

Smart Combiner Box Installation Manual



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Revision History

Rev. No.	Date	By	Description
1.0	5 April 2013	AO	Preliminary Release
1.1	16 April 2013	JS	ETL Release
1.2	9 May 2013	AO	Menu Layout
1.3	15 April 2014	AM	Reformat TOC, added AFCI section
1.4	17 July 2014	AM	Added 24VDC customer input wiring diagram
1.5	24 July 2014	AM	Rewrote Appendices 1, 2, and 3

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IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS


This manual contains important instructions for all SolarBOS Smart Combiner Box models that must be followed during the installation and use of the Smart Combiner Box.

The Smart Combiner Boxes are designed and tested according to international safety requirements. As with all electrical and electronic equipment, certain precautions must be observed when installing the Smart Combiner. To reduce the risk of personal injury and to ensure the safe installation and operation of the Smart Combiner, you must carefully read and follow all instructions and warnings in this *Installation Guide*.


1. Safety Instructions

1.1. Symbols

Safety and Hazard Symbols

	HAZARD: This symbol appears beside instructions and warnings that deal with dangerous voltages that can injure people who come in contact with them.
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Warnings

	WARNING: A warning describes a hazard to equipment or personnel. It calls attention to a procedure or practice, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the SolarBOS equipment and/or other equipment connected to the SolarBOS equipment or personal injury.
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Warnings may also be accompanied by one or more of the safety and hazard symbols described above to indicate the type of hazard described therein.






Other Symbols

In addition to the safety and hazard symbols described previously, the following symbol is also used in the *Installation Guide*:

	ATTENTION: This symbol accompanies notes that call attention to supplementary information that you should know to ensure optimal operation of the system.
	GROUND: This symbol marks the areas in the combiner for connecting equipment grounds only.

1.2. Warranty

All combiners sold in the USA have a five-year warranty. For warranty coverage, or if you have questions about the combiner warranty, contact SolarBOS at the address, telephone number, or web site listed on page 1 (to send e-mail, see the contact section of the SolarBOS web site: www.solarbos.com).

	WARNING: All electrical installation must be done in accordance with the National Electrical Code ANSI/NFPA 70, local building codes, and the requirements of the authority having jurisdiction.
	WARNING: To prevent electrical shock or injury, all wiring and commissioning procedures must be performed by qualified personnel.
	WARNING: Before installing or using the Smart Combiner, read all of the instructions and warnings on the combiner and in this <i>Installation Guide</i> .
	WARNING: PV arrays produce electrical energy when exposed to light and thus create an electrical shock hazard.
	WARNING: The Smart Combiner uses an integrated disconnect switch, yet both the line and load side of the switch may still be energized in the OFF position. Always test both sides of the disconnect before servicing the combiner.

2. Introduction

SolarBOS has introduced a new line of Arc Fault Circuit Interruption (Smart) Combiner Boxes designed for use with all module and inverter combinations.

Combiner features include:

- Listed to UL 1741
- Capable of detecting and interrupting series arcs in the array wiring
- Available in NEMA 3, 3R, 4 powder-coated steel, and NEMA 4X stainless steel or fiberglass enclosures (others available upon request)
- Integrated load-break disconnect switch (optional)
- Integrated load-break contactor switch (optional)
- Current sensing AFCI configuration (optional)

A note on nomenclature:

The solar industry oftentimes refers to a combiner box as a “combiner” or “string combiner” and if these terms are used within this manual they should be considered to mean a “combiner box.”

Additionally, UL (Underwriters Laboratories) makes a distinction between an Arc Fault Detection (AFD) device and an Arc Fault Circuit Interruption (Smart) device. An AFD device detects series arcs per the UL 1699B test standard whereas a Smart device detects and mitigates (interrupts) series arcs per the UL 1699B test standard. Since the SolarBOS combiners meet the Smart requirements they are referred to as Smart Combiners throughout this manual, even though they also meet the requirements of an AFD device.

2.1. Unpacking & Inspection

All SolarBOS Smart combiners are thoroughly checked before they are packaged and shipped. Although they are shipped in sturdy packaging, damage can still occur during shipping and delivery. It is important to carefully inspect the shipping container and contents prior to installation. If you detect any external damage after unpacking, report the damage immediately to SolarBOS and the shipping company that delivered the unit. Items not rejected within 10 days of delivery are considered accepted without recourse. If it becomes necessary to return the combiner, please use the original packing material.

If you need assistance in dealing with a damaged unit, contact SolarBOS at 925-456-7744.

3. Installation

3.1. Dimensions & Weights

Refer to Figure 1 and Tables 1-2 for enclosure dimensions. Use appropriate hardware for the mounting surface. The dimensions of the unit for each Smart Combiner option and the respective weights are shown in Table 1 below.

