



BLACKBIRD WIRING MANUAL

VERSION ZX120 5/09



TO BE USED IN CONJUNCTION WITH A
VEHICLE-SPECIFIC INSTALLATION
SUPPLEMENT



System Capabilities

The 5kW Blackbird will provide 42 amperes of 120 Volt alternating current for 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.)

The 5kW Blackbird will start and run inductive motors up to approximately 1/2 horsepower when used in conjunction with a Raven Smart Circuit™ phase correction device. 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.

And some other inductive loads such as microwave ovens.

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

Due to the Blackbird's unique active control system, the feature that allows constant generator output at varying shaft speeds, the 5kW system is unable, in most cases, to smoothly run motors above ¾ horsepower. These motors include:

- Electro-hydraulic rescue tools (Hurst, Holmatro, Amkus, etc.)
- Large-bore pumps (> 1 ½" discharge.)
- Any motor above 1/2 horsepower

In some cases we have adapted our hardware and software to operate specific motors up to 1 ½ horsepower. These are custom alterations, however. We expect in the near future that our standard equipment will support these motors.

Most 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 Smart Circuit™ 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, additional cost, a Smart Circuit™ dedicated circuit 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.

Smart Circuits™ are unnecessary and *should not* be used for resistive loads such as lights, heaters, battery chargers, hand tools, or computer power supplies. Additionally, SmartCords™ *should not* be used for motors larger than 1/2 horsepower. If larger motors, or loads not addressed here are required, contact Raven Technology (207-721-1044) for information on a custom Smart Circuit™ for your application.



Parts Included in Wiring Kit

Before beginning installation, check the parts kit thoroughly against the parts inventory list, and make sure that every necessary part is in hand. If parts are missing or you have questions regarding the parts and components, contact Raven Product Support (207-721-1044) before beginning installation.

Parts	Description
Control Box	Including wiring terminals
Generator	Including wiring terminals
Field Cable	8/3 SOW x 25' with Yellow Tape
Armature Cable	8/3 SOW x 25' with Blue Tape
Battery Cable	10/2 SOW x 25' Black/White Conductor
Control Cable	16/2 x 25'

Parts Supplied in the Mechanical Supplement Kit

The following parts are included in the mechanical supplement kit. See the mechanical installer if these parts are not available with the truck.

Parts	Description
Soft Start Module	
Clutch harness	16' red/black

General Instructions

- **All installation steps must be completed before operating the system.**
- Vehicle battery cables should be disconnected during all mechanical and electrical installation steps.
- All hoses and wires moved or relocated during installation must be secured to prevent chafing and exposure to hot surfaces. At no time should wiring be secured to fuel or exhaust system components.

Mechanical Installation

Refer to the vehicle-specific Installation Supplement contained in your installation kit for the process of installing the mechanical components of the system. In some cases, it may be desirable to perform some of the wiring steps in this manual during the mechanical installation. Familiarize yourself with both manuals before beginning installation.



Wiring the Generator Junction Box: See Figure 2:

Once the mechanical installation steps in the Installation Supplement are completed, the system may be wired and initial run-up performed. **Figure 1** shows system cable routing. Cut the appropriate lengths to route the cables between the Generator and the Raven Control Box. Keep in mind that a 10/2 battery cable and the small control cable will be routed to the Control Box as well. Route cables using approved practices. At no time should cables be routed with or attached to fuel or exhaust system components.

1. Assure that the Field and Armature cables are color coded *on each end*: blue for armature, yellow for field.
2. Remove the generator junction box cover. Observe the terminal stud on one end . This is the ground stud, and a ground strap should be preinstalled here.
3. Strip the outer jacket of each cable back 1 3/4". Use the supplied crimp connectors and shrink tube to terminate the wires, following the color code.
4. Connect the armature and field cables to the Generator terminals according to **Figure 2. Notice these are #2 Robertson (square) drive.** Do not fully tighten.
5. Install the strain relief bar, assuring that the two fasteners are not in contact with individual wire conductors.
6. Once the strain relief is tight, fully tighten the 6 generator terminals.
7. Reinstall junction box cover over the terminations and cables.

Maintaining cable color codes will assist in making proper connections during installation and assist future troubleshooting or maintenance.

Locating and Wiring the Control Box: See Figures 3 and 4 :

Location:

Select a location for the Control Box based on the following criteria: Avoid areas subject to splash and elements. Reasonable ventilation is required, and the fans and heat sink must not be obstructed. The 50 Amp master breaker on the box should be accessible and visible. A frame grounding point must be available, as the bonding point for the output neutral and ground is internal to the Control Box. Cable routing to the Box must avoid fuel lines, moving parts, exhaust system and other hot components. Cable lengths from the Generator to the Control Box should not exceed 25 feet. Contact Raven Product Support (207-721-1044) if this restriction presents a problem.

