



---

# BLACKBIRD OWNER'S MANUAL



WARRANTY REGISTRATION ENCLOSED

## **Introduction: The 60-Cycle Conundrum**

In order for alternating current (AC) power to be useful, it must be supplied at a constant 60 cycle (hz) alternating frequency. This means the current in the cord or device reverses 60 times per second. Operating 60hz devices on different or varying frequencies can cause reduced performance, device damage, or failure. Until Raven Technology developed AC-Direct technology, there were only two ways to deliver 60hz power. First was the synchronous generator. This generator produces 60 cycle power only at one shaft speed, usually 1800 or 3600 RPM. In order to supply constant frequency power, this generator (and its driving engine) cannot change speed, or operate at anything but its design speed. This type of generator severely restricts the tasks to which the prime mover can be assigned. The second method of supplying constant 60 cycle power is inverter/converter technology. This method takes the generator output, whatever the current level, and switches it many thousands of times a second to form a 60 cycle sine wave. The entire output of the generator is being switched in this manner; a very inefficient and costly method of creating 60hz power, and is fairly limited at the 5, let alone 7kW level. Raven has changed all that.

The Blackbird™ 5 and 7kW generators completely separate the frequency output of generator from the rotation speed of the driving engine. Once the Blackbird™ has reached a speed of 3000 rpm, its speed may change incrementally or vary randomly anywhere between 3000 and 10,000 rpm. Depending on the type of installation you have purchased, your engine can provide 5kW at idle, elevated idle, or changing speed. This means your engine remains dedicated to its primary task, whether that be pumping water, operating hydraulics, compressing air, moving the vehicle or operating PTO-mounted machinery.

# Warranty Registration

This form must be fully completed and returned to Raven Technology at time of installation.

## INSTALLER INFORMATION

Company Name: \_\_\_\_\_

Installer name: \_\_\_\_\_

City: \_\_\_\_\_ State /Prov. \_\_\_\_\_

Postal Code: \_\_\_\_\_ Telephone: \_\_\_\_\_

Installation Date: \_\_\_\_\_ Delivery Date: \_\_\_\_\_

## OWNER INFORMATION

Owner/Organization Name: \_\_\_\_\_

Contact Person: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ State/Prov. \_\_\_\_\_

Postal Code: \_\_\_\_\_ Telephone: \_\_\_\_\_

Email: \_\_\_\_\_

Purchase Date (day/month/year) \_\_\_\_\_

Purchased from \_\_\_\_\_

## APPLICATION

Vehicle Make / Model: \_\_\_\_\_ Year: \_\_\_\_\_ Engine type/size: \_\_\_\_\_

Vehicle Identification Number (VIN#): \_\_\_\_\_

7000 watt / 240 volt system

5000 watt / 120 volt system

Belt drive

PTO drive Drive ratio: \_\_\_\_:\_\_\_\_

Generator Serial Number: WGG\_\_\_\_H / (HP)