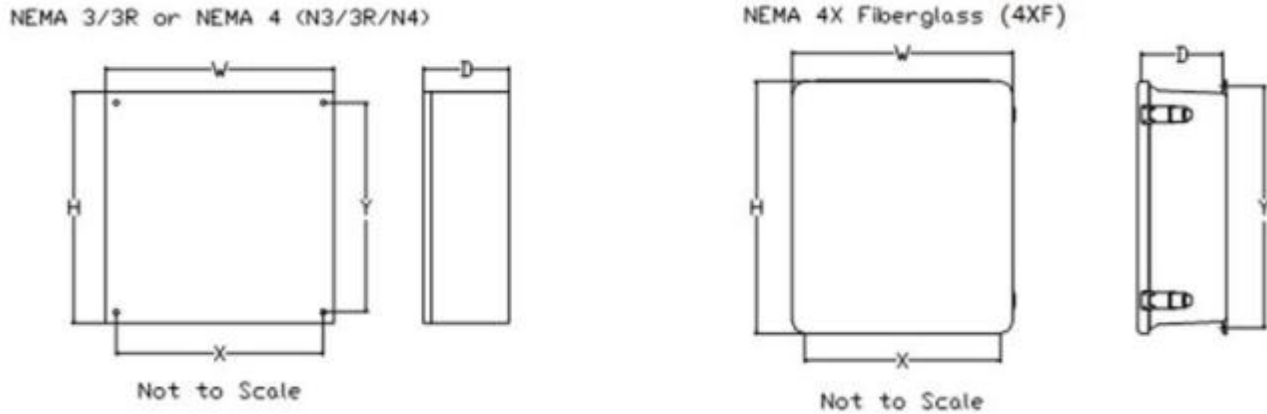


Figure 1. Combiner Enclosure Dimensions

Table 1. Smart Combiner Dimensions

Enclosure Type	# of Circuits	H	W	D	X	Y	Weight (lbs.)		
							Standard	Contactora	Disconnect
N3/N4	8, 12, 16	20.00	20.00	6.00	18.00	18.00	35	37	39
4XF	8, 12, 16	18.40	16.40	7.68	14.25	19.28	26	N/A	N/A
4XF	8, 12	20.00	16.00	8.13	13.81	17.81	N/A	30	32
4XF	16	24.00	20.00	9.88	15.25	19.25	N/A	37	39

Table 2. AFCI Combiner Dimensions

Enclosure Type	# of Circuits	H	W	D	X	Y	Weight (lbs.)		
							Standard	Contactora	Disconnect
N3/N4	8, 12, 16	20.00	20.00	6.00	18.00	18.00	35	36	38
	8, 12, 16	24.00	20.00	6.00	22.00	18.00	39	40	42
4XF	8, 12, 16	20.00	16.00	8.13	13.81	17.81	29	30	N/A
	8, 12, 16	24.00	20.00	9.88	15.25	19.25	36	37	39

All dimensions are in inches unless otherwise noted.

3.2. SMART Combiner Orientation

NEMA-3/4/4X enclosures may be installed in either the vertical or the horizontal orientation. This applies to Smart Combiner with the “N3” “N4” “4XF” and “4XSS” designation. If installed horizontally (with the door facing the sky), they should be supported by appropriate mounts.



WARNING: Do not install the Smart Combiner directly to the roof material. Doing so will void the warranty.

3.3. Disconnect Switch Assembly

The Smart Combiner includes a handle installed on the enclosure door with clearly marked ON and OFF positions. The switch handle (located on the enclosure door) allows padlocking in the OFF position enabling Lock Out/Tag Out procedures.

3.4. Defeating the Disconnect Handle

For some applications, it may be necessary to temporarily defeat the integrated disconnect switch on the Smart Combiner.

With the switch in the ON position, the handle door interlock may be defeated with a tool, such as a small screwdriver, to allow the door to be opened. The door interlock may be defeated in the ON position and will reactivate automatically when the enclosure door is closed. See item 1 on Figure 2.

With the enclosure door open, it is possible to operate the switch with an auxiliary handle by defeating the handle interlock without using a special tool.

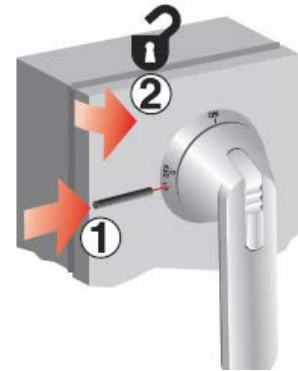


Figure 2. Defeating the Disconnect Switch




WARNING: Only qualified personnel should defeat the handle door interlock on the SMART Combiner.

4. Wiring



4.1. Input Wiring

Refer to Figure 2 and Tables 2a, 2b, and 2c for the input wiring locations of the SMART Combiner. PV positive and negative conductors are wired into the positive lug and negative distribution block, respectively. These terminal locations are clearly marked. All PV safety ground conductors are wired into the ground bus located at the bottom of the SMART Combiner.

	NOTE: The SMART Combiner enclosure is shipped with no entry holes. A knock-out is required for the appropriate conduit size. SolarBOS recommends wire entry to be made according to Figure 2.
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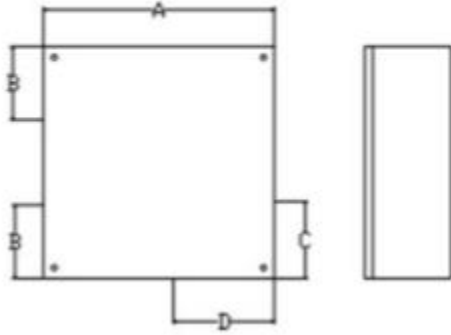
4.2. Output Wiring

Some SolarBOS SMART Combiners have large fault current ratings. When temperature and voltage drop adjustments are considered, the output conductor sizes can become quite large (500 MCM or greater) and difficult to manage. NEC Article 310.4 allows paralleling of conductors greater than AWG 1/0 to achieve higher ampacities.

