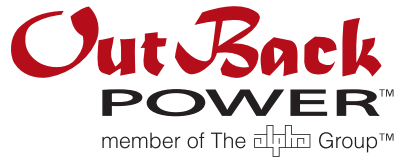




FLEXware FLEXmax 100 Rapid Shutdown Solution

Owner's Manual



About OutBack Power Technologies

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

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Table of Contents





Symbols Used	4
General Safety	4
Introduction	5
Audience	5
Welcome to OutBack Power Technologies	5
Product Overview	5
Features	5
Components	5
Components	7
Combiner	7
RSI	8
Functions	9
Arc Fault Circuit Interruption	9
Detection	9
Reset	9
Arc Fault Self-Test	10
Rapid Shutdown	10
Rapid Shutdown Self-Test	10
Verification	10
PV Combiner Disconnect	10
Installation	11
Mounting Information	11
Surge Protector	11
Connection Information	12
Troubleshooting	15
LED Indicators	15
Basic Troubleshooting	15
Specifications	17
Device Specifications	17
Regulatory Specifications	18
Listings	18
Compliance	18
Definitions	19

Important Safety Instructions

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 FLEXmax 100 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 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 FLEXmax 100 Rapid Shutdown Solution (RSD-AFCI). This product is intended to work in conjunction with the FLEXmax 100 charge controller. It allows a system to meet the 2014 National Electric Code requirements for PV systems.

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

Product Overview

Features

- o End-to-end solution listed to UL1741 with PV rapid shutdown equipment (PVRSE)
- o Arc fault circuit interrupter (AFCI) listed to UL1699B with local and remote indication
- o Type 3R enclosures rated for indoor or outdoor installation
- o Flexible design — install the combiner box vertically, horizontally, or at any intermediate angle; mount to racking or under the PV array
- o Interoperability with compatible third-party PVRSE with a dry contact input
- o Combiner box has removable component panel for ease of wire management and for serviceability
- o Combiner box has easy-to-install DIN-mount fuses for bi-directional overcurrent protection
- o Lockable disconnects on combiner and rapid shutdown boxes
- o Communications use building wire commonly available in the field (THHN/THWN-2)
- o Ground lug and grounding terminal bus bar for system and equipment grounding
- o Internal factory prewiring to save time during installation

