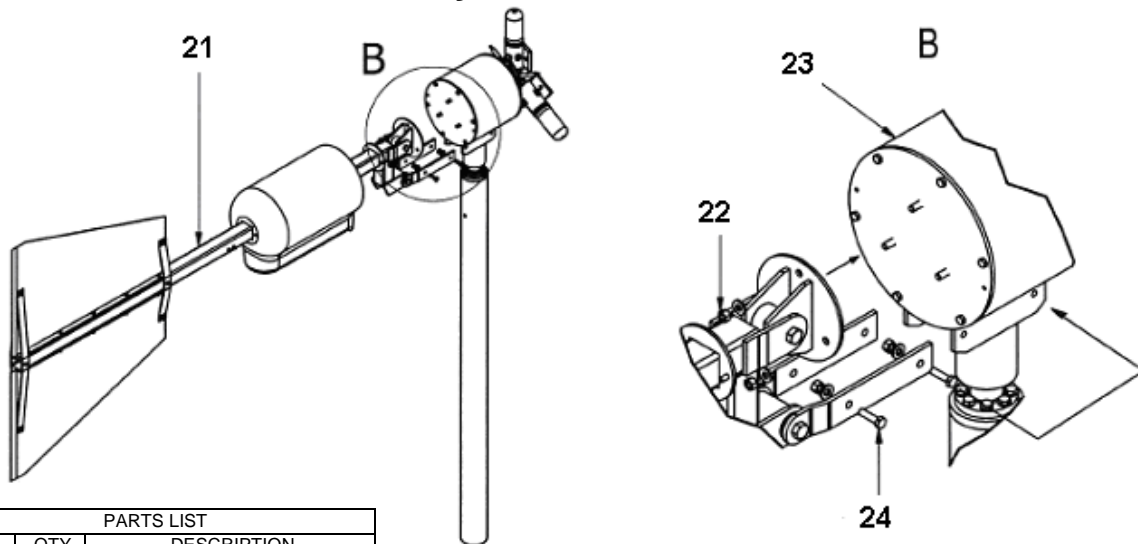


PARTS LIST		
ITEM	QTY	DESCRIPTION
15	1	Hub Collar
16	1	Shaft key
17	1	Pitch Control
18	1	Clamping spacer
19	1	10mm Spring washer
20	1	M10 x 40 Main Clamping Bolt

* You need the fastener bag marked “Pitch Control” for this work

- ▶ The shaft key (16) is factory fitted to the generator shaft using a cable tie. Remove the cable tie before fitting the pitch control (17)
- ▶ The generator is supplied with 1 syringe of white waterproof grease. Apply the grease to the shaft and ensure even coverage.
- * NB! Ensure that the shaft key (16) and hub collar (15) are in place before fitting the pitch control (17)
- ▶ Slide the pitch control (17) over the generator shaft until it comes up against the hub collar (15)
- ▶ Apply a little loctite to the main clamping bolt (20) thread and insert it together with spring washer (19) and clamping spacer (18) into the hub and screw into the end of the rotor shaft. Tighten to **60Nm (44.3 lb ft)**

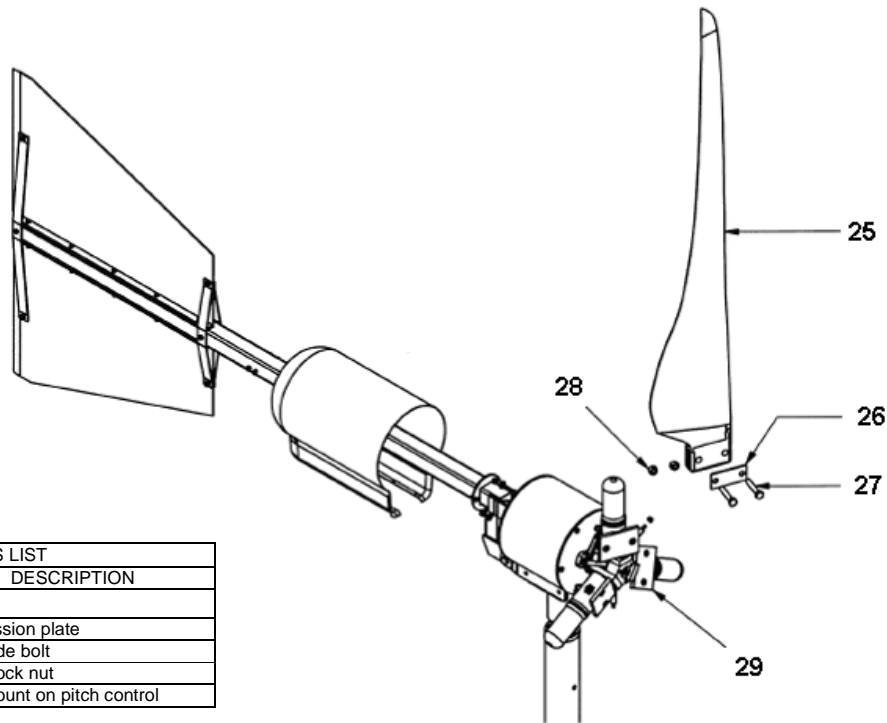
4.5 Tail Boom Weld Assembly to the Generator



PARTS LIST		
ITEM	QTY	DESCRIPTION
21	1	e300i Tail Boom Assembly
22	3	M8 Nylock Nut and washer
23	1	Generator rear end
24	4	M8 bolt, nut and washer

- * You need the fastener bag marked “Tail Boom weld Assembly” for this work.
- ▶ Fit the tail boom flange over the three studs protruding from the rear end of the generator. Use the 3 M8 nylocks and washer (22) for fastening. Torque to **20Nm (15 lb ft)**
- ▶ Fit the tail boom extensions to the welded supports located underneath the generator. Use the 4 M8 bolt sets (24) for this work. Torque to **20Nm (15 lb ft)**
- ▶ Store the remaining fasteners for later use.

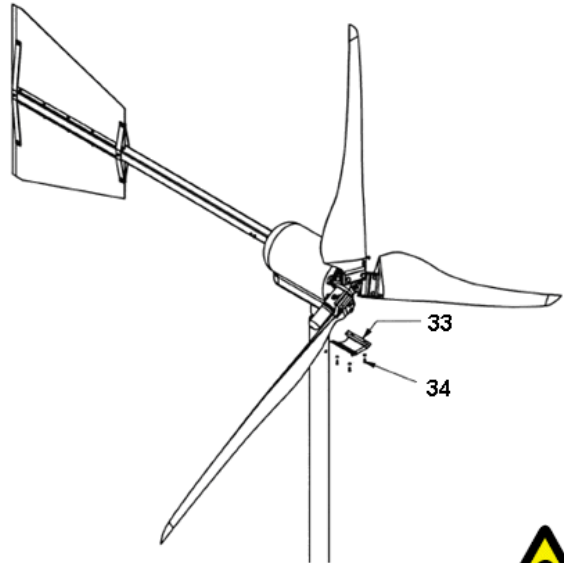
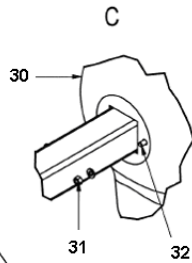
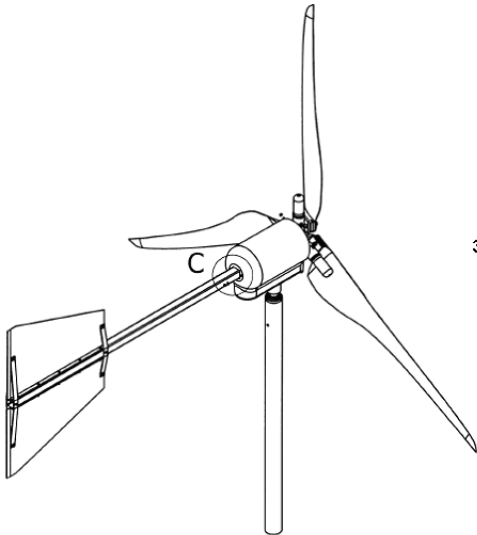
4.6 Blades



