Endurance™ wind power

we power the future

# Operator's Manual | S-Series

**To Be Installed and Maintained by Trained Personnel Only**

endurancewindpower.com

green energy that works™

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## Copyright



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This document is intended as a guide only and should not be considered as a replacement for professional services, nor as a definitive text for installing, operating, or maintaining wind turbines.

Only properly trained and experienced personnel should install Endurance Wind Power, Inc. wind turbines using all necessary and proper equipment.

The information provided by Endurance Wind Power, Inc. in this document assumes that personnel have the training, skills, experience, and equipment needed to carry out all installation, operations, and maintenance activities described herein, and that all safety precautions are always taken and all necessary safety equipment used—whether or not safety warnings are provided herein. The Installation, operation, or maintenance of Endurance Wind Power, Inc. wind turbines shall only be carried out by personnel with the necessary training, skills, experience, tools, and safety equipment.

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Actual wind resources and site conditions impact energy production, which will vary with wind turbine maintenance, altitude, temperature, topography, and the proximity to other structures. Therefore, Endurance Wind Power, Inc. makes no representation or warranties regarding energy production.

Since Endurance Wind Power, Inc. is constantly striving to improve its products, the information contained within this document is subject to change at any time without notice.

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# GENERAL INFORMATION

## Welcome to Endurance

Congratulations on your purchase of an Endurance Wind Power S-Series Wind Turbine System. Your choice of an Endurance wind turbine will reward you with years of reliable wind-generated electricity combined with the peace of mind in knowing that your turbine system has been engineered to the most stringent standards in the world.

To make sure that your Endurance wind turbine system meets all of your, and our expectations, please fill out the enclosed Warranty Registration. This will ensure that your wind turbine investment is fully protected under our warranty program, and will allow us to keep your system up-to-date with any necessary product updates. Your information is used solely for this warranty program in order that we can keep your turbine operating in top condition. We do not share, sell, or distribute your information with any third party.

## About This Manual

This manual provides information regarding the operation and maintenance of Endurance Wind Power, Inc. S-Series wind turbines. Any personnel tasked with operating or maintaining this wind turbine system should be familiar with this complete documentation package and should have it available for reference.

This manual only covers operation and maintenance of the turbine system and assumes the turbine and tower system have already been installed. For installing an Endurance tower and turbine please refer to the appropriate *Installation Manual* for details and specifications.

The information given in this manual must be read carefully and applied rigorously. Failure to observe the information provided herein may result in risks to personal health and safety, as well as economic damages and voiding of the warranty.

All information, illustrations, and specifications in this procedure are based on the latest information at the time of publication. Endurance Wind Power, Inc. reserves the right to modify, supplement, and improve the manual at any time without notice. Contact Endurance Wind Power, Inc. for the current version of this document.

## Who Should Use This Manual

Any individual who owns or operates the wind turbine should be familiar with this manual and have it available for reference.

This manual is intended for owners or operators who want to attain a fundamental understanding of the turbine.

## Technical Assistance

Technical assistance is normally provided by your local Endurance Dealer. In the unlikely event that your Dealer cannot provide a solution, you can contact Endurance Wind Power, Inc. directly via:

email: techsupport@endurancewindpower.com

phone: 1-866-WIND-823 (1-866-946-3823 (toll free in North America only)

+011-604-579-9462 (outside of North America)

For your records, enter your system information below:

Serial Number: _____

Model Number: _____

Date of Purchase: _____

Date of Commissioning: _____

## Dangers and Cautions

All dangers and cautions are meant to provide you with safety information. Disregarding dangers and cautions can result in severe personal injury to you or your equipment.

| Symbol | Description |
|---|---|
|  | This indicates that dangerous voltage is present and there is an imminent risk of electric shock, which, if not avoided, will result in death or serious injury, if proper precautions are not followed. |
|  | This indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury, if proper precautions are not followed. |
|  | This indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. This does not alert you to a property damage accident unless personal injury risks are associated with the accident. |

# SAFETY AND SPECIFICATIONS

## Safety

Anyone operating, opening, or servicing the wind turbine equipment must be properly trained and must follow all safety instructions found in this manual. All personnel should carefully review all pertinent sections of this manual prior to performing any operation, maintenance, or troubleshooting procedures on the wind turbine. Be sure to follow any and all applicable local, regional, and national safety standards applicable to your situation.

1. Personnel installing, operating, or maintaining the wind turbine must be trained specifically for the purpose, and equipped with and trained in the use of the appropriate tools and individual safety equipment. Failure to meet these requirements constitutes a risk to personal health and safety.
2. Maintaining a wind turbine may require moving heavy masses around and overhead. All tools and equipment used to perform this work must be adequate and capable of doing the job safely. Check specifications for weight and size of large components prior to moving them.
3. Environmental conditions, including temperature and wind speed, must be assessed to ensure they do not exceed the limits of safely performing tasks such as raising the tower. Failure to follow the guidelines set forth in this document and any other pertinent safety procedures will increase risk to personal safety.
4. Keep the working area free of clutter and clean up any spills to mitigate slipping or tripping hazards.
5. High voltage panels must be kept locked during turbine operation to prevent shock hazards.
6. Work on electrical and junction panels, especially those containing high voltage power, must be carried out with extreme caution, and only by properly qualified and trained personnel.
7. Using a multimeter, verify that all sources of power are absent prior to working inside any panel.

   **Note**: Turning off the turbine using the Halt command or switch does not cut power to the turbine control panels.
8. In cold weather locations, ice may accumulate on the turbine. Accumulated ice may shed and fall from the turbine. Observe caution when standing or working under the turbine or tower during conditions suitable for ice accumulation as falling ice may cause injuries and damage to structures and vehicles.
9. Install physical barriers and visual warnings around the turbine to protect the public from electrical and other dangers present in the area during maintenance procedures.


**Always disconnect the electrical power when working in proximity of the turbine.**

11. If the turbine is installed on a tilt-down tower system, do not turn on the main electrical disconnect unless the tower is secured in its full upright position. Whenever the turbine is lowered, or being lowered or raised, turn off the main disconnect to prevent the turbine from starting, as this could result in injury or damage.

## General Turbine Safe Operations

It is important to always maintain control of public access to the wind turbine. While wind turbines are inherently safe, there are some common hazards that may pose a risk to the untrained public. These include the following:

- Electrical hazards—all electrical panels must be closed and locked whenever power to the panels is on.
- Access to networked turbine remote controls—secure network access with passwords, firewalls, and other protection to prevent unauthorized operation of the turbine by untrained persons.

Wind turbines are a large rotating mass mounted at a significant height above ground level structures and people. Should the operation of the turbine become uncontrolled, there can be a potential hazard to nearby people or property. Protections are built into every Endurance wind turbine to limit this hazard and bring the turbine to a stop immediately. We recommend all persons and vehicles be kept at least 300 m (1,000 ft) away from the turbine if any of the following behaviors are evident:

- Sustained rotor speed above 250 revolutions per minute
- Obvious damage to the tower, turbine, or its blades
- Unresponsiveness to remote shutdown commands
- Unusual noise, vibration, or tower motion (some noise, vibration, and motion is normal)

## Placing the Turbine in the Halt state

The turbine can be placed in a Halt state which prevents the turbine from releasing the brakes, spinning up, or going online. This is accomplished by either making a selection on the remote software interface, or in the control panel by turning the key switch to the Off position. The Halt state should only be used as a method to stop the turbine temporarily. Always electrically disconnect the turbine from the grid to place the turbine in a parked situation for long periods or to conduct maintenance.

## Environmental Conditions

Check the weather forecast before servicing the wind turbine. Do not proceed with tilting the tower up or down if wind gusts are forecast to exceed 9 m/s (20 mph) during the projected tilting time period.

If any heavy equipment is employed (for example, a tractor), be sure the conditions are within the safe operating limits of the equipment, including wheel traction and temperatures.

# TURBINE OVERVIEW

## Technical Specifications

| Turbine | |
|---|---|
| Configuration | 3 blades, horizontal axis, upwind |
| Rated power @ 11 m/s | 5.4 kW |
| Applications | Direct grid-tie |
| Rotor speed | 167 rpm |
| Cut-in wind speed[1] | 4.1 m/s (9.2 mph) |
| Cut-out wind speed | 25 m/s (55.9 mph) |
| Survival wind speed | 52 m/s (116 mph) |
| [1] The cut-in wind speed listed here is based on measured turbine power performance. Cut-in wind speed mentioned elsewhere in regards to turbine control parameters may differ. | |

| Rotor | |
|---|---|
| Rotor diameter | 6.37 m (20.9 ft) |
| Swept area | 31.9 $m^2$ (343 $ft^2$) |
| Blade length | 3.08 m (10.1 ft) |
| Blade material | Fiberglass/epoxy |
| Power regulation | Stall control (constant speed) |

| Generator | |
|---|---|
| Type | Induction generator |
| Configuration | • single phase, 120/240 VAC split-phase @ 60 Hz<br>• patented dual voltage generation |

| Brake and Safety Systems | |
|---|---|
| Main brake system | Rapid fail-safe mechanical brake on rotor shaft |
| Secondary safety | Redundant fail-safe mechanical brake on rotor shaft |
| Automatic shutdown triggered by | • High wind speed<br>• Grid failure<br>• Over-speed<br>• All other fault conditions |

| Controls | |
|---|---|
| Control system | Field-programmable embedded controller |
| User interface | Wireless or wired network software interface for remote monitoring and control |

| Warranty | |
|---|---|
| Turbine and controls | 5 years |

| Tower | |
|---|---|
| Types | • Guyed—31.1 m (102 ft) or 36.6 m (115 ft)<br>• Freestanding monopole—18.3 m (60 ft) or 27.5 m (90 ft) |
| Maintenance access | All towers tilt |

## Performance Specifications

Power performance of the Endurance S-343 wind turbine has been evaluated in accordance with the American Wind Energy Association (AWEA) *Small Wind Turbine Performance and Safety Standard* (AWEA 9.1-2009). The results have been certified by the Small Wind Certification Council (SWCC) and the series issued *Limited Power Performance Certificate Number LPP-10-09*.

