OutBack POWER™
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FLEXware SkyBox Rapid Shutdown Solution

Owner's Manual

About OutBack Power Technologies

OutBack Power Technologies is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, batteries, accessories, and assembled systems.

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Date and Revision

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Part Number

900-0236-01-00 Rev A

Table of Contents

READ AND SAVE THESE INSTRUCTIONS!

This manual contains important safety instructions for the Rapid Shutdown Solution product.

Symbols Used

WARNING: Hazard to Human Life

This type of notation indicates that the hazard could be harmful to human life.

CAUTION: Hazard to Equipment

This type of notation indicates that the hazard may cause damage to the equipment.

IMPORTANT:

This type of notation indicates that the information provided is important to the installation, operation and/or maintenance of the equipment. Failure to follow the recommendations in such a notation could result in voiding the equipment warranty.

NOTE:

This type of notation indicates that the information provided is important to understanding the operation and limits of the equipment. Failure to follow the recommendations in such a notation could result in improper or failed operation.

MORE INFORMATION

When this symbol appears next to text, it means that more information is available in other manuals relating to the subject. The most common reference is to the *FLEXware SkyBox Rapid Shutdown Solution Quick Start Guide*.

General Safety

WARNING: Limitations on Use

This equipment is NOT intended for use with life support equipment or other medical equipment or devices.

WARNING: Reduced Protection

If this product is used in a manner not specified by SkyBox RSD product literature, the product's internal safety protection may be impaired.

CAUTION: Equipment Damage

Only use components or accessories recommended or sold by OutBack Power Technologies or its authorized agents.

Introduction

Audience

This manual provides instructions for installation, setup, and operation of the product. These instructions are for use by qualified personnel who meet all local and governmental code requirements for licensing and training for the installation of electrical power systems with AC and DC voltage up to 600 volts. This product is only serviceable by qualified personnel.

Welcome to OutBack Power Technologies

Thank you for purchasing the FLEXware SkyBox Rapid Shutdown Solution (RSD-1).
This product is intended to work in conjunction with the SkyBox True Hybrid Energy System.
It allows a system to meet the 2014 National Electric Code requirements for PV systems.

- NEC 690.12 — Rapid shutdown (allows first responders to safely de-energize controlled conductors)
- NEC 690.15 — DC combiner disconnect (opens all ungrounded circuit conductors from all energy sources)