PARTS LIST		
ITEM	QTY	DESCRIPTION
25	3	Blades
26	3	Compression plate
27	6	M12 Blade bolt
28	6	M12 Nylock nut
29	3	Blade mount on pitch control

- * You need the fastener bag marked “Blade Fasteners” for this work.
- ▶ Offer the first blade (25) to the blade mount (29). The blade serial number must face forward and be visible from the front.
- * Each blade has been factory fitted with 2 steel positioning sleeves. The protruding end of the sleeve must enter the recessed hole on the blade mount.
- * Stainless nuts can seize on the bolt. Put a little waterproof grease inside the stainless nut (28) before fitting.
- ▶ Insert the two bolts (27) through the compression plate and the blade. Fit each blade to a blade plate (29) using two M12 nylock nuts (28). Tighten to **50Nm (37ft lb)**
- ▶ Repeat the fitment for the two other blades.
- * Note that no balancing procedure for the turbine blades is required.

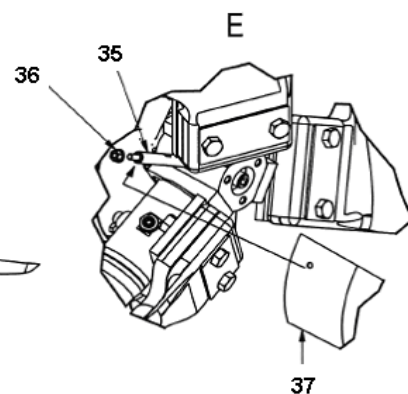
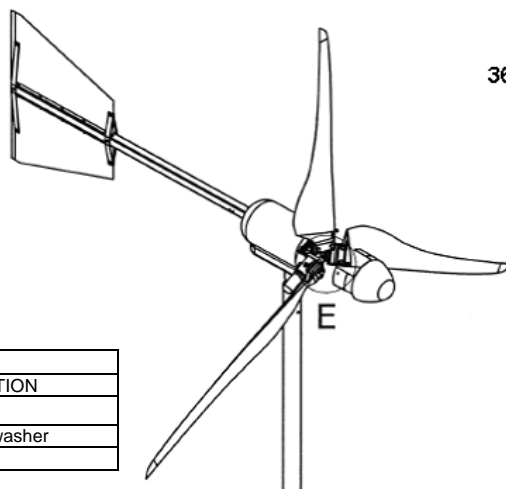
4.7 Nacelle and nose cone fitment



PARTS LIST		
ITEM	QTY	DESCRIPTION
30	1	e300i Nacelle
31	2	M6 nylock nut and washer
32	2	M6 Threaded stud
33	1	Valance
34	4	M5 Screw and washer



- * Check all previous work before fitting the “covers”.
- * You need the fastener bag marked “Nacelle and Nosecone” for this work
- ▶ Slide the nacelle (30) over the generator until the 2 M6 studs (32) protrude as shown above. Fasten with 2 M6 nylock nuts and washers (31). Tighten to **4Nm (3 lb ft)**
- ▶ Fasten the valance (33) underneath the nacelle using the 4 M5 screws and washers (34). Tighten to **3Nm (2.2 lb ft)**



PARTS LIST		
ITEM	QTY	DESCRIPTION
35	3	Nose Cone pillar
36	3	M6 Nylock Nut and washer
37	1	Nose Cone

- ▶ Fit the nosecone (37) to the three support posts (35) with three stainless M6 nylock nut and washer sets (36) and torque to **4Nm (3ft lb)**.

5. Electrical Installation

- * Installations must comply with the local electrical codes that are in force in the country of installation. Please consult your area dealer or a local qualified electrician.
- * Proper equipment grounding is essential for safe operation. It is highly recommended to install suitable surge/lightning protection. Consult your dealer or qualified personnel if you are unsure.
- * Earthing (Grounding)
The tower and all fitted equipment must be properly earthed. Consult the tower manual and your supplier for guidance.
- * Cable Installation
The tower power cable must be fitted inside the tower and should be buried underground. The cable must either be armoured or run in underground electrical conduit.



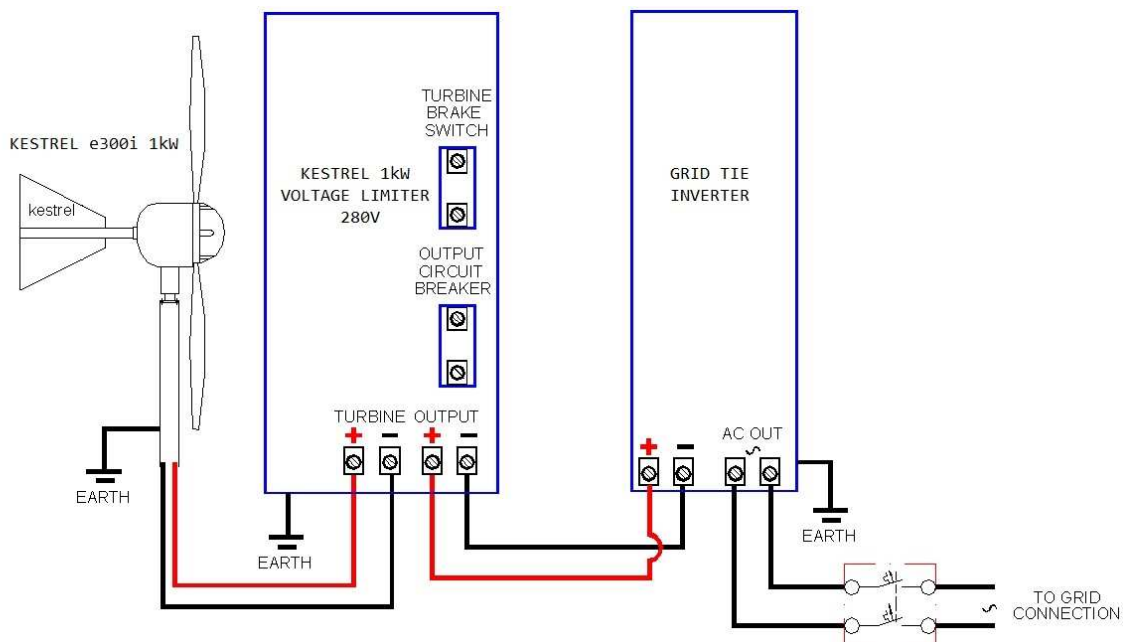
5.1 Grid tie Installations (e300i 200Vdc version)

- * Under no circumstances shall the Kestrel e300i be directly connected to any grid tie inverter. If this is done, rest assured that the grid tie inverter could be seriously damaged.
- * A grid tie installation supplies electrical energy from the wind turbine to the utility electrical grid. This type of installation is strictly regulated by local electrical codes and practices.
- * The grid tie inverter must be installed by qualified personnel in compliance with the local electrical codes.