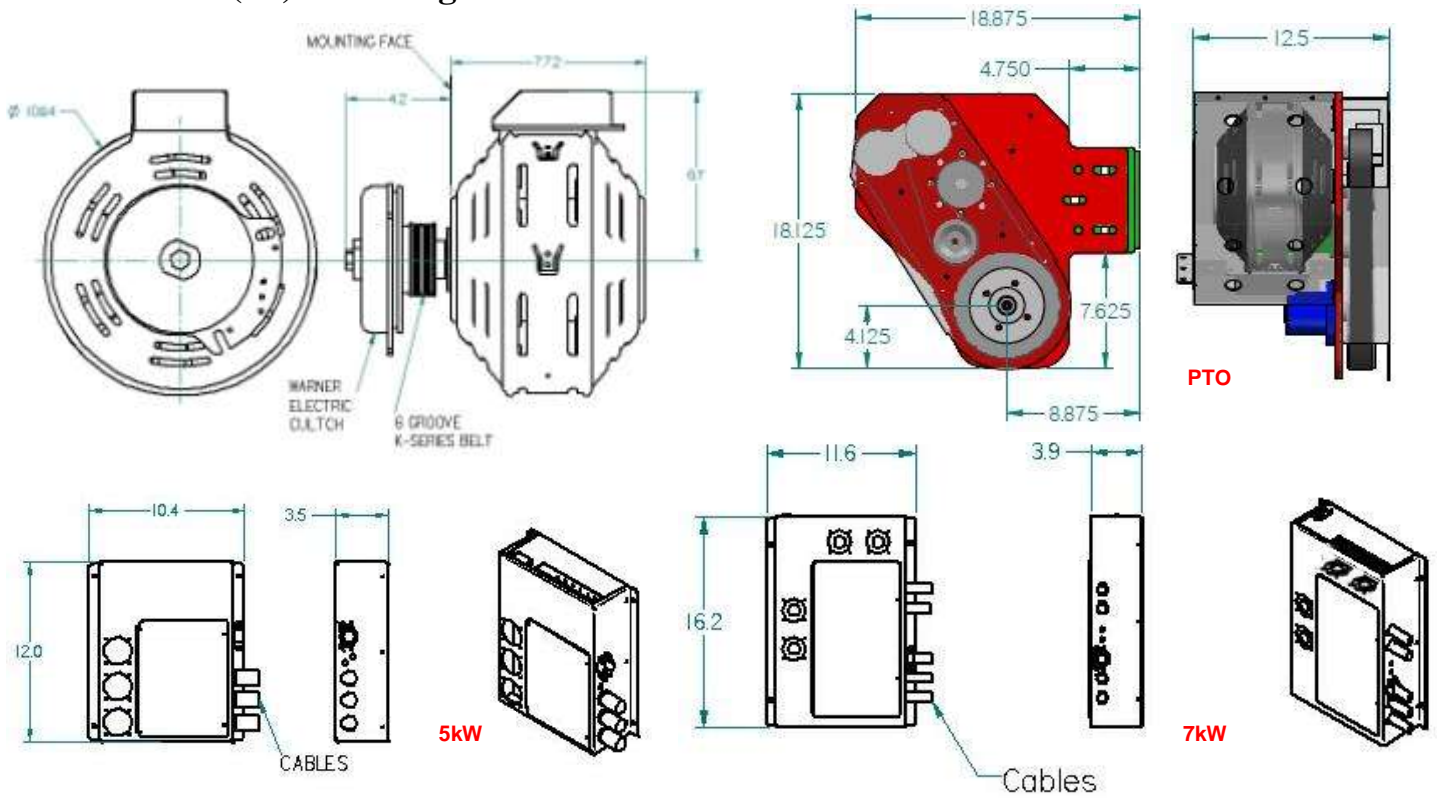
Control Serial Number: ZX\_\_\_\_ - \_\_\_\_\_

## Blackbird Specifications:

### Electrical:

Maximum Continuous Output (MCO):	5000 Watt	7000 Watt
Voltage:	118 VAC	120 / 240 VAC
Phase:	Single	Split
Output Frequency (Hz):	60 ± .5 %	60 ± .5 %
Continuous Output Current (Amps):	42	30/ Leg
Input Voltage:	≥ 12.5 VDC	≥ 12.5 VDC
Input Current at MCO:	11 Amps	14 Amps

### Dimensions (in.) and Weight:



Weight	5000 Watt Belt	5000 Watt PTO	7000 Watt Belt	7000 Watt PTO
Generator (lbs.)	72	125	72	125
Control Box (lbs.)	10	10	12	12

### Dynamic:

	5000 Watt Belt	5000 Watt PTO	7000 Watt Belt	7000 Watt PTO
Torque Requirements (max. ft-lb)	15.4	70	21.5	98
Horsepower at maximum load	8.5	8.5	12	12
RPM (Variable @ generator shaft)	3,000-10,000	650-2200	3000-10,000	650-2200

## System Capabilities: 5000 Watt

The 5kW Blackbird will provide 42 amperes of 120 Volt, pure sine, alternating current for **resistive** loads. Examples of resistive loads are:

### Resistive Loads

- lights
- heaters
- battery chargers
- power supplies (radios, computers, etc.)
- small power tools (tools with universal motors: drills, sawzalls, skill saws, etc.)