	NOTE: On units with provision for using crimp lugs use Panduit part number LAA250-38-5 for 250MCM wire or a UL listed equivalent part from another manufacturer. Be sure to use the appropriate part number for the intended wire gauge.
	NOTE: Rain tight or wet location hubs that comply with the Standard UL514B must be used for NEMA 3/3R outdoor applications. NEMA 4 or 4X applications must use watertight hubs that comply with the Standard UL514B. Use Myers-type, water-tight conduit fittings such as Thomas & Betts H200TB (for 2" conduit) or H300TB (for 3" conduit) or equivalent from others. Install fittings per manufacturer's recommendations.

4.3. Wire Entry Locations & Dimensions

NEMA 3/3R or NEMA 4 (N3/3R/N4)
Not to Scale



NEMA 4X Fiberglass (4XF)
Not to Scale

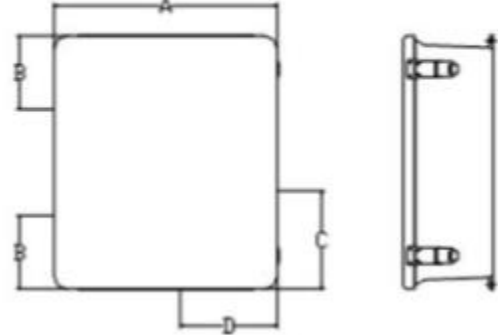


Figure 3. Combiner Wire Entry Locations

Dimension “A” and “B” are for input wire locations. Dimensions “C” and “D” are for output wire locations. These locations are recommendations only. Care should always be taken to assure there is enough wire bend space for the desired output wire gauge when choosing a conduit entry location. The wire entry locations for the standard, contactor and disconnect combiners are shown in Table 2.

Table 2. Wire Entry Dimensions

Combiner Type	Enclosure Type	# of Circuits	A	B	C	D
STANDARD	N3/N4	8, 12, 16	20	8	8	12
	4XF	8, 12, 16	16	6	6	5
CONTACTOR	N3/N4	8, 12, 16	20	8	8	12
	4XF	8, 12, 16	16	6	6	5
DISCONNECT	N3/N4	8, 12, 16	20	8	5	12
	4XF	8, 12, 16	16	6	4	5

All dimensions are in inches unless otherwise noted

5. Circuit Map

The following figure shows the channel map for the PV string inputs for up to 8, 12 and 16 channels.




Figure 4. Input wire labeling schematic for (a) 8 strings, (b) 12 strings, and (c) 16 strings

The monitoring website will display PV string current readings according to the channel map shown above.

5.1. PV Fuses

All SolarBOS SMART Combiners ship with fuses installed according to the user's predetermined requirements. All fuses and connection points are electrically tested prior to shipment. SolarBOS maintains stock of common fuse sizes if replacements are necessary or spares desired.

	<p>WARNING: Never open a fuse holder while it is under load. Electrical arcing and damage to the fuse holder will occur if a fuse holder is opened under load.</p>
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6. The Smart Sensor Module

The Smart Combiners includes a sensor module located on top of the bus bar in between the fuse holders as shown in Figure 5. The unit requires a 24V DC power supply available separately from SolarBOS. The module measures the current of each circuit. The module is also capable of communicating current information via Modbus/RS-485.

6.1. Smart Combiner Wiring

The output from the current sensor module is RS-485 serial using the standard Modbus RTU protocol. The positive data out, negative data out and data shield should be wired to the RS-485 network. The (24V DC in) is wired to the power supply. Minimum wire size of 24 AWG is required for RS-485 communications. The 24V DC wire should be sized based on distance and number of combiners.

6.1. 24VDC Input Wiring

The user must apply 24VDC at the provided terminals next to the disconnect switch (600mA for AFCI models, and 100mA for AFD model combiner boxes).

