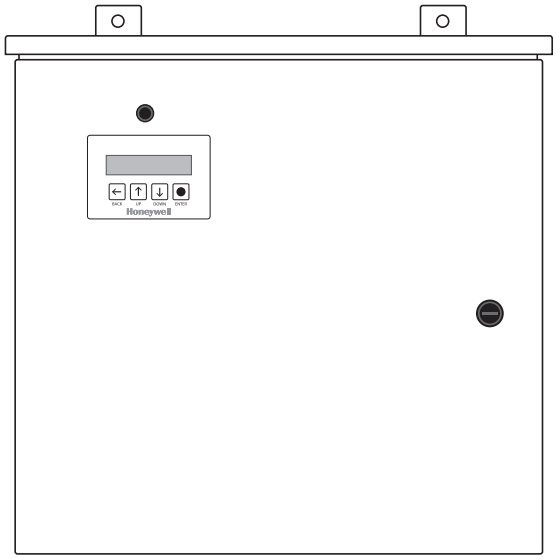
Honeywell



SMARTBOX™ CONTROLLER

for **HONEYWELL**™ Wind Turbine Model WT6500

Owner's Manual

This manual is intended for the use of a licensed contractor. If you are a licensed and insured contractor who would like to become an Authorized Installer, please send your request to Installer@WindTronics.com.

Safety Instructions

PLEASE READ THESE INSTRUCTIONS AND THE ENTIRE MANUAL PRIOR TO INSTALLATION.

Safety Icons

The following symbols identify dangers associated with the installation, use or ownership of the **SMARTBOX**™ Controller. When you see these symbols, please be aware of the potential for personal injury or property damage.

⚠ WARNING	WARNING indicates a hazard that could result in death, personal injury or property damage.

⚠ CAUTION	CAUTION indicates a hazard that could result in property damage.

IMPORTANT: PLEASE TAKE NOTE

PROFESSIONAL INSTALLATION: REQUIRED

TIP: Helpful information to ease the installation

Important Safety Instructions

⚠ WARNING	This manual contains important safety instructions that should be followed during the installation and maintenance of this product. Be sure to read, understand and save these safety instructions.

General Safety Instructions

- All electrical work must be done in accordance with all applicable local, national, and/or international electrical codes.
- Before installing or using this device, read all instructions and cautionary markings located in (or on) this guide, the unit, the batteries, turbine and any other equipment used.
- This product is designed for indoor mounting only. Do not expose this unit to rain, snow or liquids of any type.
- To reduce the chance of short-circuits, use insulated tools when installing or working with the unit or any DC source (such as PV, hydro, wind, or batteries).
- Remove all jewelry when installing or working with the unit or any DC source. This will greatly reduce the chance of accidental exposure to live circuits.
- The unit contains more than one live circuit (batteries and turbine). Power may be present at more than one source.
- This product contains no user-serviceable parts.

⚠ WARNING

LIMITATIONS ON USE
The **SMARTBOX™** Controller is not intended for use in connection with life support systems or other medical equipment or devices.

Battery Safety Information

⚠ WARNING

A battery can produce the following hazards to personal safety:
- electrical shock
- burn from high-short-circuit current
- fire or explosion from vented gasses

Observe proper precautions when working with or around batteries.

- Always wear eye protection, such as safety glasses, when working with batteries.
- Remove all jewelry before working with batteries.
- Never work alone. Have someone assist you with the installation or be close enough to come to your aid when working with batteries.
- Always use proper lifting techniques when handling batteries. Always use identical types of batteries.
- Never install old or untested batteries. Check each battery's date code or label to ensure age and type.
- Batteries should be installed in a well-vented area to prevent the possible buildup of explosive gasses. If the batteries are installed inside an enclosure, vent its highest point to the outdoors.
- When installing batteries, allow at least 1 inch of air space between batteries to promote cooling and ventilation.
- NEVER smoke in the vicinity of a battery or generator.
- Always connect the batteries first, then connect the cables to the inverter or controller. This will greatly reduce the chance of spark in the vicinity of the batteries.
- Use insulated tools when working with batteries. When connecting batteries, always verify proper voltage and polarity. Do not short-circuit battery cables. Fire or explosion can occur.
- In the event of exposure to battery electrolyte, wash the area with soap and water. If acid enters the eyes, flood them with running cold water for at least 15 minutes and get immediate medical attention.
- Always recycle old batteries. Contact your local recycling center for proper disposal information.

NOTE TO INSTALLER: This Owner's Manual should be left with the owner of the **SMARTBOX™** Controller.

The **SMARTBOX**™ Controller for the **HONEYWELL**™ Wind Turbine WT6500 is manufactured by WindTronics Inc. Please contact WindTronics Inc. at:

621 Sprucewood Avenue
Windsor, Ontario
N9C 0B3

877-946-3898

Table of Contents

3. Commisioning

4. Operation

5. Specifications

1 Introduction

Chapter 1 describes the **SMARTBOX**™ Controller with battery overview and selection details.

The SMARTBOX™ Controller

The **SMARTBOX**™ Controller is a proprietary WindTronics control system that consists of a charge controller and a non-grid-tie 1.5 kW inverter. Included within the charge controller is an automatic AC transfer switch that will automatically switch between your AC grid and power generated via the turbine.

The DC output from the turbine is fed into the Junction Box located beneath the turbine assembly. The J Box serves three purposes: provide wiring interconnections for the installation, provide an output over voltage protection of 170 VDC, and provide a diversion or “dump” load that can dynamically brake and stop the turbine either upon request from the **SMARTBOX**™ Controller or if a failure occurs in the system.

Beyond the J Box, all connections are fed into the **SMARTBOX**™ Controller. The **SMARTBOX**™ Controller consists of four main elements: an I/O interface that provides wiring interconnect for installation, a charge controller to charge a bank of batteries, a non-grid-tie 1.5 kW inverter to back-convert the batteries to an AC output and a transfer switch that can switch between AC grid input and the internal inverter’s AC.

Major System Components

SMARTBOX™ Controller
Batteries and battery enclosure

Parts Inspection

Upon opening the shipping container, review all contents to ensure the contents have not been damaged during shipping and handling. Failure to properly inspect and verify damages prior to installation may result in voiding of the manufacturer warranty. If any turbine components appear to be damaged, please contact the WindTronics service department at the following:

WindTronics, Inc.
Service Department
621 Sprucewood
Windsor, ON N9C0B3
Canada

1-877-946-3898

Battery Overview

Battery Types

Batteries are classified in two different ways: by application (their use) and construction (how they are built). The major applications are automotive, marine and deep cycle. Deep cycle includes solar electric (PV), wind power, backup power and RV/boat “house” batteries.

The major construction types are flooded (or “wet”), gel and AGM (Absorbed Glass Mat). AGM batteries are also sometimes called “starved electrolyte” or “dry,” because the fiberglass mat is only 95% saturated with sulfuric acid and there is no excess liquid. Flooded batteries may be standard, with removable caps, or a so-called “maintenance free” type. All gelled batteries are sealed and a few are “valve regulated,” which means that a tiny valve keeps a slight positive pressure. Nearly all AGM batteries are sealed valve regulated (commonly referred to as Valve Regulated Lead-Acid or “VRLA”). Most valve regulated types are under some pressure - 1 to 4 psi at sea level.

Not to be used

Starting (sometimes called “SLI,” for starting, lighting, ignition) batteries are commonly used to start and run engines. Engine starters need a very large starting current for a very short time.

Starting batteries have a large number of thin plates for maximum surface area. The plates are composed of a lead “sponge,” similar in appearance to a very fine foam sponge. This creates a very large surface area, but if deep-cycled this sponge will quickly be consumed and fall to the bottom of the cells.

Automotive batteries will generally fail after 30-150 deep cycles if deep-cycled, while they may last for thousands of cycles with normal starting use (2-5% discharge).

Minimum to be used

Most marine batteries are usually actually a “hybrid” and fall between the starting and deep cycle batteries, while a few (Rolls-Surrette and Concorde, for example) are true deep cycle. In a hybrid type, the plates may be composed of lead sponge, but the material is coarser and heavier than that used in starting batteries. It is often hard to tell what you are getting in a “marine” battery, but most are a hybrid type. Hybrid types should not be discharged more than 50%.

Since starting batteries are usually rated as either cold cranking amps (or “CCA”) or marine cranking amps (or “MCA”), the same as cranking amps (or “CA”), any battery with the capacity shown in CA or MCA may not be a true deep cycle battery. It is sometimes hard to tell, as the terms “marine” and “deep cycle” are sometimes overused. CA and MCA ratings are at 32 degrees F, while CCA is at 0 degrees F.

Recommended

We only recommend using TWO-12V, 100Ah, flooded, deep cycle, marine grade batteries. Deep Cycle batteries are designed to be discharged down as much as 80% time after time, and have much thicker plates. The major difference between a true deep cycle battery and others is that the plates are SOLID Lead plates, not sponge.

The popular golf cart battery is generally a “semi” deep cycle - better than any starting battery, better than most marine, but not as good as a true deep cycle solid lead plate, such the L-16 or industrial type.

Amp-hour Ratings

All deep cycle batteries are rated in amp-hours. An amp-hour (Ah) is a unit of electric charge measurement, calculated by multiplying amps by hours. For example, if you have a device that pulls 20 amps, and you use it for 20 minutes, then the amp-hours used would be 20 (amps) multiplied by .333 (hours), or 6.67 Ah.