5.1.1 Kestrel grid tie with a voltage limiter

Any wind turbine when disconnected (unloaded) will generate a terminal voltage in direct proportion to the generator rpm. The e300i 200V version is therefore capable of generating up to 600Vdc when disconnected. The Kestrel voltage limiter solves this problem by restricting the maximum voltage to protect the grid tie inverter.



A typical grid tie installation is shown in the diagram above.

Further information can be found in the Voltage Limiter and grid tie inverter manuals. The following highlights points relevant to the turbine. The Kestrel e300i wind turbine is rated at 200Vdc. The power range from 0 – 1kW is developed from 150Vdc up to 245Vdc. This is the normal working voltage range. This turbine is solely intended for use in grid tie installations. The turbine must connect to a Kestrel 1kW 280Vdc Voltage Limiter. The Voltage limiter output connects to the grid tie inverter input. Any grid tie inverter will disconnect itself from time to time. These times of disconnection are normal during the correct operation of the inverter. When such a disconnection takes place, the output voltage of the turbine can rise to high values. The Kestrel voltage limiter completely restricts this voltage rise. Voltage limiting is instantaneous and reliable.

5.2 Charging Installations (12/24/36/48Vdc version)

* The Kestrel e300i may be directly connected to the battery using the interface module. This is done when a parallel battery regulator is installed. An example would be the TriStar TS60. Consult your dealer or the factory for more information.

* The e300i charging versions are intended for charging batteries in remote installations. Such sites are referred to as “island” or “stand alone”.

* Additional information is given in the tower and controller manuals.



5.2.1 Kestrel Charge Controller (12/24/36/48Vdc)

The diagram (Fig 1) shows the Kestrel connected to a Kestrel charge controller. This type of controller must be installed with a diversion resistor (dump load). The diagram also shows optional solar panels that are connected through a solar regulator.

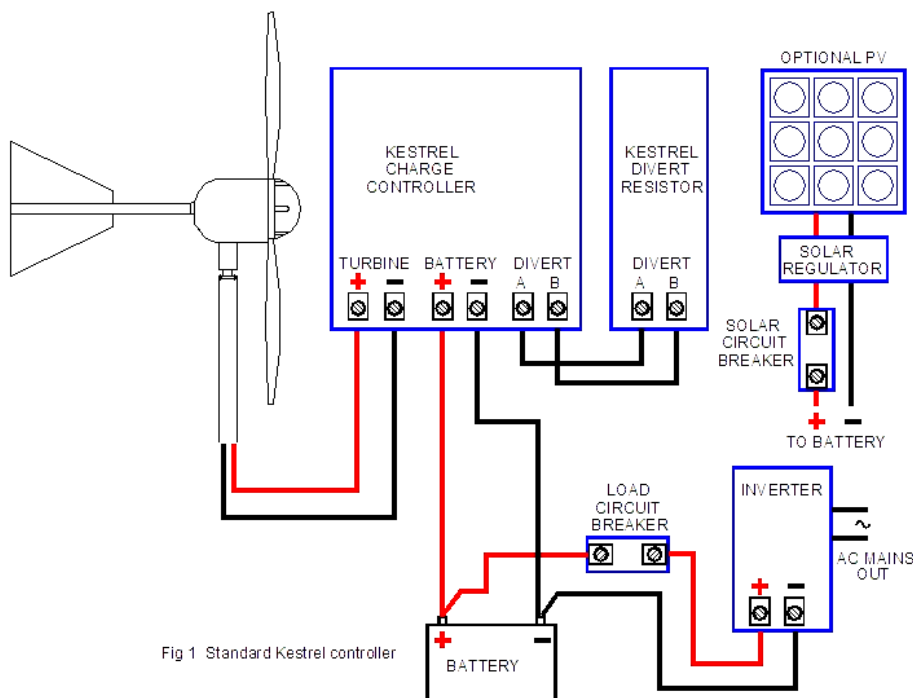


Fig 1 Standard Kestrel controller

The e300i connects to a Kestrel charge controller that supplies charge to a battery system. The controller is fitted with a diversion resistor to shunt away excess energy from the turbine. In this example (Fig 1), the dc power is inverted to mains voltage using an inverter. The installation must comply with local codes. Please consult your area dealer or a local qualified electrician.

Suitable installations for Kestrel Charge Controllers		
Battery Voltage	e300i Voltage	Kestrel Charge Controller
12	12	12Vdc 1000W C/C with Resistor
24	24	24Vdc 1000W C/C with Resistor
36	36	36Vdc 1000W C/C with Resistor
48	48	48Vdc 1000W C/C with Resistor

5.2.2 Third Party Charge Controllers (12/24/36/48Vdc)

In general, certain applications allow the use of alternative charge controllers with the e300i. These controllers often disconnect to perform measurements and other functions. The turbine voltage may then rise to a destructive level for the controller.