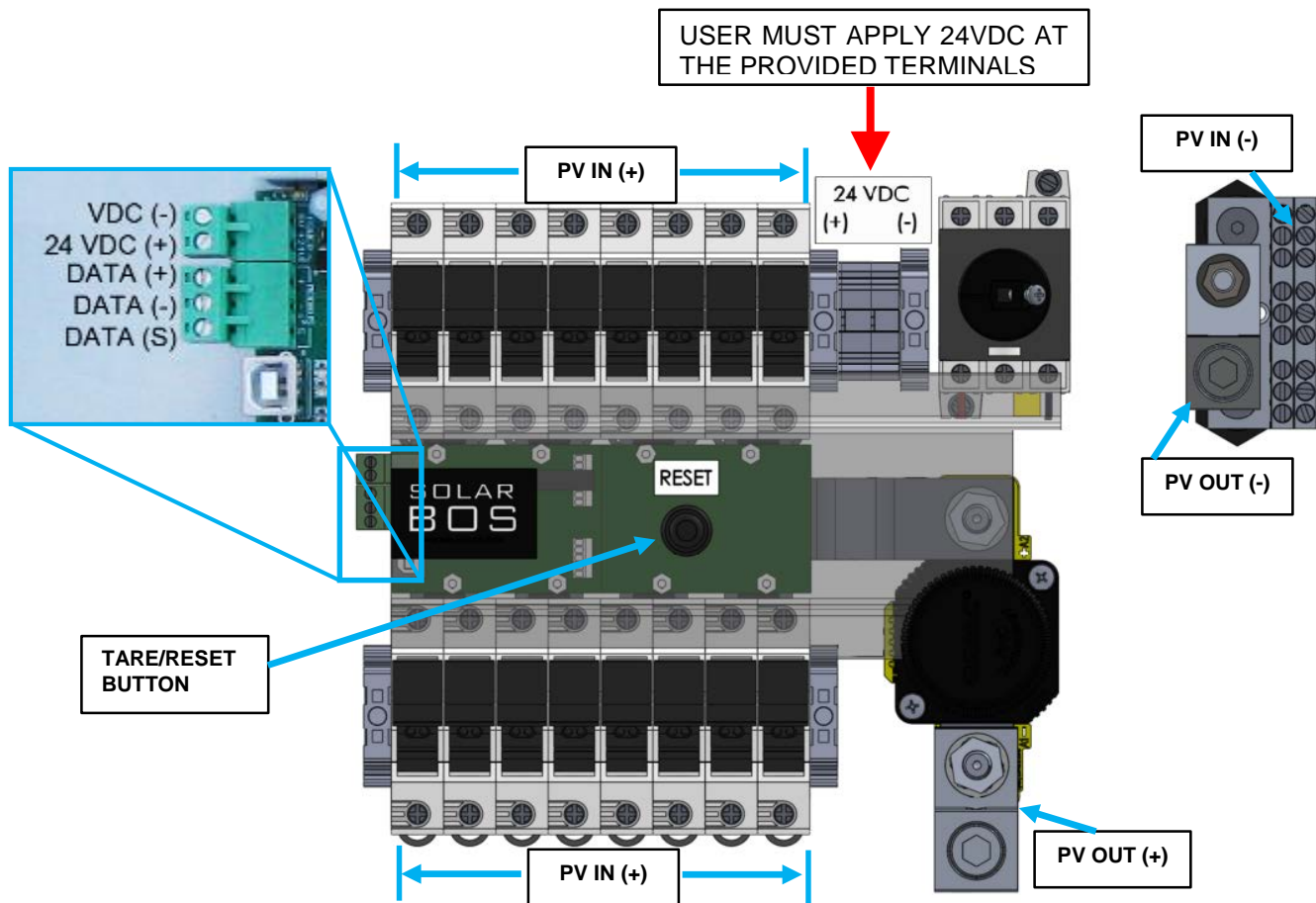


Figure 5. The SolarBOS Smart Combiner connection points. AFCI combiner shown.

NOTE: Previous revisions of combiner boxes did not ship with terminal blocks for the 24VDC user input. Refer to Appendix 4 for wiring diagram.

7. AFCI Combiner Box

7.1. Sensor Module

On the AFCI Combiners, the TARE/RESET button is mounted on a Lexan cover as shown in Figure 6. The module measures the current of each circuit as well as the electrical noise picked up by the current transformer to detect arcs. When an arc is detected, the combiner will shut off, rendering the circuit open. SolarBOS arc fault devices are PV AFCI Type 1 and/or PV AFD Type 1 and 2. The module communicates string current and arc information via Modbus/RS-485. SolarBOS recommends 24VDC and 600mA for each unit, however the board will accept an input voltage range of 20-28VDC. Arc Fault Detection (AFD – detection only) devices need only 100mA.

7.2. Wiring and Wire Installation

The data output from the current sensor module is RS-485 serial using the standard Modbus RTU protocol. The positive data out, negative data out and data shield should be wired to the RS-485 network. 24VDC should be wired from the power supply to the module. Minimum wire size of 24 AWG (12 AWG maximum) class B or C copper wire is required for RS-485 communications. Wire used should be sized based on distance and number of combiners using ampacity requirements above with a minimum size of 24AWG (12AWG maximum) class B or C copper unless special terminals are requested for larger conductors.

Installation requires wire cutters, wire strippers, torque wrench (at least 40 in-oz), and a small flat head screwdriver bit. All data and power wire ends should be stripped approximately 5/16" prior to insertion into the AFCI pressure terminals. Wire length should allow an additional 4" overall length after a suitable routing path has been determined.

All power and data terminals should be tightened to 45 in-oz (± 5 in-oz). Wires should be terminated to their respective connectors before installing the connectors onto the circuit board.

