



kestrel
wind turbines

Registration Number 2006/005438/07

VAT Registration Number 4870231406

Tel: +27 (0)41 401 2500

Website: www.kestrelwind.co.za



e400ⁱ

User Manual

Revision 1.0

(03-08)

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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 professional engineers and take advice if you are unsure.

1 SAFETY FIRST

1	Safety Considerations
1.1	Mechanical Safety
1.2	Electrical Safety
1.3	Installation Hazards
1.4	Operational Safety

Although Kestrel's wind turbines are designed with your safety in mind, accidents can easily occur and there are always inherent dangers associated with any type of machine. **Consult installation professionals if you lack experience or confidence.**

1.1 Mechanical Safety

Use good handling methods and take precautions to avoid physical injury during installation and maintenance/repair procedures. The rotating blades of any wind turbine are a main hazard. The e400ⁱ blades are extremely tough and will cause serious injury to the body. **Never install the e400ⁱ such that any person or animal could come into accidental contact with any part of the machine. Never approach the machine if the blades are rotating.**

1.2 Electrical Safety

The e300ⁱ output voltage can become dangerous and even lethal when running on open circuit. Maintain a healthy respect for this wind turbine. **Always short the output wires together when the e400ⁱ is disconnected. Do not work on the system when the turbine is running or when lightning is possible.** Disconnecting a running e300ⁱ may cause a spark and the presence of explosive hydrogen from battery charging is always a possibility. **Adequate ventilation must be provided for battery installations.** The wire size used for connections must be correct for the powers supplied. The smaller the wire diameter, the higher the wire losses and therefore the heat generated in the wire. **Use correct wire sizes throughout the installation.** The amount of energy stored in a battery is considerable and fire can result from shorts. **Fit a suitable fuse or circuit breaker in the battery cable. In general, respect the system and use common sense. Consult a qualified electrician if you are unsure.**

1.3 Installation Hazards

All installation work should be completed at ground level wherever possible. Be very aware of the blades during installation. Contact with the blades will only injure you, not the blades. The installations of poles or towers pose their own dangers. Always work carefully and have an assistant wherever possible. **Short the generator output wires (Red and Black) throughout any installation procedure.** Consult a civil engineer or reputable builder if you are not sure about installing structures. Always re-check the work as you progress. Slack bolts, poor workmanship and loose electrical connections must be avoided.

1.4 Operational Safety

The turbine blades are dangerous. **Respect a rotating turbine.** Always shut the turbine down before approaching. This may be achieved by 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.

2 WIND TURBINE OVERVIEW

2 Wind Turbine Overview
2.1 Turbine Description
2.2 Identification and Markings
2.3 Application and Uses
2.4 Charge Controllers and Inverters
2.5 Grid Tied Inverter Applications
2.6 Voltage Limiter

2.1 Turbine Description

The e400i is a unique wind turbine that incorporates superior technology. The heart of the machine comprises of a unique twin axial flux permanent magnet brushless alternator. The alternator contains no less than 96 poles and 52 magnets. The polyphase high frequency output is internally rectified to give a dc output with extremely low ripple content. The generated power is transferred to the output cables via heavy duty bronze slip rings and twin copper composite electrical brushes. The prime mover on the e400i is a 4.0m (9.85') diameter three blade wind rotor fitted with quiet running high efficiency blades. The blade hub incorporates passive pitch control. The e400i pitch control changes the operating angle of the blades to achieve speed control in high wind. The tail vane assembly is static and simply aligns the machine with the prevailing wind.

All steel components are electro-galvanised and passivated for extra protection. The standard finish consists of the application of an etching marine primer and an intermediate protective coat followed by polyurethane two pack finishing coats.

2.2 Identification and Markings

The turbine generator body carries a stamped unique serial number and a rating plate. Both the stamped serial number and rating plate are visible on the bottom yaw shaft housing. If this e400i does not carry this stamp it does not carry a Kestrel warranty and may not be authentic.

			
PRODUCT RATING LABEL			
TYPE	0503	SWT Class No.	II
VOLTAGE	48 Vdc	ROTOR DIAMETER	3,0 m
CURRENT	25,0 Adc	SWEPT AREA	7,0 m ²
RATED POWER	1000 Wdc	MANUFACTURED	Nov06
SERIAL NUMBER	0612044-048		
MADE IN SOUTH AFRICA BY	Eveready Diversified Products (Pty) Ltd T/A Kestrel Wind Turbines P.O. Box 3191, Struandale, North End Port Elizabeth, 6056 RSA		

2.3 Applications and Uses

The e400ⁱ is suitable for electrical power generation on various installations that include battery charging, water delivery and grid tie applications. Each application requires specific additional electrical equipment. Consult the manuals supplied with this equipment.