The performance data included in that certification is reproduced below. The full report is available online from the SWCC at:

- http://www.smallwindcertification.org/wp-content/new-uploads/2012/09/LPP-Report-10-09.pdf

Table 1. S-343 Power Curve Specifications

| SWCC Certified Power Curve | |
|---|---|
| Hub Height Wind Speed (m/s) | Electrical Power Output (W) |
| 4.5 | 0 |
| 5.0 | 285 |
| 5.5 | 743 |
| 6.0 | 1,007 |
| 6.5 | 1,426 |
| 7.0 | 1,966 |
| 7.5 | 2,475 |
| 8.0 | 3,030 |
| 8.5 | 3,570 |
| 9.0 | 4,029 |
| 9.5 | 4,469 |
| 10.0 | 4,823 |
| 10.5 | 5,125 |
| 11.0 | 5,385 |
| 11.5 | 5,627 |
| 12.0 | 5,827 |
| 12.5 | 5,940 |
| 13.0 | 5,983 |
| 13.5 | 5,896 |
| 14.0 | 5,738 |
| 14.5 | 5,498 |
| 15.0 | 5,219 |
| 15.5 | 4,898 |
| 16.0 | 4,588 |
| 16.5 | 4,236 |
| 17.0 | 3,829 |
| Assumed sea level air density = 1.225 kg/m$^3$ | |

Table 2. S-343 Annual Energy Production Specifications

| SWCC Certified Annual Energy Production (AEP) | |
|---|---|
| Hub Height Annual Average Wind Speed (m/s) | AEP Measured (kWH) |
| 4 | 4,064 |
| 5 | 8,881 |
| 6 | 14,078 |
| 7 | 18,659 |
| 8 | 22,048 |
| 9 | 24,122 |
| 10 | 25,047 |
| 11 | 25,098 |

# MAJOR COMPONENTS OF THE TURBINE

## External Components

Your turbine consists of the following external components:

- Rotor—This part consists of three aerodynamic blades which spin to capture the energy in the wind. The blades are aerodynamic devices that are precisely designed, engineered, and manufactured. They serve to extract energy from the wind passing through the rotor, and also to regulate power when wind speeds get too strong. The blades are constructed of fiberglass composites for durability. They are further protected by rugged tape on the leading edge. This tape is also precisely designed to improve performance and minimize noise of the blades cutting through the air.


**Do not make any modifications to the blades or this tape as this may harm performance or void your warranty.**

- Nacelle—This is the body of the turbine. It contains the braking and generating systems, including all the components needed to convert the captured energy into electricity. (Further details on these internal components are provided below.) The nacelle cover is a fiberglass shell that provides protection for the internal components and a sleek, clean look to the turbine exterior.
- Tail—This part works as a weathervane to direct the wind turbine rotor into the wind in order to maximize exposure to and capture energy from the wind. The tail plane is made of aluminum and is supported by a steel tail boom.
- Tower—This part is sometimes called the mast. It places the turbine high in the air where the rotor can catch the strongest winds.
- Control panel—This part is located in a weatherproof enclosure at or near the base of the tower. It monitors and controls the turbine operation at all times.

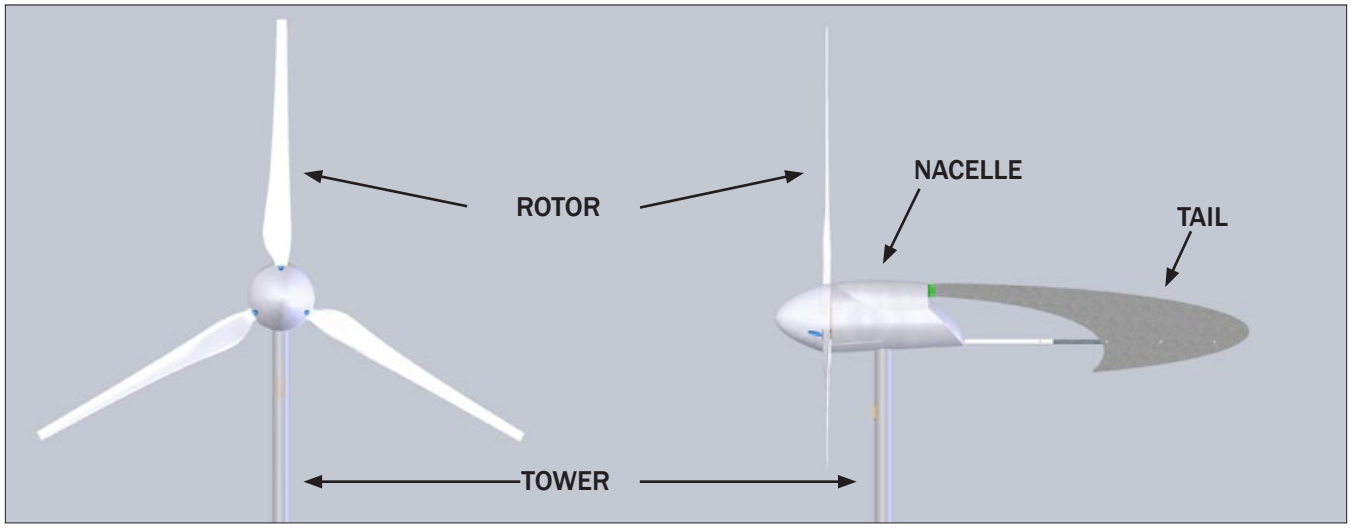


Figure 1. Tower and Turbine External Components

## Internal Components

The internal workings of your Endurance wind turbine include carefully chosen components expertly engineered in a configuration to provide reliability and longevity to your wind energy investment.

Your turbine consists of the following internal components:

- Gearbox—This part serves as a speed increaser with a ratio of 11:1. It allows the rotor to turn at a quiet, leisurely pace (around 170 rpm) while the generator spins at a more efficient high speed (around 1800 rpm).
- Induction Generator—This part provides grid-compatible power directly. It eliminates the need for expensive, complicated, inefficient, and unreliable power electronics.
- Brake Disc and Calipers—This is the most critical part of the turbine safety system. It ensures that the turbine can only operate when the control system determines it is safe and beneficial to do so. A properly functioning brake system is critical to ensuring the longevity of the wind turbine system. The brake system uses redundant calipers on a single, 16 inch brake disc to guarantee the ability to stop the rotor during any condition. The brake system is failsafe, meaning its default setting is to apply the brakes and stop the rotor.
- Rotor Hub Assembly—This is a sandwich arrangement of two steel plates on either side of the blade roots. This design ensures that the blades will stand up to the harshest wind and weather conditions.

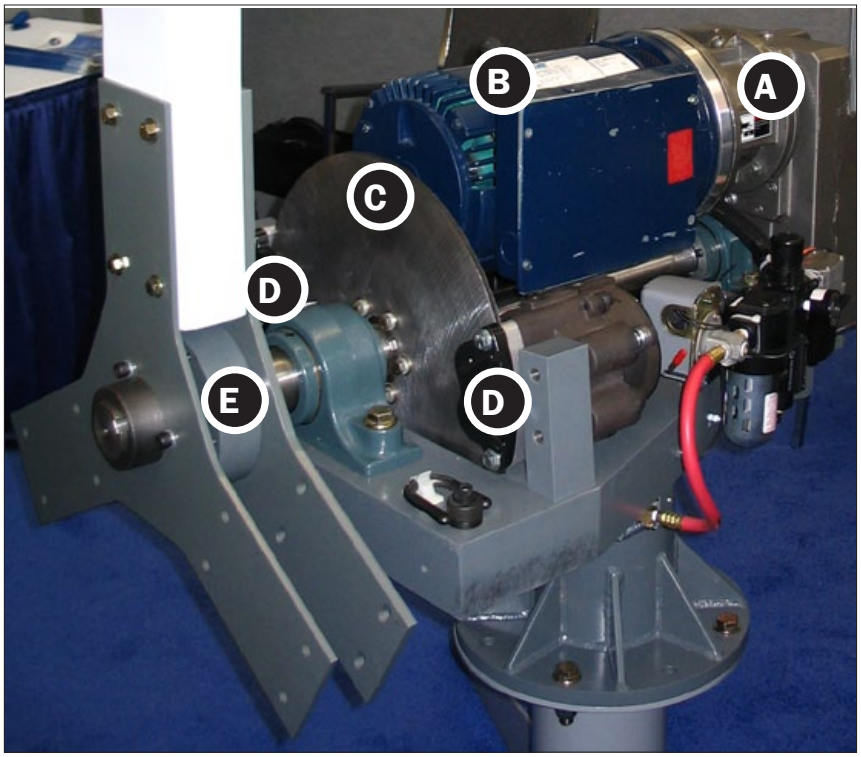


Figure 2. Turbine Components

| | |
|---|---|
| A | Gearbox |
| B | Induction Generator |
| C | Brake Disc |
| D | Pneumatic Brake Calipers |
| E | Rotor Hub Assembly |

# CONTROL SYSTEM COMPONENTS

## Sensors

There are two turbine speed sensors to ensure that the controller always knows the rotor speed. As well, the anemometer is used to decide when to enter the cut-in and cut-out states while the grid monitoring tells the controller whether the grid frequency and voltage is within tolerance. Further information on each of these components is presented in this chapter.

For further information on key controller parameters, including which sensors are utilized for specific functions, see *"Appendix A: Control Program Parameters"* on page 46.

### LSS Sensor

The low speed shaft (LSS) sensor is an optical encoder. The output from the encoder is a –5 to +12 VDC square wave with 1024 pulses per revolution . It is located on the low speed shaft resulting in an input frequency of 2.84 kHz at synchronous speed (166.4 rpm). The controller counts this signal (and calculates the rotor rpm) every 100 msec. This results in 284 pulses per counting period at synchronous speed.

### HSS Sensor

The high speed shaft (HSS) sensor is a non-contact, magnetically actuated sensor. The output from the sensor is a –5 to +12 VDC square wave. The wheel has 36 magnets resulting in 18 pulses per revolution. (Magnetic polarity alternates in adjacent magnets to provide the high and low signal of a single pulse.) The HSS sensor has an input frequency (to the controller) of 540 Hz at synchronous speed. The controller counts this signal (and calculates the rotor rpm) every 1 sec. This results in 540 pulses per counting period at synchronous speed.

### Anemometer

The anemometer is a Hall-Effect sensor with a –5 to +12 VDC square wave output. The transfer function for the anemometer is:

Wind speed (m/s) = [0.765*frequency (Hz)] + 0.35 (m/s)

Using this function, we determine that the frequency at cut-in (4.0 m/s) is 4.77 Hz and at cut-out (25.0 m/s), it is 32.2 Hz,

# Control Panel

**When the power is on, the control panel contains dangerous, high-voltage electricity and should only be accessed by trained personnel. All work performed in the control panel should be carried out only when the Main Disconnect switch for the turbine is turned off.**

Most control components are mounted on a tower-base control panel. The S-343 control panel is housed in a NEMA-12 enclosure. Wires, providing power from the grid, as well as turbine power and control wires coming down the tower, are connected to this panel.