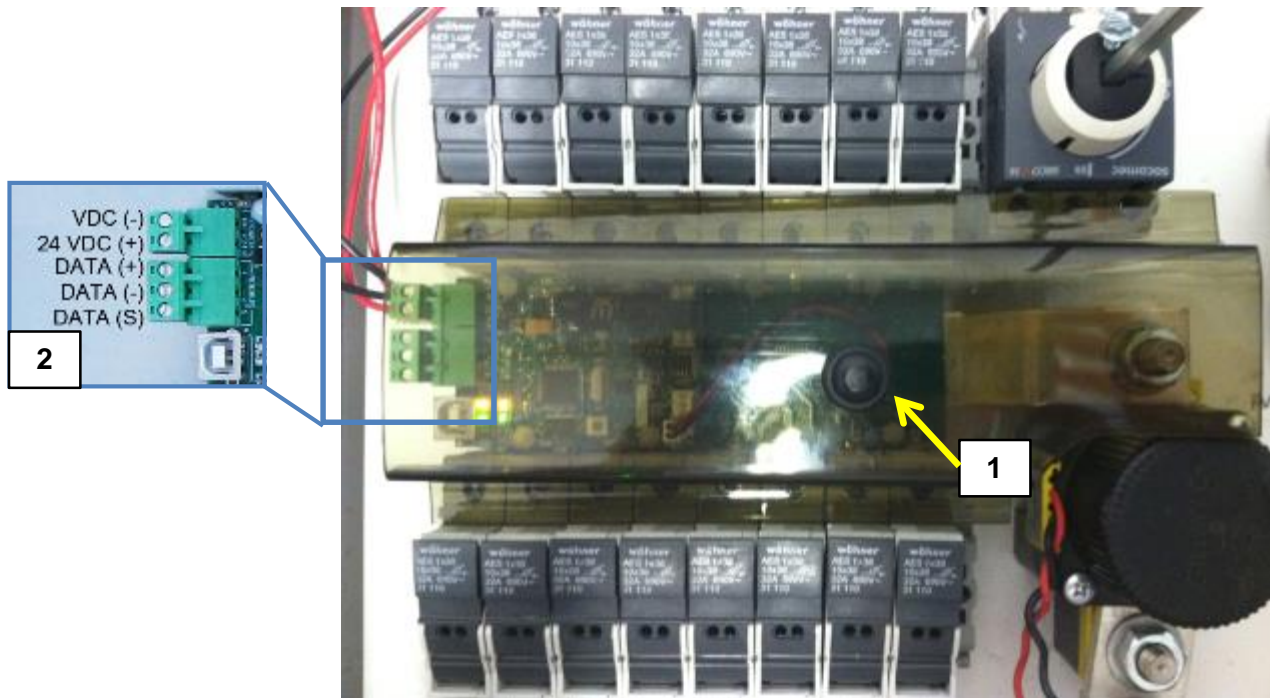


Figure 6. The SolarBOS AFCI Combiner includes the TARE/RESET button (1) and monitoring unit input terminals (2).

7.3. Even-count CT Installation

The Current Transducer (CT) is installed in one of two ways: “even-count” and “odd-count”. The terms “even” and “odd” refer to the total number of string inputs entering a given combiner box. Figure 7 shows an example of an even-count string input installation.

NOTE: Colored conductors shown for illustrative purposes only. Use appropriately sized conductors.

NOTE: For combiner units equipped with 2 CT's see Appendix for installation instructions.

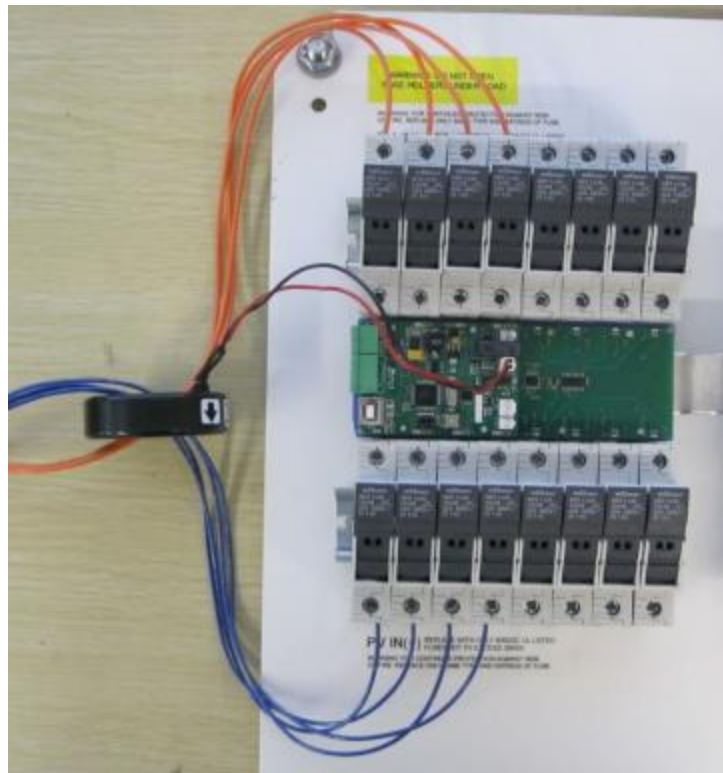
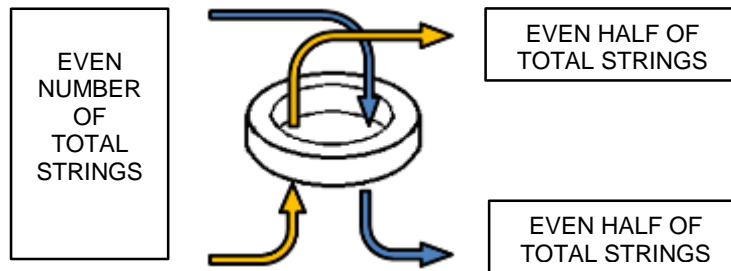


Figure 7. CT installation (EVEN-COUNT)

7.4. Odd-Count CT Installation

Figure 8 shows the top and bottom halves of an example odd-count CT installation. The lower half of the strings is short one conductor. For the CT electronics to work properly, the net amount of current flowing through the CT aperture must be balanced (0ADC).

NOTE: Colored conductors shown for illustrative purposes only. Use appropriately sized conductors.

NOTE: For combiner units equipped with 2 CT's see Appendix for installation instructions.