Wiring:

Battery Feed

Assure that all vehicle batteries are disconnected. Connect the black conductor of the 10/2 SOOW to Control Box terminal 1. The battery end of this conductor is connected to battery ground at the battery. If this is not possible or convenient, the black conductor may be connected to a high-current grounding point on the engine or transmission. Avoid frame grounding of this conductor. Connect the White conductor to terminal 2 in the Control Box and to 12V battery positive (secondary side of Battery Switch is preferable) **fused or breaker-protected at 30 amps**).

Generator Cables: Field



The Field Cable (SEOOW #8AWG 3 conductor with yellow tape) runs with the Armature Cable from the Generator junction box to the Control Box.

Strip cables as necessary and crimp supplied ring terminals to conductors using accepted methods. Heat shrink each crimp with the appropriate color shrink tubing. This will aid in future maintenance and troubleshooting. The white conductor becomes red and attaches to terminal 4. The black becomes yellow to terminal 5. The green goes to terminal 3 as shown in **Figure 3**.

Generator Cables: Armature

The Armature Cable (SEOOW #8AWG 3-conductor with blue tape) runs with the Field Cable from the Generator to the Control Box. Strip cables as necessary and crimp supplied ring terminals to conductors using accepted methods. Heat shrink each crimp with the appropriate color shrink tubing. This will aid in future maintenance and troubleshooting. The three conductors in this cable all become blue and are interchangeable on terminals 6, 7 and 8. as in **Figure 3**.

Line Out

Terminal 11 is protected by the 50 amp breaker. Terminals 9 and 10 are internally bonded.

Control Cable:

This gray #16 AWG 2-conductor wire runs from the Control Box to the Command Module. Connect the 16/2 control wire to the Control terminals shown in **Figure 3**. Ring terminals and heat shrink tubing are supplied. *Care must be taken to maintain the polarity (red-red, black-black) of these wires or Control Box damage will result.*

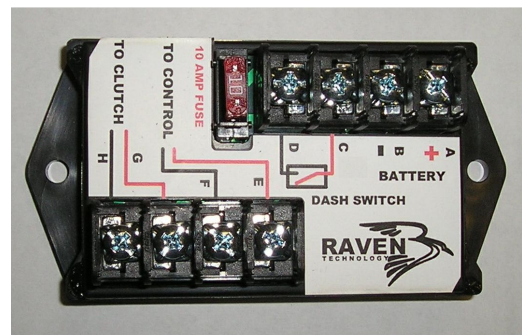
Chassis Ground (by installer):

Using care and accepted practice, establish a chassis ground and connect to the Raven Control Box ground stud (**Figure 3**) using #10AWG or larger wire.

Soft Start Module:

The Soft Start Module Controls the belt clutch on the generator and electronically activates the generator control. Clean battery power should be supplied to Terminals A and B. Terminal C provides power to the operator's switch, and Terminal D returns that power to start the system. The 16/2 black jacketed control wire is attached at Terminal E (+) and F (-) and is routed to the Control Box (Figure 3). The clutch cable (in split loom) runs from Terminals G (red) and H (black) to the black connector on the clutch. **Ford 6.0**

liter diesel: The blue fan lockup harness must go to ground upon generator operation. Terminal H can be used, if desired.