### Inductive (reactive) loads

When used in conjunction with a Raven Smart Circuit™ phase correction device, the Blackbird will start and run inductive motors up to 1/2 horsepower. These motors include:

- Standard fire service smoke ejectors
- Sump pumps
- Small refrigerators
- Most roof-top air conditioning when wired in conjunction with additional phase correction. (Contact Raven for details).

Multiple inductive motor loads may not be operated simultaneously without prior authorization by Raven Technology.

### Note:

Due to the Blackbird's unique active control system, the feature that allows constant generator output at varying shaft speeds, the system is unable, in most cases, to smoothly run motors above 1/3 horsepower. These motors include:

- Electro-hydraulic rescue tools (Hurst, Holmatro, Amkus, etc.)
- Large-bore pumps (> 1 1/2" discharge.)
- Any motor above 1/2 horsepower

Inductive loads will require some amount of parallel resistive load to operate effectively. We encourage our customers to adopt SOPs which include running lighting as parallel load when operating inductive loads to assure maximum system stability. Between 1000 and 1500 watts usually suffices. The Blackbird thrives on resistive load, and will accept inductive load most readily when it is already carrying resistive load.

## System Capabilities: 7000 Watt

The Blackbird provides 7000 watts of pure sine, alternating current for **resistive** loads. It is a split-phase system, and will provide

- two legs of 120VAC each 30 amperes (7000 watts), or
- 240VAC at 30 amperes (7000 watts), or
- a combination of both not to exceed 7000 watts.

Overall system voltage is maintained at 240 VAC leg-to-leg. Uneven loading of the output legs will cause the more greatly loaded leg to sag slightly in voltage and the less loaded leg to rise, equaling a total 240 volts. Care should be taken to design and utilize 120 volt circuit legs in a manner which maintains as nearly a balanced load on legs as is practical.

### Resistive Loads

Examples of resistive loads are:

- lights
- heaters
- battery chargers
- power supplies (radios, computers, etc.)
- small power tools (tools with universal motors: drills, sawsalls, skill saws, etc.)

### Inductive (reactive) loads

When used in conjunction with a Raven Smart Circuit™ phase correction device, the Blackbird will start and run inductive motors up to 1/2 horsepower. These motors include:

- Standard fire service smoke ejectors
- Sump pumps
- Small refrigerators
- Most roof-top air conditioning when wired in conjunction with additional phase correction. (Contact Raven for details).

Multiple inductive motor loads may not be operated simultaneously without prior authorization by Raven Technology.

### Note:

Due to the Blackbird's unique active control system, the feature that allows constant generator output at varying shaft speeds, the system is unable, in most cases, to smoothly run motors above 1/3 horsepower. These motors include:

- Electro-hydraulic rescue tools (Hurst, Holmatro, Amkus, etc.)
- Large-bore pumps (> 1 1/2" discharge.)
- Any motor above 1/2 horsepower

Inductive loads will require some amount of parallel resistive load to operate effectively. We encourage our customers to adopt SOPs which include running lighting as parallel load when operating inductive loads to assure maximum system stability. Between 1000 and 1500 watts usually suffices. The Blackbird thrives on resistive load, and will accept inductive load most readily when it is already carrying resistive load.