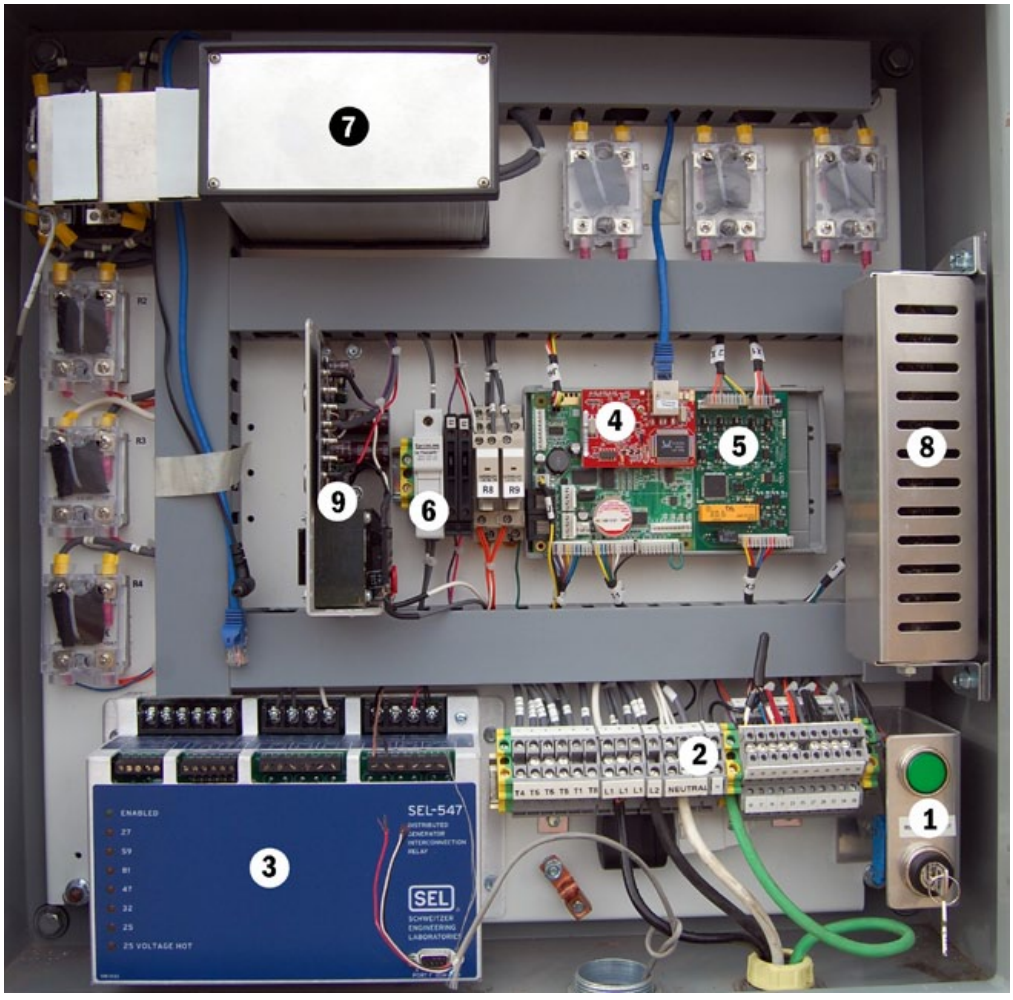


Figure 3. Control Panel

| | |
|---|---|
| 1 | Run/Off/Reset key switch and indicator light |
| 2 | Panel electrical connection terminal blocks |
| 3 | Grid monitoring relay |
| 4 | Main PLC control board |
| 5 | Watchdog circuit board |
| 6 | Fuses |
| 7 | Capacitor box |
| 8 | Voltage switching power resistor |
| 9 | DC power supply |

## Run/Off/Reset Key Switch

The key switch can be used to stop and start the turbine, to clear faults, and to reset the watchdog circuit board. It is located in the lower right of the control panel, along with a green light.

For further detail on the key switch, see:

- *"Resetting the Watchdog Relay"* on page 18
- *"Clearing a Halt or Fault Condition"* on page 24

The green light above the key switch indicates the status of the controller watchdog relay. If this green light is on, the relay is closed and the turbine controller is powered up.

For further information on the watchdog delay, see *"Controller Watchdog"* on page 17.

## Panel Electrical Connection Terminal Blocks

Upon installation of the control panel, all electrical connections are made at the terminal blocks in the lower right of the panel. This includes all electrical connections between the local grid and the panel, as well as the turbine and the panel.

## Control Panel Power

The same grid lines used to deliver power from the turbine to the grid also power the control panel (240 VAC).

## Grid Monitoring Relay

The grid monitoring relay creates a simple circuit that produces a digital input signal. If the grid monitoring relay trips (open), then the circuit is broken and the input signal goes high (+12 VDC). This indicates a bad grid and puts the controller into a WARNING: Grid Error state.

For further information on this state, see *"Turbine Operation"* on page 21.

## Main PLC Control Board

The main PLC control board is the controller for your turbine. It is programmed with the control algorithms necessary to operate the wind turbine by monitoring digital inputs and issuing digital output commands. This board has a set of light-emitting diodes (LEDs) that light up to indicate board operations.

For details on the inputs, outputs, and LEDs on the board, see *"Appendix B: Technical Details for the Main Control Board"* on page 48.

In addition to conducting the normal operation aspects of the wind turbine, the controller also continuously monitors for system faults. If one is detected, the controller will safely shut down the turbine and wait for manual intervention before the system can be restarted.

For further information on turbine operating states and faults, see *"Turbine Operation"* on page 21.

The main PLC control board can communicate with a remote computer via a software interface. It displays aspects of controller function to the user and can relay user stop, start, and other commands to the turbine.

For further information, see *"Endurance Remote Interface"* on page 26.

### Commissioning Test Access

Commissioning tests are accessible by removing the jumper on DI-15 of the controller (lower right of main control board). When the jumper is removed, the commissioning test parameters can be selected from the remote software interface. The jumper should always be installed during normal operation to prevent accidental operation in a commissioning test mode.


**Only trained Endurance service personnel should utilize the commissioning tests to perform specific tasks.**

## Internal Watchdog Timer

The main PLC control board uses an internal watchdog timer. This watchdog timer will only trigger if there is a serious hardware or software problem that freezes the program.

The internal watchdog timer is reset each time the control software completes a major control task. If the watchdog timer is not reset before it counts down to zero (approximately two seconds), then the controller will reboot. The system will behave as though there were a power outage.

If the problem persists, the controller will reboot repeatedly and the brakes will continue to be applied, keeping the system in a safe state. This condition indicates a problem with the control program or board. Contact your EWP Dealer service technician for a resolution to this problem.

# Controller Watchdog

Located next to the main PLC control board is the watchdog circuit board. This board includes a latching relay that will cut DC power to the brakes in the panel if it detects an error. The watchdog monitors the pulse sent by the main PLC control board about once per second.

If this pulse disappears, this could indicate a serious problem with the control program and the watchdog would cut the DC power to the system forcing the brakes to apply. At this point, the watchdog relay latches off and the controller cannot restart the turbine without manual intervention.

When the watchdog relay trips, the green light on the Run/Off/Reset key switch will turn off. There is also an LED on the watchdog board labeled RELAY. It is lit when the relay is on.

## Back-Up Over-Speed Monitoring

The control system also utilizes the watchdog board as a backup means of detecting over-speed, should the controller program fail to detect such a condition. The watchdog monitors both turbine speed sensors for an over-speed condition.

If an over-speed condition arises, the watchdog reacts in the same fashion as described above to stop the turbine. This condition will occur only if the main control board fails to detect an over-speed at approximately 183 rpm and if the watchdog detects a rotor speed in excess of approximately 200 rpm.

## Resetting the Watchdog Relay


**The control panel carries high voltage that is extremely dangerous. Extreme caution is required when resetting the watchdog relay. The watchdog relay should only be reset by a qualified service technician.**

To return the turbine to normal operation the latching relay must be returned to the closed position.

To do this action:

- Turn the key switch to the **Reset** position and hold until the green light turns on, indicating the latching relay has reset to the closed position.

**Important**: Returning the turbine to service in this manner should only be done following a thorough inspection and service of the cause of the over-speed condition.

If the watchdog relay has tripped, this signifies a failure either in the controller or in the braking system. EWP recommends that all turbine operating parameters be noted and the turbine's main power be disconnected until the turbine can be serviced by an experienced technician.

# Fuses

Three fuses provide protection for the wiring and components within the control panel. These fuses are housed inside fused terminal blocks near the center of the panel. All of these fuses can be easily removed or replaced by opening the fuse holder top.


**When the power is on, the control panel contains dangerous, high-voltage electricity. Turn off the turbine Main Disconnect switch prior to opening the control panel enclosure to service fuses.**

Table 4. Control Panel Fuses

| Fuse | Size | Circuit |
|---|---|---|
| F1 | 5A | Low current AC components (e.g. DC power supply) |
| F2 | 1A | +12 VDC components |
| F3 | 1A | –5 VDC components |

## Capacitor Box

The capacitor box houses two capacitors:

- 405–485 micro-Farad (µF) start capacitor
- 60 µF run capacitor

The capacitors serve to smooth the motoring operation and adjust the power factor during electrical generation.

## Voltage Switching Power Resistor

The voltage switching power resistor is employed as part of the patented dual-voltage switching (DVS) system.

During transitions between the Freewheel state to the Generating 120 V state, and between the Generating 120 V and Generating 240 V states, this power resistor is briefly inserted into the power circuit. This insertion serves to smooth out the operation during these transient events so as to minimize torque excursions in the turbine drivetrain.

## DC Power Supply

The control board, sensors, and (low voltage) relays are powered via a +12/–5 VDC linear power supply that is housed in the control panel.

## Control System Relays

Installed on the control panel are nine relays numbered from R1 to R9. Each of these relays serves a specific purpose.

Table 5. Control Panel Relays

| Relay | Type | Purpose |
|---|---|---|
| R1 | Mechanical double-pole, double throw (DPDT) | Reverses polarity on the turbine generator primary winding during motoring periods. |
| R2 | Solid-State Relay (SSR) | Inserts the start capacitor into the generator secondary winding circuit, connecting that circuit to the grid Hot-1 line. |
| R3 | SSR | Inserts the Voltage Switching Power Resistor into the generator primary winding circuit, connecting that circuit to the grid Hot-1 line during state transitions. |
| R4 | SSR | Inserts the run capacitor into the generator secondary winding circuit, connecting that circuit to the grid Hot-1 line. |
| R5 | SSR | Connects the generator primary winding circuit to the grid Hot-1 line, bypassing the Voltage Switching Power Resistor. |
| R6 | SSR | Connects the generator primary and secondary winding circuits to the grid neutral line during 120 V operation. |
| R7 | SSR | Connects the generator primary and secondary winding circuits to the grid Hot-2 line during 240 V operation. |
| R8 | Ice-cube relay | Used to trigger DPDT relay R1. |
| R8 | Ice-cube relay | Powers the brake circuit when activated which releases the brakes on the turbine. |

For details on the status of each relay during specific operating states and state transitions, see *"Appendix B: Technical Details for the Main Control Board"* on page 48.