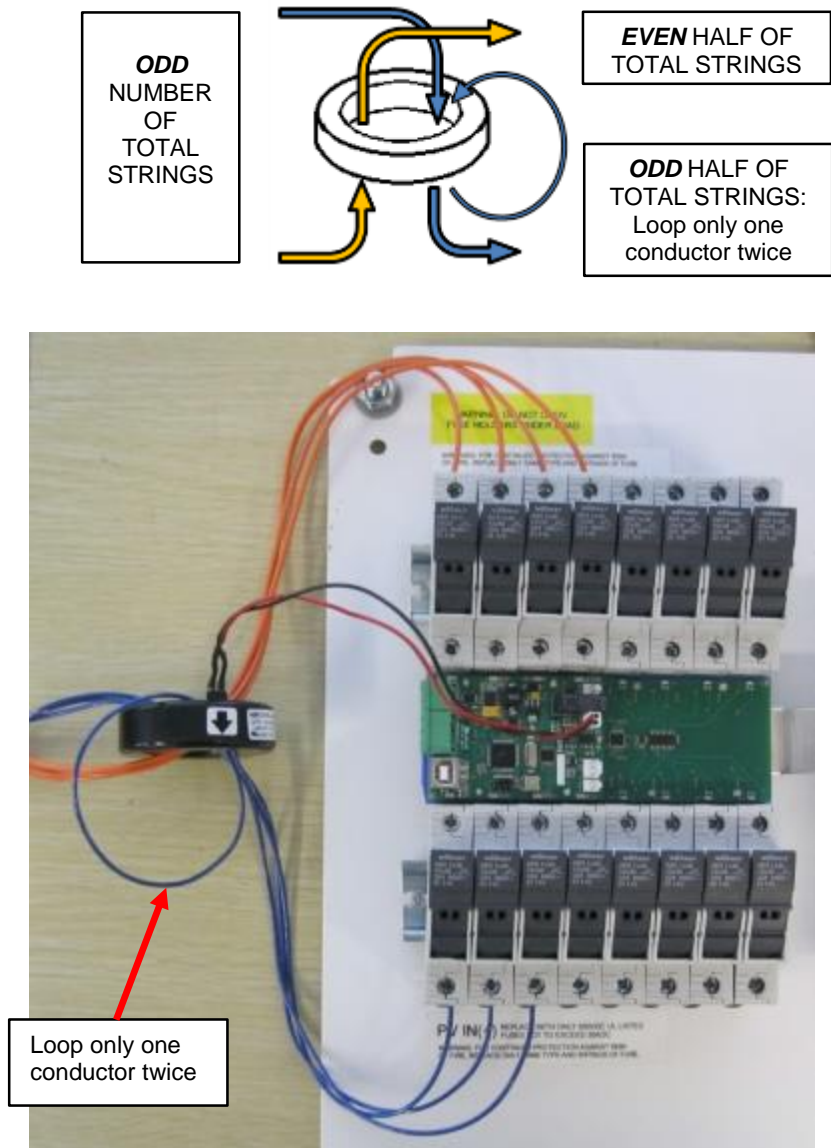


Figure 8. CT installation (ODD-COUNT).

7.5. Lexan Guard Installation

Plug in the lead from the TARE/RESET button to the sensor board header labeled "SW." Replace the Lexan guard as shown in the Figure 8. To correctly secure the Lexan guard, squeeze the two sides together to fit the guard in between the fuse holders and completely cover the sensor board.

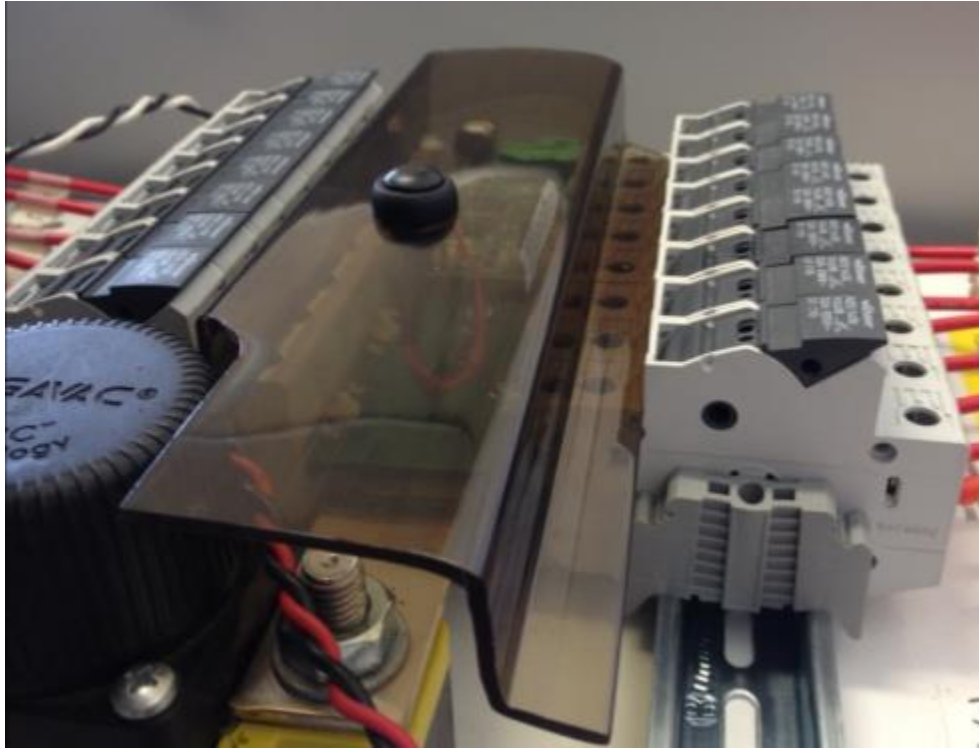


Figure 8. Lexan Guard installation.

8. Commissioning the Combiner Box

8.1. Channel Light Map

The Channel Light Map shows the numbering convention used for the sensor board LED indicators. In Figure 9, channel 7 is lit.