2.4 Charge Controllers and Inverters

Any wind turbine produces uncontrolled power that varies with incident wind speed. The open circuit generator voltage is directly proportional to generator speed (rpm). Some form of regulator must control this “raw power”. A battery charging regulator is often referred to as a charge controller.

A charge controller is required for the Kestrel to charge a battery. Kestrel can supply a standard charge controller for the e400ⁱ. A suitable diversion resistor is available from Kestrel.

An inverter can be connected to the battery and is used to convert the battery dc power to ac power. An inverter therefore allows the use of standard electrical equipment that works on ac voltage.

2.5 Grid Tied Inverter Applications

The 250Vdc version of the e400ⁱ is suitable for connection to an approved Grid Tie Inverter. Grid Tied installation is subject to local electrical codes of practice and is usually carried out by qualified personnel. Prior approval from the local utility company must be obtained before connection to the mains.

2.6 Voltage Limiter

Grid tied applications require a Voltage Limiter to be connected between the e400ⁱ (250Vdc version) and the Grid Tie Inverter. Certain operating modes of the inverter allow the Kestrel output voltage to rise beyond the limit of the inverter. The Kestrel Voltage Limiter will restrict the rise in voltage as the inverter performs various functions. Refer to the manual provided with the Kestrel Voltage Limiter.

3 UNPACKING AND TURBINE ASSEMBLY

3 Unpacking and Turbine Assembly

- 3.1 Components Supplied
- 3.2 Tools Required
- 3.3 Unpacking
- 3.4 Technical Requirements for Assembly
- 3.5 Generator Assembly
- 3.6 Tail Assembly
- 3.7 Fitting the Pitch Control
- 3.8 Blade Assembly

3.1 Components Supplied

The following components are supplied.

- Pitch hub assembly
- Shaft drive key
- Propeller blade set
- Generator assembly
- Tail boom (two pieces)
- Tail (two pieces)
- Tail Stabiliser (two pieces)
- Nacelle cover
- Nosecone
- All fasteners and bolts
- Assembly grease
- Locktite