Product Overview

Features

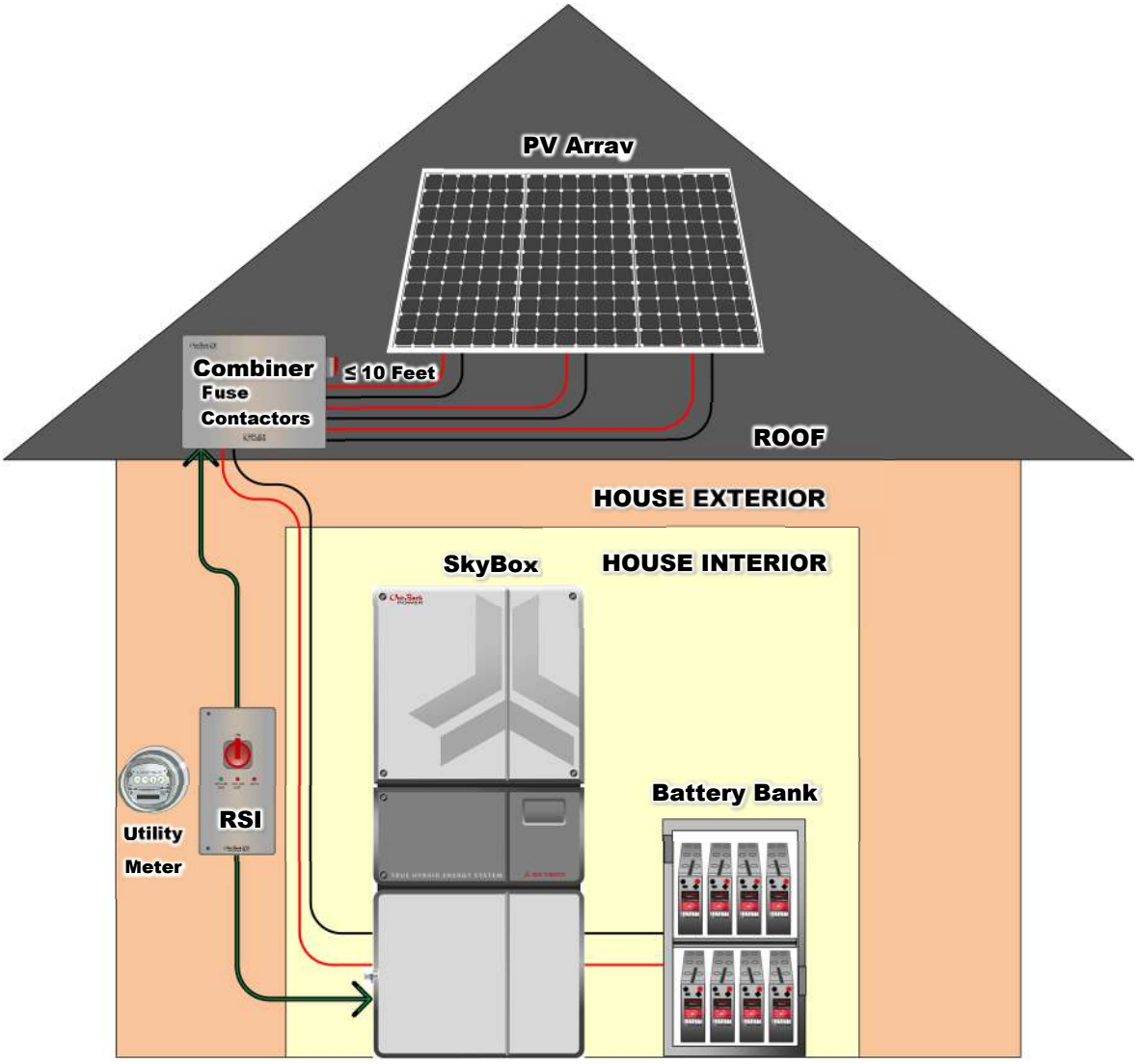
- End-to-end solution listed to UL1741 with PV rapid shutdown systems (PVRSS)
- Type 3R enclosures rated for indoor or outdoor installation
- Flexible design — install the combiner box vertically, horizontally, or at any intermediate angle; mount to racking or under the PV array
- Interoperability with compatible third-party PV rapid shutdown system equipment (PVRSE) with a dry contact input
- Combiner box has removable component panel for ease of wire management and for serviceability
- Combiner box has easy-to-install DIN-mount fuses for bi-directional overcurrent protection
- Lockable disconnects on combiner and rapid shutdown boxes
- Communications use building wire commonly available in the field (THHN/THWN-2)
- Ground lug and grounding terminal bus bar for system and equipment grounding
- Internal factory prewiring to save time during installation

Components

The primary component in the RSD-1 system is the DC combiner box. This combines up to three PV source circuits and provides an overcurrent protective device (OCPD) for each circuit.

The combiner provides a local disconnecting means. It also provides a contactor for PV rapid shutdown functionality to de-energize PV circuits within 10 feet of the PV array.

The other main component is the Rapid Shutdown Initiator (RSI) which works with the combiner to induce the rapid shutdown function. To power the RSI, an isolated Class 2 DC power supply (24 Vdc ± 3%, up to 1.5 Adc) must be used.