The accepted amp-hour rating time period for batteries used in wind electric and backup power systems (and for nearly all deep cycle batteries) is the “20 hour rate.” This means that a battery is discharged down to 10.5 volts over a 20 hour period while the total actual amp-hours it supplies is measured. Sometimes ratings at the 6 hour rate and 100 hour rate are also given for comparison and for different applications. The 6 hour rate is often used for industrial batteries, as that is a typical daily duty cycle. The 100 hour rate is sometimes used for determining battery capacity for long-term backup amp-hour requirements.

Battery Selection

Battery selection is one of the most important steps in the installation process. Not selecting the correct batteries will result in short battery life, constant charge and discharge cycles, and overheating of batteries which could result in serious damage to equipment, battery explosions or fire. The charge controller will prevent over-charging, although this must be set up correctly.

DO NOT use standard automotive (starting) batteries. While automotive batteries may last for thousands of cycles in normal starting use (2-5% discharge), they will generally fail after 30-150 cycles if used in a deep cycle application as with the **HONEYWELL™** Wind Turbine, which will discharge batteries down to 50%. Any battery rated in CCA or CA should not be used. Since some marine batteries are rated with CCA, care must be used when selecting a marine battery.

AC Load Detail and Selection

The non-grid-tie option requires the installation of AC sub panel. This means that the user must select certain loads and move them into a separate sub panel. The sub panel will always be provided with AC power from either the grid or the turbine when the batteries are charged. The SmartBox controls a transfer switch internally when the conditions are ready.

A critical decision to be made during installation is selecting which loads to run off of the sub panel. The first step is to measure the current in the sub panel. The second step is to determine which loads should be moved to the sub panel. The calculation is made by determining the appliances to be run off the sub panel, and adding up the listed wattage on each appliance. The total should be less than 1500W. The **SMARTBOX™** Controller can handle most home appliances’ starting current. The limitation is 1750W for three minutes and 3000W for two seconds.

General rules to determine what should go on the sub panel:

- In general, avoid appliances in the kitchen and laundry room.
- Putting the furnace or refrigerator on the sub panel is okay, but be sure to total the “on” time wattage required by all appliances

- Water pumps can be add to the panel, but the pump must be rated at 120 VAC.
- Typically, 1500W can handle all the lighting and some appliances.
- You may want to mark wall plugs in the home to indicate that the plug is on wind turbine power instead of grid power.

The following are lists of various recommended and non-recommended appliances, and their typical power requirements:

Recommended Appliances

Appliance	Wattage	Notes
Clock radio	10	
Electric blanket	60 / 100	Single/Double
Fans:		
Ceiling	65 - 175	
Window	55 - 250	
Energy Star Furnace:		
NO AC	100 - 750	200 for a 2500 sq/ft home
Lights	10 - 150	Add total wattage of each lights on panel
Personal computer:		
CPU - awake / asleep	120 / 30	
Monitor - awake / asleep	150 / 30	
Laptop	50	
Radio (stereo)	70 - 400	
Televisions	65 - 170	
VCR/DVD	17 - 25	
Water pump	250 - 1100	

Figure 1.1 Recommended Appliances

NOT Recommended

- Air conditioner = 1000-3000
- Coffee maker = 900–1200
- Clothes washer = 350–500
- Clothes dryer = 1800–5000
- Dishwasher = 1200–2400 (using the drying feature greatly increases energy consumption)
- Dehumidifier = 785
- Hair dryer = 1200–1875
- Heater (portable) = 750–1500
- Clothes iron = 1000–1800
- Microwave oven = 750–1100

- Refrigerator (frost-free, 16 cubic feet) = 725
- Toaster = 800–1400
- Toaster oven = 1225
- Vacuum cleaner = 1000–1440
- Water heater (40 gallon) = 4500–5500
- Water bed (with heater, no cover) = 120–380

2 SMARTBOX™ Controller Installation

Chapter 2 provides details on installing the **SMARTBOX**™ Controller and getting it ready for operation.

System Diagrams

TIP: The instructions in this section apply to a typical installation. Installation procedures may vary according to your specific application. For special applications, consult a qualified electrician or your WindTronics certified dealer.

PROFESSIONAL INSTALLATION: Installation must be compliant with all local electrical codes. Installation of this equipment should only be performed by a qualified electrician or by a Certified Renewable Energy System Installer.

Turbine Block Diagram

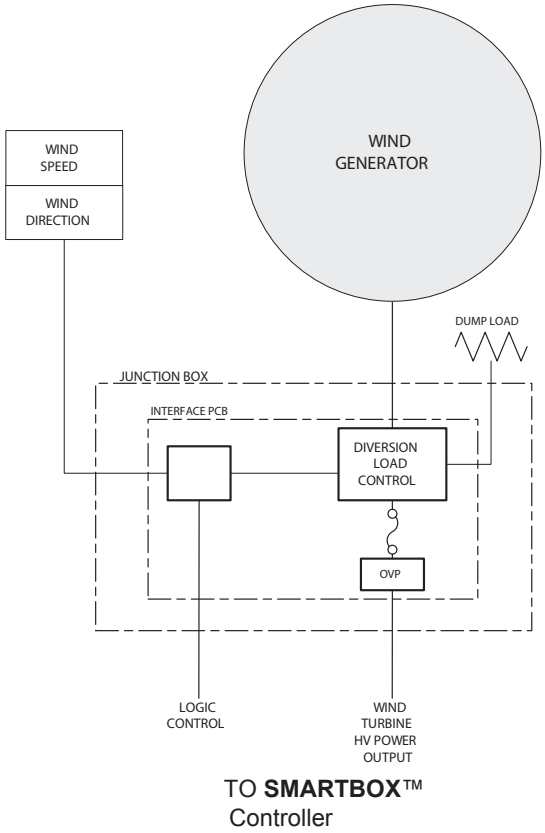


Figure 2.1 Turbine Block Diagram

SMARTBOX™ Controller Diagram

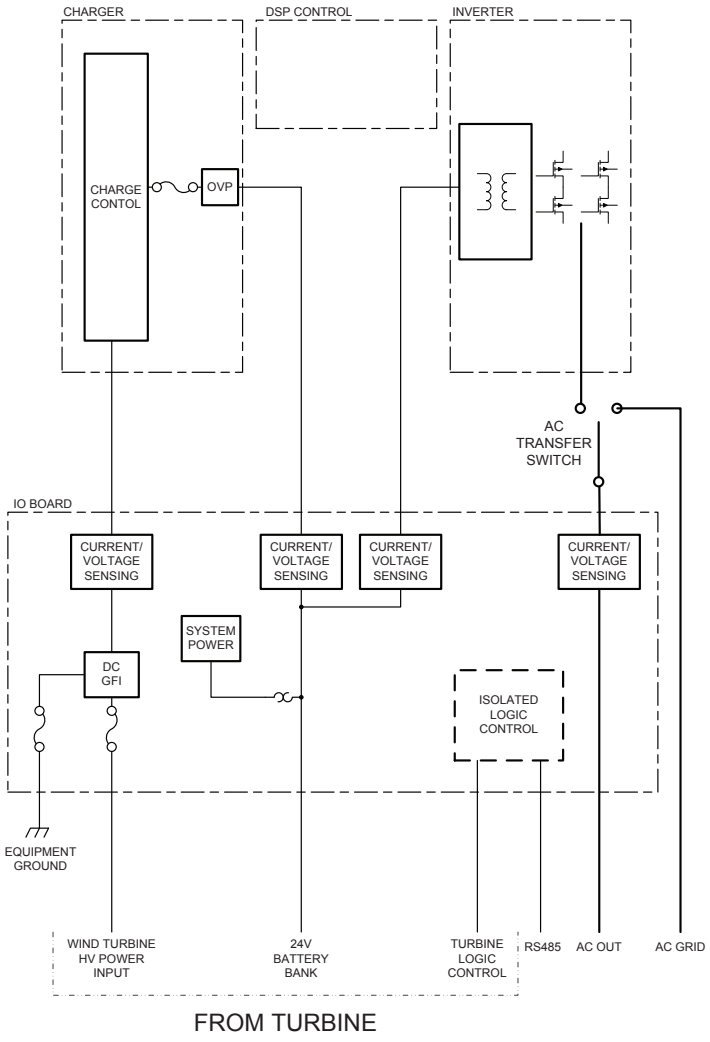


Figure 2.2 SMARTBOX™ Controller Diagram

Mounting

The **SMARTBOX™** Controller must be mounted vertically and installed indoors in a dry, protected location away from flammable material, sources of high temperature, moisture and vibration. The location must also be sheltered from direct sunlight, rain, snow and wind-blown debris.

It is best to mount the **SMARTBOX™** Controller near near the building's electrical panel egress. This will typically result in the **SMARTBOX™** Controller being mounted on or near an external wall where the battery enclosure can then be located outdoors.

⚠ WARNING

RISK OF FIRE OR EXPLOSION
To reduce the risk of fire or explosion, do not install the **SMARTBOX™** Controller in sealed compartments containgin batteries or in locations that require ignition-protected equipment. Failure to follow this warning may result in death, personal injury or property damage.