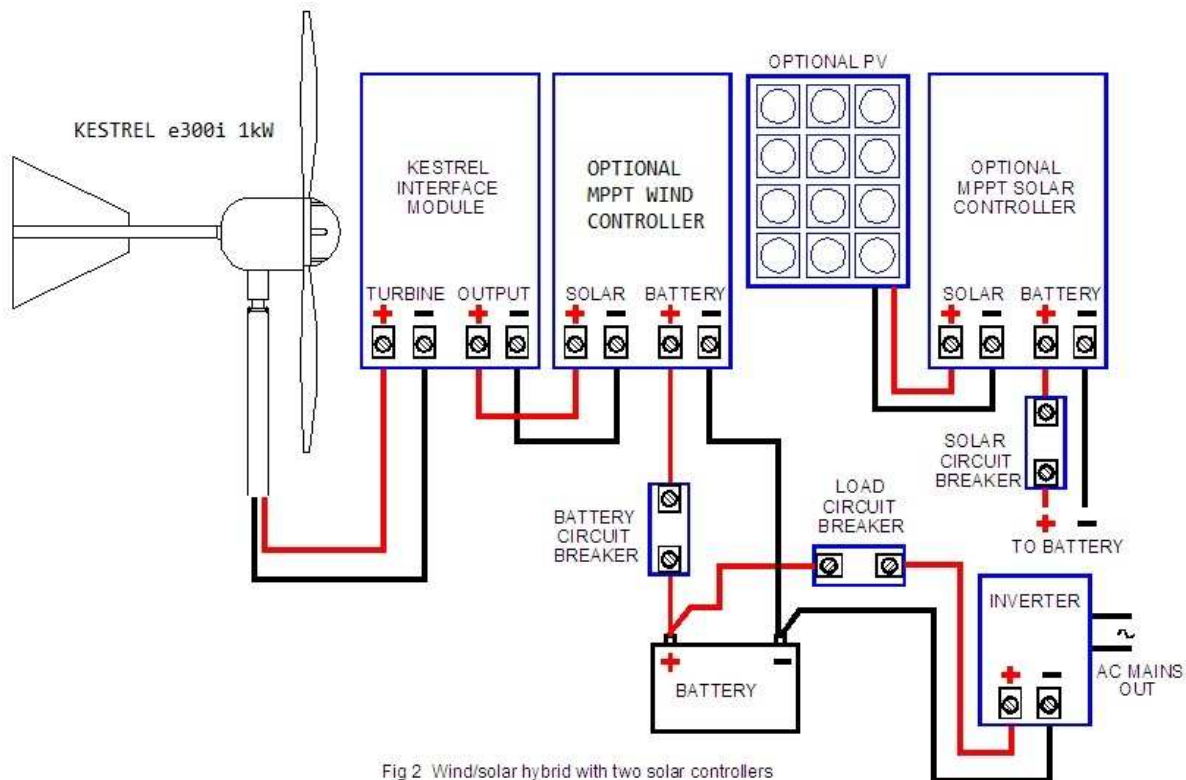


Fig 2 Wind/solar hybrid with two solar controllers

The Kestrel Interface module includes a turbine brake switch and isolating battery circuit breaker. The e300i is selectively wound to provide the maximum energy efficiency. Any MPPT (Mean Power point Tracking) algorithm in a third party controller will enhance the generator low wind performance. Although Kestrel does not warrant the use of third party controllers, there are many successful installations and possibilities.

Most alternative controllers are designed for use with solar panels but the high quality dc output from a Kestrel wind turbine allows them to be used. In any situation, the turbine voltage must never exceed the controller input voltage limits. This is usually 150Vdc. The following installation suggestions ensure that the turbine voltage will never exceed a maximum value of 150Vdc.

Suitable installations for Direct Connect MPPT controllers		
Battery Voltage	e300i Voltage	MPPT Controller Spec.
12	24	Vin (Max) 150Vdc Output >60A
24	24	Vin (Max) 150Vdc Output >60A
36	36	Vin (Max) 150Vdc Output >60A
48	⊕	Not Suitable

Please discuss alternative controllers with your Kestrel dealer.

5.2.3 Charging with a Voltage Limiter (12/24/36/48Vdc)

When the distance between the turbine and battery is excessive, an option is to use a 110Vdc supply. This system uses the Kestrel e300i 110Vdc and a Kestrel Voltage Limiter. The turbine power cables are considerably thinner and there is an improvement in efficiency.

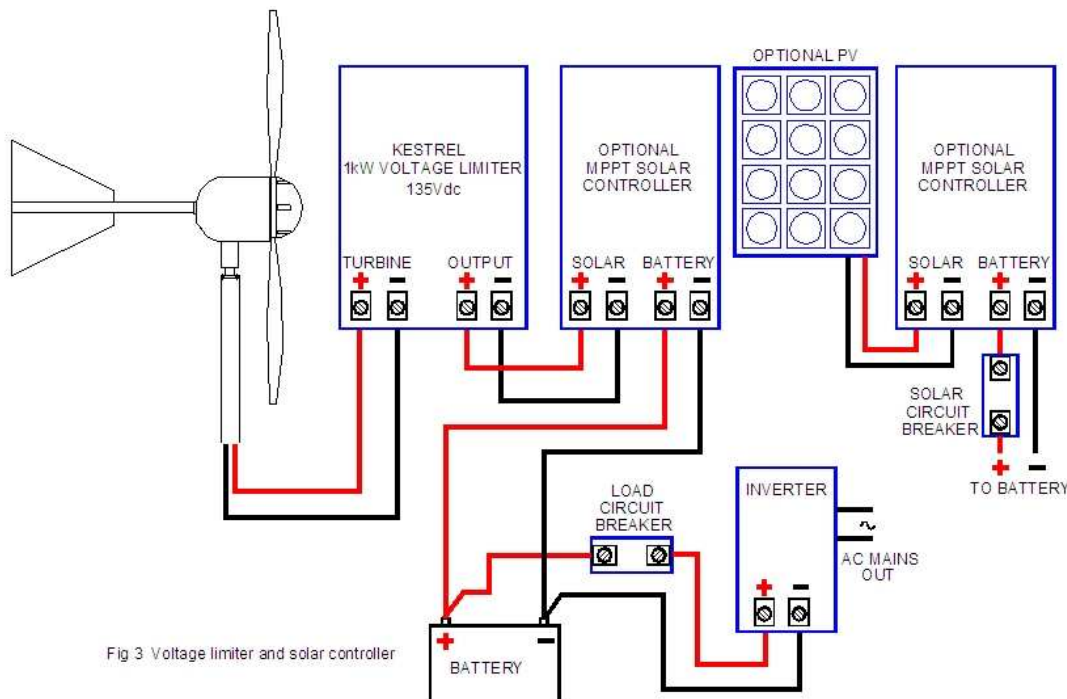


Fig 3 Voltage limiter and solar controller

All charging installations use the same e300i 110Vdc turbine. On any occasion when the charge controller allows any increase in turbine voltage, the limiter restricts the voltage rise to 135Vdc. The turbine therefore never exceeds the

150Vdc input of the MPPT controller. The same charge controller type is used on both wind and solar.

Suitable Installations for 135Vdc Voltage Limiter and MPPT Controllers		
Battery Voltage	Turbine Voltage	MPPT Controller Spec.
12	110	Vin (Max) 150Vdc Output >60A
24	110	Vin (Max) 150Vdc Output >60A
36	110	Vin (Max) 150Vdc Output >40A
48	110	Vin (Max) 150Vdc Output >40A
60	110	Vin (Max) 150Vdc Output >40A

Cable Sizes

Cable choice will depend on the turbine working voltage and current. Measure the distance from the tower top to the controller. Select a suitable cable from the table.

- * The distance is one way and allows for +ve and –ve wires.
- * Distance is in metres and (feet).
- * Wire size is in square millimeters and American wire gauge (AWG)
- * Wiring must comply with local electrical standards. Consult a professional in your area for compliance.
- * % power loss shows that more power is lost as cable size reduces.

Wire Size for 12V e300i (65A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	122mm ² (2x 00)	92mm ² (0000)	73mm ² (000)
40m (130ft)	☹	184mm ² (2x000)	147mm ² (2x00)
60m (200ft)	☹	☹	220mm ² (2x0000)

Wire Size for 24V e300i (35A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	35mm ² (2)	25mm ² (3)	20mm ² (4)
40m (130ft)	66mm ² (00)	50mm ² (0)	40mm ² (1)
60m (200ft)	100mm ² (0000)	74mm ² (000)	60mm ² (00)
80m (260ft)	140mm ² (2x00)	100mm ² (0000)	80mm ² (000)

Wire Size for 36V e300i (30A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	19mm ² (4)	14mm ² (6)	11mm ² (7)
40m (130ft)	38mm ² (1)	28mm ² (2)	22mm ² (4)
60m (200ft)	57mm ² (0)	42mm ² (1)	34mm ² (2)
80m (260ft)	76mm ² (000)	56mm ² (0)	45mm ² (1)
100m (330ft)	95mm ² (0000)	71mm ² (000)	57mm ² (00)