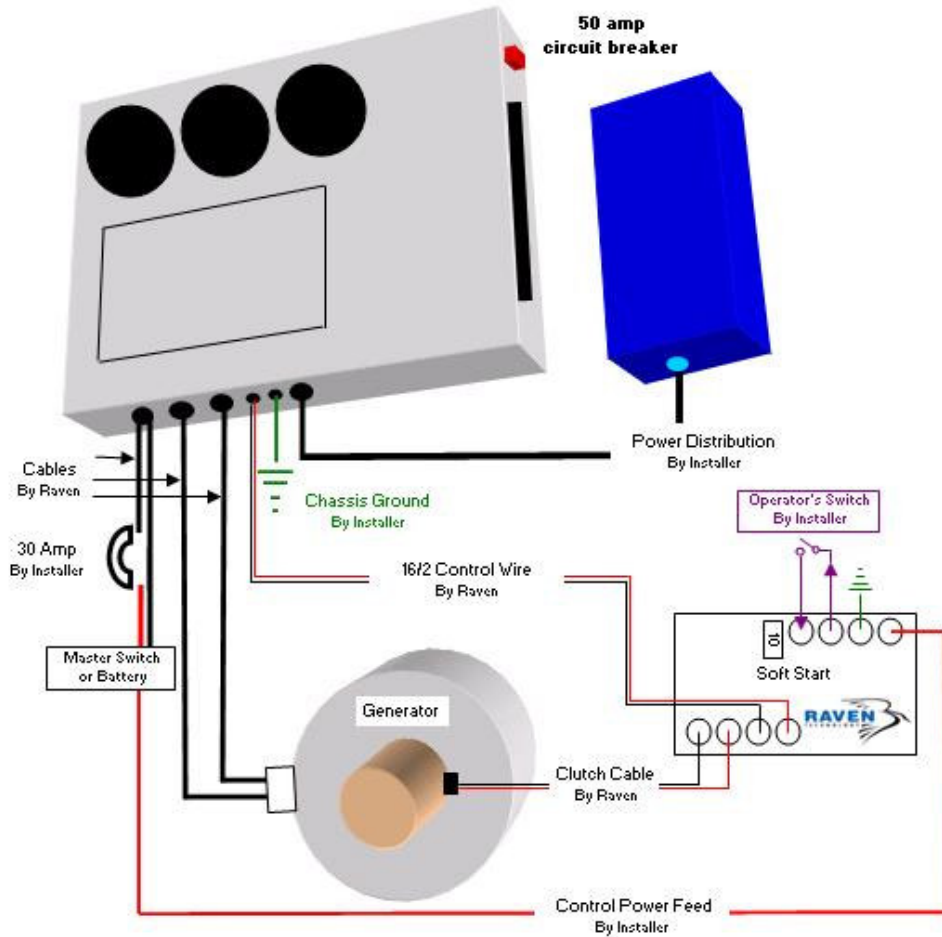
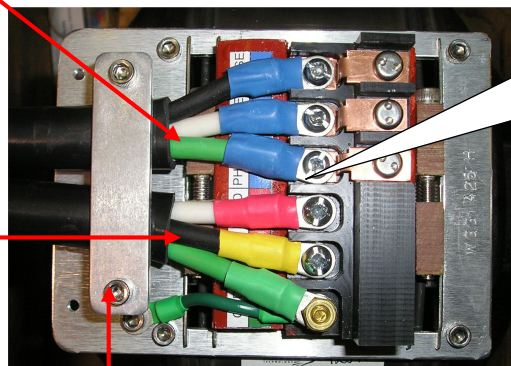


Figure 1

Armature Cable
All blue- any wire can connect to any of the three terminals as shown

Field Cable
Red, Yellow, Green



Strain Relief Bar

Maintaining cable color codes will assist in making proper connections during installation and assist future troubleshooting or maintenance.