## Raven Technology Smart Circuit™ System

Inductive motors by nature return out-of-phase power back into the power feed line. When the Blackbird's™ unique microprocessor control system senses this return power, it attempts to adjust to it and system voltage instability results. This condition can, at times, cause damage or failure to the Blackbird™ and to electrical loads powered by the system. The Raven SmartCircuit™ is a phase correction circuit which stores this out-of-phase energy (normally wasted by electric induction motors) and sends it back into the load in-phase where it is then converted by the motor into useful magnetic energy for rotation. The result is overall system voltage stability and increased load efficiency: a standard fire service smoke ejector which normally draws around 6 amps when running, actually draws only around 4.5 amps at the power source when plugged into a Smart Circuit™. Parallel resistive load (lights or heaters) also lessen the chance of voltage instability, and should be used in conjunction with an inductive load.

### Packaging:

Smart Circuit™ is available both as the standard in-line SmartCord™ or a dedicated SmartCircuit™ on a vehicle which can be used for any applicable device requiring phase correction. These circuits are, to a certain degree, load-specific. The standard SmartCord™ is sized for a typical fire service smoke ejector.

### Uses and Restrictions:

SmartCords™ or dedicated Smart Circuit™ outlets *should* be used for electric induction motors up to 1/2 horsepower, such as smoke ejectors, pumps with discharge of 1 1/2" or less, and small (dorm size) refrigerators. It also may be helpful in the smooth operation of microwave ovens.

SmartCircuits™ are unnecessary and *should not* be used for resistive loads such as lights, heaters, battery chargers, or computer power supplies. Additionally, SmartCords™ *should not* be used for motors larger than ½ horsepower without prior authorization. If larger motors, or loads not addressed here are indicated, contact Raven Technology (207-721-1044) for information on a custom SmartCircuit™ for your application.

## System Operation

Depending on the application, the Blackbird™ delivers full output at engine idle, elevated idle, or at any speed between idle and engine redline (V-configuration engine's upper limit is about 3400 RPM). Make sure that if required, high idle is engaged, either automatically or manually whenever the generator is operated

### Belt Drive:

The generator is not affected by changes in engine speed beyond your minimum required idle.

- High idle and/or generator operation may depend on certain vehicle conditions being met. These conditions may be: vehicle-in-park, park brake-set, or foot-off-accelerator. Check with your installer regarding these conditions.
- A slight “chirp” from the belt drive when the generator is first engaged or when engine RPM drops rapidly (as in emergency pump shutdown) is not cause for alarm, but the generator should not make any unusual noises during operation.
- **The Blackbird™ should always be turned off before the engine is shut down to prevent undue wear on the belt train.**
- Parallel resistive load of 500 watts or more should accompany the operation of inductive motors up to 1/2 horsepower. Motors above 1/2 HP should not be operated at any time, or voltage instability and possible system damage will result.

### PTO Drive:

The generator and PTO are protected by an integral torque-limiting coupling which protects both the generator and the PTO from damage when the PTO is engaged at high engine RPM. Assuming your installation incorporates a hot-shift PTO, you need not slow the engine RPM to engage the generator (check with your installer for specifics on your PTO and its operation, it is preferable to engage at the lowest possible RPM.) If the vehicle is to be underway during generator operation, road speed should not exceed 15 MPH.

- The generator is not affected by changes in engine speed beyond your minimum required idle.
- PTO and/or generator operation may depend on certain vehicle conditions being met. These conditions may be: vehicle-in-park, park brake-set, or foot-off-accelerator. Check with your installer regarding these conditions.
- . The Blackbird™ drive has been designed to allow operation at all engine speeds. Changes in engine (PTO) RPM will not affect the output of the generator. Check with your installer to verify that your PTO ratio provides this flexibility.
- Parallel resistive load of 500 watts or more should accompany the operation of inductive motors up to 1/2 horsepower. Motors above 1/2 HP should not be operated at any time, or voltage instability and possible system damage will result.
- **The PTO should always be turned off before the engine is shut down.**

PTO Shaft RPM must never exceed 2175 RPM! Damage or injury may result!