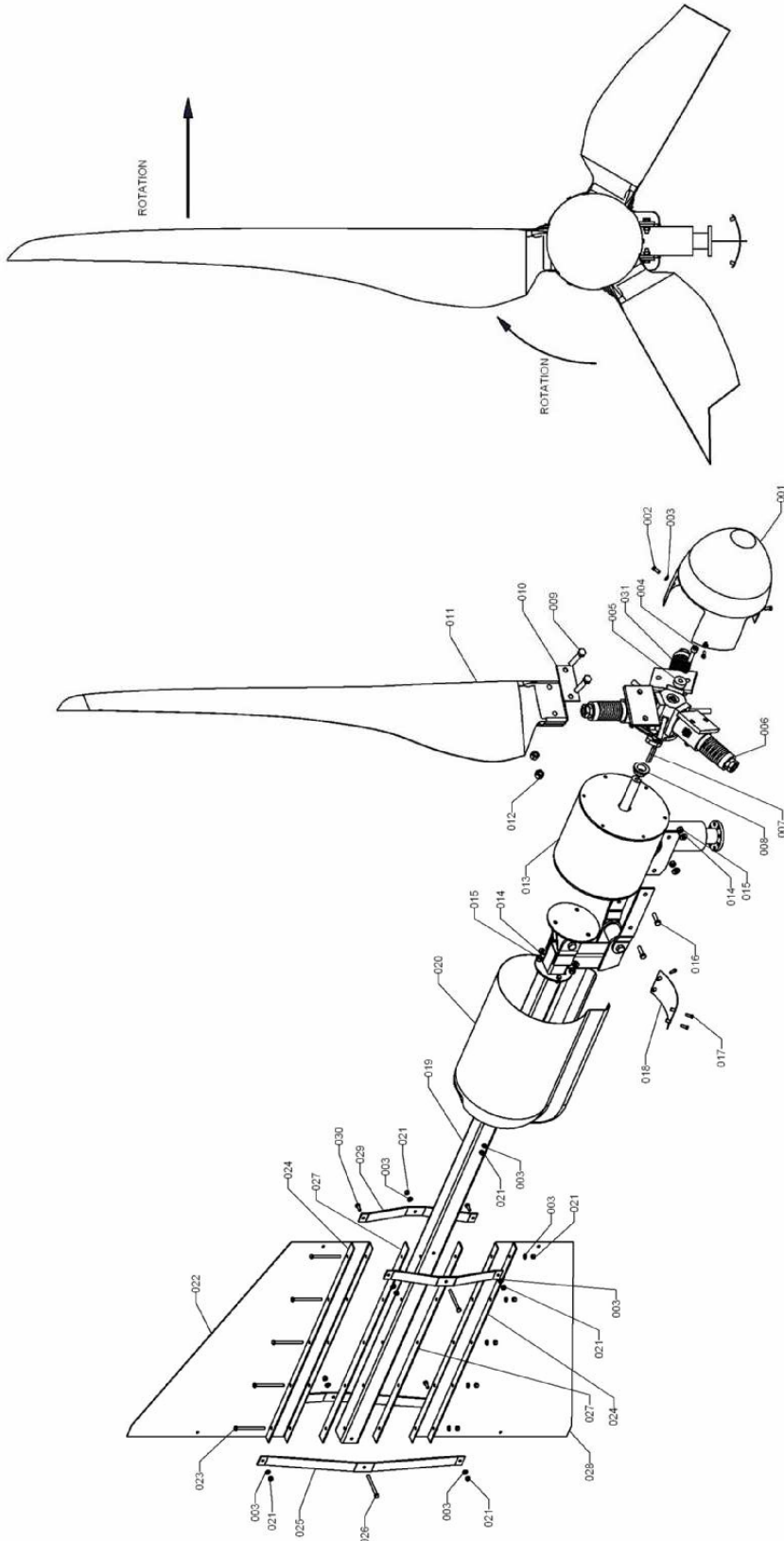
3.2 Tools Required

The following hand tools are required for turbine assembly and installation.

- 10mm metric ring spanner or socket wrench (two required)
- 13mm metric ring spanner or socket wrench
- 19mm metric ring spanner or socket wrench (two required)
- Small size electrical screwdriver
- Medium size electrical screwdriver
- 10mm Allen key wrench
- Wire strippers for electrical connections
- Tape measure to adjust the blades
- Torque wrench

3.3 Unpacking

Open the packaging container and check for any transit damage. The parts contained are listed in section 3.1 and on the included packing slip. Lay out the parts and identify them with the assembly drawing provided.



Part	Qty	Description	Item #
001	1	Nose Cone	30924
002	3	Screw C/Head M6x16 S/Steel	30152
003	16	Washer Plain Metric 6mm S/Steel	30092
004	1	H/Tensile Cap Screw M10x40L ZP	30660
005	1	Hub Clamping Spacer	30689
006	1	Pith Control	30990
007	1	Shaft Key (8mmx7mm)	30054
008	1	Hub to Bearing Collar	30899
009	6	Hex Bolt M12x65L S/Steel	
010	3	Compression Plate	30768
011	3	e400i Blade Set	30029
012	6	Nut-Hex M12x1.75 Nylock	30173
013	1	e400i Generator Assembly	30022
014	7	Washer Plain Metric 8mm S/Steel	30096
015	7	Nut Hex M8 Nylock S/Steel	30095
016	4	Bolt Hex M8x30L S/Steel	30088
017	4	Screw M5x16 C/Head S/Steel	30149
018	1	Nacelle Cover Plate	30925
019	1	Tail Boom	30769
020	1	Nacelle	30925
021	13	Hex Nut Nylock M6x1 S/Steel	30091
022	1	Top Tail Plate	30830
023	5	Hex Bolt M6x1 x80L S/Steel	30957
024	2	Clamping strip	30835
025	2	Rear Stiffner	30831
026	2	Hex Bolt M6x1 x70L S/Steel	30819
027	2	Rubber Strip	30836
028	1	Bottom Tail Plate	30153
029	2	Front Stiffner	30834
030	4	Hex Bolt M6x1 x16L S/Steel	30094
031	1	Spring Washer 10mm S/Steel	30053

4 Technical Requirements for Assembly

Torque Settings

DESCRIPTION	BOLT TYPE	TORQUE (Metric)	TORQUE (Imperial)
NOSE CONE SCREWS	M6 x 16, S/S	5Nm	3,7 ft·lb
FRONT BOLT	12.9 HI-TENSIL + LOCTITE M10 X 35	60Nm	44,3 ft·lb
BLADE BOLT	M12 x 80, S/S WITH M12 NYLOCK NUT	35Nm	25,8 ft·lb
TAIL BOOM	M8 BOLTS, S/S	30Nm	22,1 ft·lb
	M8 NYLOCKS	25Nm	18,4 ft·lb
NACELLE SCREWS	M6 x 16, S/S	3Nm	2,2 ft·lb
	M5 x 15, S/S	3Nm	2,2 ft·lb
TAIL BOLTS	M6 x 60, S/S WITH M6 NYLOCK NUT	10Nm	7,4 ft·lb
MOUNTING BOLTS	M8 x 25, 8.8 HI-TENSIL PLATED	35Nm	25,8 ft·lb