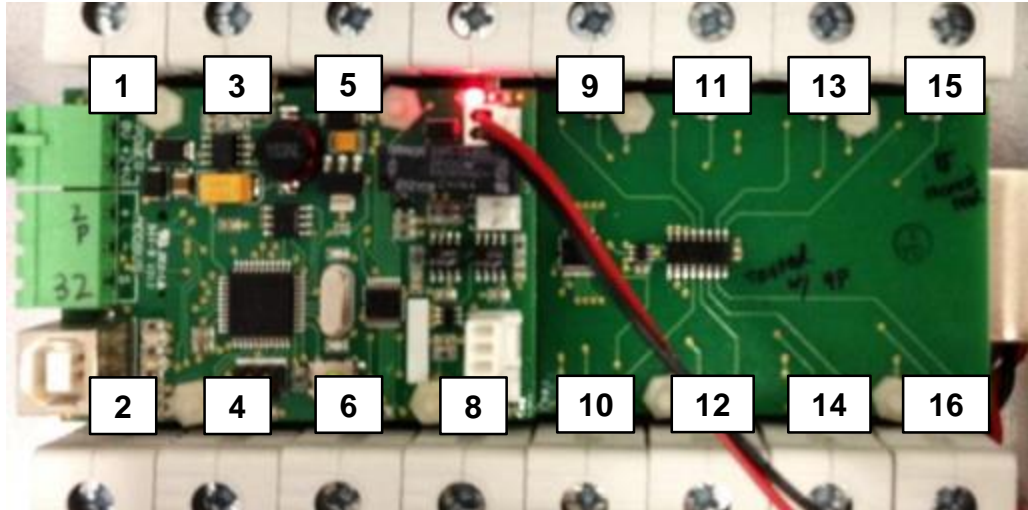


Figure 9. Channel Light Map.

8.2. Sensor Board Functions Menu

The sensor board functions menu has six available functions accessible by the TARE/RESET. In general, to navigate the menu functions:

1. Press and hold the TARE/RESET button until the LEDs flash, then release the button. The board is now in menu selection mode.
2. Subsequent actuations of the button will scroll through the available menus, as indicated in the following table.
3. To enter a desired menu, press and hold the button until the LEDs flash, then release the button.
4. Subsequent actuations of the button will scroll through any available sub-menu options, which are explained in the following sections.
5. To abort from any menu option, power cycle the 24VDC power to the board to reset the microcontroller. The board reboot is completed when the green LED starts blinking.

CHANNEL LIGHT	SENSOR BOARD MENU OPTION	MENU DESCRIPTION or SUB-MENU OPTIONs
1	ZERO-TARE	Zero current calibration
2	SET MODBUS ADDRESS	Address range: 00-99
3	OPERATING CALIBRATION	Enter TOTAL 3-digit current Ex: 85A = "085"
4	SET REPORTING INTERVAL	1. Instantaneous 2. 1-minute average 3. 15-minute average
7	AFCI SELF-TEST	Simulates an arc fault
8	EXIT MENU	Exits the menu

8.3. Field Calibration

After hardware installation (combiner box completely installed and wired with the PV system fully operational), it is necessary to calibrate the current sensors.

Two calibrations must be performed: one with zero current in the combiner (disconnect is in the OFF position and all fuseholders are OPEN) and one with all circuits running above 4A each. The TARE/RESET button is used to interact with the controller on the sensor module and perform these calibrations. The button location and size may vary between models.

NOTE: It is recommended to do the ZERO-TARE calibration 1-2 times, followed by OPERATING CALIBRATION, also one or two times.

8.4. Zero Current Calibration



1. Ensure zero current is flowing through the busbar. Turn off the contactor by using the override switch and then opening the fuse holders on each circuit.
2. Press and hold the TARE/RESET button for 3 seconds until all circuit lights flash on and then off. Release the TARE/RESET button and the light on circuit 1 will stay lit. This indicates you are now in the “menu” mode of the sensor module. Option 1 is indicated by the light below circuit 1 staying lighted, and is used to trigger the Zero Current Calibration (see Figure 10).
3. With the circuit 1 light still lit, press and hold the TARE/RESET button for 3 seconds (until circuit 1 light flashes), then release. The sensor board will cycle through all circuits setting the zero point on each. No additional user action is required.
4. When finished, the board will automatically enter RUN mode.


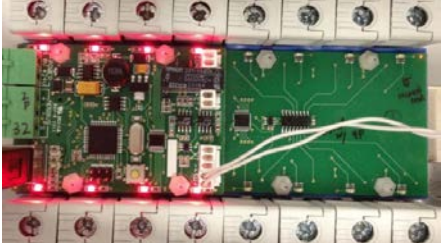
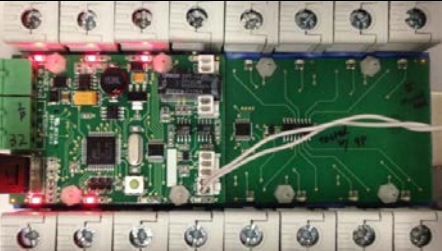


Figure 10. Channel 1 Light ON.

8.5. Operating Calibration

The Operating Calibration procedure involves “entering” multiple levels of menu options. If during this process a mistake is made, the process can be aborted by power cycling the 24VDC power to the board. This will reset the microcontroller.