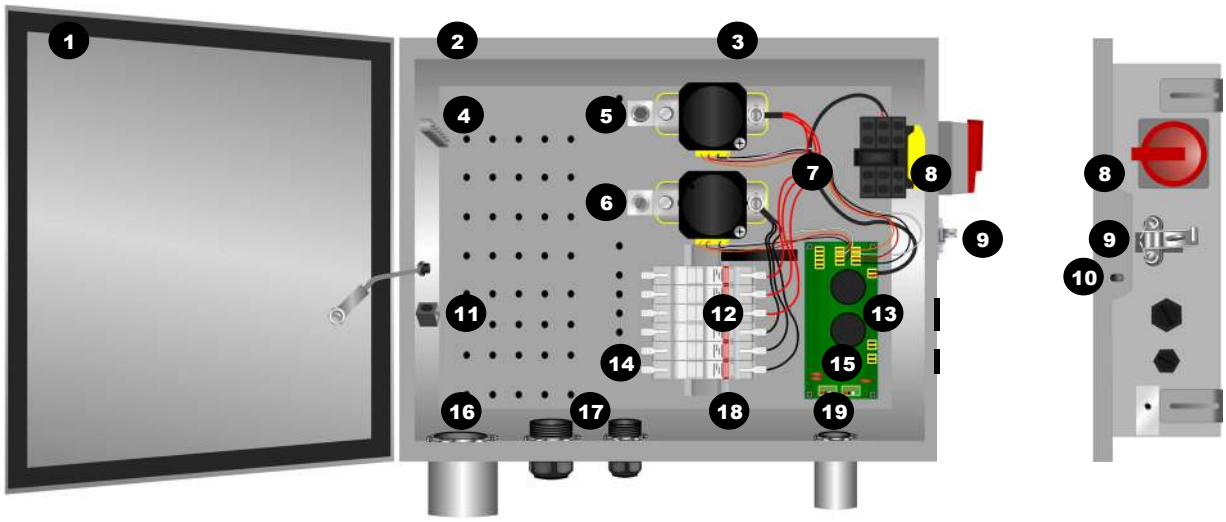
- Combiner Box
  - Contains OCPD, main contactors, PV Combiner Disconnect
  - Includes local disconnect to de-energize PV circuits within 10 feet of the array (required distance may vary with local code requirements)
- Rapid Shutdown Initiator (RSI)
  - Contains control circuit for PVRSS (contactors and relay-trip breakers)
  - Includes PVRSS disconnect switch
  - Includes LED indicators for PV connection or disconnection

Figure 1 Example of Residence with RSD-1

Components

Combiner

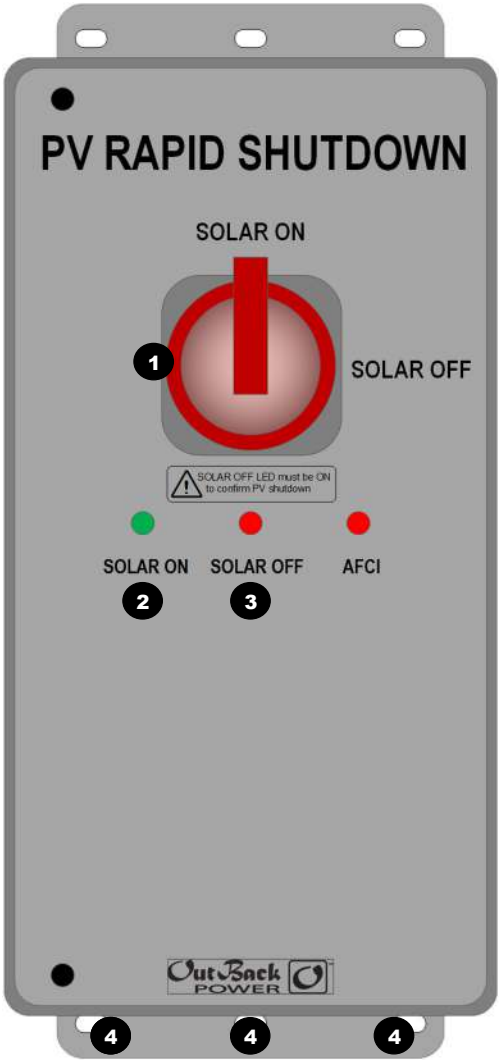
NOTE: All external wires are provided by installer