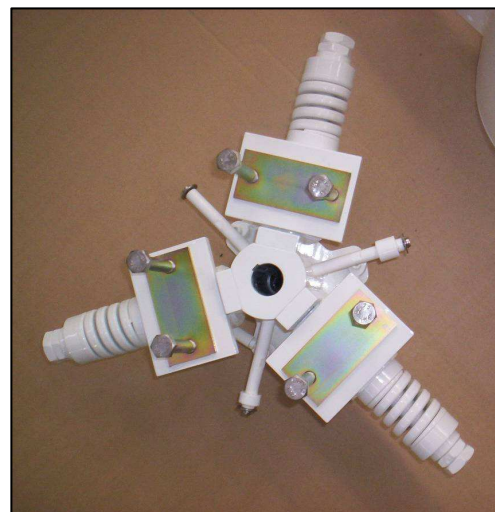


3.5 Generator Assembly

The alternator (01) is factory assembled.

3.6 Pitch control Assembly

The pitch control boss (03) is factory assembled.



3.7 Tail Assembly (if not factory assembled)

Offer the tail boom (05) to the rear of the generator and align the three inner fixing holes with the inner studs. Fasten the boom to the rear of the generator with the three M8 Nylock nuts (18).



Now fit the four lower bolts (20), washers (19) and nuts (18) on to the generator sides by means of the side bars. Level the boom with the generator, secure the bolts through the rubber bushes so that the boom is held in place and tighten all fastenings to the required torque setting (see 3.4 Pg 7).



Slide the nacelle cover (0730) along the boom so that it is covering the generator. Secure the nacelle cover to the rear of the generator with the two M6 screws to the required torque setting (see 3.4 Pg 7). Slide the front closing plate between the underside of the generator and the nacelle cover and secure with the four M5 screws to the required torque setting (see 3.4 Pg 7) through the holes provided.

Fasten the tail (07) upper and lower halves to the boom with the five stainless bolts (23), stainless flat washers (24) and with the five stainless Nylock nuts (23) provided. Now fit the tail stabilisers, two on each side of the tail using the one longer stabiliser bolts (27) through the tail boom and the middle of each stabiliser on either side. The other two stabiliser bolts (26) are fitted through the tail with the washers (28) and nuts (29) at each end of each stabiliser.



Do not over-tighten such that the tail boom is crushed or distorted. Always adhere to the torque settings provided. Check once again that all bolts are fitted and tightened to torque settings (3.4).

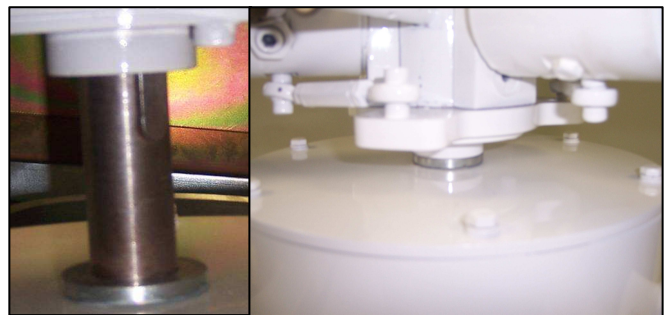
3.8 Fitting the Pitch Control

The generator is a complete unit. The shaft drive key is factory fitted to the generator shaft with a cable-tie. Remove cable-tie, before fitting pitch control.



Smear waterproof grease (30) over the shaft and insert a little inside the front of the generator where the shaft projects out.

Offer the pitch control hub to the shaft and slide it onto the shaft.



Using a hexagon key, fit the front shaft bolt (15) and washer (14) to the spring locking washer provided into the generator shaft and tighten the assembly.

It is important that the bolt is secured with Loctite.



3.9 Blade Assembly e400ⁱ

IMPORTANT: The wheels of a car are balanced to allow smooth operation. In the same way, the propeller rotor must be assembled such that it is balanced. Rotor imbalance will cause vibration, unstable operation of the turbine and eventual damage. Please follow the steps given below to assemble a balanced rotor.

GENERAL

NOTE: The blades are fitted on the front of the pitch control hub. Refer to the assembly drawing and fit all three blades on to the hub as shown. Each blade carries a serial number and a balance mark on the front face of the blade. Be sure to fit the blades the correct way round. The blade root is marked "FRONT" below the serial number on each. The rotation is clockwise viewed at the front of the turbine. Each blade mount has two bolt holes. Fit the bolts with the washers provided and through the blade compression plate with the Nylock nuts behind the pitch control.



The rotation is clockwise viewed at the front of the turbine. Each blade mount has two bolt holes. Fit the bolts with the washers provided and through the blade compression plate with the Nylock nuts behind the pitch control.

The blades are factory balanced. Note that exact balancing requires that the three blade tips be equally spaced when fitted.

Please follow the instructions given below.