# TURBINE OPERATION

Endurance wind turbines are designed to operate automatically. The control system continuously monitors the wind and rotor speed to make decisions on turning the turbine on or off, as well as other aspects of operation. If an unforeseen event occurs, the control system will automatically shut the turbine down; this may require a manual reset once the detected fault is fully investigated and cleared.

## Operating States

Your turbine has four basic operating states:

1. Normal Operation—The turbine is available to produce power when the wind is right.
2. User Halt—The turbine has been manually shut down to prevent operation.
3. Fault—The controller has detected a problem with the turbine that requires attention. The turbine needs to be manually reset before it can be returned to normal operation.
4. Warning—The controller has detected a problem with the turbine that will likely clear itself after a time-out period.

These four basic operating states have additional sub-states that are determined by specific conditions and dictate the status of the turbine brakes and the state of the power connection to the grid.

Table 3. Turbine Operating State Details

| Turbine State | Sub-State | Brake Status | Turbine Power State | Conditions |
|---|---|---|---|---|
| Normal Operation | Calm | Applied | Off | Winds too light to start |
| | Cut-in | Released | Off | Rotor not spinning in low winds |
| | Freewheel | Released | Off | Idling in low winds |
| | Motoring | Released | 120 V motor | Motoring up to starting speed |
| | Generating low | Released | 120 V generating | Producing low power |
| | Generating high | Released | 240 V generating | Producing high power |
| | High winds | Applied | Off | Winds too strong |
| User Halt | — | Applied | Off | Manual input commands needed to exit Halt or Fault state and return to Normal |
| Fault | RPM Error | Applied | Off | |
| | Over-speed | Applied | Off | |
| | Unknown | Applied | Off | |
| Warning | Grid error | Applied | Off | Auto restart after 5 min |
| | Anemometer error | Applied | Off | Auto restart after 1 min |
| | Motoring error | Applied | Off | Auto restart after 3 hr |

# Operating Sub-States

## Normal Operation

There are six normal operating sub-states:

- Calm—The turbine is waiting for sufficient wind to release the brakes.
- Cut-In—There is sufficient wind to release the brakes and prepare to start spinning the rotor.
- Freewheel—The brakes are released and the rotor is free to spin up to operating speed.
- Motoring—The generator is being temporarily powered as a motor to help bring the rotor up to operating speed.
- Generate 120 V—The turbine is producing 120 VAC electrical power from the wind.
- Generate 240 V—The turbine is producing 240 VAC electrical power from the wind.

## User Halt

The turbine controller can be placed in a manual Halt condition which requires a manual Run command to clear the Halt condition and return the turbine to service.

**Note**: If the control system gets confused upon start-up (for example, due to grid electrical problems), the controller may place the turbine in this state as a precaution.

If the turbine is discovered in a Halt state, do a cursory check of the turbine prior to restoring it to service. For information on clearing a Halt condition, see *"Clearing a Halt or Fault Condition"* on page 24.

## Fault

A Fault occurs when there is a condition that is serious enough to require a manual reset of the turbine to return it to operation.

To assess what caused the initial Fault condition, refer to *"Troubleshooting"* on page 43 in this manual for assistance. As well, take the required steps to rectify the problem to ensure that it will not occur again after manually resetting the controller.

There are two main Fault conditions that could be encountered:

- Overspeed—If the turbine rotor ever exceeds 183 rpm for 0.2 seconds, the controller registers this error and stops the turbine. This error should not occur during normal operation of the turbine. This condition indicates a serious problem that should be addressed before returning the turbine to service.
- RPM Error—The turbine control system uses redundant rotor speed sensors to ensure that the control system always knows the actual rotor speed. If these

two rotor speed signals do not agree with each other, the controller registers an error and shuts down the turbine. This error indicates a serious problem with one of the rotor speed sensors or signals. This condition should be rectified prior to returning the turbine to service.

For information on clearing a Fault condition, see "Clearing a Halt or Fault Condition".

### Clearing a Halt or Fault Condition

There are two methods for clearing a Halt or Fault condition:

- Using the ERI—To clear any of the Fault conditions, first place the turbine in a Halt state. To do this using the ERI, ensure the turbine is on and communicating with the ERI. From the main screen press the **Halt** button and wait several seconds. Once the ERI confirms the turbine is in a Halt state, press the **Run** button and wait several seconds. The turbine should now be in normal operating mode. For further details on the ERI, see *"Endurance Remote Interface"* on page 26.

- From the Control Panel—Halt and Fault states can be cleared from the control panel.


**Extreme caution is required with this method as the control panel carries high voltage electricity that is extremely dangerous. This method is not recommended for safety reasons. However, if the above ERI reset method cannot be used, this option can be utilized by an experienced electrician or turbine repair specialist to reset the turbine.**

While the turbine is powered On, turn the key switch in the lower-right of the panel from Run to Off and back to Run. This will clear any Halt or Fault condition, returning the turbine to normal operation.

## Warning

The turbine control system will temporarily shut down the turbine for specific operating conditions. Once these conditions clear, the turbine will revert to normal operation following a prescribed time-out period. The specific conditions include the following:

- Highwinds—To protect the rotor from potentially damaging gusts, the turbine will shut down when winds exceed approximately 25 m/s (55 mph). Once the wind speeds subside to less than about 19.5 m/s (45 mph) for at least 30 minutes, the turbine will return to normal operation.

- Grid Error—To ensure safety of the electrical system, the control system monitors grid voltage and frequency for compliance with IEEE 1547 standards. If the voltage or frequency is determined to be out of range, the turbine will shut down. Once normal grid conditions resume for at least five minutes, the turbine reverts to normal operation.

- Anemometer Error—If the control system detects that the turbine is producing power without any measurable wind speed to do so, the turbine is shut down as a precaution. Normally, this condition indicates the anemometer has stopped due to icing (although a more permanent failure of the anemometer could also trigger this condition). Once the icing (or other condition) has cleared for one minute, the turbine will resume normal operation.
- Motoring Error—If the turbine attempts to motor to bring the rotor up to speed and fails to turn the rotor, or fails to accelerate it to speed in a specified time, this error is registered and the turbine is shut down. This error could result from a failure to release the brakes (for example, due to icing in the pneumatic system) or an electrical problem with the motoring circuits. The turbine will revert to normal operation after a time-out period of three hours, allowing time for transient conditions (such as pneumatic system icing) to clear. The condition can be cleared manually through Halt and Run commands from the remote interface. If the motoring error condition is persistent, contact your EWP Dealer service technician to correct the problem.

## Control Program Parameters

A list of critical control parameters is available in *"Appendix A: Control Program Parameters"* on page 46.

# ENDURANCE REMOTE INTERFACE

The Endurance Remote Interface (ERI) software program can be loaded onto a personal computer (PC) to provide access to basic information about the operating state of the turbine, and the ability to stop and start the turbine, perform commissioning test functions, and update the controller firmware, if required.

## Overview

The software is available as a downloadable package (use your web browser to download the current version) from the EWP web site. Install the software according to the instructions provided with the program. You will also require a wired or wireless connection to the turbine controller. Wireless access points are provided with your Endurance wind turbine.

The factory default values for the ERI are as follows:

- IP Configuration—The default IP address is 192.168.0.61
- Turbine Password—The default password is **admin** (lower case)
- Site Name—The default name is **Endurance control panel**

With an established connection, your turbine operation can be controlled and information can be monitored remotely on your PC.

When the software is installed, start it by clicking the icon on your computer. The ERI software main window will appear.

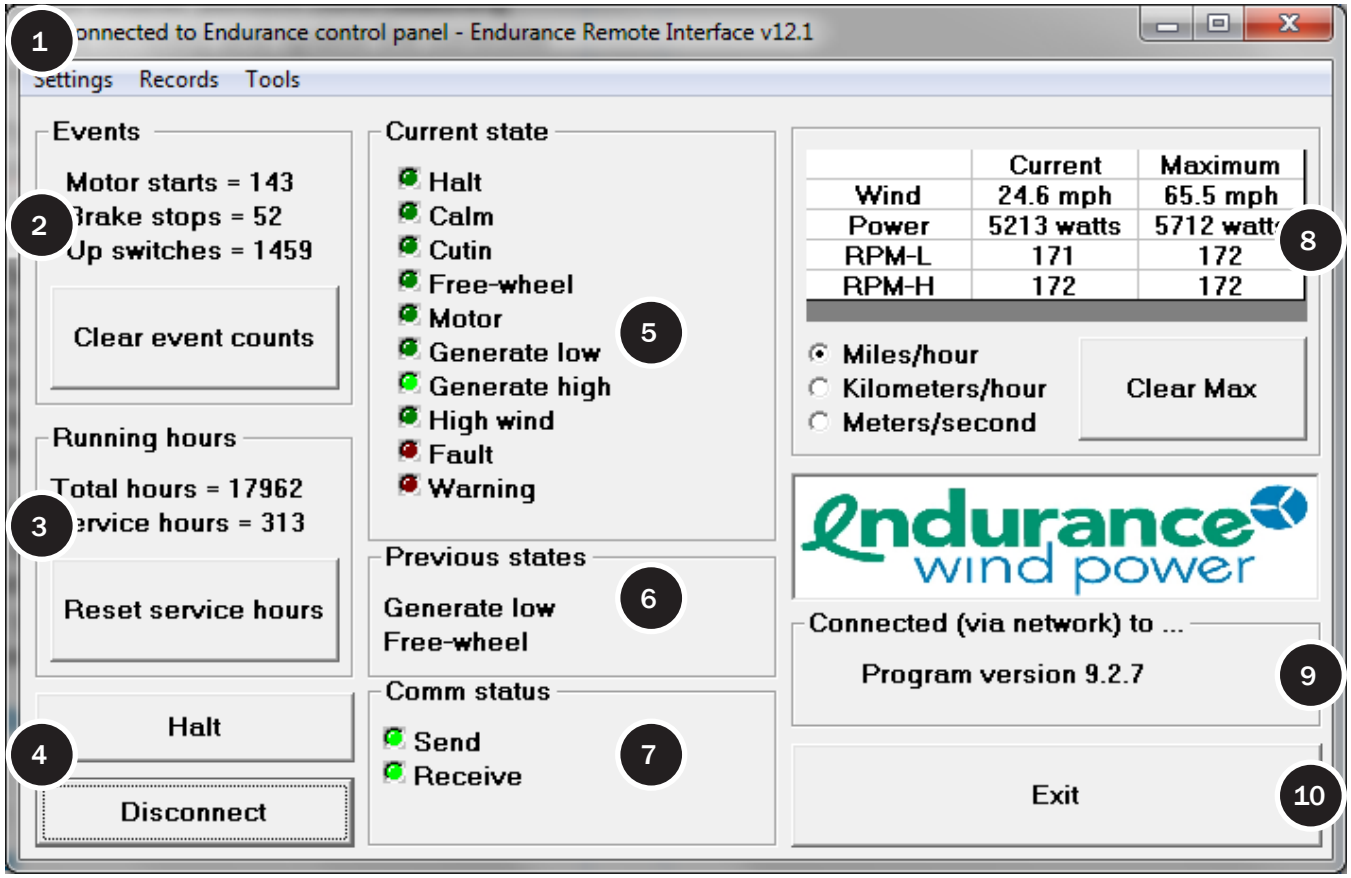


Figure 4. Endurance Remote Interface Main Window

| | |
|---|---|
| 1 | Menu bar |
| 2 | Events pane |
| 3 | Running hours pane |
| 4 | Halt and Disconnect buttons |
| 5 | Current state pane |
| 6 | Previous states pane |
| 7 | Comm status pane |
| 8 | Turbine data pane |
| 9 | Communication connection pane |
| 10 | Exit button |