Wire Size for 48V e300i (19A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	9mm ² (7)	7mm ² (8)	5.5mm ² (9)
40m (130ft)	18mm ² (4)	14mm ² (5)	11mm ² (7)
60m (200ft)	28mm ² (3)	20mm ² (4)	16mm ² (5)
80m (260ft)	35mm ² (2)	27mm ² (3)	22mm ² (4)
100m (330ft)	45mm ² (0)	34mm ² (2)	27mm ² (3)



Wire Size for 110V e300i (12A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	2.5mm ² (13)	1.8mm ² (14)	1.5mm ² (15)
40m (130ft)	5mm ² (10)	3.7mm ² (11)	3mm ² (12)
60m (200ft)	7.5mm ² (8)	5.6mm ² (10)	4.5mm ² (11)
80m (260ft)	10mm ² (7)	7.5mm ² (8)	6mm ² (9)
100m (330ft)	12mm ² (6)	9mm ² (7)	7.5mm ² (8)

Wire Size for 200V e300i (6A maximum current)

One Way Distance	3% Power loss	4% Power loss	5% Power loss
20m (66ft)	0.7mm ² (17)	0.5mm ² (20)	0.4mm ² (21)
40m (130ft)	1.36mm ² (16)	1mm ² (17)	0.82mm ² (18)
60m (200ft)	2.04mm ² (14)	1.53mm ² (15)	1.22mm ² (16)
80m (260ft)	2.72mm ² (13)	2.04mm ² (14)	1.63mm ² (15)
100m (330ft)	3.4mm ² (12)	2.55mm ² (13)	2.04mm ² (14)

6. Installation Commissioning

The turbine installation on the tower is complete. The electrical installation is also complete and approved. Safety precautions are in place ready for the tower to be raised.

- Complete a visual check on the wind turbine and ensure that no foreign objects or tools are on the turbine.

- ▶ Clean the turbine and blades removing any finger marks.
- ▶ Thoroughly check all three blades for any damage during installation. Edge damage will increase noise and change the sound signature of the turbine.
- ▶ Verify that the electrical installation is complete.
- ▶ Verify that the turbine is free to rotate smoothly with no unusual noises. Now apply the turbine brake switch. Consult the charge controller manual for more information.
- ▶ Observing all safety requirements, refer to the tower manual for the tower raising procedure.
- ▶ Raise the tower as instructed in the tower manual, completing the tower installation and making secure.
- ▶ Observe the turbine to run smoothly with no vibration or unusual mechanical noise.

Congratulations! The installation is now complete !

7. Maintenance Schedule

The Kestrel e300i operates with minimum maintenance. The frequency of visual inspections and integrity checks depends on the wind class of the installation site. Wind Power Class definition for wind power density and average wind speed at a hub height of 10m is given below. In general, higher class wind sites require more frequent installation checks.

WARNING (Pitch Control)

The pitch control mechanism is a factory assembly and is not user serviceable. Specialist tools and knowledge is required to carry out any maintenance or repair procedures. Do not make any unauthorized adjustments or modifications to any part of this assembly. Do not force or twist the blades other than gently when checking for wear or defects.

7.1 Wind Power Class

Find the Wind Power Class for the site. This number from 1 to 7 decides the turbine maintenance intervals.

Wind Power Class	Wind Power Density (W/sq m)	Wind Speed m/s
1	Up to 100	Up to 4,4
2	100 – 150	4,4 – 5,1
3	150 – 200	5,1 – 5,6
4	200 – 250	5,6 – 6,0
5	250 – 300	6,0 – 6,4
6	300 – 400	6,4 – 7,0
7	Above 400	Above 7,0

7.2 Planned Maintenance Schedule

The following schedule is designed to avoid machine failure. Component life will be reduced on sites that exhibit high turbulence. Plan turbine maintenance on the Wind Power Class selected in 7,1.

Wind Power Class	1	2	3	4	5	6	7
First post installation visual check	All sites 1 month after installation						
Visual Inspection, listen for abnormal noise and vibrations.	After extreme weather and every 6 months				After extreme weather and every 2 months		
Close inspection, check for any loose bolts, blade damage. Check the integrity of the pitch control (See tips below). Check the six rubber boots on the track rod ends. Check the three pitch shaft plastic covers. Treat and touch up any paint defects.	12 monthly intervals				Six monthly intervals		
Dismount the machine and check for transfer brush wear. Check for wear on pitch control parts. Replace as required. Treat any corrosion and touch up paint.	Every 5 years				Every 3 years		
Dismount the machine and replace all bearings (generator, yaw shaft and pitch control)	Every 8 – 10 years				Every 6 – 8 years		

OTHER AUXILIARY INSPECTIONS

Inspections should also be done with regard to all other site equipment. Specific procedures are contained within the relevant user manuals. The following list illustrates typical topics.

- a) Inspection of the tower including all bolts/fasteners ground anchors and guy wires.
- b) Inspection of the Kestrel e300i tower securing bolts.
- c) Check all electrical connections for tightness and corrosion.
- d) Functionality and general checks on all other electrical equipment.

8. Questions and Answers

1	The tail is swinging from side to side or moving up and down.	The blade rotor is unbalanced. There is blade damage.
2	The turbine fails to track light winds / always comes to rest in one direction.	The tower is not vertical /the turbine is not horizontal.
3	I can hear a rattle or unusual noise.	Something is loose on the turbine or the tower. This requires urgent attention.
4	The turbine does not stop when I apply the brake switch.	The blades are extremely powerful. Switch the brake on and off a few times. The turbine will stop when the wind reduces down a little.
5	The turbine starts and only rotates very slowly.	The brake switch is on. There is a cable short. The generator is shorted (unlikely).
6	What maintenance must be done and how often?	Consult the maintenance schedule in this manual.
7	The tower vibrates at certain wind speeds.	The turbine is out of balance. The tower is resonating with natural vibration.
8	The turbine sounds different from when it was installed.	See (3). A blade is damaged. The blade leading edge tape is defective
9	Should I lower the turbine in high wind?	If possible, the turbine should be lowered in predicted extreme gales.
10	Will the turbine remain in control when disconnected?	Yes. The pitch control will always limit the rotor speed. The voltage on the wires will however be a danger!
11	I can hear a slight hum/whine from the turbine.	This is a normal sound from any generator and depends on loading.
12	The tower deflects slightly downwind and then returns to vertical as the wind speed increases.	The tower withstands the lateral thrust from the turbine. This bending force reduces as the pitch control operates.
13	Can I replace one damaged blade?	No. Blades are balanced in a set of three. All three blades must be replaced.
14	Can I adjust the pitch control to alter the machine performance?	No. The pitch control is factory assembled and calibrated. Do not tamper in any way.