Minimum Clearance for Proper Mounting

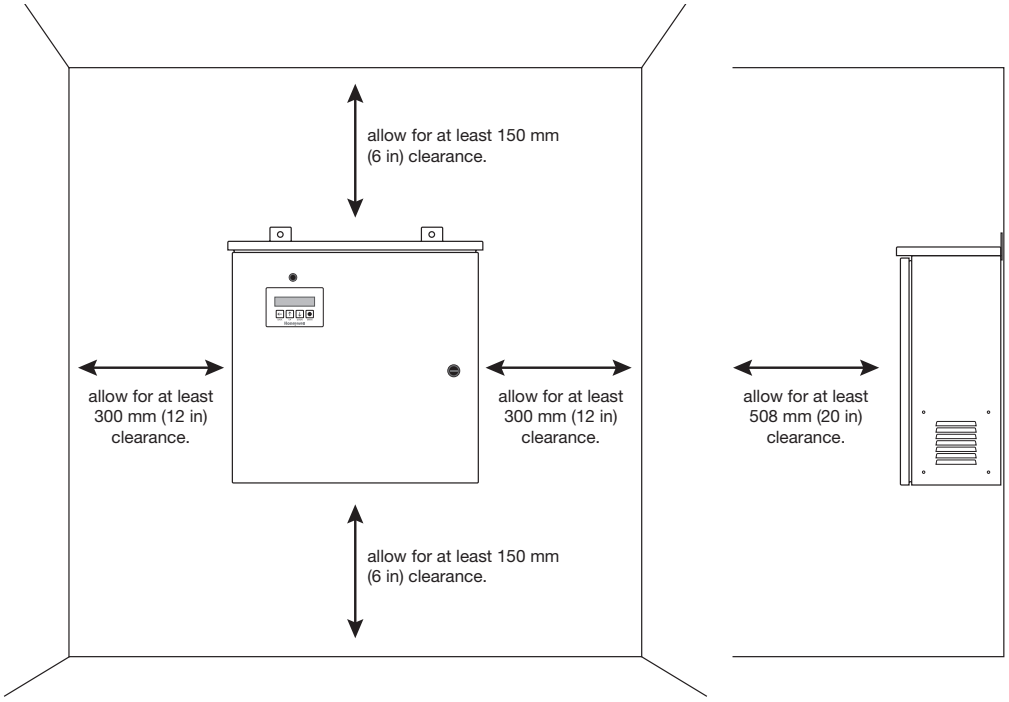


Figure 2.3 Minimum Clearance for Proper Mounting

CAUTION

EQUIPMENT DAMAGE
Never install the **SMARTBOX**™ Controller where it is exposed to salt water spray. Exposure to salt water will void the warranty and may cause a shock hazard.

WARNING

EXPLOSION/CORROSION DAMAGE
To reduce the risk of corrosion from hydrogen-sulfide gas vented by batteries, do not install the **SMARTBOX**™ Controller in sealed compartments containing batteries. Failure to follow this warning may result in death, personal injury or property damage.

Grounding

The **SMARTBOX**™ Controller is designed to work only with the **HONEYWELL**™ Wind Turbine. The turbine uses a negative-grounded electrical system. Grounding for the turbine, battery and AC circuits are provided inside the wiring compartment. Each ground connection can accommodate up to #6 AWG wire size.

GFI: A fuse rated at .5A 250V, accessible from the bottom of the wiring compartment, grounds the negative conductor of the turbine and provides turbine ground-fault protection. Only a Littelfuse 0312.500HXP or equivalent fuse should be used as a replacement.

⚠ WARNING

SHOCK HAZARD
DO NOT connect the battery negative to ground. NEC requirements specify that the battery negative ground must be done only through the 1A fuse. Bonding the battery negative to ground will disable the turbine's ground fault protection and will result in improper operation. The battery compartment should be grounded if made of metal. Failure to follow this warning may result in death, personal injury or property damage.

⚠ WARNING

SHOCK HAZARD AND FIRE HAZARD
Fuses must only be replaced by qualified service personnel, such as a certified electrician or technician. For continued protection again risk of fire, replace only with the same type and rating of fuse. Failure to follow this warning may result in death, personal injury or property damage.

⚠ WARNING

SHOCK HAZARD
Disconnect wind and battery circuits before removing the grounding connections or before removing or installing the fuse. Wait at least 5 minutes for the internal circuitry to discharge before servicing the unit. Failure to follow this warning may result in death, personal injury or property damage.

Wiring

PROFESSIONAL INSTALLATION: REQUIRED

Installations must meet all local electrical codes. Installations for the equipment should only be performed by a qualified electrician or an Authorized Installer.

⚠ WARNING

SHOCK HAZARD
Disconnect turbine and battery circuits before wiring. Turn off all power before wiring. Failure to follow this warning may result in death, personal injury or property damage.

Wiring Diagram

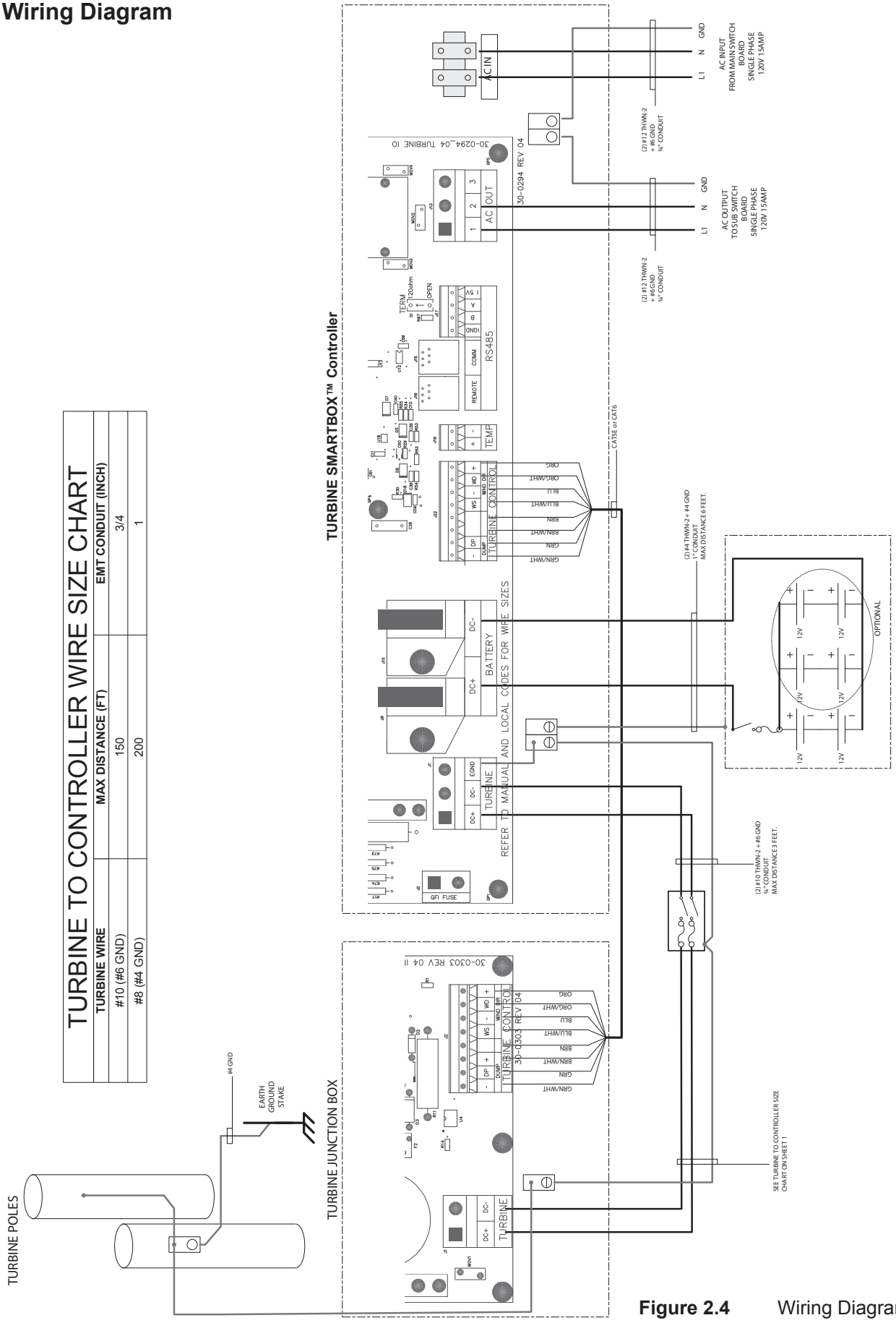


Figure 2.4 Wiring Diagram

Turbine Wiring and Distances

The **HONEYWELL™** Wind Turbine and **SMARTBOX™** Controller can be installed at a maximum distance of 200 feet apart. The **SMARTBOX™** Controller and battery enclosure can be installed at a maximum distance of 10 feet apart.

Turbine Current Rating and Wiring

The turbine input is rated for 20 amps maximum Isc (short circuit). The recommended wire type is #10 AWG USE-2/RHW-2 or THWN-2, 90 degrees C wire for a turbine-to-Smart-Box distance of up to 150 feet. The wire gauge should be increased to #8 AWG for a distance of 150-200 feet. Due to the outside location of the turbine, a 70 degree C ambient temperature correction is recommended.