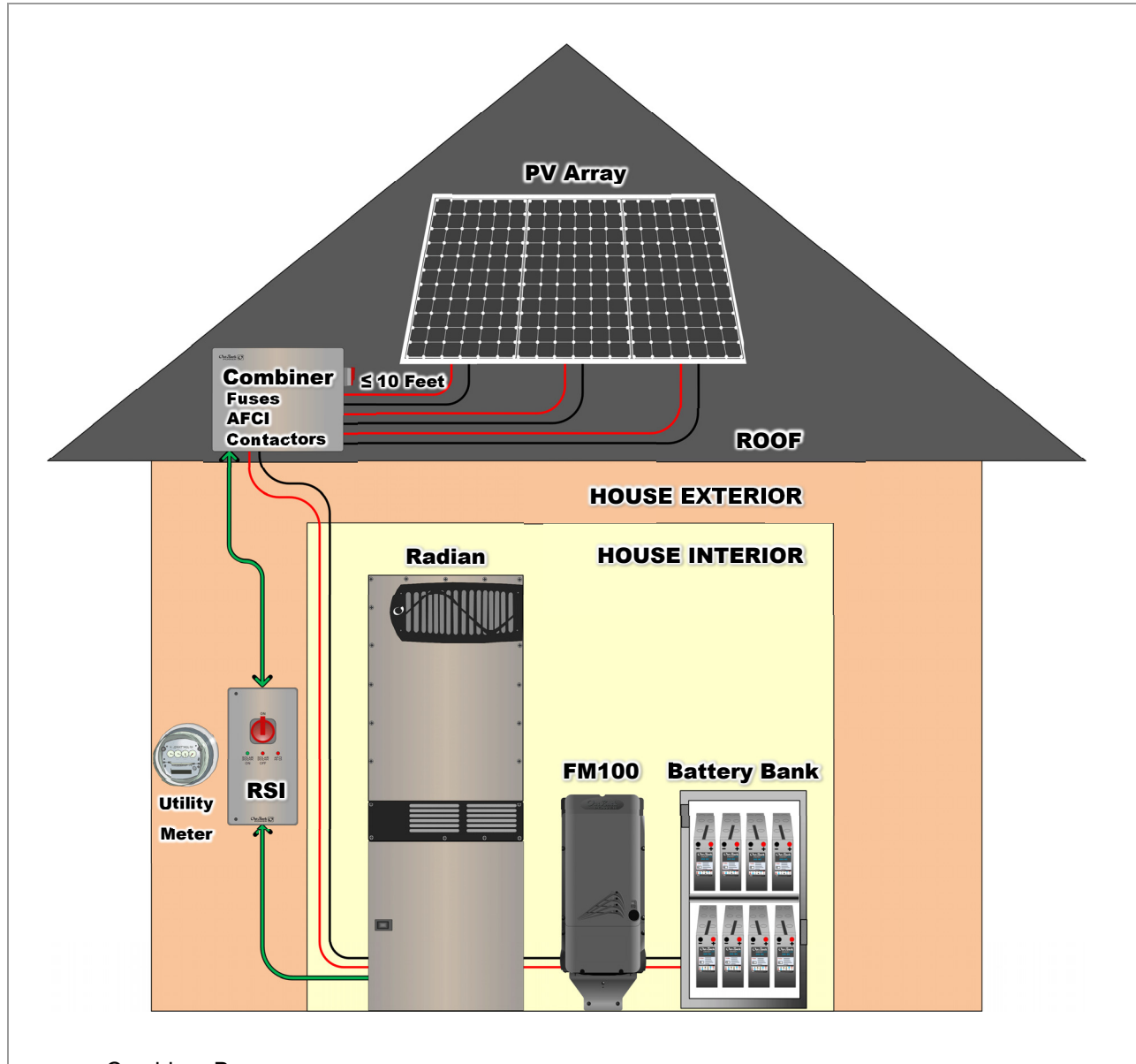
Components

The primary component in the RSD-AFCI system is the DC combiner box. This combines up to six 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 \pm 3%, up to 1.5 Adc) must be used.

Introduction



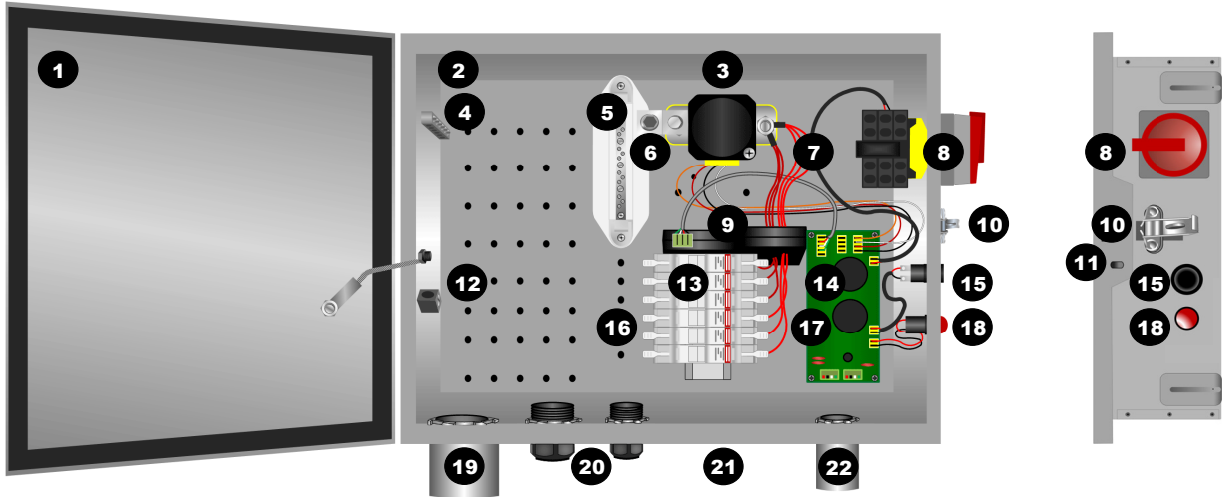
- o Combiner Box
 - Contains OCPD, AFCI, main contactors, PV combiner disconnect
 - Includes local disconnect to de-energize PV circuits within 10 feet of the array (required distance may vary with local code requirements)
- o Rapid Shutdown Initiator (RSI)
 - Contains control circuit for PVRSE
 - Includes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