9. Technical Specification

Maximum Power	1150W
Rated power at 11m/s 200Vdc	1000W *
Rated power at 11m/s 110Vdc	1000W *
Rated power at 11m/s 48Vdc	1000W *
Rated power at 11m/s 24Vdc	900W *
Rated power at 11m/s 12Vdc	850W *
Annual energy capture at 5m/s average 200Vdc	2200kWh
Annual energy capture at 5m/s average 110Vdc	2200kWh
Annual energy capture at 5m/s average 48Vdc	2200kWh
Annual energy capture at 5m/s average 24Vdc	1940kWh
Annual energy capture at 5m/s average 12Vdc (For average wind speed of 5ms ⁻¹ and 12m tower at sea level)	1790kWh
Rated sound level at 5m/s and 60m downwind	<40dB
Cut-in wind speed	2,5ms ⁻¹
Cut-out wind speed	N/A
Maximum voltage 200Vdc	600Vdc
Maximum voltage 110Vdc	360Vdc
Maximum voltage 48Vdc	165Vdc
Maximum voltage 24Vdc	136Vdc
Maximum voltage 12Vdc	72Vdc
Output power form	Two wire DC
Rotor swept area	7,07 sq m
No. of blades	3
Tower top mass	75kg
Lateral Thrust at 12ms ⁻¹ (27mph) and 40ms ⁻¹ (90mph)	800N and 8600N
NOTE: Lateral Thrust at 40ms⁻¹ is theoretical for a failed pitch control. For normal operation, thrust at 40ms⁻¹ is <1000N	
Speed Control	Passive pitch
Protection	IP55

* Approximate value dependent on atmospheric conditions. Contact manufacturer for detailed values

Note: Specifications may change due to continuous research and development. Consult your dealer or the factory Web site: www.kestrelwind.co.za

10. Compliance

Declaration of Conformity

**Eveready Diversified Products (Pty) Ltd T/A
Kestrel Wind Turbines**

in South Africa

declare under our sole responsibility that the product

 **Wind Turbine**

To which this declaration relates is in conformity with the following standards

IEC 60038	Rotating Electrical Machines
IEC 60204-1	Safety of Machinery
IEC 60038	IEC Standard Voltages
IEC 60529	Degrees of Protection of Enclosures
IEC 61000	Electromagnetic Compatibility

and follows the provisions in the directives

IEC61400-2 (Small wind Turbines)

Date: 25th April 2007

Place: Port Elizabeth South Africa

Authorising Signature:



James Carpy
Technical Director

Kestrel Wind Turbines
P O Box 3191
North End
Port Elizabeth
6056
Republic of South Africa

11. Warranty

Kestrel e300i Two Year Limited Warranty

1. General Terms and Conditions

- 1.1) The user must complete and return the Warranty Form within one month from the date of installation or within three months after receipt of the Kestrel product.
- 1.2) All requested information in the Warranty Form including site location, tower details, equipment serial numbers and pictures must be provided.
- 1.3) The product under warranty must be in normal use for which it is intended.
- 1.4) The product must be installed and commissioned in accordance with the instructions provided in the product manual.
- 1.5) The product installation must be inspected by a registered Kestrel dealer either prior to or during final commissioning.
- 1.6) Kestrel retains the right to have any remedial work required during the warranty period to be completed by any agent, dealer, re-seller or other appointment by Kestrel.
- 1.7) Written notice of any defect must be delivered to an authorized Dealer or to the Kestrel factory within fifteen days of the failure date.
- 1.8) The remaining warranty period at any time is transferable.
- 1.9) Kestrel reserves the right to change or update this warranty at any time.

2. What the Warranty Covers

- 2.1) Kestrel warrants that the product complies to standard specification upon delivery and for a period of 24 months after the Warranty Form registration.
- 2.2) Any product failure traceable to defective design, material, component or sub-assembly.
- 2.3) During the warranty period, Kestrel will at its sole discretion repair, replace or refund the purchase price of defective components or sub-assemblies.
- 2.4) Repaired or replaced product may be new, upgraded, re-manufactured or refurbished at the sole discretion of Kestrel.
- 2.5) Kestrel will provide return shipping to customers within South Africa or to the nearest port of entry for customers outside South Africa.

3. What the Warranty Does Not Cover

- 3.1) Any Costs incurred due to the site removal and re-installation of any defective product.
- 3.2) Any shipping costs for product delivery to Kestrel or any appointed Dealer or alternative repair facility.
- 3.3) Any equipment not manufactured by Kestrel
- 3.4) Product that has undergone modification or tampering.
- 3.5) Damage or loss caused by wind speeds in excess of 60m/s (134mph)
- 3.6) Any form of abuse, misuse or vandalism
- 3.7) Damage resulting from windstorm, lightning, hail, fire or any other insurable loss under standard and extended coverage policies generally available for endorsement to the wind system consumer.
- 3.8) Tower or support structure failures including any foundations.
- 3.9) All acts of God including tornadoes and all other cyclonic windstorms.
- 3.10) Damage due to voltage irregularities including lightning and utility system failures.
- 3.11) Damage due to impact by flying objects or debris.
- 3.12) Failures caused by not servicing and maintaining the product in accordance with the instructions supplied by Kestrel
- 3.13) Components that in the opinion of the manufacturer have been subject to overload, mechanical abuse, improper installation, use with any unsuitable power source, or any other non-warranty condition.
- 3.14) Any damage to the product during shipping.
- 3.15) There is no obligation to implement any future product design changes or improvements on previously manufactured product.

Annexure 1: General Information

The Kestrel e300i is a high quality wind turbine that often becomes a local landmark. It is a serious machine with a remarkable performance and is designed to give the owner many long years of trouble free service. Please enjoy the informative annexures.

The Kestrel e300i is a wind turbine that reliably supplies electrical energy with minimum attention and maintenance. Kestrel also promotes good customer service so that any Kestrel owner is assured of sharing in our good relationship with our product users.

A brand new turbine may require a marginally higher wind speed to start. This is normal. The startup wind speed will reduce over a few months as the main bearing seals “run in”.

The pitch control hub should be checked in the following way. Visually inspect the unit. Check for any stress cracks, broken or cracked springs and corrosion. Use gentle pressure to twist the blade in both directions. There should be virtually no movement or slackness. Push and pull the blade along it's length. There should be no movement of the blade. If any wear or defect is detected, consult your dealer or the factory. Do not under any circumstances strip the assembly down without the required knowledge.

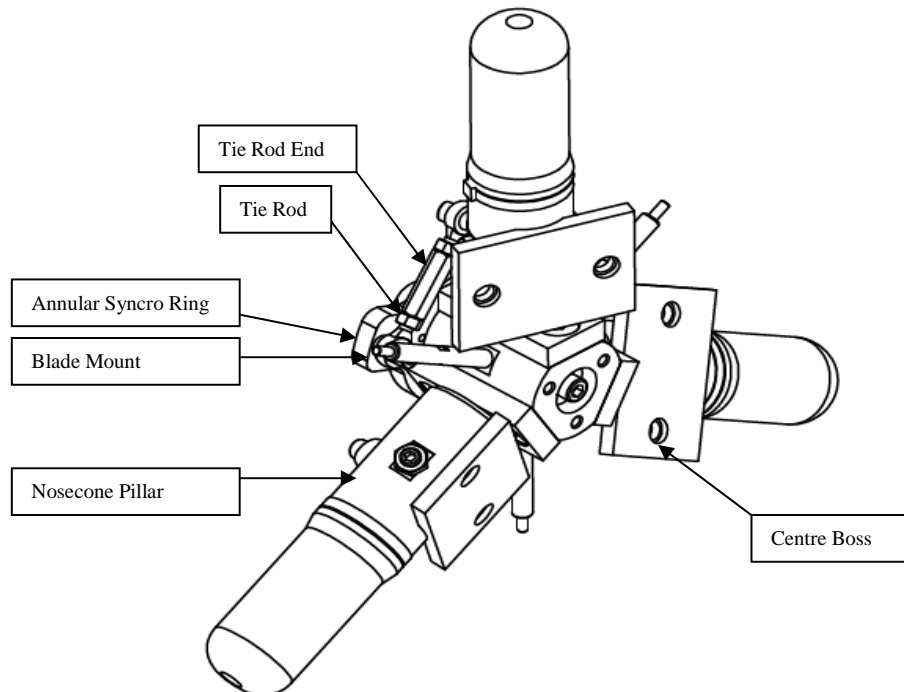
The generator produces a slight humming sound. This is quite normal. Any other grinding, clicking or scraping noises are abnormal and must be investigated.