# Main Window Display

The main window display consists of the following sections:

## Events

This pane shows the counters for events. These values indicate important information about the turbine operation. Events include the following:

- Motor starts—This counter indicates how many times the turbine has been motored up to speed to prepare to produce electricity from the wind.
- Brake stops—This counter indicates the number of times the brakes have been applied. It does not differentiate between brake applications at full speed or when the rotor is stopped. It includes all brake application incidents except for grid power interruptions when the controller itself shuts down.
- Up switches—This counter indicates the number of times the patented Dual-Voltage Switching (DVS) System has switched the turbine generator from 120 V output operation to 240 V output operation.

The **Clear event counts** button will reset each of the three event counters back to zero.

## Running Hours

This pane shows the time counters for running hours. These values indicate turbine operating time as follows:

Total Hours—This indicates the total lifetime cumulative number of hours the turbine is in an operational state where the rotor is rotating.

Service Hours—This indicates the number of hours since the last service hour reset that the turbine has been in an operational state where the rotor is rotating. This value can be reset to zero using the **Reset service hours** button.

### Reset Service Hours

Click the **Reset service hours** button to reset the service hours to zero. This should be done only after the turbine has undergone its regularly scheduled maintenance service.

## Halt and Disconnect Buttons

When you click these toggle buttons, its opposite state will become available.

- **Halt** button or **Run** button—Click this button to start or stop the turbine remotely at any time. As well, use this button to clear any Fault conditions detected by the controller. Be careful to always check the turbine appropriately prior to resetting

from a Fault state. The source of the fault should be determined and cleared before returning the turbine to service.

- **Disconnect** button or **Connect** button—Click this button to connect or disconnect the ERI from the turbine.

## Current State

This pane indicates the current operating state of the turbine. The current state is designated by the LED indicator lighting (turning bright red or green). The states are as follows:

- Halt—This state indicates a manual Halt command has been issued via remote or at the control panel, and the brakes are currently applied. A manual restart is required to start the turbine.
- Calm—This state indicates the turbine is awaiting sufficient wind speed to warrant releasing the brakes.
- Cut-In—This state indicates enough wind speed has been sensed to warrant releasing and holding off the brakes. If sufficient wind speed continues, the turbine will freewheel or motor up to speed.
- Freewheel—The turbine is operating with the brakes off and is spinning in the wind but has not yet reached synchronous rpm.
- Motor—The turbine is using the generator as a motor to bring the rotor quickly up to speed to prepare it to generate electricity from the wind.
- Generate Low—The turbine is generating electricity at 120 V in low winds.
- Generate High—The turbine is generating electricity at 240 V in higher winds.
- Highwinds—The turbine controller has detected winds in excess of 25 m/s (90 kph; 56 mph) and has shut down waiting for the strong winds to subside.
- Fault—The turbine controller has detected a serious problem with the turbine and has shut down. A manual reset is required. Be sure to inspect for and repair the source of the fault prior to returning the turbine to service. The type of fault is indicated next to the Fault tag when the LED light turns on.

  Detectable faults include:

  - Over-Speed—This is where the turbine rotor speed has exceeded 183 rpm.
  - RPM Error—This is where the controller has detected a discrepancy between the two turbine rpm sensors.
- Warning—The turbine controller has detected a potential problem and has shut down. The turbine will automatically reset once the problem has cleared. No user interaction is required. The type of warning is indicated next to the Warning tag when this LED light turns on.

  Detectable warnings include:

  - Grid Error—The controller has detected that the grid voltage or frequency is outside of the required range specified by utility standards. The turbine is shut down as a precaution but will restart once the grid returns to expected operating parameters.

- Anemometer Error—The controller has noticed the wind speed measured is too low but the turbine is generating wind power. This usually indicates the anemometer has iced up but could also indicate an anemometer failure. The turbine will restart once the anemometer starts working again (either by thawing out or being repaired).
- Motoring Error—The controller noticed it took too long to motor the rotor up to speed. This could be the result of a transient condition such as ice in the pneumatic brake lines. The situation may correct itself, but if it persists, service may be necessary.

## Previous States

The controller keeps track of the two previous states in addition to the current state. The history is presented in this pane in the middle of the window. This pane is useful to know how the turbine arrived at the current state, as this may come in handy when trying to diagnose any problem that might occur.

The state at the top of the list is the one immediately prior to the current state. The one at the bottom is the one two states prior to the current.

**Note**: Faults and Warning are indicated here without details as to the type of fault or warning.

## Comm Status

This pane blinks a Send and Receive LED for every communication sent and received, respectively, by the remote Commander software. When communicating successfully, the Send LED will blink briefly, followed immediately by a brief blink of the Receive LED.

## Turbine Data

The upper-right pane displays the turbine data. The current and maximum values for wind speed, power, low speed rotor rpm, and high speed rotor rpm are displayed here.

The wind speed displayed is a 1-min average of the wind speed measured at the anemometer on the tower. The wind speed units are selectable using the radio buttons at the bottom of this pane:

- Miles per hour (mph)
- Kilometers per hour (kph)
- Meters per second (m/s)

The power displayed is in units of watts.

**Important**: The controller does not measure actual power output of the turbine. The power displayed here is an accurate estimate of generator output based on

a calculation using the measured rpm of the rotor and the design slip ratio of the generator.

The rpm shown is the instantaneous rotational speed of the wind turbine rotor (measured every 0.1 seconds) for both the high speed and low speed shaft.

Note that a maximum value for wind speed, power, and rpm do not necessarily occur simultaneously. Rather, it is likely these maximums did not occur at the same time. The maximum values can be reset to zero at any time by clicking the **Clear Max** button. These values will then immediately be replaced by the Current values.

## Communication Connection

The Communication connection pane indicates whether a connection has been established with the turbine controller. When connected, this pane reads *Connected to... Program version n.n.n* where the n.n.n is the version number of the turbine controller firmware. When communication fails or the program is otherwise not connected, this pane blinks *Not connected*.

The reasons for a failed connection include:

- Modem not connected or powered up—Check the modem connections to the computer and AC power, and check the modem power LED.
- Wrong COM port selected—Choose the proper COM port from the **Settings>Local Connection Settings** menu.
- Improper Network Address—Correct the network address from the **Settings>Local Connection Settings** menu.
- Modems too far apart—Try placing the remote modem closer to the turbine.

## Exit

Click the **Exit** button to close the remote Turbine Monitor program.

**Note**: The ERI does not affect the operation of the turbine. It is not required in order for the turbine to operate normally. The turbine controller operates autonomously, and the ERI is merely a means to monitor and remotely interface with the machine.

# Minimizing the Window

Minimizing the ERI software window will send the program to the system tray (typically located in the lower-right part of your desktop). The program will continue to run in the background. To access the window, right-click on the icon in the system tray.

# Menus

## Settings

This menu allows you to select how the ERI will communicate with the controller (using the serial port where the modem is attached to your PC or an Ethernet connection). It also allows you to set up notifications for events that occur.

Settings are either stored on the PC or within the controller. The Local Connection Settings and Notifications are stored on the local PC allowing you to connect to different turbines and preserve how you wish to be updated by events. Turbine Network Settings, Time Clock, and Site Name are all stored within the controller for a given turbine and are turbine specific.

### Local Connection Settings

Click **Settings>Local Connection Settings** and select **Network** option. In the Network Address window type in the address of the turbine controller which is factory set as 192.168.0.61:3500. Ensure the modem is plugged into an outlet and the PC (or a home network router) and that the turbine is powered on with its controller modem properly attached. If you have no communication through the modem, you may need to change network settings on your PC or router. Contact your EWP Dealer service technician for assistance.

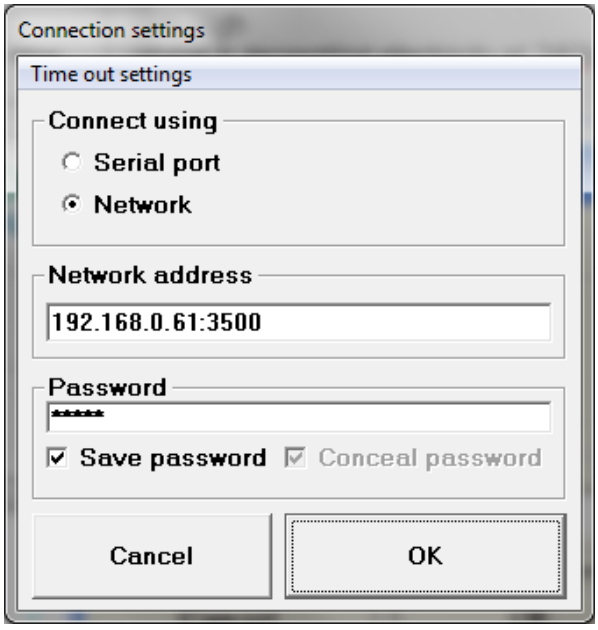


Figure 5. Local Network Connection Settings

If the ERI software is left running, it may time out and disconnect communications with the turbine controller. This is to allow access from other computers either local or remote. This setting can be changed by going to **Settings>Local Connection**

**Settings**. In the **Connection Settings** dialog box, click **Time out settings** where you can change the intervals or bypass timeout settings altogether.

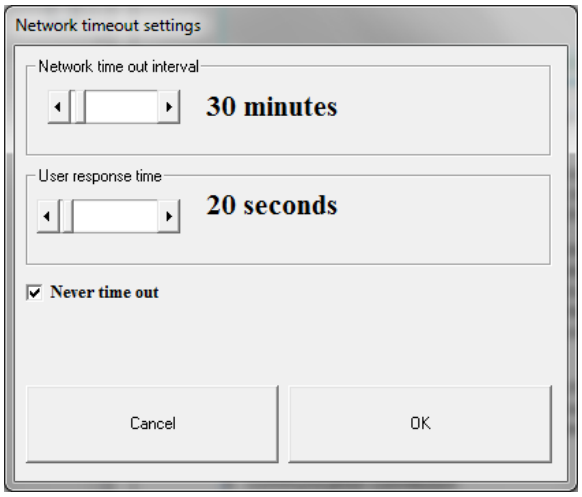


Figure 6. Connection Timeout Settings

In the **Connect using** pane of the **Connection settings** dialog box, select between using a serial port or network connection to communicate between the ERI software and the controller. EWP recommends using a network connection but a serial connection is possible for older, legacy turbines.

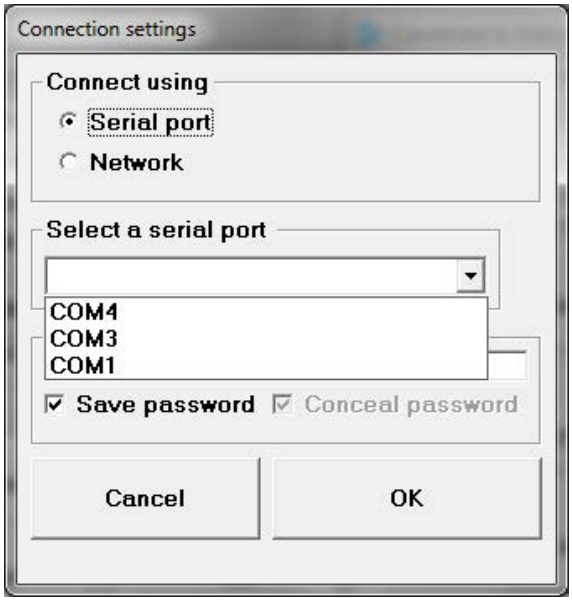


Figure 7. Local Network Connection Settings

### Turbine Network Settings

Click **Settings>Turbine Network Settings** and select either **IP Settings** or **Password**. The IP Settings menu option allows you to set standard networking parameters which includes IP address, Netmask, Name server, Gateway, and Port. These values are populated by default by the ERI.

## Notifications

You can select when and how you would like the Remote Turbine Monitor to notify you on your screen using the menu **Settings>Notifications**. For each event in the leftmost column, you can choose whether to be notified, what sound you would like played, and how often to repeat the notification.

For example, to be notified whenever the turbine enters a particular state, set the cell in the Notify column to Yes by clicking in that cell. The setting will toggle between Yes and No each time you click there. Click in the corresponding cell in the **Sound to play** column to pull up a dialog box to select a custom sound file. Here you can also set the repeat interval (in seconds). Set the interval to zero to be notified just once per occurrence.

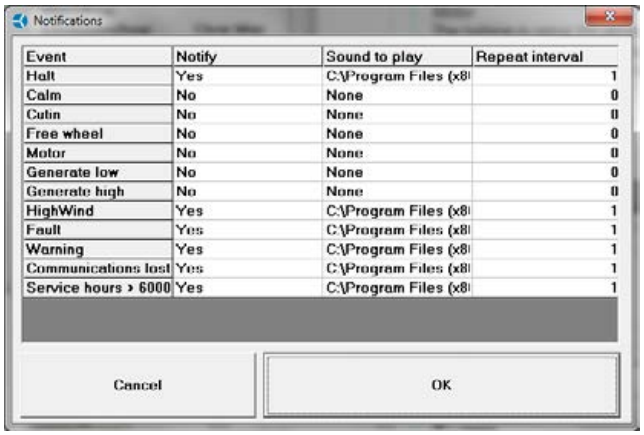


Figure 8. Notification Settings

## Time Clock

Use the Time Clock menu to set either the time or date for the controller. Enter the time and date as needed and click **OK** to update the information.

## Site Name

Use the Site Name menu to set a site name for the turbine. Enter the site name and click **OK** to update the information.

## Factory Reset

You can reset the critical turbine configuration parameters to the factory default values:

- IP Configuration—The default IP address is 192.168.0.61
- Turbine Password—The default password is **admin** (lower case)
- Site Name—The default name is **Endurance control panel**

If you forget either the IP address or your password, it may be impossible to re-establish a connection to the turbine. Reset the configuration parameters to the default values in order to access the turbine using the default settings.


**Extreme caution is required when carrying out this technique as the control panel carries high voltage electricity that is extremely dangerous. For safety reasons, this method is not recommended. However, if a factory reset is required it can be carried out by an experienced electrician or turbine repair specialist.**

To trigger the reset command, go to the physical key switch in the control panel:

**Important**: This reset must be done within 10 seconds.

1. Remove the test jumper inside the control panel.
2. Toggle the key switch 5 (or 6) consecutive times within 5 seconds, followed by 5 seconds in which no further toggling occurs.

   A key switch toggle is defined as moving the toggle from the Off position to Run, and then back to the Off position.
3. Replace the test jumper after executing the switching sequence.

   If a mistake is made during the switching sequence or if the sequence did not appear to be recognized, wait at least 10 seconds before trying again.

## Records

The controller logs and stores information about the operating state of the turbine over various time periods. This information may be useful to service technicians in diagnosing certain problems.

## Downloads

The data files are accessible through the ERI. If access to this data is required your EWP service technician will advise you on how to access it. The files can be downloaded by selecting the type of Record buffer and clicking the **Download** button. The file requested will then be downloaded to a folder on your local computer. The location of this folder may vary depending on your computer settings, and your EWP technician should be able to locate it.

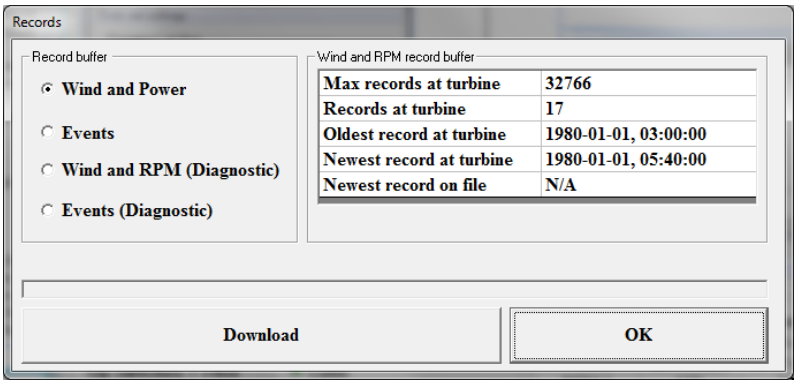


Figure 9. Records Settings Dialog Box

## Triggers

For troubleshooting purposes, diagnostic files are available. These files can be created at the instance of a trigger event to help with troubleshooting specific problems. The triggers are configurable from the **Diagnostic triggers** dialog box. Mark the check box next to any event of interest and the controller will capture a log of data leading up to the occurrence of that event.

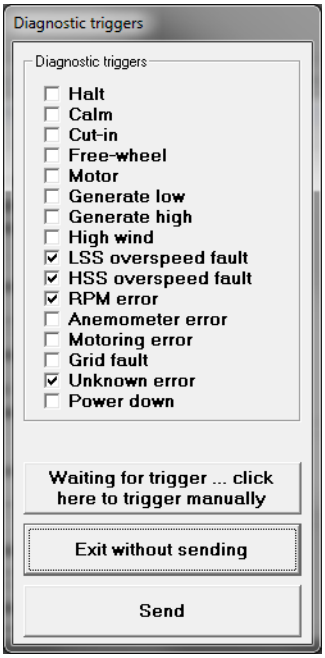


Figure 10. Diagnostic Triggers Dialog Box

**Important**: Select diagnostic triggers carefully to ensure the correct period is logged for successful troubleshooting.

## Recording Intervals

You can select to record the mean wind speed in 1, 10, or 60 minute intervals. The default is the 10 minute interval.

The 1 minute interval selection will record approximately three weeks of data, the 10 minute interval selection will record approximately 7.5 months of data, and the 60 minute interval will record approximately 3.75 years of data.

Once the maximum capacity is reached, the oldest recorded value is overwritten with new data every recording interval. We recommend that you archive this data elsewhere if you wish to maintain such records. Download the data at an interval shorter than the capacity period in order to ensure that no data is overwritten before it is downloaded.


Figure 11. Recording Intervals Dialog Box

### Events

All events during the turbine operation are logged and stored on the micro-controller:

- Power-up and Power-down
- Connection and Disconnection with the remote interface software
- Transition from one normal operation state to another
- Error events
- Warning events

The event logs can be downloaded and archived elsewhere.

## Tools

### Upgrade Firmware

If a turbine firmware upgrade becomes available, the upgrade can be completed directly through the ERI. Refer to the latest *S-Series Firmware Installation and Release Notes* (available from the EWP Dealer Portal) on how to install a firmware upgrade.

All S-series models use the same firmware but they may require different versions with a few different parameters. When upgrading, be sure to activate the proper firmware version according to your turbine model. Consult your service technician if there is any question whether you are using the proper firmware version for your turbine model.

Should you install the incorrect firmware or if your turbine was physically changed with an Upgrade Kit, you can reinstall the correct firmware and the configuration will change to the default for the newly installed firmware.

## Downloads

You can download firmware upgrades using the Network Download Utility. This utility is supplied with the ERI software (version 12.0 and later). It can also be downloaded from the EWP Technical Services website. If you have no previous version of ERI, we recommend that you install ERI version 12.0 (or later) and then launch the Network Download Utility.

To use the Network Download Utility, refer to the latest *S-Series Firmware Installation and Release Notes* (available from the EWP Dealer Portal).

# MAINTENANCE SCHEDULE

It is critical to properly maintain your wind turbine in order to keep it in peak running condition. For a detailed list of required maintenance items and procedures, refer to the *S-series Annual Maintenance Checklist*.

# MAINTENANCE

## Shutting Down the Turbine

Your wind turbine can be shut down using various means.

To temporarily stop the machine without disconnecting power to the unit, use the **Halt** button on the ERI. If the ERI is not available, the turbine can be halted from the control panel.


**Extreme caution is required when carrying out this technique as the control panel carries high voltage electricity that is extremely dangerous. For safety reasons, this method is not recommended. This procedure should be carried out by an experienced electrician or turbine repair specialist.**

To stop the turbine from the control panel, turn the key switch to the Off position and the controller will apply the brakes and prevent the turbine from starting up.

To stop the turbine and prevent it from starting, disconnect the turbine from its external power source (the grid). This cuts the power to the turbine, including the brakes and controller, and the failsafe system will apply the brakes and shut the turbine down. To shut off the power, either open the utility disconnect switch at the tower base, or turn off the circuit breaker servicing the turbine in the service panel. The circuit breaker for the turbine may be located more conveniently in your home. Ask your installer or service technician where the service breaker for your turbine is located and be sure it is clearly marked for future reference. Disconnecting the turbine from the grid is the recommended method for shutting down the turbine for prolonged time periods and the only method acceptable to use for safely servicing the machine.

# Servicing the Turbine

Your EWP wind turbine will function at is best efficiency for a long time when properly cared for with regular maintenance and inspections. Adhering to the prescribed maintenance schedule also ensures your warranty remains in effect.

Maintenance and inspection necessitates access to the turbine itself and the inside of the nacelle. This access is made easier with the EWP tilting tower system.

Before servicing the turbine or tower for maintenance, be sure to open the **Main Disconnect** switch that provides the high voltage (240 VAC) power to the turbine. This will help to ensure that the machine cannot unexpectedly start up.

## Turbine Electrical Disconnects

The turbine is installed with a lockable disconnect at the tower base or other accessible location near the turbine. This disconnect will provide a manual means to disconnect the utility electric service from the turbine and control panel. In addition to the manual disconnect, a 240 VAC – 40 A double-pole breaker is installed where the turbine service connects to the main breaker panel.

# Tilting Tower


**Tilting the EWP tower up and down should be done by an authorized service technician familiar with the details of the procedure. The turbine and tower are very heavy, making the procedure dangerous if not done properly.**

The necessary equipment to tilt down the turbine will vary with your tower height and type. For the more common guyed towers, a typical system will include:

- Winch and sufficient cable of proper rated capacity for the job (typically 2,000 lbs minimum line pull and 300 ft of cable).
- Properly rated shackles, pulleys, and other rigging accessories for the lift and lowering process.
- Side guys for stabilizing the gin pole.
- Properly positioned stand to support the weight (minimum 2,000 lbs) of the lowered tower such that the turbine is approximately 4 to 5 ft off the ground.


**Do not rely on advertised ratings to ascertain the winch capacity. Typical off-road style winches intended for mounting on vehicles do not have sufficient load or spool capacity for lifting the EWP tower system. Consult your service technician or EWP Technical Services for help in selecting the proper winch and cable system for your application.**


**A tilted down turbine and tower system should be properly prepared and secured if left unattended in the lowered position for any period of time. An improperly prepared and secured system could be subject to damage from winds which could push the tower off its stand.**

A properly prepared turbine will be locked in the yaw position with the rotor axis horizontal and the tail removed. The tower must be adequately strapped to a stable stand. The gin pole should be either lowered or properly secured with cables in all directions.

## Maintenance Plug (Manual Brake Release)

For maintenance purposes, the pneumatic brake system can be powered up to facilitate pumping off the brakes using the auxiliary outlet located behind the service panel on the nacelle. This plug (type IEC 320) utilizes a power cord typically found on PC computers and requires standard 120 V AC power. The plug is switched to allow you to release or apply the brakes as needed.


**Disconnect power to the turbine control panel prior to powering up the brakes with the maintenance plug. Failure to do so could result in electrical short circuits that could damage wiring.**


**Always leave the manual switch in the Off position when not using the manual brake release cord. Leaving the switch on will result in having 120 VAC present on the manual plug prongs on the turbine, presenting an electrical shock hazard.**

## Brake Pad Wear

Brake pad wear on the S-series wind turbine is expected to be negligible over the lifetime of the unit. Brake pad wear should be checked annually during routine maintenance but they should not need replacing unless any indication of excessive pad wear is detected.

# TROUBLESHOOTING

The following troubleshooting guide is not comprehensive. If further assistance is required, contact EWP Technical Services.

| Problem | Possible Cause | Potential Solution |
|---|---|---|
| Turbine is not spinning | Insufficient wind | This is normal. The ERI should indicate Calm or Cut-In. |
| | There is sufficient wind but the turbine has just been turned on. | Turbine remains in a CALM state for five minutes after it initially powers up (whether manually or after a grid outage) to comply with electrical service regulations. If it is safe to do so, this timeout period may be bypassed by cycling the turbine to Halt and then Run, using the ERI. |
| | Turbine is in an error or timeout state. | Check the state of the turbine using the ERI. Timeout states (Highwinds, Grid Error, Anemometer Error, Motoring Error) will reset themselves, so wait for the situation to clear. Fault conditions (Overspeed, RPM Error) require a manual reset following an assessment of the condition. |
| ERI indicates Halt | Turbine was placed in Halt state remotely or entered a Halt state on initial power up. | Click the **Run** button on the ERI, or have technician use the key switch in the control panel to clear the Halt condition. |
| | Turbine was placed in manual Halt state from the turbine control panel. | Have technician use the key switch in the control panel to clear the Halt condition. |
| ERI indicates High Wind | Anemometer detected winds exceeding the maximum allowable (~56 mph) and is waiting for the winds to subside. | This is normal and will reset once winds subside to below ~45 mph for 30 minutes. |

| Problem | Possible Cause | Potential Solution |
|---|---|---|
| ERI indicates Warning: Anemometer Error | Anemometer has iced up. | Turbine will return to normal operation once the ice has melted from the anemometer and the wind spins it up again. |
| | Anemometer is broken. | Have service technician replace the anemometer. |
| | Anemometer signal is not reaching the controller. | Have service technician check the anemometer signal in the control panel and replace any faulty equipment. |
| ERI indicates Warning: Grid Error | Grid voltage or frequency is out of range. | Utility service at your site is outside of specified permissible voltage or frequency limits. When the error clears itself, the controller waits 5 minutes and then restarts the turbine. |
| ERI indicates Fault: Over-Speed | Turbine has encountered a condition where its rotational speed exceeded allowable limits. | Have a service technician thoroughly check the turbine, including the brake system for problems, and take corrective action prior to returning the turbine to service. |
| ERI indicates Fault: RPM Error | One of the two turbine rpm signals is not reading properly at the controller. | Have a technician check the turbine speed signal encoders and signals for the source of the problem and take corrective measures prior to restoring the turbine to service. |
| ERI indicates Warning: Motor Error | There is ice blocking the brake lines due to cold weather. | Wait for warmer temperatures to see if the condition clears itself. If the turbine does start in warmer weather, have a technician service the pneumatic system to prevent icing problems. |
| | The rotor did not spin up to speed properly. | Have a service technician assess the problem and correct any issues with the brake or electrical system. Causes can include the following: a non-functioning pneumatic compressor; lack of +12 VDC current at the tower top; or faulty contactors, SSRs, or capacitors in the control panel. |

| Problem | Possible Cause | Potential Solution |
|---|---|---|
| No communication between the turbine and the ERI | Turbine is powered down. | Power up the turbine if it is safe to do so. |
| | ERI is not properly set to communicate with the turbine controller. | Correct the settings in the ERI to match the settings of the turbine controller. |
| | Wireless antennas are spaced too far apart. | Move the wireless antennas closer or replace them with longer range antennas if necessary. |
| | Turbine watchdog has tripped and cut power to the controller. | Have technician check the turbine for the cause of the watchdog relay trip and reset the watchdog when it is safe to do so. |
| | Main control board is frozen or locked up. | If LED DS2 is showing solid red, this indicates the control program is corrupt or absent preventing it from functioning. Contact EWP Technical Services to resolve this issue. |

For more detailed troubleshooting information on the S-series turbine, refer to the *S-Series Troubleshooting Manual*. This manual is meant for the service technician who has an understanding of the S-343 wind turbine. The manual is a complete guide to troubleshooting issues with the turbine that covers nearly all situations that may be encountered.

# APPENDIX A: CONTROL PROGRAM PARAMETERS

Table 6. Summary of Critical Control Program Parameters for the S-343

| Parameter | States Used | Controller Input | Value | Notes |
|---|---|---|---|---|
| Wait period after power-up | Calm | N/A | 5 min | Wait period after controller is started (on power-up or after a system re-boot) before turbine is allowed to start. May be bypassed during commissioning tests when DI-15 jumper is removed. |
| Wait period after Grid Error | Warning: Grid Error | N/A | 5 min | Wait period after grid monitoring relay resets following recovery from a grid voltage or frequency excursion. |
| Cut-in wind speed | Calm Cut-In Freewheel Highwinds[1] | Anemometer | 4.0 m/s | The wind speed at which the brakes are released when in the Calm state. |
| Low rpm | Cut-In Freewheel Motoring | LSS sensor | 3 rpm | Rpm on the low-speed shaft. Used to determine if the brakes have released and the wind is turning the rotor. |
| Synchronous rpm | Freewheel | LSS sensor | 166.4 rpm | Rpm on the low-speed shaft. |
| Max motoring time | Motoring | N/A | 15 sec | Motoring will proceed until this time expires or 50% of synchronous rpm is reached, whichever comes first. |
| Motoring time to reach Rpm_Lo | Motoring | N/A | 5 sec | If Rpm_Lo is not reached after motoring for this long, a motoring error occurs. |
| Minimum generating rpm | Gen_Lo | HSS sensor | 166.0 rpm | When rpm drops below this speed, switch offline. |
| Maximum Gen_Lo rpm | Gen_Lo | LSS sensor | 171.4 rpm | Rpm above which the generator switches from 120 V to 240 V. |
| Minimum Gen_Hi rpm | Gen_Hi | HSS sensor | 167.1 rpm | Rpm below which the generator switches from 240 V to 120 V. |
| 1-min average cut-out wind speed | All | Anemometer (1-min avg) | 22 m/s | Switch to Highwinds if 1-min average wind speed exceeds this value. |
| Instantaneous cut-out wind speed | All | Anemometer (5-sec avg) | 27 m/s | Switch to Highwinds if instantaneous wind speed (5-sec average) exceeds this value. |
| Wind speed at which it is safe to exit Highwinds | Highwinds | Anemometer (1-min avg) | 19.5 m/s | Exit Highwinds and return to Cut-In if 1-min average wind speed drops below this value. |
| Minimum Time In Highwinds | Highwinds | N/A | 30 min | Minimum time that must be spent in Highwinds before returning to a normal operating state. |

| Parameter | States Used | Controller Input | Value | Notes |
|---|---|---|---|---|
| Over-speed rpm | All | LSS sensor | 183.0 rpm | Rpm at which over-speed error occurs. Measured on the LSS. |
| RPM sensor error tolerance | All | LSS sensor & HSS sensor | 45.0 rpm | RPM Error occurs if low- and high-speed shaft rpm values differ by more than this value. |
| Minimum anemometer reading | All | Anemometer (1-min avg) | 1 m/s | If anemometer reads below this value and rotor rpm is above kf RPM_Synch, we have an anemometer error. |
| Motor timeout | All | N/A | 10 min | This timer starts when a motoring event is initiated and must expire before a subsequent motoring event can occur. |
| Motor error timeout | Warning: Motor error | N/A | 3 hr | This timer starts when a motoring error is detected and must expire before the warning state is automatically cleared. |

[1] The turbine reverts to Cut-In from Highwinds if the winds drop below cut-out, but remain above cut-in after a set time period.

# APPENDIX B: TECHNICAL DETAILS FOR THE MAIN CONTROL BOARD

## Controller LEDs

The controller LEDs are located on the main PLC control board in the control panel. There are 4 LED lights labeled DS1, DS2, DS3, and DS4. These LEDs are indicators regarding the operation of your turbine.


**When powered on, the control panel contains dangerous, high-voltage electricity and should only be accessed by trained personnel.**

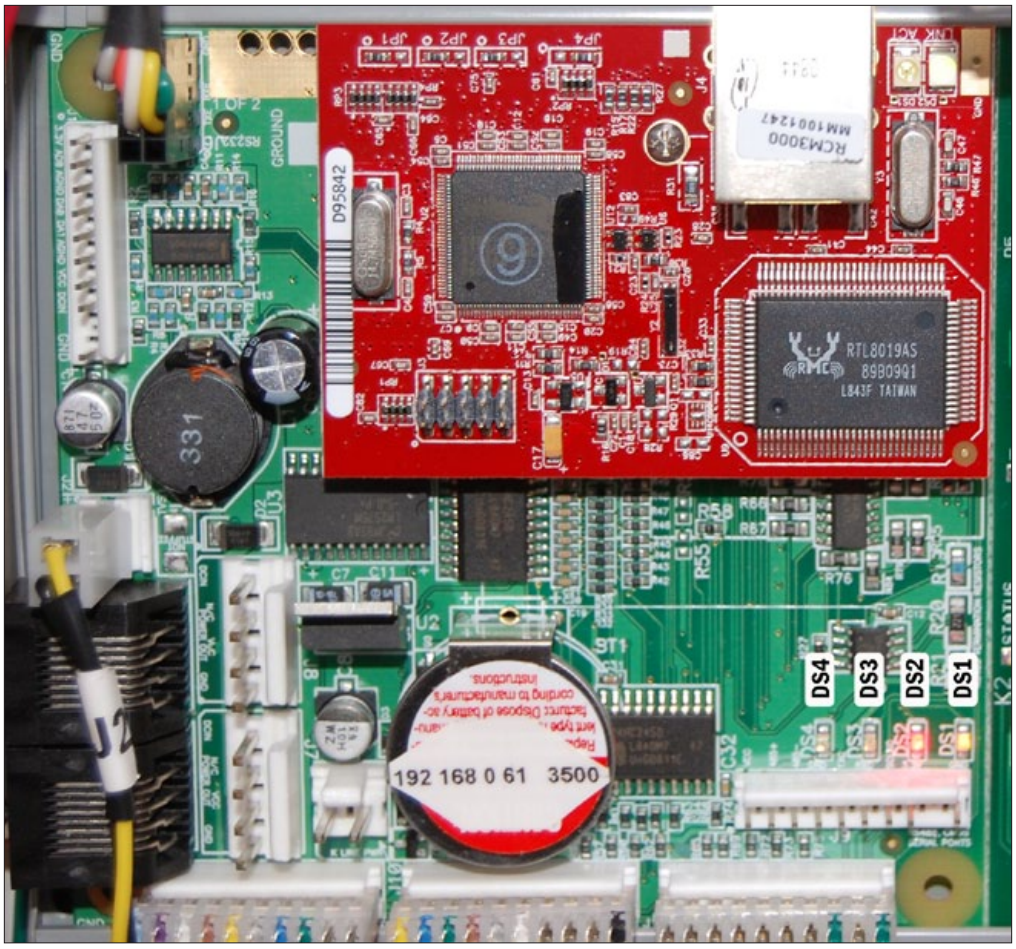


Figure 12. Main PLC Control Board with LED Lights

Table 7. Summary of PLC LED Indicator Lights

| LED | Indicator | Purpose |
|---|---|---|
| DS1 | Yellow blink | An approximate 1 Hz blink rate indicating the heartbeat of the controller, which is sent to the watchdog. |
| DS2 | Red blink | Indicates a write to flash memory of critical data collected by the controller. Writes occur during fault detection, remote Halt commands, and all Run commands, as well as every eight hours under normal operating conditions.<br>**Note**: If this LED shows a solid, steady red, this indicates an un-programmed controller. Contact EWP Technical Services to resolve this issue. |
| DS3 | Yellow blink pattern | The blink pattern indicates the following operating states:<br>• 0 blinks—Halt; brakes applied<br>• 1 blink—Calm; brakes applied<br>• 2 blinks—Cut-in; brakes released<br>• 3 blinks—Freewheel; brakes released<br>• 4 blinks—Motoring; brakes released; connected at 120 V<br>• 5 blinks—Generating 120 V; brakes released; connected at 120 V<br>• 6 blinks—Generating 240 V; brakes released; connected at 240 V<br>• 7 blinks—High Winds; brakes applied<br>• 8 blinks—Fault; brakes applied<br>• 9 blinks—Warning; brakes applied |
| DS4 | Yellow blink | Indicates communication with remote interface attempted. |

## Controller Inputs

There are 6 digital inputs (DI) utilized by the controller:

- DI-00—Low speed shaft (LSS) speed sensor
- DI-01—Wind speed anemometer
- DI-02—High speed shaft (HSS) speed sensor
- DI-03—Grid monitoring
- DI-04—Manual Halt command
- DI-15—Commissioning Test Access

## Controller Outputs

The controller has eight digital outputs (DO). These outputs are used to release (or apply) the brakes, as well as for grid connection. Being digital outputs means that the output signal is either 0 or +12 V.

Table 8. Summary of Controller Outputs

| Controller Digital Output | Relay Controlled | Function |
|---|---|---|
| D0-00 | R6 | Connects grid neutral to turbine generator primary winding (T4 for generating, T1 for motoring) and secondary winding (T5) during 120 V operation. |
| D0-01 | R7 | Connects grid Hot-2 to turbine generator primary winding (T4) and secondary winding (T5) during 240 V operation. |
| D0-02 | R1 via R8 R2 & R4 | Reverses polarity on turbine generator primary winding by closing ice-cube relay (R8) which triggers double-pole double-throw (DPDT) mechanical relay (R1).<br>Also connects grid Hot-1 to turbine generator secondary winding (T6) through start (via R2) and run (via R4) capacitors. |
| D0-03 | None | Sends a 1 Hz pulse to the watchdog board. |
| D0-04 | R5 | Connects grid Hot-1 to turbine generator primary winding (T1 for generating, T4 for motoring). |
| D0-05 | R3 | Connects grid Hot-1 to turbine generator primary winding (T1) through the power resistor during state transitions. |
| D0-06 | R4 | Connects grid Hot-1 to turbine generator secondary winding (T6) through run capacitor. |
| D0-07 | R9 | Powers on the brake system to release the brakes. |

## Controller Output Status During State Transitions

Table 9. Summary of DO Status During State Transitions

| Transition Event | | |
|---|---|---|
| From | To | |
| Motor | Freewheel | Switch all DO off (No delays). |
| Freewheel/Cut-In | Motor | Switch DO 02 (Motor) on, DO 06 (Run Cap) on;<br>wait ~100 ms;<br>DO 00 (Neutral) on, DO 04 (Resistor Off) on |
| Freewheel | GenLow | Switch DO 00 (Neutral) on, DO 05 (Resistor On) on;<br>wait ~100 ms;<br>DO 06 (Run Cap) on, DO 04 (Resistor Off) on, DO 05 (Resistor On) off |
| GenLow | GenHigh | Switch DO 00 (Neutral) off, DO 04 (Resistor Off) off, DO 05 (Resistor On) on;<br>wait ~31 ms;<br>DO 01 (Hot-2) on;<br>wait ~1/4 sec;<br>DO 04 (Resistor Off) on, DO 05 (Resistor On) off |
| GenHigh | GenLow | Switch DO 06 (Run Cap) off, DO 04 (Resistor Off) off, DO 05 (Resistor On) on;<br>wait 1/16 sec;<br>DO 01 (Hot2) off, DO 04 (Resistor Off) on, DO 05 (Resistor On) off;<br>wait ~31 ms;<br>DO 00 (Neutral) on;<br>wait 1/8 sec;<br>DO 06 (Run Cap) on |

Table 10. Summary of Controller Output Status by Turbine State[1]

| Digital Output Channel | | 00 | 01 | 02 | 04 | 05[2] | 06 | 07[3] |
|---|---|---|---|---|---|---|---|---|
| State # | State | R6 (Neutral) | R7 (Hot–2) | R1 (DPDT) via R8; R2 (Start Cap) | R5 (Hot–1 Resistor Off) | R3 (Hot–1; Resistor On) | R4 (Run Cap) | R9 (Brake) |
| 0 | Halt | Off | Off | Off | Off | Off | Off | Off |
| 1 | Calm | Off | Off | Off | Off | Off | Off | Off |
| 2 | Cut-In | Off | Off | Off | Off | Off | Off | On |
| 3 | Freewheel | Off | Off | Off | Off | Off | Off | On |
| 4 | Motor | On | Off | On | On | Off | On | On |
| 5 | GenLow | On | Off | Off | On | Off | On | On |
| 6 | GenHigh | Off | On | Off | On | Off | On | On |
| 7 | Highwind | Off | Off | Off | Off | Off | Off | Off |
| 8 | Fault | Off | Off | Off | Off | Off | Off | Off |
| 9 | Warning | Off | Off | Off | Off | Off | Off | Off |
| Default | Unknown | Off | Off | Off | Off | Off | Off | Off |

[1] This table indicates the state of the digital outputs as programmed for normal operating conditions. Note that during unusual fault events, the status of the digital outputs may vary from these prescribed states.

[2] DO-05 for the switch resistor is only active during transient states so it is indicated as Off for all states in the table.

[3] DO-07 controls the brakes—On indicates the brakes are being pumped off, while Off indicates the brakes are applied.