1	Gasketed Door/ Type 3R Enclosure	Protects from the environment	**11**	Ground Cable Terminal	Provides “lay-in” lug for optional pass-through ground wire
2	Component Panel (Removable)	For ease of wire management and for serviceability	**12**	Fuse Holders	PV source overcurrent protection; fuses provided by user
3	Bidirectional PV Contactors	Opens PV circuits for local disconnect or rapid shutdown	**13**	Combiner Control Board	Controls all functions within the combiner; commands the contactor
4	Ground Terminal Bus Bar	Provides a means for system and equipment grounding	**14**	PV Input Connections	Connections for positive and negative PV source circuits
5	PV Positive Output Terminal	Connection on contactor for PV positive output circuit	**15**	Communications Terminals	Communicates with RSI and additional combiner boxes
6	PV Negative Output Terminal	Connection on contactor for PV negative output circuit	**16**	2” EKO (PV Output)	Accommodates conduit and a UL 514-compliant fitting for PV output circuits
7	Internal Prewiring	Factory-installed for ease of installation	**17**	Cable Glands (PV Input)	Provide waterproof strain relief for PV source circuits
8	PV Combiner Disconnect	Activates the contactor for disconnection; can be padlocked in the OFF position	**18**	½” EKO (optional)	For installation of a third-party surge protection device (provided by user)
9	Secure Latch	Fastens door; can be padlocked	**19**	½” and ¾” (2 ea) EKO (Communications)	Accommodate conduit and a UL 514-compliant fitting for communication wires
10	Securing Screw	Secures door in place if padlock is not used			

Figure 2 Components of Combiner Box

RSI



1	Rapid Shutdown switch	Initiates the PVRSS function; disconnects RTB and main contactor in combiner.
2	**SOLAR ON** indicator	Green LED indicator; illuminates when DC voltage is present and Rapid Shutdown switch is in the ON position.
3	**SOLAR OFF** indicator	Red LED indicator. **SOLAR OFF** must be illuminated to confirm PV shutdown. This indicator tells responders that the Rapid Shutdown switch is in the **OFF** position to create a "safe" condition.
	NOTE: The third LED indicator (marked **AFCI**) is not used in this product.	
4	½" (3) EKO	These accommodate conduit and a UL 514-compliant fitting for communication wires

NOTE:

SOLAR ON does not necessarily indicate that the PV system is active.
See the **Troubleshooting** section on page 15.

Figure 3 Components of RSI

Functions

Rapid Shutdown

The rapid shutdown requirement is intended for firefighters or first responders. In an emergency, a responder may need to set the PV system in a “safe” (de-energized) state according to NEC 690.12.

For this reason, the RSI is required to be mounted close to the main utility meter. The RSI must be easily visible.

The RSI includes a Rapid Shutdown switch that initiates a disconnection of all elements of the PV system. Opening this switch sends a signal to all combiners to open the main contactor on each.

Opening this switch also sends a signal to the SkyBox, ordering it to open its contacts. According to NEC 690.12, the rapid shutdown must reduce the DC circuit to less than 30 Vdc and 240 VA within ten seconds of initiation.

Rapid Shutdown Self-Test

The rapid shutdown should be tested every six months. This test should be performed as described in the **Verification** section.

Verification

Turning the Rapid Shutdown switch to the right (clockwise) puts it in the OFF position. The **SOLAR OFF** LED indicator will illuminate upon successful shutdown. If this does not occur, see the **Troubleshooting** section on page 15.

PV Combiner Disconnect

Each combiner has a PV Combiner Disconnect switch which is used to turn off a particular array. This is used if the array or circuit needs to be serviced. The switch can be padlocked in the OFF position as a “lockout/tagout” procedure to prevent a shock hazard.

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Installation

This section assumes the use of the combiner and the RSI.

- The combiner box is a required part of all RSD-1 systems. All examples in OutBack literature show one or more combiners in use, including the *Quick Start Guide*.
- The RSI is required for all RSD-1 systems utilizing the PVRSS function.

Mounting Information

The RSD-1 combiner box accommodates multiple mounting types.

- It can be mounted horizontally, vertically, or at any intermediate angle.
- It has slotted mounting feet which allow a variety of positions.
- It is capable of being mounted directly under the PV array if necessary.
- It must be mounted at least 36” (91.4 cm) above the ground.
- The combiner box has a latch which should be padlocked to limit internal access.
- The main disconnect can also be padlocked in the **OFF** position for safety.

NOTE:
If the box is not padlocked, the securing screw must be used to secure the door. See Figure 2 on page 8.

The RSI has mounting brackets at the top and bottom.

- It should be installed near the service meter.
- It must be mounted vertically and must be at least 36” (91.4 cm) above the ground.
- The Rapid Shutdown switch can be padlocked in the **OFF** position for safety.