Figure 1 Example of Residence with RSD-AFCI

Components

Combiner

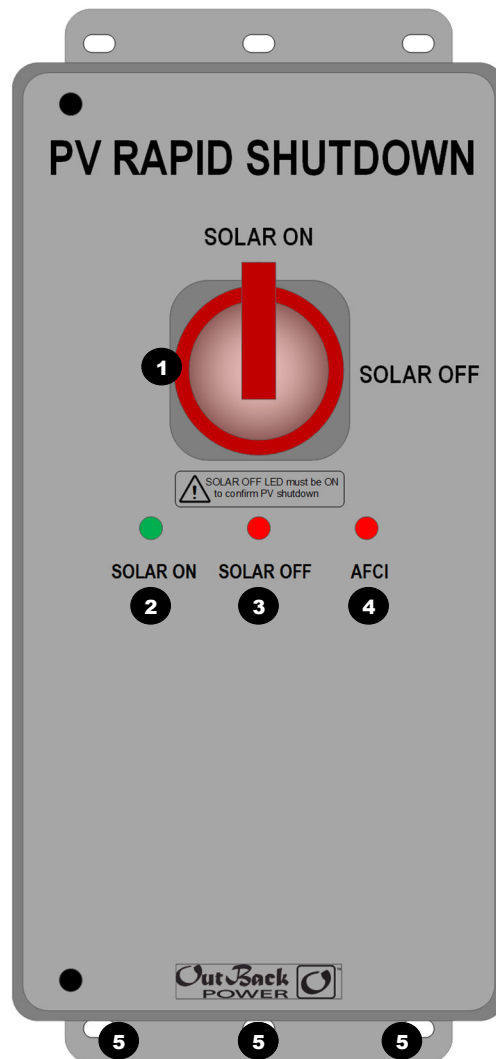
NOTE: All external wires are provided by installer



1	Gasketed Door/ Type 3R Enclosure	Protects from the environment	12	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	13	Fuse Holders	PV source overcurrent protection; fuses provided by user
3	Bidirectional PV Contactor	Opens PV circuits for local disconnect or rapid shutdown	14	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	15	Arc Fault Self-Test Button	Allows AFCI to be tested without opening the combiner box
5	Negative Terminal Bus Bar	Combines negative PV source circuits	16	PV Input Connections	Connections for positive PV source circuits
6	PV Positive Output Terminal	Connection on contactor for PV positive output circuit	17	Communications Terminals	Communicates with RSI and additional combiner boxes
7	Internal Prewiring	Factory-installed for ease of installation	18	AFCI ANNUNCIATOR	Illuminates during an arc fault event or test
8	PV Combiner Disconnect	Activates the contactor for disconnection; can be padlocked in the OFF position	19	2" EKO (PV Output)	Accommodates conduit and a UL 514-compliant fitting for PV output circuits
9	Arc Fault Detection Device	Detects series DC arc fault events	20	Cable Glands (PV Input)	Provide waterproof strain relief for PV source circuits
10	Secure Latch	Fastens door; can be padlocked	21	½" EKO (optional)	For installation of a third-party surge protection device (provided by user)
11	Securing Screw	Secures door in place if padlock is not used	22	½" and ¾" (2 ea) EKO (Communications)	Accommodate conduit and a UL 514-compliant fitting for communication wires

Figure 2 Components of Combiner Box

RSI



- | | | |
|----------|----------------------------|--|
| 1 | Rapid Shutdown switch | Initiates the PV Rapid Shutdown function; disconnects 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. |
| 4 | AFCI indicator | Red LED indicator; illuminates when receiving an "arc fault" signal from the combiner. |
| 5 | 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

Arc Fault Circuit Interruption

In a PV system, an electrical arc occurs when current bridges a gap between conductive surfaces. Gaps can occur due to conductor damage, or can be caused by inadequate system connections.