Depending on the application, the Blackbird™ delivers full output at engine idle, elevated idle, or at any speed between idle and engine redline (V-configuration engine's upper limit is about 3400 RPM). Make sure that if required, high idle is engaged either automatically or manually whenever the generator is operated. The Command Module offers signals which might be used to activate OEM or aftermarket elevated idle systems. Contact Raven for information.

### **Belt Drive:**

- In most V-8 engine belt-drive systems, the dash or console pilot light for generator operation is wired to act a diagnostic tool. The light should remain on during generator operation. High speed flashing of the light indicates that the generator upper rotational speed has been exceeded and the generator has declutched and turned off. This shutdown can be reset by turning the operator's switch off and then on. Slow speed blinking of the light indicates either lack of rotation (engine is not turning, belt is broken, etc.) or a high-temperature thermal fault in the generator. In the case of thermal shutdown, reset is not possible. Contact Raven Product Support at 207-721-1044. If the operator's switch is turned on with the engine off, the light should come on for one second while the Command Module checks for vehicle conditions, and then go out.
- The generator output is not affected by changes in engine speed beyond your minimum required idle. The generator will declutch itself at very high engine speed (approximately 3400 V-configuration engine RPM) to protect components. It can be reset using the operator control-off/on.
- High idle and/or generator operation may depend on certain vehicle conditions being met. These conditions may be: vehicle-in-park, park brake -set, or foot-off-accelerator. Check with your installer regarding these conditions.
- A slight "chirp" from the belt drive when the generator is first engaged or when engine RPM drops rapidly (as in emergency pump shutdown) is not cause for alarm, but the generator should not make any unusual noises during operation.
- **The Blackbird™ should always be turned off before the engine is shut down to prevent undue wear on the belt train.**
- Parallel resistive load of 500 watts or more should accompany the operation of inductive motors up to 1/2 horsepower. Motors above 1/2 HP should not be operated at any time, or voltage instability and possible system damage will result.

## System Operation

### PTO Drive:

The generator and PTO are protected by an integral torque-limiting coupling which protects both the generator and the PTO from damage when the PTO is engaged at high engine RPM. Assuming your installation incorporates a hot-shift PTO, you need not slow the engine RPM to engage the generator (check with your installer for specifics on your PTO and its operation, it is preferable to engage at the lowest possible RPM.) If the vehicle is to be underway during generator operation, road speed should not exceed 15 MPH.

- The generator is not affected by changes in engine speed beyond your minimum required idle.
- PTO and/or generator operation may depend on certain vehicle conditions being met. These conditions may be: vehicle-in-park, park brake-set, or foot-off-accelerator. Check with your installer regarding these conditions.
- . The Blackbird™ drive has been designed to allow operation at all engine speeds. Changes in engine (PTO) RPM will not affect the output of the generator. Check with your installer to verify that your PTO ratio provides this flexibility.
- Parallel resistive load of 500 watts or more should accompany the operation of inductive motors up to 1/2 horsepower. Motors above 1/2 HP should not be operated at any time, or voltage instability and possible system damage will result.
- **The PTO should always be turned off before the engine is shut down.**

PTO Shaft RPM must never exceed 2175 RPM! Damage or injury may result!

## Testing and Troubleshooting the Blackbird™

In the unlikely event of a system malfunction or failure-to-start, there are some preliminary tests which can be performed by a qualified electrician or mechanic. Contact Raven (207-721-1044) before performing any of these tests. Aside from the vehicle wiring and fuses providing circuits to the Raven Control Box, there are no user-serviceable parts.

### Test for DC power supply to Field:

With the truck running, all DC loads energized, and the generator control off: Assure that the DC voltage between terminals 1 & 2 in the Raven Control Box is at least 12.5 VDC.