Good rotor balance is very important for long and reliable operation. The wind turbine must not be allowed to continue in operation if any unbalance is observed. The most common symptom of imbalance is observed when the turbine swings slightly from side to side as it speeds up. The swinging action will be worse at a particular rotor speed and may well disappear at higher speeds.

The rotor blades can suffer chips and erosion, mainly on their leading edge. Small chips can be repaired with glassfibre filling compound. All cracks must be carefully examined. Surface cracks can be repaired but any structural cracks must render the blade inoperative. If there is any doubt, the blade set must be replaced for safety. All blade damage can allow water to enter. This will cause the blade set to become unbalanced which will cause other mechanical failures and shortened bearing life.

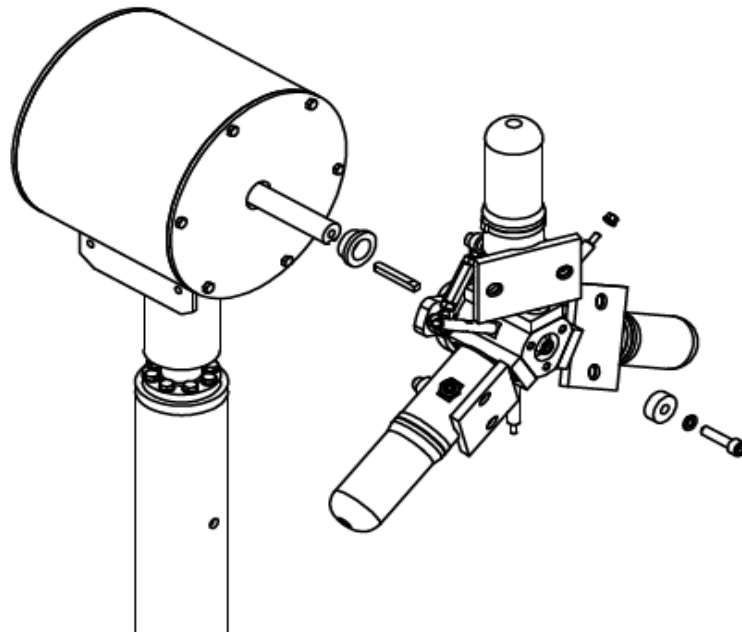
Pitch Control

The Kestrel Pitch control consists of a patented design that after a long development phase was thoroughly tested. The final product is maintenance free, fully sealed from the environment and is extremely reliable.



When the turbine reaches the rated rpm, the centrifugal force generated by the blades and blade mounts begin to compress the springs. As the blades move outward, they are rotated. This blade rotation alters the blade angle to the wind. The turbine is then limited to the rated maximum power and rpm. This system results in the turbine producing full power at the rated wind speed and above. The turbine continues to safely harvest the maximum energy as wind speed increases. High gusts and high wind speed result in a very small increase in rpm as the blades control the turbine. The pitch control is designed to be maintenance free. The six rubber boots on the tie rod ends and the three polyurethane spring covers must be replaced if they are damaged in any way or show signs of deterioration over time. Although these components are UV stabilized, this may occur in environments with high solar irradiation.

The Generator



The Kestrel e300i generator is a completely sealed unit and requires no regular maintenance. The generator carries two single deep groove bearings. All bearings are of a high quality and are sealed for life. The generator is a brushless twin rotor axial flux permanent magnet assembly with 96 poles and fifty-two magnets. The magnets are rare earth neodymium boron composition. The thermal management in the generator ensures that the temperatures never reach the Curie point. The generator will never overheat and is rated for 100% duty cycle. This means that the turbine is designed to produce the full rating of 1kW for the complete duration of a high wind period.

Unlike many generators, the Kestrel e300i produces dc power. There are therefore no inductive effects in cabling and radiated emission is absolutely minimal. The power output has a much lower ripple content compared to a three phase system. High ripple content reduces battery life and should be avoided.

The Transfer Brushes

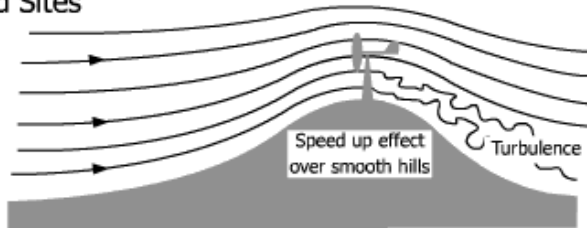
A dual brush and slip ring assembly delivers generator power to the output cables. It is located within the same assembly that supports the complete turbine on the tower. It is referred to as the “swivel assembly” and is extremely well designed and strong. The complete assembly is simple to remove from the generator and can be replaced as a complete unit. Kestrel intends in the future to provide an exchange service for the complete swivel assembly.

There is a total of four high quality copper/carbon composite brushes, two for +ve and two for -ve. The transfer system is well rated and requires no replacement for many years of service. Some owners may feel a little uncomfortable that one cannot easily inspect the brushes. Kestrel strives to produce a wind turbine that is reliable and has a minimal maintenance schedule.

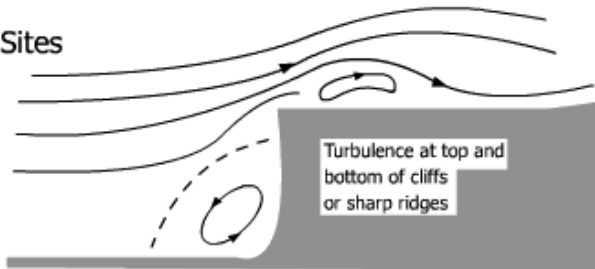
Annexure 2: Choosing a Site (Courtesy of BWEA)

Flow over hills and obstacles

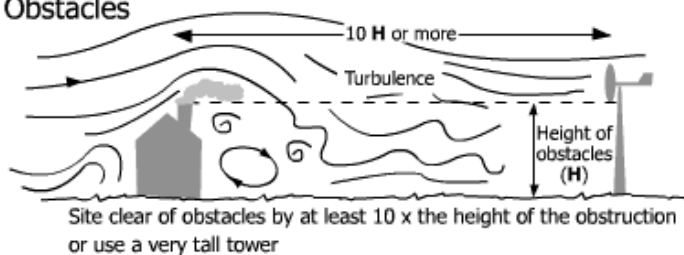
Good Sites



Bad Sites



Obstacles



The output from a wind turbine is highly sensitive to wind speed. It is essential that turbines should be sited away from obstructions, with a clear exposure or fetch for the prevailing wind. Wind speed also increases with height so it is best to have the turbine high up, and most small turbines have towers much higher relative to their diameter than large ones.