An “arc fault” is a safety concern for several reasons:

- o Risk of electric shock if the mounting system or other components become electrified.
- o Fire hazard due to heat buildup from the current flow.

A series arc occurs across open connections in a single conductor. A parallel arc occurs if the current bridges multiple conductors that were meant to remain separate. The arc fault circuit interrupter (AFCI) in the combiner is intended to protect against series arcs.

Detection

The combiner has a dedicated arc fault detection device. The device operates by detecting the distinct electrical noise created by an arc. The detector has two current transducers, each of which monitors up to three PV circuits. If an arc is detected, the detector sends a signal to the main control board in the combiner box.

- o The control board sends a signal to open the combiner’s main contactor. The **AFCI ANNUNCIATOR** turns on.
- o The control board also sends a signal to the RSI and turns on the **AFCI** indicator.



NOTES:

- ❖ This is a simple alarm indicating that an arc fault has occurred somewhere in the system. If multiple combiners are in use, the RSI cannot specify which combiner triggered it.
- ❖ Only the combiner with the detected arc will open its contactor. Any other combiners in the system will continue to operate.

If an arc fault occurs, see the **Troubleshooting** section on page 15.

Upon an arc fault event, the system is required by NEC 690.11 to be reset manually. The manual reset also resets the RSI **AFCI** indicator and the combiner **AFCI ANNUNCIATOR**.

Reset

To reset the detector following an arc fault:

1. Turn the PV Combiner Disconnect switch (or the Rapid Shutdown switch) to the **OFF** position. The **AFCI ANNUNCIATOR** and **AFCI** indicator should turn off. All combiner box contactors will open.
2. Turn the same switch to the **ON** position. The **AFCI ANNUNCIATOR** and **AFCI** indicator should remain off. All combiner box contactors will close.



NOTE:

The Rapid Shutdown switch can be used to reset all combiners at once from a central location.

Introduction

An arc fault can also be reset by disconnecting all DC power from the system, including the batteries.

The arc fault detector has been evaluated to have a low instance of nuisance tripping. However, installing external DC components may increase the risk of nuisance tripping.

Arc Fault Self-Test

The arc fault function can be manually tested. The arc fault self-test mimics the conditions of an arc fault. The combiner and RSI give the same indications as described in **Detection** on page 9.

To perform the arc fault self-test:

1. Ensure the system is functioning and all indicators are normal.
2. Push the arc fault self-test button as shown in Figure 2 on page 7.
3. Listen for an audible click as the contactor opens.
4. Check the **AFCI ANNUNCIATOR** on the combiner. It should be illuminated.
5. Optional (if installed): Check the **AFCI** indicator on the RSI. It should be illuminated.

Reset the system by the same method as described on page 9.

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 FLEXmax 100, 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.




Installation

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

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

Mounting Information

The RSD-AFCI combiner box accommodates multiple mounting types. 

- o It can be mounted horizontally, vertically, or at any intermediate angle.
- o It has slotted mounting feet which allow a variety of positions.
- o It is capable of being mounted directly under the PV array if necessary.
- o It must be mounted at least 36" (91.4 cm) above the ground.
- o The combiner box has a latch which should be padlocked to limit internal access.
- o 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 7.

The RSI has mounting brackets at the top and bottom. 

- o It should be installed near the service meter.
- o It must be mounted vertically and must be at least 36" (91.4 cm) above the ground.
- o 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 3/8" (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.

Installation

- A. PV Conduit (2")
- B. PV Cable Glands
- C. Surge Protector (1/2")
- D. Communications Conduits (1/2" and 3/4")

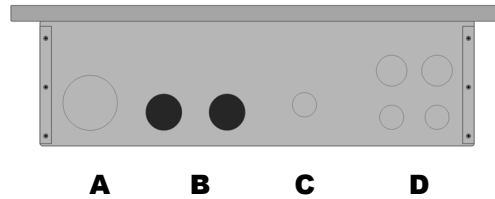


Figure 4 Surge Protector and other Knockout Locations

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 DC load center. When its contactors are closed, it sends power to the load center PV connections, charge controller, and batteries (1). See Figure 5 on page 13.