### Test for System Resonance:

***Caution: very high voltages occur in the Control Box during this test!***

With the engine off and the Control Box 50 Amp circuit breaker off:

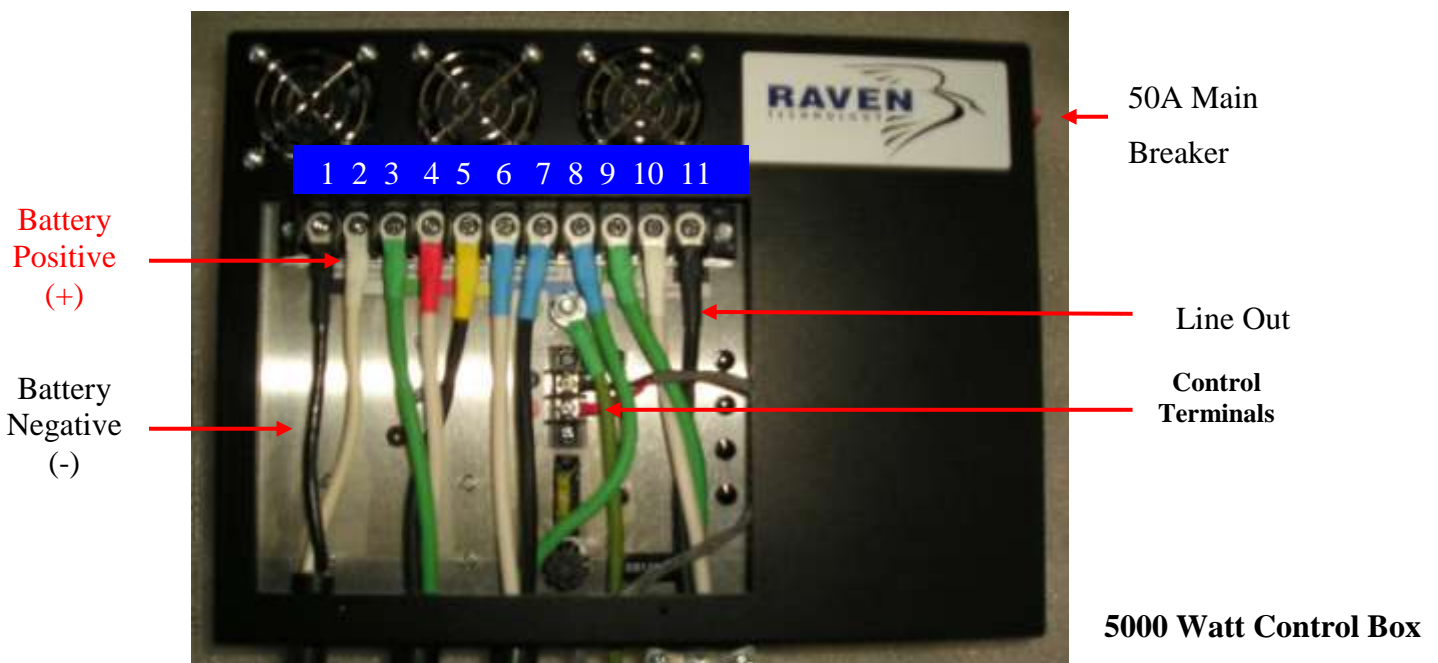
Remove and isolate the red control cable wire (#18 AWG) from its terminal in the Control Box. Jump power from the battery positive (white wire) in the control box to the positive (red) control terminal. The Control Box cooling fans should operate and the Generator should hum. Using a voltmeter, measure the AC voltage between terminals 4 and 5 (red, yellow) in the Control Box. Voltage should be at least 180VAC. Remove the jumper and reconnect the control wire to its terminal.

### Test for AC Output:

Start the engine and turn on the Generator (and high idle, if required). Assure that the main breaker on the end of the Control Box is in the 'on' position.