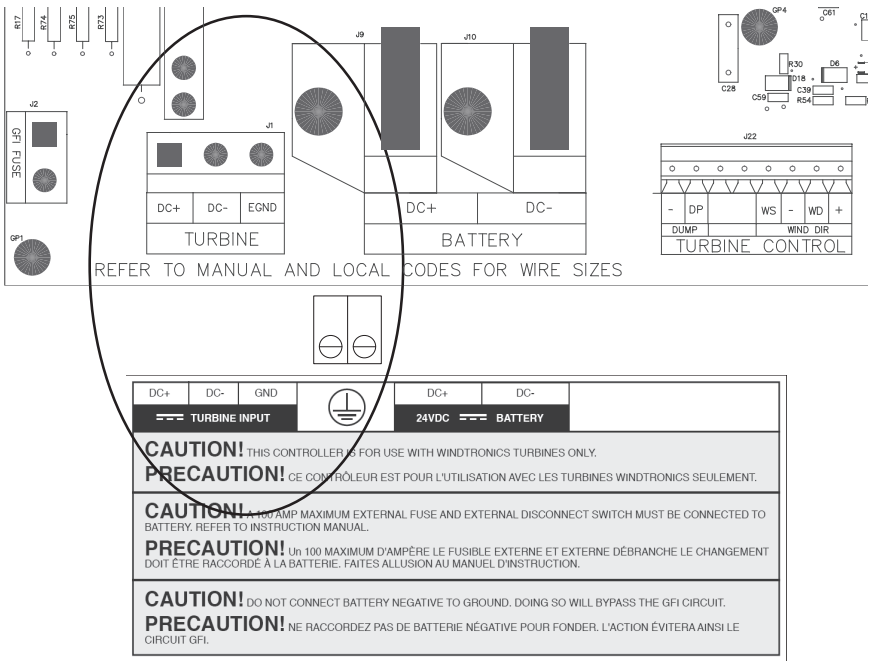


Figure 2.5 Turbine Connection Location

Turbine Over-current Protection

The NEC requires the turbine circuit to be protected with a device rated for 125% of the rating of the circuit. The DC-rated fuse or circuit breaker between the turbine and the **SMARTBOX™** Controller must have a maximum size of 15 (the maximum current rating of the **SMARTBOX™** Controller).

⚠ WARNING

SHOCK HAZARD OR FIRE HAZARD
Over-current protection must be installed to protect the **SMARTBOX™** Controller from short circuits and to provide a means of disconnecting it. Failure to follow this warning may result in death, personal injury or property damage.

⚠ WARNING

REVERSE POLARITY DAMAGE
Before making the final DC connection or closing the DC breaker or disconnect, check cable polarity at both the battery and the **SMARTBOX™** Controller. Positive (+) must be connected to positive (+). Negative(-) must be connected to negative (-). Failure to follow this warning may result in death, personal injury or property damage.

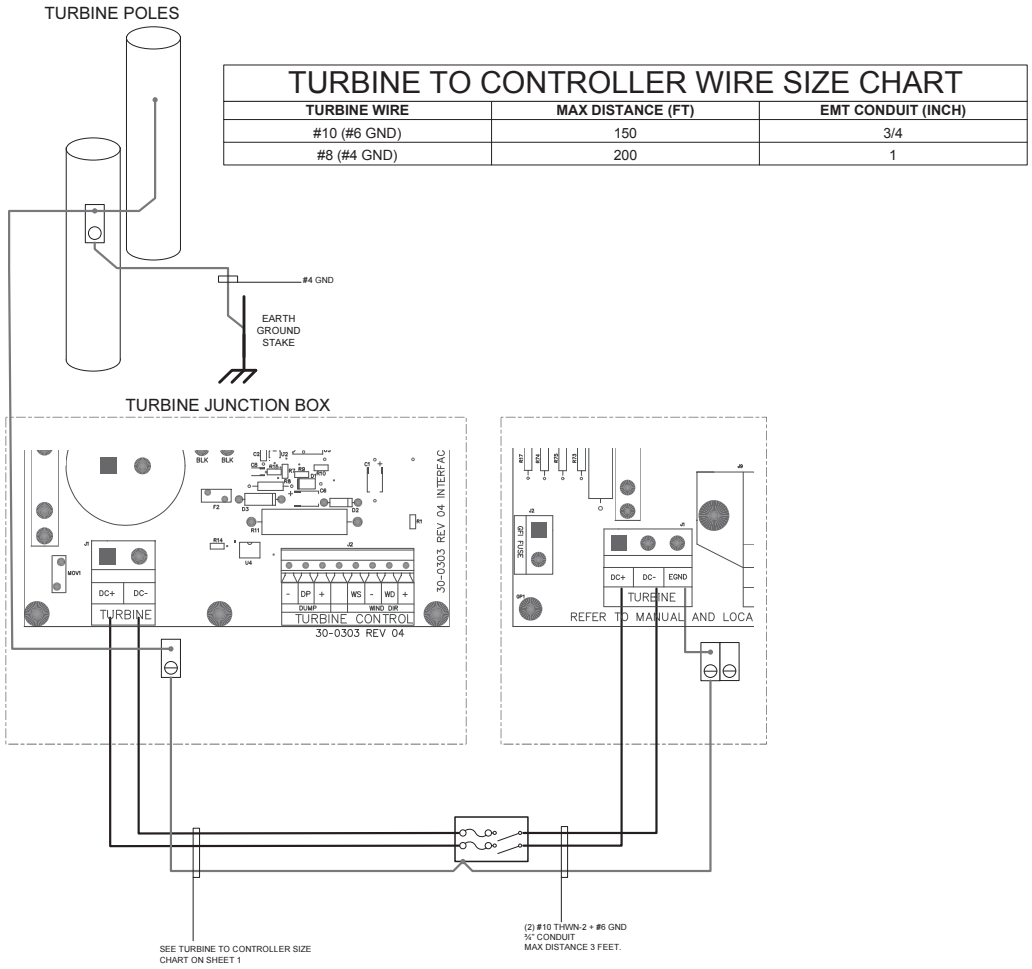


Figure 2.6 Turbine Circuit Diagram

Battery Wiring

The battery charge current is rated at 60 amps and inverter current is rated 72 amps maximum. The recommended wire type is #4 AWG USE-2/RHW-2 or THWN-2, 90 degrees C wire for a **SMARTBOX™** Controller-to-battery-enclosure distance of up to 6.3 feet. The wire gauge should be increased to #2 AWG wire for a distance of 6.3-10 feet.

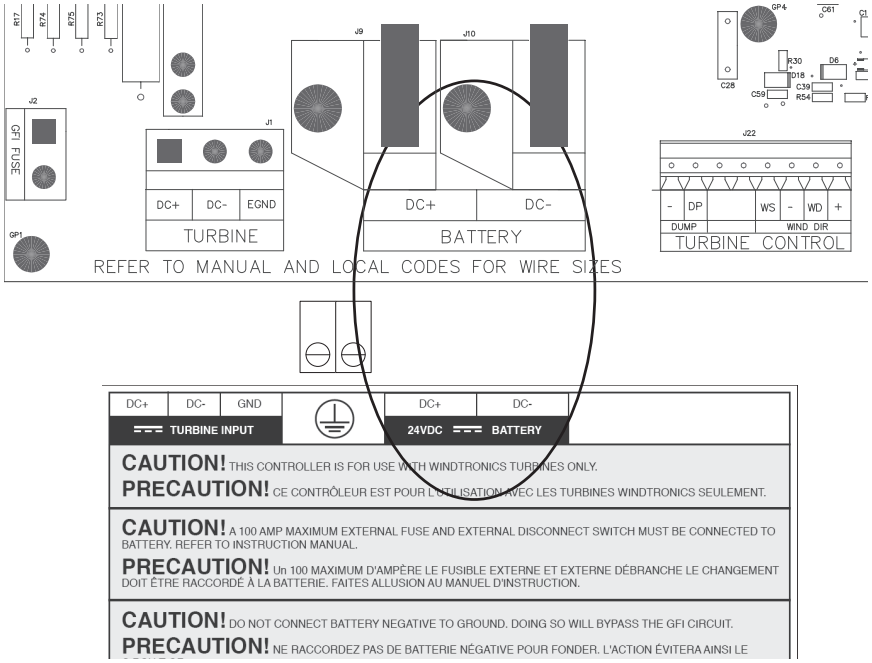


Figure 2.7 Battery Connection Location

Battery Over-current Protection

The NEC/CEC requires the battery circuit to be protected with a device rated for 125% of the rating of the circuit. The DC-rated fuse or circuit breaker between the battery and the **SMARTBOX™** Controller must have a maximum size of 75A (the maximum current rating of the **SMARTBOX™** Controller).

⚠ WARNING

SHOCK OR FIRE HAZARD
Over-current protection must be installed to protect the **SMARTBOX™** Controller from short circuits and to provide a means of disconnecting it. Failure to follow this warning may result in death, personal injury or property damage.

⚠ WARNING

REVERSE POLARITY DAMAGE
Before making the final DC connection or closing the DC breaker or disconnect, check cable polarity at both the battery and the **SMARTBOX™** Controller. Positive (+) must be connected to positive (+). Negative(-) must be connected to negative (-). Failure to follow this warning may result in death, personal injury or property damage.