It is generally agreed that the ideal position for a wind turbine generator is a smooth hilltop, with a flat clear fetch, at least in the prevailing wind direction. The wind speeds up significantly near the top of the hill and the airflow should be reasonably smooth and free from

excessive turbulence. Excessive turbulence causes fatigue damage and shortens a turbine's working life.

In practice, especially for very small machines that need to be located near to the user, ideal siting will not be easy. As far as possible though, keep away from local obstructions such as large trees and houses, or use a taller tower to ensure that the turbine is well above the obstructions.

Before considering the installation of a wind turbine the potential site should be assessed. Initial indications of wind strength and direction can be obtained by observing the deformation of vegetation and trees, and in many cases the user may already have a good feel for the winds in the locality. However impressions can be deceptive.

A more reliable way to evaluate the wind resource, which is strongly recommended when there is doubt over whether the wind is strong enough, is to take regular measurements over a period of several months, preferably a year. It

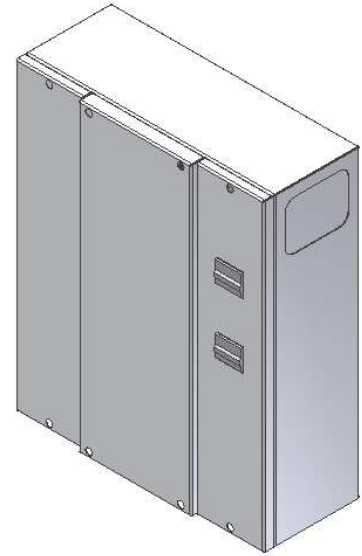
is not straightforward to use data even from nearby sites, and probably the nearest meteorological station or airfield where records have been kept is many miles away. However, measurements taken at a proposed site can be compared with measurements taken elsewhere at the same time, and used as a guide to the probable correlation over longer periods. In addition computer models are available for professionals to use, although such predictions should be applied with care.

- a) Get a reliable estimate of the wind speed at the proposed site.
- b) Mount the turbine on as high a tower as possible and well clear of obstructions, but do not go to extremes. Easy access will be required for erection, and foundations for the tower may be needed depending on the size and tower type. It is also important to ensure that the wind turbine can be easily lowered for inspection and maintenance.
- c) Try to have a clear, smooth fetch to the prevailing wind, e.g. over open water, smooth ground or on a smooth hill.
- e) Use cable of adequate current carrying capacity (check with the turbine supplier. This is particularly important for low voltage machines). Cable costs can be substantial.
- f) Consult your local authority as to whether you need planning permission. You should try to minimise the environmental impact of the turbine, and it will be helpful to inform your neighbours of your plans at an early stage.

Annexure 3: Kestrel Patented Voltage Limiter

Kestrel Voltage Limiter Type: 0702-1000-135-ID and -280-ID

Sustainable/renewable energy sources such as wind turbines and hydro-generators produce uncontrolled electrical energy. Grid tie inverters cannot endure any overvoltage on their input. The Kestrel Type 0702 Voltage Limiter ensures that the turbine is capped to a maximum voltage at all times. This voltage is well within the maximum sustainable input voltage of many battery charge controllers (135Vdc version) and grid tie inverters (280Vdc version).



The Kestrel Type 0702 voltage limiter uses electronic means to control the incoming voltage. The product uses mature technology causing no electrical disturbance during operation. Power from the wind turbine is delivered through the product to the charge controller or grid tie inverter. The limiter monitors the turbine voltage and supplies power.

Any excess energy is converted to heat in the voltage limiter. The unit is highly efficient and allows the wind turbine to operate over the full range of incident wind speeds. Since the voltage limiter is external to the generator, it can be sited close to the charge controller or grid tie inverter.

The product is housed in a steel enclosure for wall mounting and includes a turbine brake switch and an output circuit breaker. It is extremely reliable in operation and incorporates a failsafe design. Unit cooling is achieved by natural convection and fan assist. Contact your Kestrel dealer for more information.

Additional components may be required to comply with certain local electrical codes. Consult your dealer.

Annexure 4: Grid tie Inverters

Kestrel does not manufacture grid tie inverters. The inverter that is installed must be suitable for connection to a wind turbine. The main requirements for a suitable inverter are given below.



Continuous power rating
Input dc voltage range
Input dc current rating

1kW
0 – 400Vdc (minimum)
0 – 6Adc

Control algorithm

Voltage/Power

- * Your Kestrel dealer or the factory can comment on characteristic of any control algorithm.
- * No input rectifier is necessary. The Kestrel e300i turbine and the voltage limiter both output dc current.

Images are for illustration only. Kestrel does not endorse any grid tie inverter. Consult your dealer for recommendations on inverters.

Annexure 5: Resilient Mounting Kit

1,0 Scope

Your Kestrel e300i may be supplied with a resilient mounting kit. All wind turbines will create operational noise and vibration. This vibration is complex and comprises of different fundamental frequencies and their harmonics. Vibration and noise will always be present in any rotating machine and a wind turbine produces a variety of vibrations that originate from aerodynamic interaction with the incident wind. The objective is to minimise these noises and vibrations being transmitted into the support structure, whether a tower or outrigger system.

Towers and support structures can also vibrate in the wind but such affects are excluded from this application note.

2,0 Vibration Damper Concept

Two new steel flanges are fastened with screws, one to the tower top and one to the generator. A plastic disk is fitted between new tower flange and the generator flange. Each flange fixing bolt is fitted with plastic insulating bush which has a steel sleeve.

The damper system is failsafe and the bolts cannot pull out or slacken.

The original Kestrel generator mounting flange and the tower top flange remain unchanged. The new damper can be retro-fitted to all previous Kestrel turbines



3,0 Exploded View

The image shows the plastic disk, plastic sleeves and inner steel sleeves. All plastic parts are manufactured in UV stable polyurethane. The optimum hardness for these parts is 70 Shore.



Fit the tower flange



Fit the plastic disk



Fit the top flange

The turbine mounts straight on to the new damper flange



Earth Cable

4,0 Earthing/ Grounding

A suitable earth strap or cable connection is connected across the two new flanges. Threaded holes are provided on the edge of the new flanges. The strap then bridges across the damper to give earth continuity between the turbine and the tower.

5,0 List of Parts

Part No.	Description	Quantity
32115	Resilient Mount kit (Complete)	-----
32116	Bottom flange e300i Resilient	1
32117	PU flange e300i Resilient	1
32118	Top flange e300i Resilient	1
32112	Bolt hex M10 x 60 A2 S/steel	6
30119	Washer flat 10mm A2 S/steel	6
32120	Compression sleeve – e300i resilient	6
32119	PU sleeve e300i resilient	6
32121	Washer fender 10 x 30 x 2.5 S/steel	6
30118	Nut Nylock M10 A2 S/steel	6
32179	Earth strap	1
30101	Bolt CSK Allen Cap M8 x 30 HT 8.8 Z/plated	8
30101	Bolt hex M8 x 16 A2 S/steel	2

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