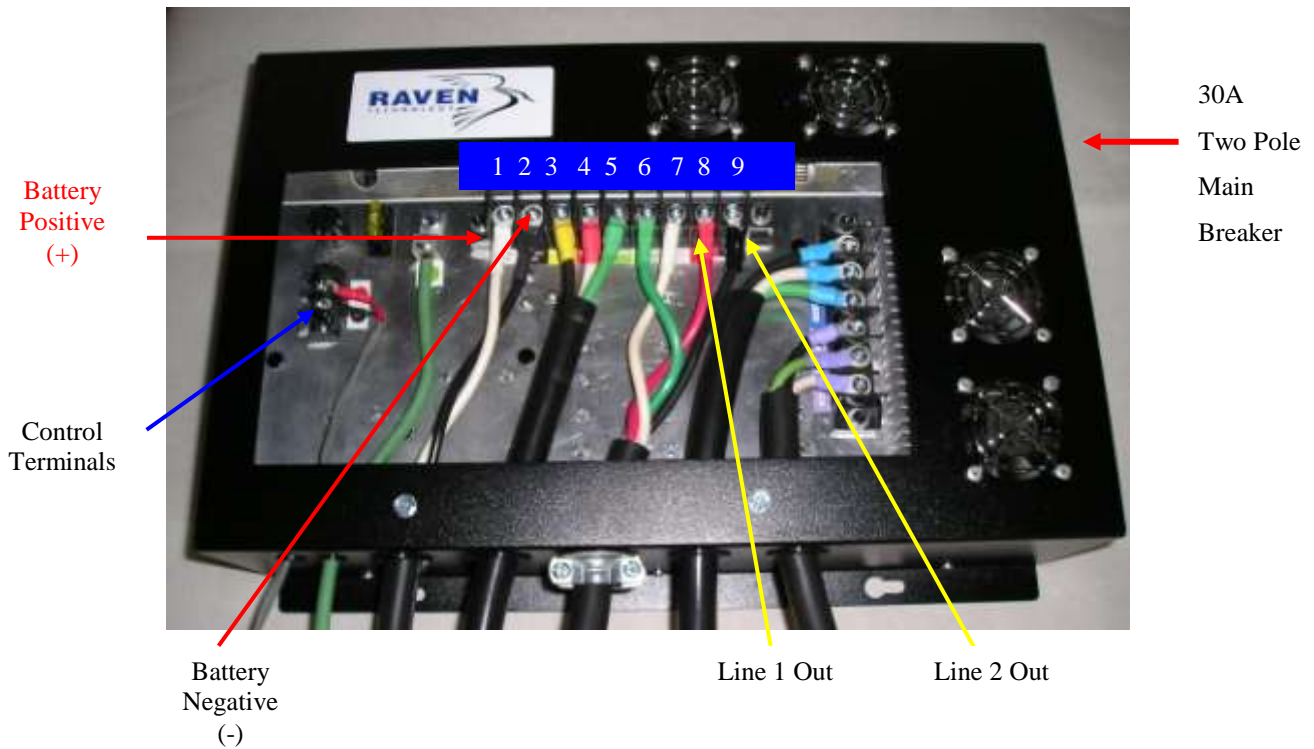
### 5000 Watt Systems:

- Measure the AC voltage between terminals 10 and 11 in the Raven Control Box. This Voltage should be approximately 118 VAC. (Note with no load, the waveform will not be a true sinusoid and the meter reported voltage may vary somewhat from 118 VAC. A 60 watt load is sufficient to restore proper output waveform.) If terminals 10 and 11 do not read approximately 118 VAC, assure that all conditions (next page) are met:



**7000 Watt Systems:**

- Measure the AC voltage between terminals 8 and 9 (leg 1 and leg 2) in the Raven Control Box. This Voltage should be 240 VAC. (Note with no load, the waveform will not be a true sinusoid and the meter reported voltage may vary somewhat from 240 VAC. A 60 watt load is sufficient to restore proper output waveform.) If terminals 8 and 9 do not read 240 VAC, assure that all conditions below are met:



**Conditions for Operation, 5000 watt and 7000 watt systems:**

1. Engine is at high idle, if required.
2. The clutch or PTO is engaged
3. There is at least 12.5VDC at the control terminals and the Control Box cooling fans are operating
4. There is at least 12.5VDC to terminals 1 and 2
5. The main circuit breaker is on

**If these conditions are met and there is no output, contact.  
Andy Bertocci, Product Support Manager  
207-721-1044, or [abertocci@raventechpower.com](mailto:abertocci@raventechpower.com)**

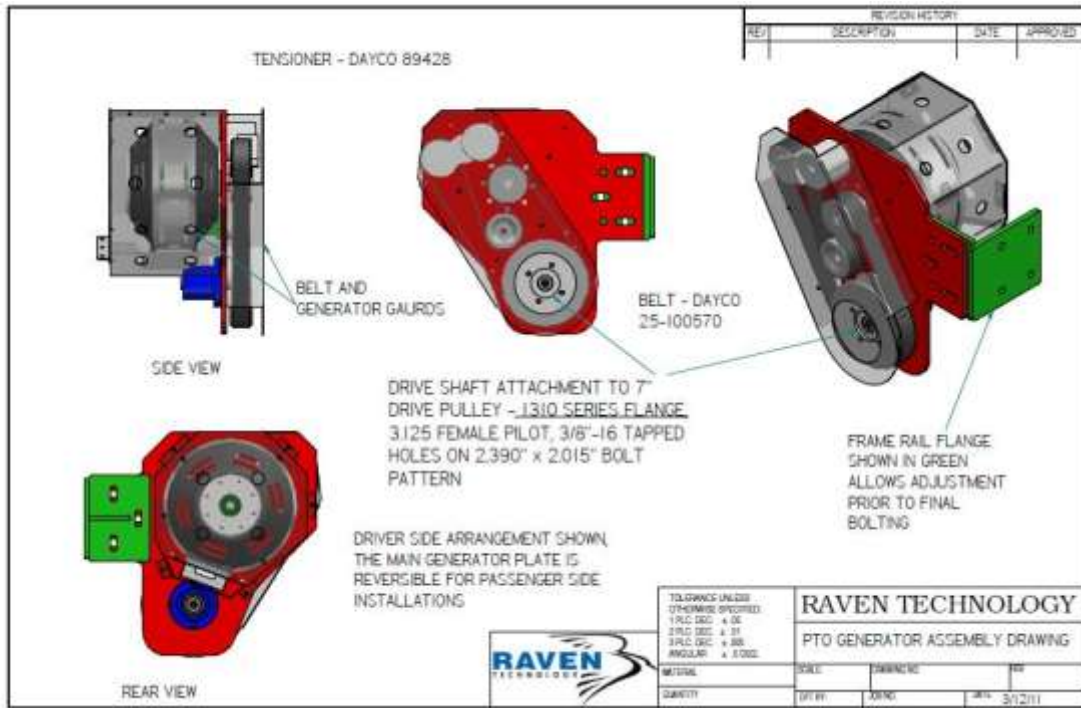
## Maintenance

### Belt Drive Systems, PTO Systems:

The Blackbird™ has been designed to be easily operated and require a minimum amount of maintenance. The only moving parts are the two rotors in the generator housing. There are no brushes or slip rings, and all electrical connections are sealed or enclosed. As part of normal engine inspection (at least weekly):

- Inspect drive belt, pulleys, and idlers for abnormal wear and proper tension.
- Inspect mounting bolts and bracketing for any looseness.
- Inspect wiring and cabling for chafe and/or heat damage.

### PTO Drive Systems:



All questions should be directed to Raven Product Support at 207-721-1044 or [abertocci@raventechpower.com](mailto:abertocci@raventechpower.com)