- Support the generator (02) such that the blades can be fitted to the pitch hub (03).
- Fit two blade bolts (11) through a blade compression plate (09) such that they face toward the generator. Now fit the first blade (08) on to the bolts and offer the blade **from the front** to one blade mount. Fit the two Nylock nuts (13) on to the blade bolts from the rear. Do not tighten the nuts.
- Repeat (b) such that all three blades are sandwiched between the three compression plates (09) and the three blade mounts on the pitch control hub. Now gently tighten all six blade bolts such that each blade can still move sideways.
- Using a tape measure, accurately measure the distance between each of the three blade tips. Move each blade sideways until all three blade tips have the same measured distance between them.
- Now tighten all the blade bolts to the required torque setting (see 3.4 Pg 7). Do not over-tighten the bolts such that any blade is damaged or crushed.
- Check the assembly for correctness. Check the blades are fitted correctly, the bolts are all tightened and that the rotor spins freely and evenly on the generator. Check the distance between the three blade tips (or balance marks) to be equal.
- Now fit the nose cone (10) over the three spokes and fit the three Nylock nuts (16) and washers (17).



4 SITE CONSIDERATIONS AND MOUNTING

4 Site Considerations and Mounting

- 4.1 Flange Mounting Detail
- 4.2 Roof Mounting
- 4.3 Towers

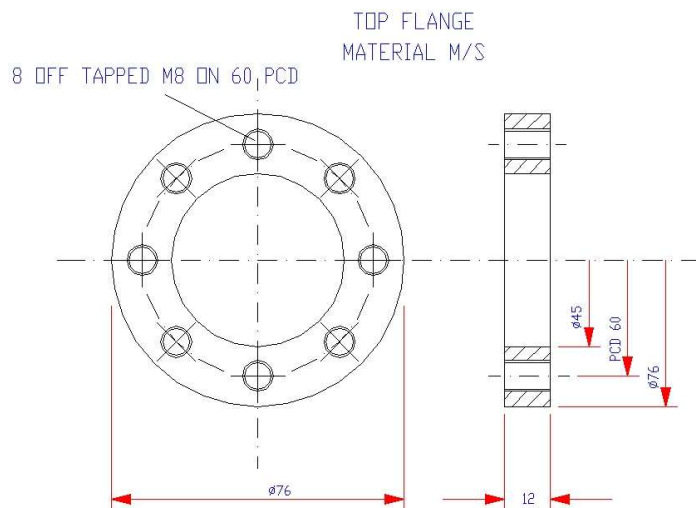
The turbine is supplied with a “weld on” mounting flange for adaptation. Custom structures must incorporate a 76mm (3”) - 100mm (4”) diameter pipe for machine mounting. Larger pipes may interfere with the blades when pitch control operates.

There are infinite variations on sites and the information and suggestions may be adapted to suit local conditions. Wind speed increases with height above the ground. An installation site should be chosen which is free of obstructions like buildings, trees, mounds and hills. A "pure" airflow is paramount for good performance. Naturally some compromise can be reached but there should be a clear entry for the prevailing wind direction of the location. The absolute minimum height of the structure should be 9m when placed clear of obstructions.

The general rule is that the e400ⁱ should be 8m (25') higher than any obstruction within a 150m (500') radius of the tower. Otherwise mount the e400ⁱ as high as possible. All obstructions add to possible turbulence, which will cause undue stress on the unit and reduced performance. Wind speed increases with height above the ground. The power in the wind is a cubic function of wind speed. Doubling the wind speed increases the power by eight times.

4.1 Flange Mounting Detail

The e400ⁱ is mounted using eight M8 Hi-Tensile bolts and spring washers fitted through the bottom flange on the weather cocking swivel assembly.



4.2 Roof Mounting

Roof mounting is possible but the turbine performance may suffer as a result of wind shift and turbulence. Roof mounting structures are beyond the scope of this document and must comply with the relevant structural standards that are in force.

4.3 Towers

Towers are required to conform to relevant standards and must be designed to withstand the loading regime of the wind turbine. Full details are included with any Kestrel tower kit supplied.

5 WIRE AND CABLE SIZES

5 Wiring and Cable Sizes
5.1 Turbine Wiring
5.2 Lightning Protection
5.3 Wire and Cable Sizes

5.1 Turbine Wiring

The e400ⁱ wind turbine produces dc power and therefore has two double insulated output wires (tails). The RED wire is POSITIVE and the BLACK wire is NEGATIVE.

Observe the Polarity at all times. Only connect +VE RED cables to +VE RED terminals and -VE BLACK cables to -VE BLACK terminals. Otherwise, equipment damage may result and any warranty will be invalidated.

The following suggestions are made as a guideline. If you are in doubt, consult an electrician.