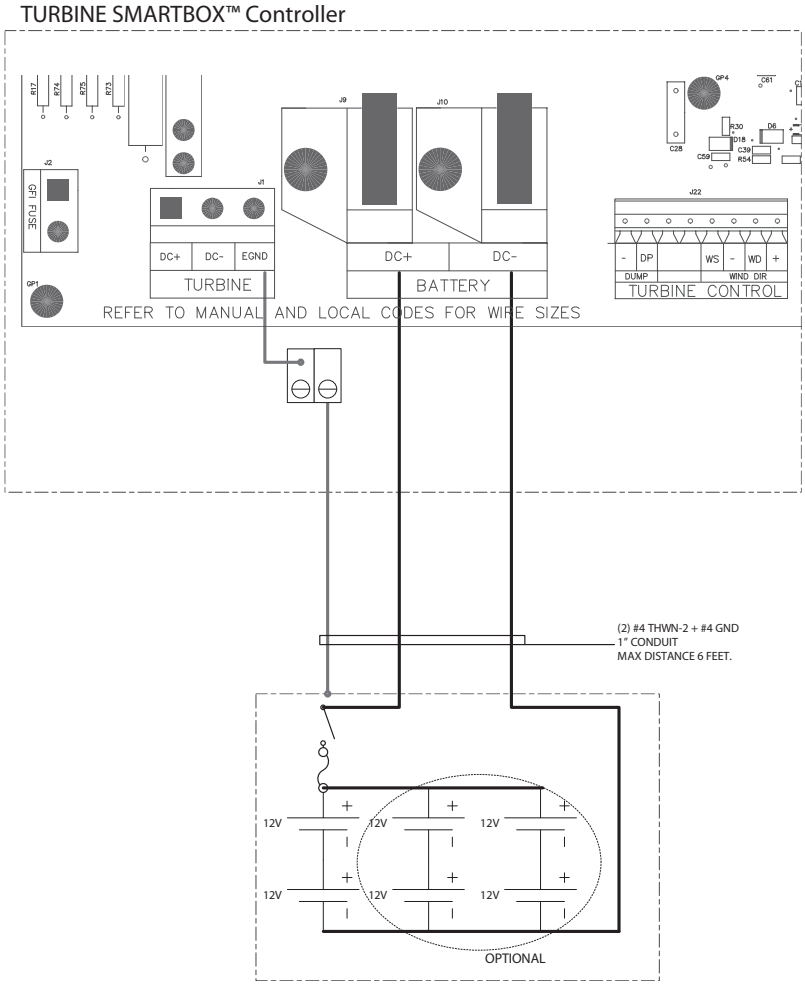


Figure 2.8 Battery Circuit Diagram

AC Input Wiring

The AC input current is rated at 15 amps. Use standard NEC calculations and local codes for proper wiring.

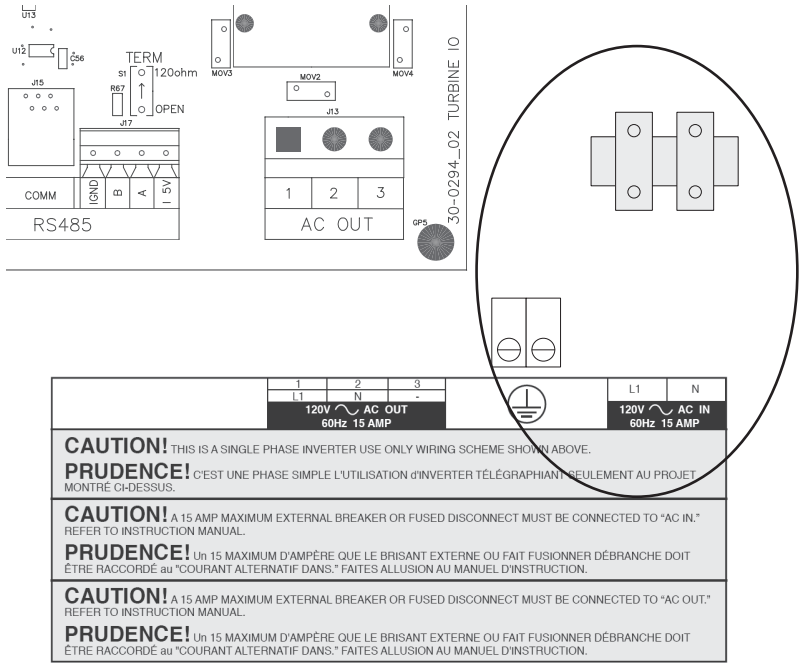


Figure 2.9 AC Input Current Wiring Diagram

AC Output Wiring

The AC output current is rated at 15 amps. Use standard NEC calculations and local codes for proper wiring.

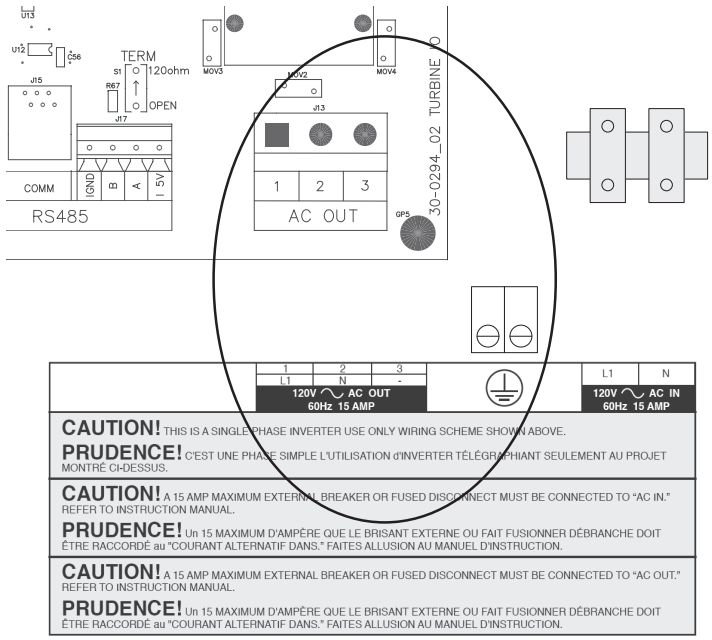


Figure 2.10 AC Output Current Rating Diagram

AC Output Over-current Protection

The NEC/CEC requires the AC output circuit to be protected with a device rated for 125% of the rating of the circuit. The AC-rated fuse or circuit breaker between the battery and the **SMARTBOX™** Controller must have a maximum size of 15A (the maximum current rating of the **SMARTBOX™** Controller).

⚠ WARNING

SHOCK OR FIRE HAZARD
A maximum of a 15amp over-current protection must be installed to protect the **SMARTBOX™** Controller from short circuits and to provide a means of disconnecting the **SMARTBOX™** Controller. Failure to follow this warning may result in death, personal injury or property damage.

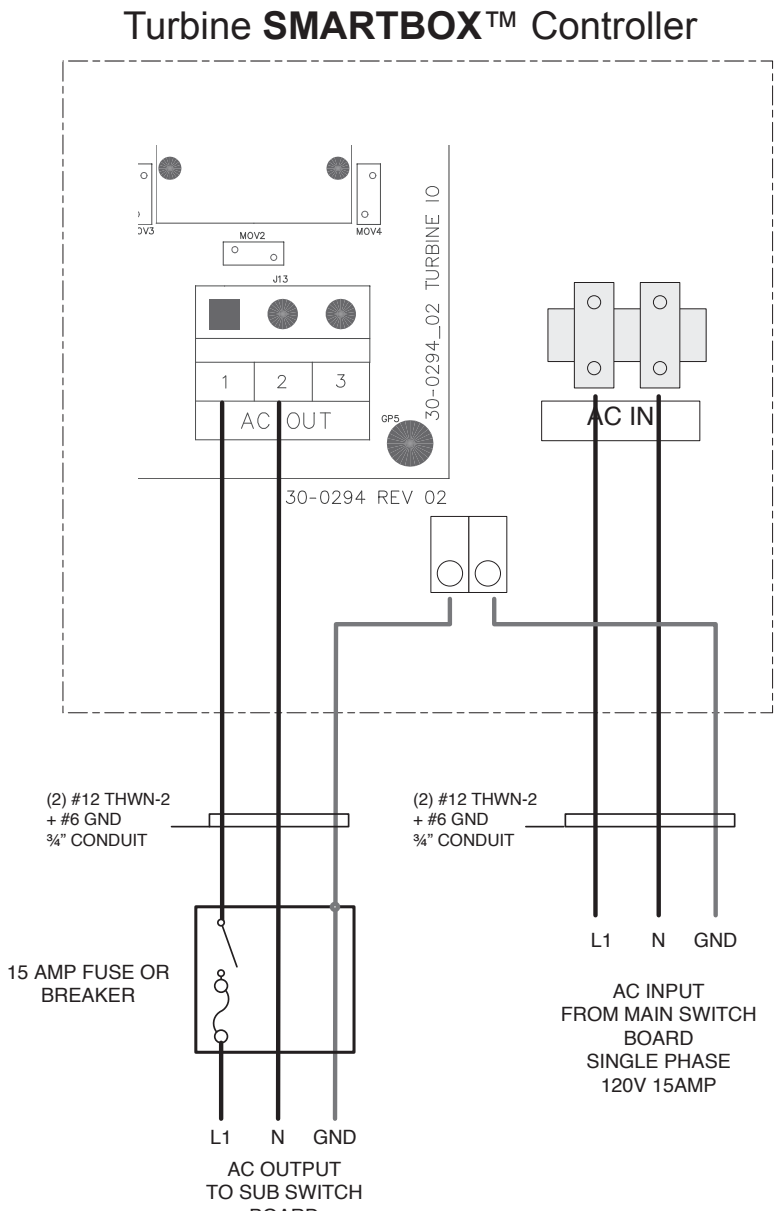


Figure 2.11 AC Circuit Diagram

Control Wiring

Control wiring can use stranded CAT5, CAT6 or equivalent wire.