- o The combiner's control board receives power from the RSI (3). It sends rapid shutdown status information (5) and arc fault status information (4) to the RSI. Both sets of wires must be connected for correct rapid shutdown operation.
- o 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.
- o 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.
- o 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.

- o It receives power (2) from the isolated Class 2 power supply.
- o It sends power (3) to the combiner(s) control board.
- o It receives arc fault and rapid shutdown status information from the combiner(s) (4) and (5).
- o It sends rapid shutdown information to the charge controller (6) and receives status information from the charge controller in response (7). Both sets of wires must be connected for correct rapid shutdown operation.



CAUTION: Equipment Damage

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

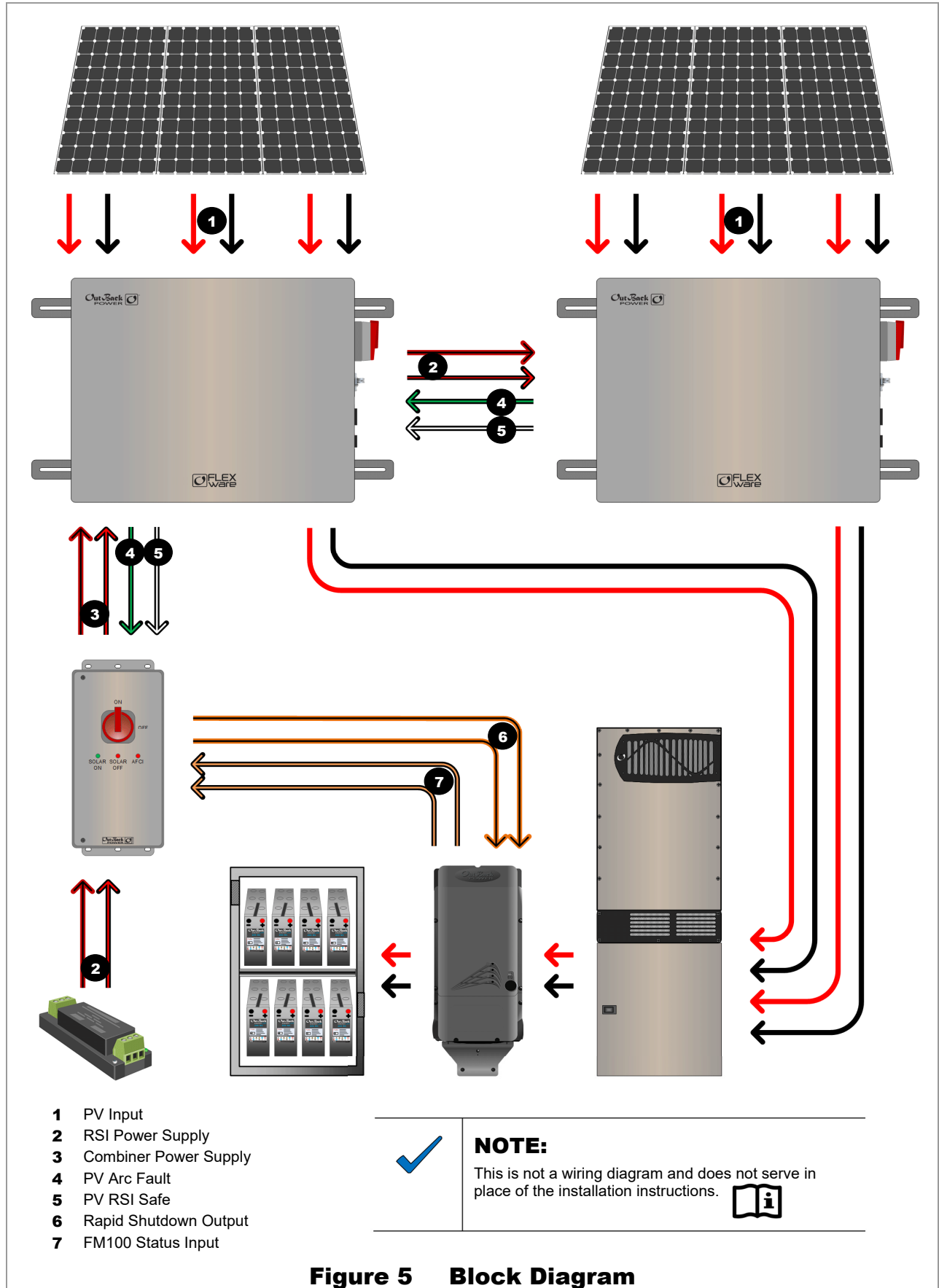
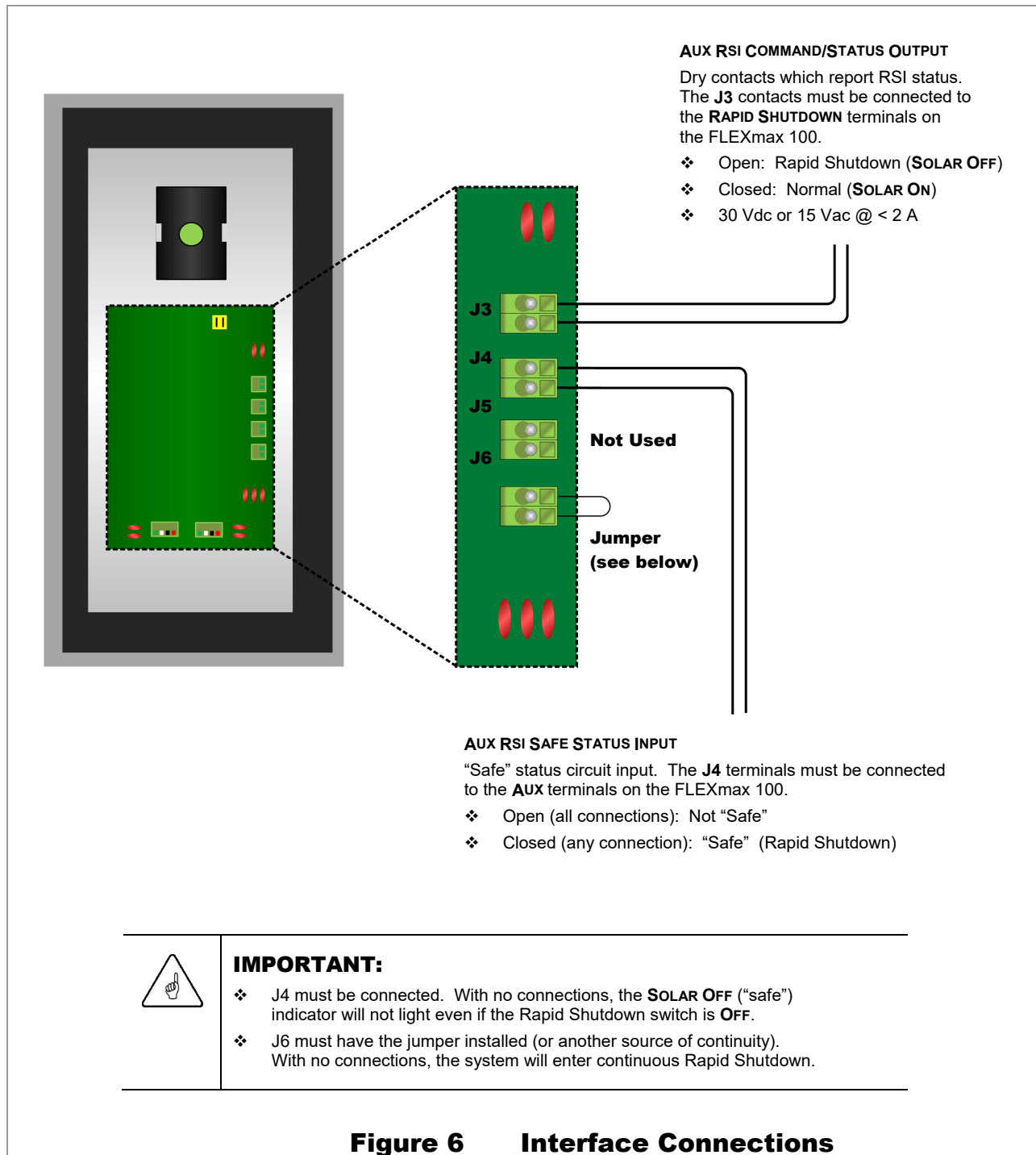


Figure 5 Block Diagram

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 FLEXmax 100, or possibly other devices, to send or receive status messages.