Figure 2

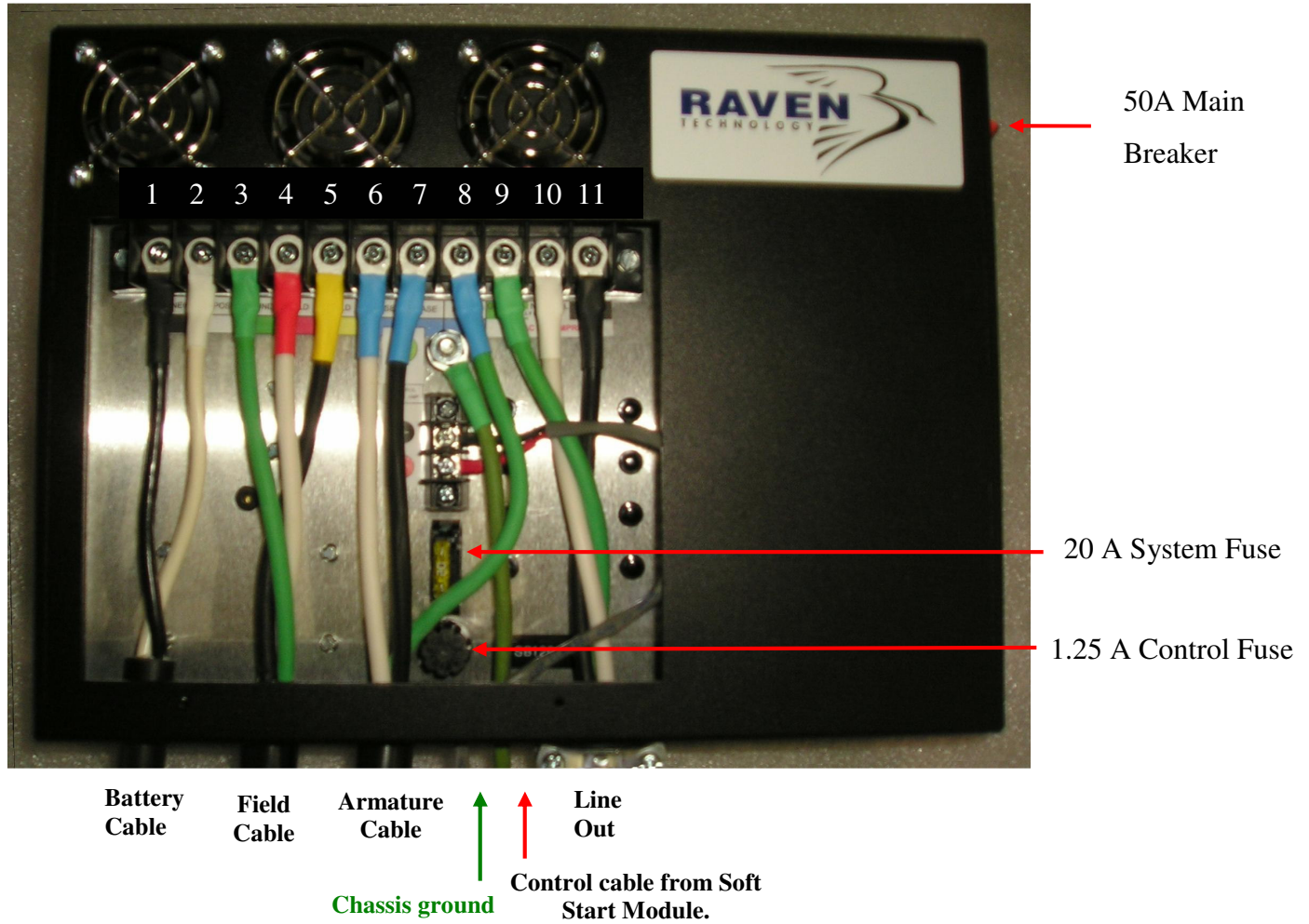


Figure 3



Initial Mechanical Run-up (Generator will not generate power during these tests):

- 1 Check all mechanical components to ensure correct installation.
- 2 Assure that the operator's switch is in the 'OFF' position.
- 3 Start and run the engine briefly at idle. Observe belt tracking and alignment. The generator may turn slowly as bearing drag in the clutch will transmit some torque.
- 4 Shut off engine and check belt tension. Correct any alignment or travel problems.
- 5 Disconnect the red control wire from its terminal in the Control Box and protect the wire from grounding or contacting any other wire during the test.
- 6 Start the engine and engage the clutch using the operator's switch. Engine high idle should engage (or be engaged if it is wired for manual engage). Observe any changes in belt behavior as the generator turns. Note: A whining noise and a noticeable amount of air blowing from the generator rotors will assure you that the generator is clutched in and not free-turning. Run engine at high idle for 2-3 minutes. Turn off the generator before turning off the engine. Generator may wind down for as long as a minute. Recheck belt tension and alignment.
- 7 Reconnect the red control wire to its terminal in the Control Box.

Initial Electrical Run-up

1. Assure that all electrical connections are made and system grounds are established. Output power from terminals 9, 10, and 11 in the Control Box should be connected to an approved distribution system on the vehicle.
2. Apply a 60 watt or greater load to the output, and assure that the 50 amp circuit breaker on the Control Box is in the 'ON' position. Engage the Generator using the operator's switch. The clutch will engage, the Control Box cooling fans will operate, and engine high idle should engage (or be engaged if it is wired for manual engage). The Generator will begin generating. Voltage will stabilize at about 118 VAC. Frequency is locked at 60Hz and will not vary with load or engine speed. Voltage will briefly follow engine speed as change in speed occurs, but will return to about 118 volts within a second or so. *Under no-load conditions, voltage may appear up to 130 volts, depending on the meter used, and the output will be a square wave rather than pure sine. This is a normal no-load condition.*



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.

Battery power should be disconnected before exposing connections in the Raven Control Box. Power should be restored only for the tests below, and disconnected when testing is not in progress. After testing, final repower should occur only after the Control Box is closed.

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 terminal 2 (Battery positive) to the positive (red) control terminal. The Control Box cooling fans should operate, 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 manual). Assure that the 50 amp main breaker on the end of the Control Box is in the 'on' position. 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 are met:

- Engine is at high idle, if required.
- There is at least 12.5VDC at the control terminals and the Control Box cooling fans are operating
- There is at least 12.5VDC to terminals 1 and 2
- The 50 amp circuit breaker is on

If these conditions are met and there is no output, contact Raven Product Support (207) 721-1044.

Questions or comments should be addressed to Andy Bertocci, Manager, Product Support, at 207-721-1044, or [**abertocci@raventechpower.com**](mailto:abertocci@raventechpower.com)