The output wires must be extended as required for the installation. Good wire connections are absolutely essential to avoid poor power delivery and high temperatures at the connection. All electrical systems lose energy because cables have a resistance. The mounting structure must be directly earthed for lightning. The power cable is usually brought down the inside of the mounting structure to give some protection. Supply cables should never be spanned or suspended from the turbine structure and should be buried at least one half metre deep in a suitable plastic or steel conduit.

5.2 Lightning protection

Proper grounding is essential to protect the system from induced voltages and static. Local requirements for electrical installations must be satisfied. Ensure that the generator is electrically connected to the mounting structure and that the structure is earthed. This is usually done by burying a 2 to 3m (6' – 10') length of water pipe (steel or copper) horizontally, 1000mm (3.3') below the ground surface. A good connection is made between the middle of the pipe and the structure. An improved method is to bury a cross of pipe, which requires a "X" shape to be excavated. The connection is made in the centre of the cross.

The negative battery connection should also be grounded using a ground point close to the battery. First, consult the Charge Controller Manual to avoid earth loops. The wire size for grounding should be the same size as the power cables. Commercial lightning arrestors are available at electrical stores and can be fitted at the bottom of the structure or pole or at the regulator input.

5.3 Wire and Cable Sizes

The copper wire sizes given in the tables are calculated for 3% power loss in wire resistance. This is usually acceptable in low voltage installations. A larger wire size will increase the delivered power but usually a compromise is reached as larger cables cost more. It is recommended that the wire sizes given be taken as a minimum value.

Measure the distance from the top of your structure (i.e. the e400ⁱ) to the regulator. Select the wire size for that distance from the table. The double run of +ve and -ve is already accounted for.

The power cable should be run down the inside of the pole or structure and then buried in a suitable underground conduit at least 500mm below the ground surface.

Wire Size for 48V e400ⁱ (65A maximum current)

10m (33')	20m (66')	30m (96')	40m (130')	50m (165')	80m(260')	100m (330')
6sq mm (9)	10sq mm (7)	16sq mm (5)	20sq mm (4)	25sq mm (3)	40sq mm (1)	50sq mm (0)

Wire Size for 110V e400ⁱ (28A maximum current)

10m (33')	20m (66')	30m (96')	40m (130')	50m (165')	80m(260')	100m (330')
10sq mm (7)	20sq mm (4)	35sq mm (2)	35sq mm (1)	50sq mm (0)	70sq mm (00)	100sqmm(0000)

Wire Size for 200V e400ⁱ (12A maximum current)

20m (66')	40m (130')	60m (200')	80m(260')	100m (330')
0,5sq mm (20)	1,5sq mm (15)	2,5sq mm (14)	2,5sq mm (14)	4sq mm(11)

6 BATTERY CONSIDERATIONS

6 Battery Considerations

- 6.1 Lead Acid Batteries
- 6.2 Sealed Gel Batteries
- 6.3 Ni-Cad Batteries
- 6.4 Temperature Compensation

Batteries are available in many shapes, sizes and chemistry. Battery dealers will be pleased to assist. The most common ones are reviewed below. In general, only "Deep cycle" batteries and cells should be used and automotive or vehicle batteries will have a short life as they are not designed for cyclic charging and discharging. A cell is a single unit of 2V and a battery consists of a number of cells joined in series. The usual installation consists of 12V batteries arranged in series or parallel, or both. Batteries should not be exposed to temperature extremes and good ventilation is required as batteries can emit hydrogen while being charged.

The stored energy in a battery is given in Ampere Hours (Ah) or Watt hours (Wh). The capacity is often based on a 10 hour discharge rate. A 100Ah battery will therefore supply a current of 5A for 20hrs or 10A for 10hrs or 20A of current for 5hrs. It will not however supply 100A of current for 1hr. There is much literature available on this subject. It is recommended that the e300^z should be charging at least 200Ah of battery capacity for a 12V system.

6.1 Lead Acid Batteries.

These are the most popular choice of battery type and can be vented/flooded (Water may be added), or semi-sealed or low maintenance (Water cannot be added). Charging voltage is typically 13.8-14.0 / 27.6-28.0Vdc for these batteries.

6.2 Sealed Gel Batteries

Sealed gel batteries are more expensive but offer clean and safer operation as no acid can be spilled. Since they are sealed, they must never be boosted and the charging voltage is important. Charging voltage is typically 14.0 / 28.0Vdc. Consult your battery supplier.

6.3 Ni-Cad Batteries

This type of battery is traditionally used where large currents must be delivered and where deep cycling is required. They are however relatively expensive. Consult your battery supplier for details.

6.4 Temperature Compensation

Much has been documented on this subject and there are certain merits. Generally, lower and higher ambient temperatures allow higher and lower charging voltages respectively. e400 regulators do not have this facility. Batteries should be sited in a cool area and temperature compensation is only useful in extreme temperature variations.