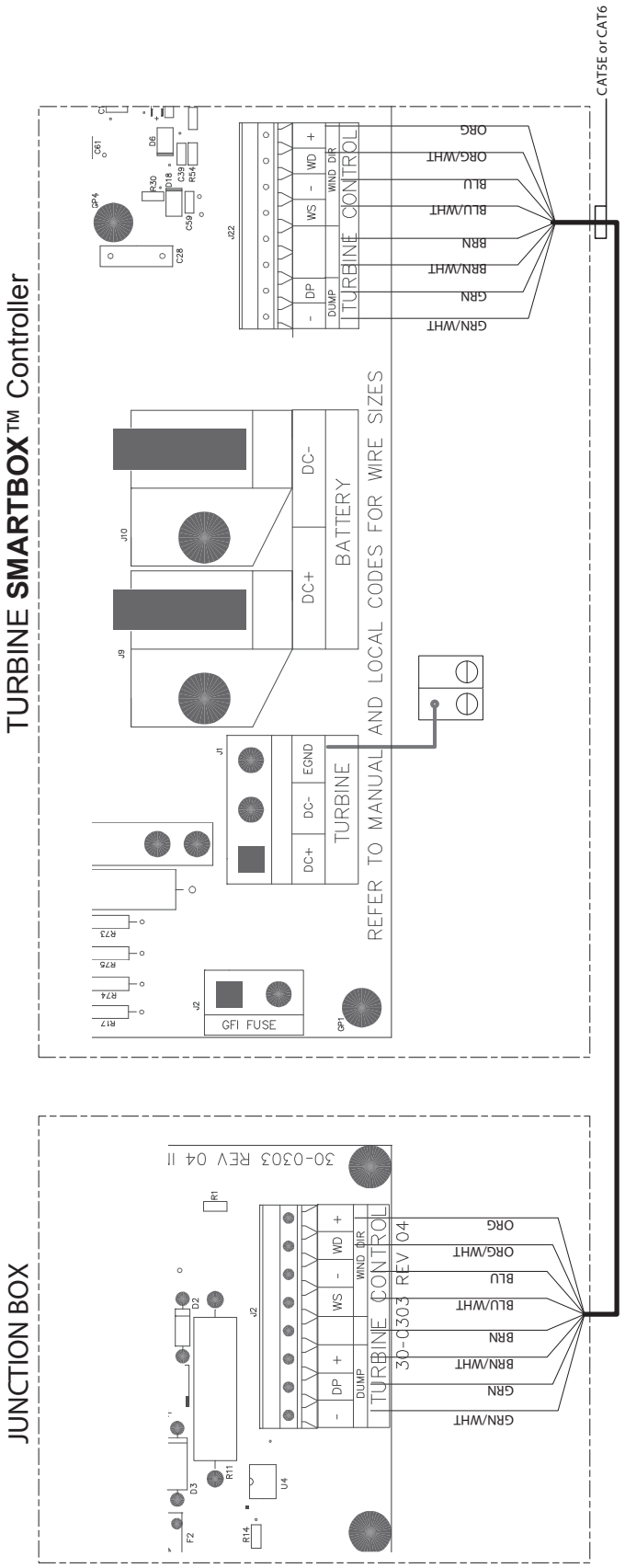


Figure 2.12 Control Wiring Chart

Enclosure Internal Wiring

NEC/CEC and UL require that no wires cross within the Junction Box. Punch outs have been provided on the bottom of the Junction Box to meet this requirement.

Battery Setup

⚠ WARNING

FIRE HAZARD
Batteries must be set correctly to avoid explosion or fire. Failure to follow this warning may result in death, personal injury or property damage.

Battery setup takes place during the commissioning process and can be accessed in the menu where the installer must configure the **SMARTBOX™** Controller based on what batteries are connected to the system. The following table shows the battery options and the values that will be set up by default.

The installer does have the option to configure the charging manually. Of the parameters listed below, the installer sets up the first three: Battery Type, Battery Banks and Capacity.

Battery Setup Chart

Setting	Values	Defaults	Description
Battery Type	Flooded GEL AGM	Flooded	Sets the battery type and automatically set the default values below based on that type
Battery Banks	1-6	1	Sets the number of 24V paralleled battery banks connected
Capacity	50-500	100 Ah	Sets the amp-hour rating of ONE battery
Recharge Voltage	20.0-27.0 V	22 V	Sets the voltage at which the charger transitions from absorption to bulk charge

Figure 2.13 Battery Setup Chart

Connecting the SMARTBOX™ Controller

⚠ WARNING

SHOCK HAZARD
Whenever a turbine is not locked and turning, a shock hazard exists at the output wires or exposed terminals. To reduce the risk of shock during installation, stop and lock the turbine before making the connections. Failure to follow this warning may result in death, personal injury or property damage.

⚠ WARNING

SHOCK HAZARD
Do not connect the battery negative to ground. Bonding the battery negative to ground disables turbine ground-fault protection. Failure to follow this warning may result in death, personal injury or property damage.

To connect the SMARTBOX™ Controller:

1. Mount **SMARTBOX™** Controller to the wall per instructions on pages 9-10; Figure 2.3.
2. Place battery enclosure in a dry, well-ventilated indoor space.
3. Install and level turbine. See the **HONEYWELL**™ WindTurbine Owner's Manual.

⚠ WARNING

SHOCK HAZARD
Always lock the blades before working with the turbine. Unlocked blades can produce voltages on the DC output. Failure to follow this warning may result in death, personal injury or property damage.

4. Attach the electrical conduit. Follow local electrical codes for compliance.

⚠ WARNING

WARRANTY VOID WARNING
DO NOT drill holes for conduit in **SMARTBOX™** Controller. Use pre-punched holes located at the bottom of the **SMARTBOX™** Controller. Drilling holes anywhere on the **SMARTBOX™** Controller will void the warranty of the product. Failure to follow this warning may also result in death, personal injury or property damage.

⚠ WARNING

FIRE AND SHOCK HAZARD
The NEC code stipulates that AC, DC and control wiring MUST NOT cross within any enclosure. Failure to follow this warning may result in death, personal injury or property damage.

5. Run wiring between turbine and **SMARTBOX™** Controller. Reference the turbine wiring diagram on page 12; Figure 2.4.
6. Run turbine control wiring. Reference the turbine control wiring diagram on page 19; Figure 2.12.
7. Run battery wiring. Reference the battery wiring diagram on page 15; Figure 2.7.
8. Run AC wiring. Reference AC wiring diagrams on pages 17-18; Figure 2.9, 2.10, 2.11.
9. Follow commissioning for start up procedure. Page 24.

⚠ WARNING

REVERSE POLARITY DAMAGE
Before making the final DC connection or closing the DC breaker or disconnect, check cable polarity at both the battery and the SmartBox. Positive (+) must be connected to positive (+). Negative(-) must be connected to negative (-). Failure to follow this warning may result in death, personal injury or property damage.

3 Commissioning

Chapter 3 describes the step by step process of commissioning the **SMARTBOX**™ Controller.

For Information on:	See:
Commissioning Process	page 24

Commissioning Process

⚠ WARNING

EXPLOSION OR FIRE HAZARD
Entering battery information incorrectly may result in explosion or fire.

During commissioning, the **SMARTBOX™** Controller and turbine must be set up. Settings for the battery type, battery banks and battery capacity must be set up in the **SMARTBOX™** Controller, and the turbine's components will need to be tested. This testing can be done with the control panel and LCD screen on the front of the system controller. Ensure you have this system information prior to commissioning. The commissioning process will reference menu displays.

The following is the proper procedure to commission the turbine. Do not proceed with commissioning until all disconnects are in the off position and the turbine is mechanically locked. The turbine dynamic brake will remain enabled up until the turbine disconnect step.

The following is the proper procedure to commission the **HONEYWELL™** Wind Turbine. Do not proceed with commissioning until ALL DISCONNECTS are in the OFF position and the turbine blades rotate freely.

1. **Check all connections for polarity.**

2. Apply battery power to the unit with the disconnect or selector switch inside the battery enclosure.

3. The LCD display will light up and prompt a display:

Display	Description
WINDTRONICS RX.XX FIRST POWER UP	The Smart Box will display this for 5 seconds and then move to the required setup information.

4. The system will automatically walk you through the commissioning process. All steps must be completed before the turbine will operate. If problems are found during this process, the battery disconnect can be turned off at any time to restart the process. All of the settings will be saved, but you must start over and go through all the steps until commissioning is complete.

5. **For optimal performance it is important to enter optimal battery information (steps 5-7). We highly recommend using two 12V deep cycle/flooded/marine 100Ahr batteries. For this selection please enter the following optimal settings for best performance.**

   At the first prompt screen, select the battery type by using the arrow keys. Press ENTER when finished.

Display	Description	Optimal
ENTER BATTERY TYPE FLOODED	Set the battery type	**Flooded**

6. Select the battery Amp-hour rating for ONE battery by using the arrow keys. Press ENTER when finished.

Display	Description	Optimal
ENTER BATTERY AHr 100	Set the battery amp-hour rating for ONE battery	Enter **140** for 100Ahr batteries

7. Select the number of battery banks in parallel by using the arrow keys. Press ENTER when finished.

Display	Description	Optimal
ENTER BATTERY BANKS 1	Set the number of battery banks	Enter **3** for one bank of 2-12V batteries

8. At this point the batteries are all set up. Now you will proceed to setting up the turbine and checking its components for operation. Turbine setup requires two people: one located at the turbine and one located at the system Smart Box.

9. Step 10 is for testing the turbine. Turn on the turbine disconnect.

10. If the wind is not causing the turbine wheel to spin, gently spin the wheel by hand to determine if the system Smart Box is detecting a voltage level.

Display	Description
TURBINE INPUT OK	Shows if a turbine voltage was found.

11. Step 12 is for testing the AC grid connection. Turn on the AC disconnect from the grid input.

12. Check the LCD screen and make sure the AC voltage is OK. Press ENTER to continue.

Display	Description
AC Grid 120V OK??	Checks the AC voltage. Press ENTER to skip this step if this is a non-grid-tie connection.

13. Step 14 is for testing the AC load connection.Turn on the AC disconnect to the load. Turn on all items on the sub panel load to make sure that the turbine inverter can handle the load.

14. The system commission process is now complete. Press ENTER to start the turbine. If required, this process can be restarted via the technician's menu.

Display	Description
COMMISSION COMPLETE	Press ENTER to start the turbine.