NOTE:
If the structure where the RSI is installed is also equipped with utility service, the structure must have a permanent sign or plaque reading “PHOTOVOLTAIC [or PV] SYSTEM EQUIPPED WITH RAPID SHUTDOWN”. This plaque must be reflective, with all letters capitalized and having a minimum height of ⅜” (9.5 mm) in white on red background.

Surge Protector

An optional surge protection device can be installed in the combiner. A knockout has been provided to accommodate this type of device. Figure 4 shows the underside of the combiner and the location of the knockout.

NOTE:
Any installed devices must be liquid-tight to sustain the combiner's environmental rating.

A. **PV Conduit (2")**
B. **PV Cable Glands**
C. **Surge Protector (½")**
D. **Communications Conduits (½" and ¾")**

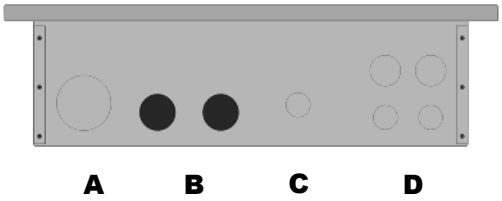


Figure 4 Surge Protector and other Knockout Locations

Connection Information

Combiner

The combiner box can take input circuits from up to six PV subarrays. It provides a single output which is connected to the SkyBox. When its contactors are closed, it sends power to the SkyBox PV connections (**1**). See Figure 5 on page 13.

- The combiner's control board receives power from the RSI (**3**). It also sends status information to the RSI (**4**). Both sets of wires must be connected for correct PVRSS operation.
- The communication wires may be run in the same conduit as the PV wire only if the communication wiring is rated for the highest system voltage.
- Up to six combiners can be used in a single system with a single RSI. The control wires must be placed in series ("daisy chained") between combiners.
- Regardless of the number of combiners in use, the last combiner must have a jumper placed across its sensing terminals to close the circuit. If only one combiner is present, the jumper must be placed there as shown in the installation instructions.