7 TECHNICAL SPECIFICATIONS

7 Technical Details
7.1 Technical Specifications
7.2 Declaration of Conformity

7.1 TECHNICAL SPECIFICATIONS

e400ⁱ

Maximum Power	3300W
Rated power at 11m/s 200Vdc	3000W
Rated power at 11m/s 48Vdc	3000W
Annual energy capture at 5m/s average 200Vdc	4240kWh
Annual energy capture at 5m/s average 48Vdc	4040kWh
	(For average wind speed of 5ms ⁻¹ and 12m tower at sea level)
Rated sound level	<50dB
Cut-in wind speed	2,5ms⁻¹
Cut-out wind speed	N/A
Maximum voltage 200Vdc	1000Vdc
Maximum voltage 48Vdc	250Vdc
Output power form	Two wire DC
No. of blades	3
Tower top mass	175kg
Lateral Thrust at 12ms⁻¹ (27mph) and 40ms⁻¹ (90mph)*	800N and 8600N
	<small>*NOTE: Lateral Thrust at 40ms⁻¹ is theoretical for a failed pitch control. For normal operation, thrust at 40ms⁻¹ is <1000N</small>
Speed Control	Passive pitch
Protection	IP55

7.2 DECLARATION OF CONFORMITY

Declaration of Conformity

Eveready Diversified Products (Pty) Ltd t/a
Kestrel Wind Turbines

in South Africa

declare under our sole responsibility that the product

e400ⁱ (3kW) Wind Turbine

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

EN 60034-2:	<i>Rotating Electrical Machines</i>
EN 60038: 2002,	<i>IEC Standard Voltage</i>
EN 60034-5: 2005,	<i>Rotating Electrical Machines Degrees of Protection</i>
EN 60204-1: 2006,	<i>Safety of Machinery</i>
EN 300386:	<i>EMC Compliance</i>

and follows the provisions in the directives

EN 61400-2: 2006, ***Design Requirements for Small Wind Turbines***

Date: 15th March 2008

Place: Port Elizabeth, South Africa

Authorising Signature:



James Carpy
Technical Director

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

8 TROUBLE SHOOTING

REST ASSURED THAT THE KESTREL WILL BE SERIOUSLY DAMAGED FROM POLARITY REVERSAL. OVERCHARGING OF THE BATTERY CAN OCCUR WITH NO FITTED CHARGE CONTROLLER. IT IS UNWISE TO DISCONTINUE CHARGING BY DISCONNECTING THE e400ⁱ FROM THE BATTERY. THE TURBINE THEN HAS NO LOAD WHATSOEVER AND CAN REACH VERY HIGH ROTATIONAL SPEEDS.

Uncontrolled output voltage can reach LETHAL values.

IF THE e400ⁱ IS DISCONNECTED FOR ANY REASON, SHORT THE GENERATOR OUTPUT WIRES. THIS WILL LOAD THE GENERATOR AND MINIMISE ROTATION.

DO NOT ALLOW THE e400ⁱ TO OPERATE WITH DAMAGED BLADES OR TAIL. DAMAGE TO THE BLADES WILL CAUSE VIBRATION THAT CAN INCREASE TO DESTRUCTIVE LEVELS.

DO NOT ALLOW THE e400ⁱ TO OPERATE WITH ANY SIGN OF UNBALANCE. ANY REPETITIVE SWINGING OF THE TAIL INDICATES THAT THE MACHINE IS UNBALANCED.

- Q There is wind but the e400ⁱ does not rotate or only rotates very slowly.
- A The e400ⁱ output is shorted. There is an electrical short elsewhere in the system. The blades are fitted the wrong way round. The e400ⁱ is restricted from swinging 360 degrees into the wind. The charge controller is defective. Other connected equipment is defective. (Disconnect the e400ⁱ from the equipment and check that the blades rotate easily). There is a short within the turbine generator. In very light wind, the e300ⁱ may well not rotate. This is quite normal as there is no useful power in such a light wind and bearing life is greatly extended. On older machines, check the generator bearings.
- Q The e400ⁱ is rocking from one side to the other at low speed but appears to run smoothly at higher speeds.
- A The blade rotor assembly is unbalanced. Remove the rotor and check for damaged blades. Rebalance the rotor if possible or fit a new blade set.
- Q The e400ⁱ is vibrating or noisy.
- A Check all fasteners on the unit, in particular the blade assembly. Vibration or noise can only be caused by the imbalance of damaged blades. Check for bearing wear on older machines.
- Q Can the e400ⁱ be left running and disconnected?
- A Theoretically yes, but high voltages may be produced. Always short the output wires when the e400ⁱ is disconnected from the regulator.
- Q What should be done in storm conditions?
- A Never approach the e400ⁱ during strong wind conditions. The e400ⁱ has been tested up to winds of 160km/h and is designed to survive such conditions. It is acceptable to lower the turbine for predicted extreme weather conditions simply for peace of mind.