4 Operation

Chapter 4 is an overview of **SMARTBOX™** Controller operation including operating states, system faults and menu structures.

Introduction

The basic operation of the turbine/**SMARTBOX™** Controller electronic system is to optimize the efficient utilization of the energy captured from the wind. Low wind energy is stored in batteries while loads are connected automatically to the grid. High wind energy is efficiently and rapidly transferred to the load via the bulk storage capacity of the batteries.

If the batteries are fully charged and no AC demand is present, the **SMARTBOX™** Controller will send the turbine's energy to a dump load, and wait for an AC demand.

Turbine Operating States

The turbine goes through a series of different states. The chart lists and describes each possible operating state:

State	Description	Charger	Inverter	Transfer Switch	Dump Load
Bulk Charge	Bulk charging the batteries	On	Off	Grid	On*
Absorption Charge	Absorption charging the batteries	On	Off	Grid	On*
Float Charge	Float charging the batteries	On	On	Turbine	On*
Fault Stop	Turbine fault exists	Off	Off	Grid	On
User Stop	Turbine stopped by user	Off	Off	Grid	On

* The dump load is enabled as required to keep turbine voltages at an efficient level.

Figure 4.1 Turbine Operation States

Starting/Stopping Turbine

1. Toggle the DOWN key on the SmartBox front panel to MAIN MENU.

Display	Description
MAIN MENU .STOP-START TURBINE?	Allows user to turn the turbine on or off

2. Press enter

Display	Description
TURBINE-STOPPED UP=STOP DWN=RUN	Press UP to stop the turbine. Press DOWN to start the turbine

Viewing Operating Status

The operating status of the WT6500 can be viewed via the LCD screen on the **SMARTBOX™** Controller. To regulate energy consumption, the **SMARTBOX™** Controller has two operating states: display and running. The **SMARTBOX™** Controller will also maintain one of three different turbine operating states: turbine running, fault stop and user stop.

Controller Energy Consumption States

- **Display On State**
  The Display state is enabled by pressing any key on the **SMARTBOX™** Controller. This state will enable the LCD backlight and cause user information to scroll on the second line of the LCD screen. This state is also active when accessing the menus. If no buttons are pressed, the **SMARTBOX™** Controller will automatically switch back to the running state.

- **Display Off State**
  The off state is the default state if the turbine is producing energy from the wind, waiting for the wind, or if any button on the system controller is pressed. The display backlight will be off and no information will scroll. If any faults occur in this state, the fault will be displayed. The controller will maintain this state if the turbine input voltage is greater than 20VDC.

Turbine Operating States

- **Turbine Running State**
  When the turbine is in its running state, the following will be shown on the display and is based on the energy consumption state:

Display - Main Menu Scroll	**Description**
CHARGER: BULK ABSORPTION FLOAT/READY STOPPED FAULT	**Displays the charger operating state:** Charge is in bulk charge stage Battery is in absorption stage Battery charge cycle complete and ready for use Charge cycle has stopped Reference Fault Table on page 37, Figure 4.3
TURBINE: STOPPED RUN NO WIND RUN WIND FAULT STOP	**Displays the turbine operating state:** Stopped State Turbine is running but no wind is present Turbine is running and wind is present Reference Fault Table on page 37, Figure 4.3
AC: GRID AC TURBINE FAULT	**Displays the transfer switch location:** AC output is connected to grid AC output is connected to turbine inverter Reference Fault Table on page 37, Figure 4.3
POWER	Displays the power generated by the turbine
PRODUCTION	Displays the total accumulated energy generated by the inverter from batteries
WIND SPEED	Displays measured wind speed

Display - Display Off	Description
TURBINE RUNNING PRESS ANY KEY	Turbine is running with no faults. Back light is off with no information scroll.

Figure 4.2 Turbine Running States

- **Turbine Fault Stop State**
  The turbine will enter its Fault Stop state if any faults occur. The turbine will stop operating and the user must clear the faults to restart the turbine. The faults are cleared by pressing ENTER on the **SMARTBOX™** Controller control panel. The following will be shown on the **SMARTBOX™** Controller LCD screen and is based on

the energy consumption state (see the Fault and Troubleshooting section for complete details):

Display- Display State	Description
TURBINE FAULT GFI	Turbine is stopped and contains a GFI fault.
TURBINE FAULT NO WIND SPEED	Voltage sensed but Anemometer not sensing wind speed.
TURBINE FAULT TURBINE OVER CURRENT	Turbine is stopped and contains an over current fault.
TURBINE FAULT TURBINE OVER VOLTAGE	Turbine is stopped and contains an over temperature fault.
TURBINE FAULT NO TURBINE	Anemometer is sensing wind speed but there is no voltage sensed.
TURBINE FAULT LOW BATT	Turbine is stopped and contains a low battery fault.
TURBINE FAULT HIGH BATT	Turbine is stopped and contains a high battery fault.
TURBINE FAULT OVER TEMP	Turbine is stopped and contains an over temperature fault.
TURBINE FAULT CHARGE OVER CURRENT	Turbine is stopped and contains an over current fault.
TURBINE FAULT INVERTER NO OUTPUT	See Figure 4.4
TURBINE FAULT INVERTER OVER CURRENT	See Figure 4.4

Figure 4.3 Turbine Fault Stop States

- **Turbine User Stop State**
  The turbine will enter its User Stop state if the user engages the manual stop command in the technician's menu accessible via the **SMARTBOX™** Controller. When the **SMARTBOX™** Controller is in user mode, the turbine is immediately stopped. While in user stop mode, no A/C will be produced so the inverter is shut off and the transfer switch is switched back to the grid. The **SMARTBOX™** Controller must be placed in run mode before a charge cycle can start again.

Display - Stopped State	Description
TURBINE STOPPED PRESS ANY KEY	Turbine is stopped with no faults. Back light is off with no information scroll.

System Protection

- **Cool Down**
  The turbine will shut off and begin cool down if the charger reaches or exceeds a temperature of 125°c or/and the enclosure reaches or exceeds a temperature of 60°c. The turbine will resume working after the charger temperature drops below 70°c and/or the enclosure temperature drops below 45°c.

- **Over Wind Speed**
  The turbine will turn off when wind speed reaches 42mph or higher. It will resume working after the wind speed drops to 35mph or lower.

System Faults

The **SMARTBOX™** Controller constantly monitors the status of the turbine. Any time the turbine senses a fault, the dynamic brake will stop the turbine and the **SMARTBOX™** Controller will stop producing energy from the turbine. “TURBINE FAULT” will be displayed on the LCD screen along with the fault detected. The user must clear any faults in order to restart the turbine.

If a fault occurs, follow these steps to clear it:

1. View the faults listed and correct the fault.
2. Press ENTER on the front panel. If the fault is fixed the controller will go to stop state. If the system finds any other faults, the next fault will be displayed.
3. When all faults are clear, go to start/stop turbine in the menu and restart the turbine.

Non Grid-Tie SmartBox Fault Specifications

Fault	Description	State Required for Fault
GFI	GFI - Ground Fault	
NO WINDSPEED	Voltage from Turbine but no data from anemometer	Turbine Voltage > 40 VDC and Wind Speed < 1 MPH for 1 minute
TURBINE OVER CURRENT	Turbine over current	Current from turbine > 18 Amps
TURBINE OVER VOLTAGE	Turbine over voltage	Voltage from turbine > 190 VDC
NO TURBINE	Anemometer reporting windspeed but no voltage from wind turbine.	Turbine Voltage < 5 VDC and WindSpeed > 10 MPH for 1 minute
LOW BATTERY	Battery too low	Battery Voltage < 15 VDC for 1 minute
HIGH BATTERY	Battery too high	Battery Voltage > 32 VDC
OVER TEMP	Enclosure or Heat Sink over temp	Enclosure > 65°C or Heat Sink > 140°C
CHARGE OVER CURRENT	Current to batteries over limit	Charge current > 66 Amps
INVERTER NO OUTPUT	Inverter is on, but not outputting A/C	Inverter AC output < 100 VAC for 1 minute
INVERTER OVER CURRENT	Inverter is over current limit	Inverter AC Current > 14.5 Amps for 3 minutes

Figure 4.4 Non-Grid-Tie SmartBox Specifications

SMARTBOX™ Controller Front Panel

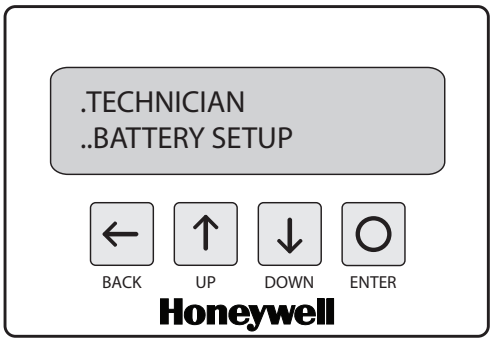


Figure 4.4 **SMARTBOX™** Controller Front Panel

Navigation Buttons

1. **BACK button**. The back button will bring you back to the previous menu level and CANCEL any changes made.
2. **UP button.** The up button will scroll through the current menu selections or make a configuration change depending on the current menu level.
3. **DOWN button.** The down button will scroll through the current menu selections or make a configuration change depending on the current menu level.
4. **ENTER button.** The enter button will enter the currently selected menu choice. It will also commit and save any configuration changes if applicable.
5. **Line 1.** In this example, line one shows you your current menu level, in this case the TECHNICIAN menu, the one dot tells us that we are one menu level deep from the home screen.
6. **Line 2.** The second line shows us that if we hit ENTER we will enter the BATTERY SETUP menu, the two dots indicate that we will be two menu levels deep from the home screen if we enter the BATTERY SETUP menu.

System Menu and Navigation

Operations Menu

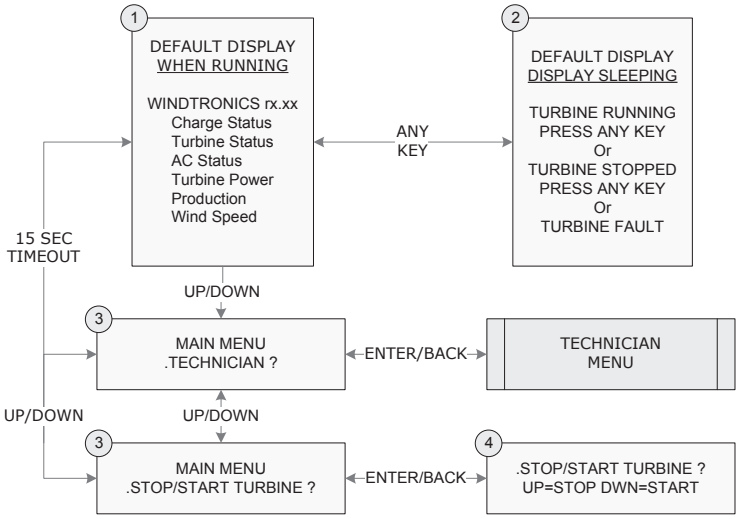


Figure 4.5 System Menu

1. **This is the home screen.** The **SMARTBOX™** Controller will scroll the listed information while in run mode and also the current firmware revision.
2. **Turbine Fault Stop.** Indicates if a fault has occurred.
3. **This is the top menu level.** From here you can go to the TECHNICIAN MENU or the START/STOP TURBINE MENU. Pressing enter to make a selection.
4. **The Start/Stop Turbine Menu.** Pressing UP will place the **SMARTBOX™** Controller in user stop mode. In this mode the turbine will not spin and no A/C will be produced. Pressing DOWN will start the turbine. This will start a battery charge cycle.

Technician Menu

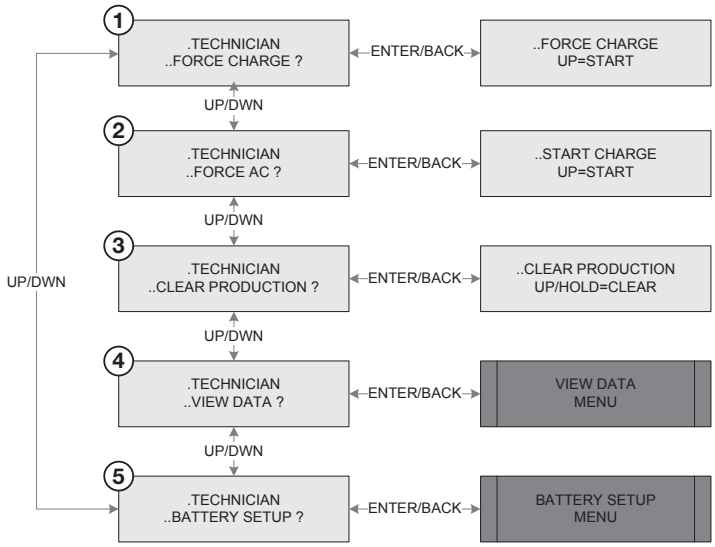


Figure 4.6 Technician Menu

1. **Force Charge.** This forces the turbine into the bulk charge state to begin charging the batteries.
2. **Force AC.** This turns on the inverter and switches the transfer switch to turbine AC. It also switches the turbine mode into float charge.
3. **Clear production.** This clears the Watt-Hour productions values in the turbine both turbine and AC productions values.
4. **View Data.** Selecting view data moves a menu level down to the view data menu.
5. **Battery Setup.** Selecting battery setup moves a menu level down to the battery setup menu.

View Data Menu

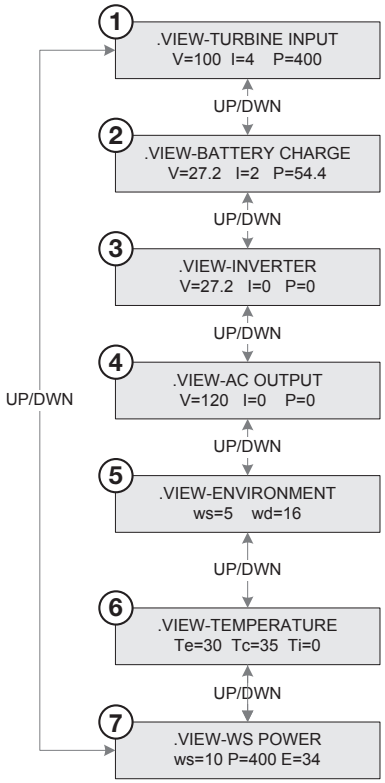


Figure 4.7 View Data Menu

1. **Turbine Input.** This screen shows the turbine output voltage (VDC), current (amps) and power (W).
2. **Battery charge.** This screen shows the voltage (VDC), current (amps) and power (W) being applied to the batteries.
3. **Inverter.** This screen shows the voltage (VDC), current (amps) and power (W) being applied to the inverter.
4. **AC Output.** This screen shows the output voltage (VDC), current (amps) and power (W) of the inverter.
5. **Environment.** This screen shows the current wind speed (ws) and wind direction (wd). The wind speed is in mph and wind direction is in degrees.
6. **Temperature.** This screen shows enclosure temperature (Te), charger temperature (Tc) and external temperature (Ti). Temperature external is reserved for future use and may display 0. All temperatures are in Celsius.
7. **WS Power.** This screen shows wind speed (ws) in MPH, power (P) in W and total energy (E) in watt-hours.

Battery Setup Menu

WARNING

RISK OF FIRE OR EXPLOSION
These settings must be followed correctly. Setting them incorrectly will highly increase the risk of fire and/or battery explosion. Failure to follow this warning may result in death, personal injury or property damage.

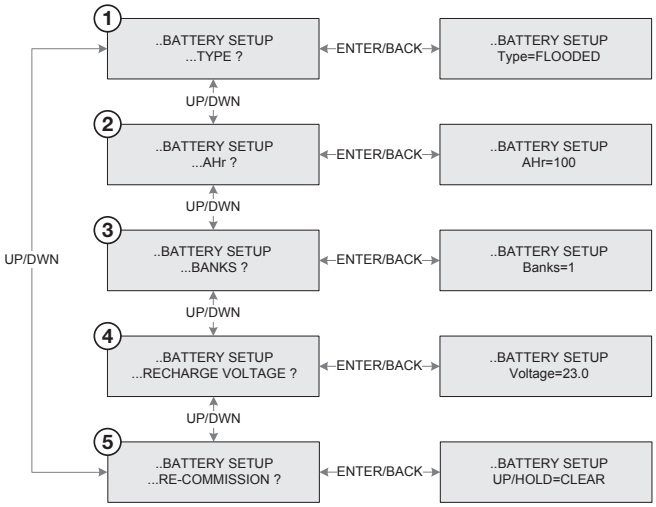


Figure 4.8 Battery Setup Menu

1. **Battery Type.** Use the up and down keys to select the type of batteries you have. Choose from FLOODED, GEL and AMG. Press Enter to save, Back to cancel.
2. **Ahr.** Use the up and down keys to select the Amp-Hours of your batteries. Press Enter to save, Back to cancel.
3. **Banks.** Use the up and down keys to select the number of battery banks you have. Press Enter to save, Back to cancel.
4. **Recharge Voltage.** The recharge voltage is the battery voltage at which point the inverter will shut off. The charge system will leave the float state and return to bulk charge to restart the charger cycle.
5. **Re-Commission.** To start the commissions process over hold down the up key. This is necessary if the turbine has moved and needs to be reconfigured.

5 Specifications

Non Grid-Tie Smart Box Electrical Specifications

Description	Rating	Units
Input		
Maximum Turbine Voltage	200	Volts DC
Operating input voltage range	30-170	Volts DC
Maximum input current	18	Amps DC
Maximum input short circuit current	20	Amps DC
Inverter		
Operating voltage range	120VAC+/-3%	Volts AC
Operating frequency range or single frequency	60Hz+/-0.05%	Hz
Nominal output voltage (ac)	120	Volts AC
Nominal output frequency	60	Hz
Maximum continuous output current	12.5	Amps AC
Maximum continuous output power (ac)	1500	VA
Maximum output fault current (ac) for 3 minutes	14.5A / 3 min	Amps AC
Maximum output overcurrent protection (ac)	20	Amps AC
Charge		
Nominal output voltage (dc)	24	Volts DC
Charger output voltage operation range (dc)	12-30	Volts DC
Maximum continuous output current (dc)	60	Amps DC
Maximum continuous output power (dc)	1500	Watts DC
Maximum output current (dc)	60	Amps DC
Maximum output fault current (dc)	62	Amps DC
Environment	60	Hz +/- 0.05%
Normal operation temperature range	0 - 40	Deg C
Storage temperature range	-30 - 70	Deg C
Other		
GFI Trip	0.5	Amps
Operating Power	<3.5	Watts
Output Waveform	Pure Sine	THD > 3%
Inverter Efficiency	94.00%	
Changer Efficiency	>90%	
Charger regulation method	Three Stage: bulk, absorption, float	

Manufacturer reserves the right, without notice or liability, to change design and specifications at any time.

DATA SUBJECT TO CHANGE WITHOUT NOTICE

WindTronics
Honeywell International Inc.
621 Sprucewood Avenue
Windsor, Ontario N9C 0B3
Tell: 877-946-3898
www.honeywell.com

Honeywell