Troubleshooting



LED Indicators

Table 1 Indicators

Box	Indicator	When Lit	Notes
RSI	SOLAR ON (green)	DC voltage present in system. Rapid Shutdown switch ON .	May be lit at the same time as AFCI . 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.
RSI	SOLAR OFF (red)	System is in “safe” mode. Rapid Shutdown switch OFF .	This indicator should never be lit at the same time as any other.
RSI	AFCI (red)	Arc fault condition or deliberate arc fault self-test.	Accompanied by at least one AFCI ANNUNCIATOR (on one or more combiners). May be lit at the same time as SOLAR ON .
Combiner	AFCI ANNUNCIATOR (red)	Arc fault condition or deliberate arc fault self-test.	Accompanied by AFCI on RSI. Will not be accompanied by AFCI ANNUNCIATORS in other combiners unless other arc faults are present. May be lit at the same time as SOLAR ON .

Basic Troubleshooting

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

	<p>NOTE:</p> <p>When a true arc fault event occurs, the RSD-AFCI disconnects the PV by design. RSD-AFCI troubleshooting is not required. However, it may be necessary to troubleshoot and locate the cause of the problem. Diagnosis of an arc fault is not covered under the scope of this document. See Table 2.</p>
	<p>WARNING: Shock Hazard</p> <p>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.</p>

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

Troubleshooting

Table 2 Troubleshooting

Symptom	Possible Cause	Possible Remedy
AFCI indicator and combiner AFCI ANNUNCIATOR lit.	Arc fault event. NOTE: The SOLAR ON indicator remains lit.	If an arc fault is present, the shutdown of the system constitutes correct operation. The RSD-AFCI does not need troubleshooting. Investigate any potential causes throughout the PV system.
	Arc fault self-test button was pressed.	Turn combiner disconnect switch or Rapid Disconnect switch off, then on.
AFCI indicator lit. Combiner AFCI ANNUNCIATOR not lit.	Arc fault in another combiner (multiple combiner system only). NOTE: The SOLAR ON indicator remains lit.	Check all combiners. An arc fault will activate the AFCI ANNUNCIATOR in that combiner only.
	Missing connection or loose jumper in RSI.	Check J6 in RSI (see page 14).
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 fuses. 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).



Specifications

Device Specifications

Table 3 Electrical and General Specifications

Device	Combiner Box	Rapid Shutdown Initiator
Designation	FWPV6-FH600-SDA	RSI
Description	6-string combiner box with PV rapid shutdown, AFCI, and manual disconnect	Initiates a PV rapid shutdown event; provides indication for PV status
Compatibility	Can accommodate 6 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 mm ²)
Output	#14 to 2/0 AWG	
LED indicators	AFCI ANNUNCIATOR	<ul style="list-style-type: none"> • SOLAR ON • SOLAR OFF • AFCI
Overcurrent Protection	(6) 600 Vdc DIN rail fuse holders	N/A
Voltage Rating	600 Vdc	24 Vdc ± 3%
Total Current (maximum)	64 Adc	N/A
DC input	24 Vdc ± 3%	24 Vdc ± 3%
Normal Operation Power Draw	0.10 Adc	0.06 Adc

Table 4 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	<ul style="list-style-type: none"> • 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:

- o 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
- o UL1699 — Standard for Arc-Fault Circuit Interrupters (2nd Edition, revised 11/08/2013)
- o UL1699B — Photovoltaic (PV) DC Arc-Fault Circuit Protection (Issue: 1/14/2013)
- o CSA C22.2 — General Use Power Supplies, No. 107.1-01 Issue: 2001/09/01 Ed:3 (R2011) with PV Rapid Shutdown

Compliance

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

- o 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 5 Terms and Definitions

Term	Definition
AFCI	Arc Fault Circuit Interrupter
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
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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