9 MAINTENANCE

The e400^z is designed for continuous operation on 100% duty cycle and requires no regular part replacement.

NEVER APPROACH A ROTATING TURBINE

The e400^z is designed to operate 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.

Wind Power Class	Wind Power Density (W/sq m)	Wind Speed m/s	Wind Speed mph (Imperial)
1	Up to 100	Up to 4,4	Up to 9,8
2	100 – 150	4,4 – 5,1	9,8 – 11,4
3	150 – 200	5,1 – 5,6	11,4 – 12,5
4	200 – 250	5,6 – 6,0	12,5 – 13,4
5	250 – 300	6,0 – 6,4	13,4 – 14,3
6	300 – 400	6,4 – 7,0	14,3 – 15,7
7	Above 400	Above 7,0	Above 15,7

NOTE: PRODUCT SPECIFICATIONS MAY CHANGE DUE TO CONTINUOUS DEVELOPMENT. CONSULT THE FACTORY OR AN APPOINTED DEALER.

The following schedule is designed to avoid machine failure. Component life will be reduced on sites that exhibit high turbulence.

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 3 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). Touch up paint.	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 4 – 5 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.

- Inspection of the tower including all bolts/fasteners ground anchors and guy wires.
- Inspection of the e400ⁱ tower securing bolts.
- Check all electrical connections for tightness and corrosion.
- Functionality and general checks on all other electrical equipment.

Maintenance Tips

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/or 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 its length. There should be no movement of the blade. If any wear or defect is detected, consult your dealer or the Kestrel 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 glass fibre 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.

10 WARRANTY CONDITIONS

WARRANTY AGREEMENT

Kestrel's wind turbines are manufactured to the highest standards, in accordance with Kestrel Wind Turbines' standard and quality specifications, and warrants that the wind turbine is in good working order upon delivery and for a period of 24 months. Warranty terms and conditions are outlined below.

1. Eveready warrants that Turbines will, on delivery, be free of defects in design, material and workmanship and will be fit for their intended purpose for a period of two years calculated from the date of installation, subject to proper installation, maintenance and use in accordance with the User Manual.
2. This warranty is further subject to the Customer returning the defective Turbine at its cost to the premises of Eveready within the warranty period and furnishing full details in writing of the alleged defect.
3. Eveready's obligations under this warranty shall be limited to the repair or replacement of defective Turbines at its cost or to a refund to the Customer of the original cost thereof, as Eveready may determine in its discretion. Eveready shall not be responsible for any damages suffered by the Customer pursuant to any defects covered by this warranty.
4. This warranty shall not apply to any damage to Turbines caused by winds exceeding 160 kilometres per hour or any other factors beyond the control of Eveready.
5. The Customer may purchase an extended warranty from Eveready in respect of Turbines, subject to Eveready's standard conditions.

CONTACT KESTREL WIND TURBINES

Kestrel Wind Turbines

Eveready Diversified Products (Pty) Ltd

Eveready Road

Struandale

North End

Port Elizabeth

South Africa

P.O. Box 3191

North End

Port Elizabeth

6056

Eastern Cape

Republic of South Africa

Tel: +27 (0)41 401 2500

Email: kestrelwind@eveready.co.za

Registration Number 2006/005438/07

VAT Registration Number 4870231406

Web: www.kestrelwind.co.za

CUSTOMER AND PRODUCT DETAILS:

CUSTOMER NAME:

INSTALLATION LOCATION: DATE:

TYPE OF SYSTEM: (I.E. WATER PUMPING, BATTERY CHARGING):

MODEL OF MACHINE (E150/E220/E300I/E400I): VOLTAGE OF SYSTEM:

SERIAL NUMBER:

ACCESSORIES: (PLEASE TICK THE APPROPRIATE BOX)

Standard Controller (dump)	<input type="checkbox"/>
Charge Controller	<input type="checkbox"/>
Divert Resistor	<input type="checkbox"/>
Voltage Limiter	<input type="checkbox"/>
<u>Non-Kestrel Controller</u> Outback MX60	<input type="checkbox"/>

INSTALLATION CHECKLIST:

- All bolts are secured to recommended Torque Settings: YES/NO
- All proper connections are secured: YES/NO
- Machine is installed on a Kestrel Tower: YES/NO
- Machine is running with no obvious vibrations: YES/NO
- System is operational: YES/NO

WARRANTY START DATE: SIGNATURE:

WARRANTY END DATE: DATE: