

Seven - Air X Operation

7-1 Operational Summary

Wind turbines operate by capturing the kinetic energy of moving air: **the wind**. They convert it to rotational motion to turn an alternator that produces electrical power. The electrical power must be regulated to a voltage to charge the system batteries, and there must be a system to prevent overcharging the batteries and resume charging as the battery voltage drops. A means to protect the wind turbine from extreme wind damage must also be provided.

The Air X accomplishes all these goals by incorporating a three phase brushless permanent magnet alternator and microprocessor controlled electronics to optimize its power production capability. The microprocessor continuously adjusts the loading of the alternator to keep the blades operating at their optimal angle of attack. The result:

- high power production;
- high blade efficiency; and
- lower blade noise.

7-2 Operating Modes

Charging: With Air X connected to batteries with the voltage below the voltage regulation set point, the blades will spin in response to the wind. With an available wind, the blades will continue to spin until the battery voltage matches the regulation set point.

Note that Air X requires a minimum battery bank voltage (approximately 10.5 volts on a 12-volt system) or the controller will behave as if an open circuit condition exists. Refer to **Open Circuit/Free Spinning** section. When charging the batteries, the Air X LED will be continuously illuminated.

Regulation: As Air X produces power and the battery voltage rises to the regulation set point voltage, Air X will go into “regulation.” At that point it stops producing power and the blade rpm will lower dramatically (almost stopping). Air X will remain in regulation until the battery voltage drops slightly below the regulation set point – this is often referred to as the **cut-in voltage**. When the cut-in voltage is reached, the blades will resume spinning in response to the available wind. Regulation mode is indicated by the Air X LED blinking at a rate of approximately twice a second.

Stall Mode: Stall mode is marked by a dramatic reduction in turbine speed to approximately 500 – 700 rpm. Air X will enter stall mode when a wind speed of 35 mph (15.6 m/s) is sensed, and it will remain in stall mode until the speed drops to 32 mph (14 m/s). If a wind speed of 50 mph (22 m/s) is detected, the turbine will completely shut down for 5 minutes.

When in stall mode the Air X LED will blink quickly – approximately 10 times per second.

Braking Mode: Air X may be placed in braking mode by directly shorting the turbine positive and negative wires together or by the use of a stop switch. The stop switch first disconnects the turbine from the battery and then shorts the positive and negative wires. In very strong winds the blades may rotate slowly even with the switch activated.

No Load Operation /Open Circuit /Free Spinning: Air X will spin freely if disconnected from an electrical load. This results in a cycle of rapid blade speed followed by rapid braking – this mode of operation may accelerate wear of the turbine and is also non-productive. To turn Air X off for short periods of time Southwest Windpower recommends using a properly installed switch. If your Air X will be shut down for an extended period of time Southwest Windpower recommends lowering the turbine completely or securing the blades to prevent rotation.

7-3 Voltage Regulation

Air X continually monitors the battery voltage and compares it to the voltage regulation set point. Refer to specifications for voltage regulation set points. The voltage regulation set points are factory set to the values listed in the specifications. These values may be adjusted to suit individual applications.

When the voltage regulation set point is achieved, Air X enters regulation mode – effectively switching off and waiting for the battery voltage to drop to the cut-in voltage. The cut-in voltage is slightly lower than the voltage regulation set point. The difference between the two values is referred to as “hysteresis” and is purposely done so the turbine does not bounce in and out of a single regulation set point. Refer to specifications for specific voltage cut-in values.

7-3-1 Adjusting Regulation Voltage

The voltage regulation set point is adjustable using the potentiometer on the side of Air X body. **Please read the accompanying caution before attempting to adjust the voltage regulation set point.**

The most accurate method of setting the regulation voltage is to disconnect the turbine from the batteries and use an adjustable voltage source and multi-meter to apply the desired voltage across the positive and negative turbine leads. With the target voltage applied, turn the potentiometer fully clockwise, and then slowly turn the potentiometer counter-clockwise until the LED just illuminates. The regulation set point will then be set to the voltage applied across the turbine leads.

Alternatively, the regulation set point voltage may be adjusted using a trial and error method. Use the accompanying chart as a guide to increase or decrease the voltage regulation set point. Monitor the battery voltage over a period of time and make small adjustments until the regulation set point voltage is at the desired level.

System Voltage	Voltage Regulation Set-Point Adjustment Range*	Voltage Change due to 1/8 Turn of Potentiometer**
12 Volt	13.6 – 17.0 Volts	0.56 Volts
24 Volt	27.2 – 34.0 Volts	1.12 Volts
48 Volt	54.4 – 68.0 Volts	2.24 Volts

* Adjustment ranges are approximate; actual ranges may be greater.

** Turn clockwise to increase voltage, counter-clockwise to decrease voltage.



CAUTION: Increasing the voltage regulation set point above the initial factory setting will NOT increase the power output of Air X. This adjustment changes the point at which the turbine stops charging the batteries. By setting the voltage too high you may increase the probability of overcharging and damaging the batteries.

7-3-2 Using an Alternate Charge Controller

There are some conditions under which the Air X internal regulator is not appropriate as the primary regulator. These conditions include:

- **Systems where battery temperature varies widely**

Battery charge efficiency varies in extreme temperatures. If these conditions exist, an external regulator with a temperature compensation sensor should be used to optimize the charge rate. There are several regulators available that adjust the charge rate based on ambient battery temperature.

- **Batteries that are extremely sensitive to charge voltage**

Follow the recommendations of the battery manufacturer. For most battery systems the Air X internal voltage regulator is completely adequate.

- **Multiple turbines with a bus system**

Multiple turbine installations will typically function best using a single voltage regulator close to the battery bank. This is particularly true if the wire lengths connecting each turbine to the bus vary by distance or wire gauge.

The Air X internal voltage regulator cannot be completely turned off; however, by setting the voltage regulation set-point to its highest value (potentiometer turned completely clockwise), the Air X internal regulator may be virtually eliminated from the battery charging system.

If a charge controller other than the Air X internal controller is utilized, it must be a diversion style regulator. A diversion style regulator charges the batteries, and as the batteries become charged, the excess power is diverted to a resistive load. This technique allows for the capture of full turbine power even after the batteries are charged.

Do not use a pulse width modulated (PWM) or shunt style controller; Air X is not designed to work with these types of controllers. Additionally, most controllers designed to work with solar panels are not suitable for use with Air X. These controllers “disconnect” the solar panels – or in this case Air X - from the battery bank when the batteries are charged, allowing Air X to spin free, which is not recommended.



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