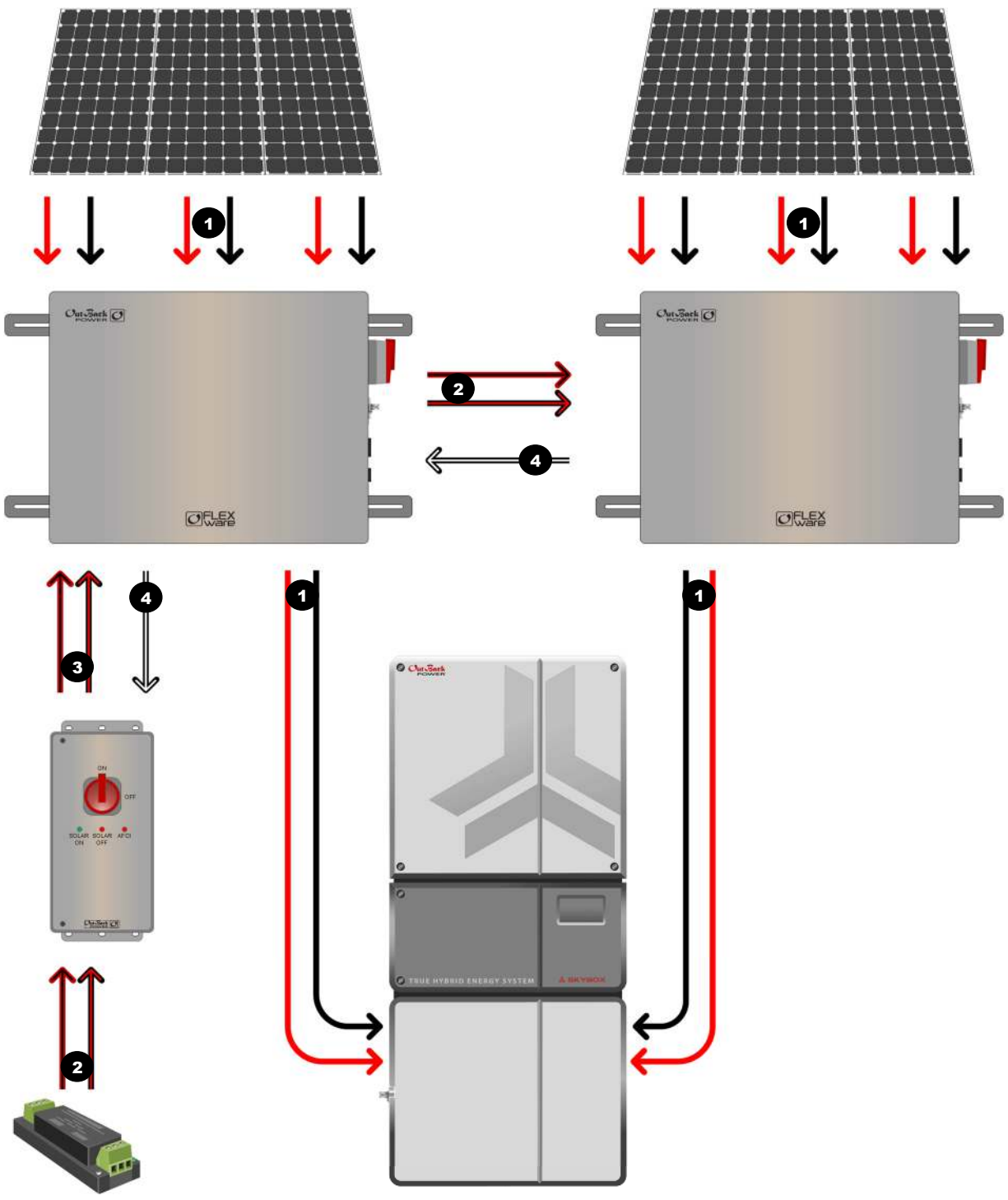
RSI

The RSI communicates with the combiner box (and with any additional combiners also connected to it). See Figure 5 on page 13.

- It receives power (**2**) from the isolated Class 2 power supply.
- It sends power (**3**) to the combiner(s) control board.
- It receives PVRSS status information from the combiner(s) (**4**).

Both sets of wires must be connected for correct PVRSS operation.

CAUTION: Equipment Damage
The 24-volt conductor is not grounded and is not to be connected to chassis or any other grounding system.



1 PV Input
2 RSI Power Supply
3 Combiner Power Supply
4 PV RSI Safe

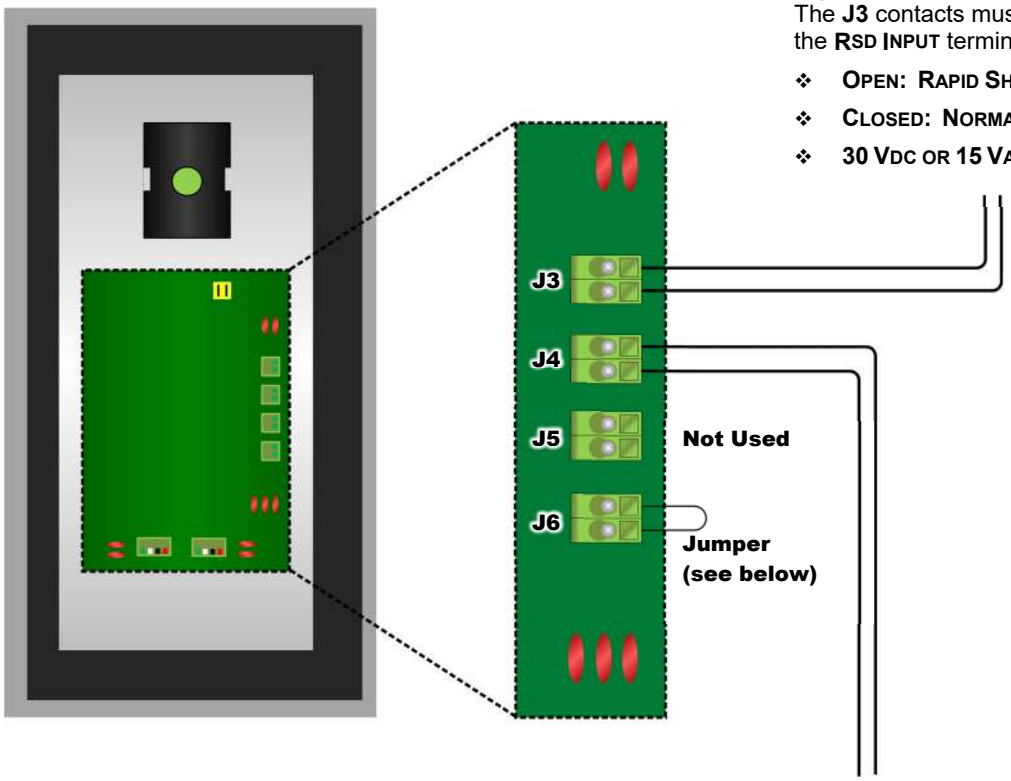
NOTE:
This is not a wiring diagram and does not serve in place of the installation instructions.

Figure 5 Block Diagram

Optional Connections

RSI

The RSI has several sets of auxiliary terminals. Terminal **J6** has a factory-installed jumper. **J3**, **J4**, and **J5** do not. The terminals can be wired to the SkyBox, or possibly other devices, to send or receive status messages.



AUX RSI COMMAND/STATUS OUTPUT

Dry contacts which report RSI status. The **J3** contacts must be connected to the **RSD INPUT** terminals on the SkyBox.

- **OPEN: RAPID SHUTDOWN (**Solar Off**)**
- **CLOSED: NORMAL (**Solar On**)**
- **30 VDC OR 15 VAC @ < 2 A**

AUX RSI SAFE STATUS INPUT

"Safe" status circuit input. The **J4** terminals must be connected to the **AUX RELAY** dry contact terminals on the SkyBox.

- **OPEN** (all connections): Not "Safe"
- **CLOSED** (any connection): "Safe" (Rapid Shutdown)

IMPORTANT:

- **J4** must be connected. With no connections, the **SOLAR OFF** ("safe") indicator will not light even if the Rapid Shutdown switch is OFF.
- **J6** must have the jumper installed (or another source of continuity). With no connections, the system will enter continuous **RAPID SHUTDOWN**.

Figure 6 Interface Connections

Troubleshooting

LED Indicators (RSI)

LED	When Lit	Notes
SOLAR ON (green)	DC voltage present in system. Rapid Shutdown switch **ON**.	Despite the label, **SOLAR ON** does not indicate that the PV system is active. It will illuminate even if PV is completely disconnected or if an arc fault is present. The name indicates to responders that this control does not shut down other parts of the electrical system. It only affects PV-related devices.
SOLAR OFF (red)	System is in "safe" mode. Rapid Shutdown switch **OFF**.	This LED can also illuminate when PV and relay-trip breakers are disconnected.
AFCI (red)	Not used with SkyBox.	The SkyBox provides the AFCI function. It provides the ability to see any arc faults and initiate a self-test. If this indicator is lit, see Table 1.

Basic Troubleshooting

The following table describes known situations which can cause unexpected behavior in the RSD-1. The table also describes all known situations which will cause the LED indicators to light.

WARNING: Shock Hazard

An arc fault causes the AFCI to disconnect that section of the PV system to prevent fire or shock injuries. These hazards may still exist on the array itself if physical troubleshooting is required. Make certain to cover the PV modules and take any other necessary steps to reduce risk.

See the next page for a table of basic troubleshooting steps.

Troubleshooting

Table 1 Troubleshooting

Symptom	Possible Cause	Possible Remedy
SOLAR OFF indicator and another indicator both lit.	RSI miswired.	Check all wiring between RSI and combiner.
SOLAR ON indicator lit, but charge controller does not register PV input.	Combiner disconnect switch turned off.	Turn on combiner disconnect switch.
SOLAR ON indicator lit, but charge controller registers reduced PV input.	Array wiring error or poor connection.	Check all PV wiring to combiner. Use DVM to confirm voltage of each subarray at combiner input terminals.
	Fuses blown in combiner box.	Check all fuses.
No indicators lit.	Battery or DC source is disconnected. Loss of combiner box control voltage caused the PV contactor to disconnect. System is not in the formal “safe” condition, although PV array is still forced to be off.	Check all power supply fuse. Check power supply terminals.
SOLAR OFF indicator does not light when Rapid Shutdown switch is turned off.	Battery or DC source is disconnected. System is not in the formal “safe” condition, although PV array is still forced to be off.	Check all power supply fuse. Check power supply terminals.
	Missing connection in RSI.	Check **J4** in RSI (see page 14).
AFCI indicator lit.	Missing connection or loose jumper in RSI.	Check **J6** in RSI (see page 14).

Specifications

Device Specifications

Table 2 Electrical and General Specifications

Device	Combiner Box	Rapid Shutdown Initiator
Designation	FWPV3-FH600-SD2	RSI
Description	Combiner box with PV rapid shutdown and manual disconnect	Initiates a PV rapid shutdown event; provides indication for PV status
Compatibility	Can accommodate 3 PV input strings per combiner	Can control up to 6 combiner boxes
Terminals:		
Input	#14 to #8 AWG (2.5 to 10 mm^2) (Cable glands)	#24 to #16 AWG (0.25 to 1.5 mm2)
Output	#14 to 2/0 AWG	
LED indicators	N/A	• SOLAR ON • SOLAR OFF • AFCI (not used with SkyBox)
Overcurrent Protection	(6) 600 Vdc DIN rail fuse holders	N/APNL
Voltage Rating	600 Vdc	24 Vdc ± 3%
Total Current (maximum)	48 Adc	N/A
DC input	24 Vdc ± 3%	24 Vdc ± 3%
Normal Operation Power Draw	0.10 Adc	0.06 Adc

Table 3 Mechanical and Environmental Specifications

Device	Combiner Box	Rapid Shutdown Initiator
Enclosure Material	Powder-coated aluminum	
Enclosure Rating	UL Type 3R	UL Type 3R
Operating Temperature	–25 to 60°C	–25 to 60°C
Security	• Lockable • Switch is lockable in OFF position	Switch is lockable in OFF position
Mounting	Vertical to horizontal (adjustable feet)	Vertical only (brackets)
Knockouts	2”, ½”, and ¾”	½”
Dimensions (H x W x D)	15.5 × 19.5 × 4.5” (39.4 × 49.5 × 11.4 cm)	14.1 ×7.3 × 3.75” (30.5 × 17.8 × 12.7cm)
Weight	~ 12 lb (5.4 kg)	~ 4 lb (1.8 kg)

Regulatory Specifications

Listings

This product carries a listing report by UL. It is listed to the following standards:

- UL 1741 — Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources (2nd Edition, 1/28/2010, with revisions through 3/23/2016) with PV Rapid Shutdown
- CSA C22.2 — General Use Power Supplies, No. 107.1-3 Issue: 2001/09/01 Ed:3 (R2011) with PV Rapid Shutdown

Compliance

This product has been tested to comply with the following standards:

- FCC Part 15, Class B

FCC Information to the User

This equipment has been tested and found to comply with the limits for a Class B digital device when powered by a DC source, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

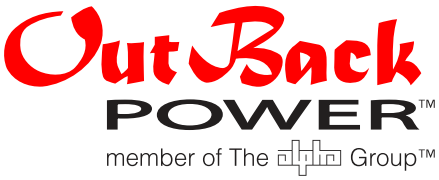
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Consult the dealer or an experienced radio/TV technician for help.

Definitions

The following is a list of initials, terms, and definitions that may be used in conjunction with this product.

Table 4 Terms and Definitions

Term	Definition
AFCI	Arc Fault Circuit Interruption
Combiner	An enclosure which combines multiple PV circuits, using individual circuit protection
Controlled conductor	A section of wire between the combiner and either the RTB or the PVRSE device
CSA	Canadian Standards Association; establishes Canadian national standards and the Canadian Electrical Code, including C22.1 and C22.2
Dry contact	A relay contact with no source voltage; switches the continuity to be used by an external device
DVM	Digital Voltmeter
EKO	Electrical Knockout
Grounded Conductor	The DC conductor (negative or positive) which is mechanically bonded to ground in one place
NEC	National Electric Code
PVRSS	Photovoltaic Rapid Shutdown System
PVRSE	Photovoltaic Rapid Shutdown (System) Equipment
RSI	Rapid Shutdown Initiator
GSLC	GS Load Center; the DC and AC load center for Radian series inverters
UL	Underwriters Laboratories; refers to a set of safety standards governing electrical products



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