STEP	INSTRUCTIONS	NOTES
1	Ensure that the PV system is ON, and PVDC current is flowing through all strings.	Close all fuseholders. Turn ON main switch. Verify contactor is ON. Verify load (i.e., inverter) is pulling PVDC current through the busbar.
2	Use a current clamp to verify each active string is at a similar current and greater than 4A.	The current in each string should remain constant throughout the calibration procedure, therefore calibration is recommended during a clear day.
3	Measure and add up the total string currents.	Example: For an installation of 10 strings, with each measuring 8.5A, the total current is 85A.
4	Press and hold the TARE/RESET button for 3 seconds until all channel lights flash ON and then OFF momentarily.	
5	Release button. Channel 1 LED will light up to indicate that the board has entered the “menu” mode.	
6	Subsequent actuations of the button will “scroll” through LEDs 1-8, one at a time. Momentarily push the button until the channel 3 LED is lit.	NOTE: Only LEDs 1, 2, 3, 4, 7, and 8 have a menu option associated with them.
7	When LED 3 is selected, press and hold the button until the LED flashes.	
8	Release button Channel 10 LED will light up to indicate that the board has entered OPERATION CALIBRATION mode.	
8a	Subsequent actuations of the button will again scroll through all LEDs.	However, this time after each button press, the previous LED will stay ON (except for channel 10 LED). Each additional press of the button will light up one more LED.
8b	In OPERATION CALIBRATION, the board is ready to accept a 3-digit number. This number represents the total current value measured previously in Step 3. Use a leading 0 for current values < 100A. For the example, 85A will be entered as “085.”	NOTE: “0” is indicated by LED 10 only. “1” is indicated by LEDs 1. “2” is indicated by LEDs 1 & 2. “3” is indicated by LEDs 1, 2, & 3 etc.

STEP	INSTRUCTIONS	NOTES
9	<p>Momentarily press the button until the desired first digit is “displayed”.</p> <p>The digit “0” is shown.</p>	
10	<p>Press and hold the button until the LEDs flash.</p>	
11	<p>Release the button.</p>	<p>The desired first digit will be stored. Channel 10 LED will light up again. This indicates that the board is ready for the second digit.</p>
12	<p>Momentarily press the button until the desired second digit is “displayed”.</p> <p>The digit “8” is shown.</p>	
13	<p>Press and hold the button until the LEDs flash.</p>	
14	<p>Release the button.</p>	<p>The desired second digit will be stored. Channel 10 LED will light up again. This indicates that the board is ready for the third digit.</p>
15	<p>Momentarily press the button until the desired third digit is “displayed”.</p> <p>The digit “5” is shown.</p>	
16	<p>Press and hold the button until the LEDs flash.</p>	
17	<p>Release the button.</p>	<p>The desired third digit will be stored.</p>
18	<p>No further user action is required.</p>	<p>The board will cycle through each channel one at a time.</p>

When the user-action portion of the OPERATION CALIBRATION procedure is completed, the sensor module will automatically:

1. Read back the stored values by flashing each digit one time.
 - a. The user should verify that the correct current values were entered.
 - b. In the example for 85A, the board will flash “0,” then “8,” and finally “5.”
2. Next, the board will calibrate each channel one by one.
3. Then it will light up all active channels simultaneously.
 - a. The user should verify that all active and inactive channels are correctly identified (Figure 11).
4. When finished, the board will enter RUN mode, indicated by the flashing green LED near the USB connector.



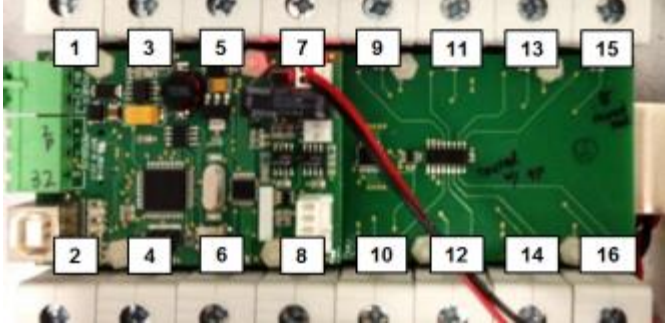
Figure 11. Sensor module indicating 13 of 16 circuits as active.

Note: Calibration steps MUST be performed in order to ensure accurate readings of string currents. It is recommended that the current be steady during the calibration procedure (i.e. no clouds or overcast sky).



8.6. Setting Modbus Address


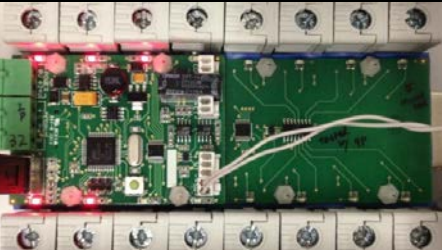
To set the modbus address, enter the menu by pressing and holding the TARE/RESET button for 3 seconds to enter menu selection mode. Refer to the Channel Light Map.

Channel Light Map

<p>For the SET MODBUS ADDRESS menu option, the LED</p> <p>NOTE: "0" is indicated by LED 10. "1" is indicated by LED 1. "2" is indicated by LEDs 1 and 2, etc.</p>	
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Note: setting the modbus address without computer connectivity allows for address 0-99 only. The board must be connected to a computer to receive 3 digit modbus addresses (see TBD).

STEP	INSTRUCTIONS	NOTES
1	Ensure that the PV system is ON.	
2	Press and hold the TARE/RESET button for 3 seconds until all channel lights flash ON and then OFF momentarily.	
3	Release button. Channel 1 LED will light up to indicate that the board has entered the "menu" mode.	
4	Subsequent actuations of the button will "scroll" through LEDs 1-10, one at a time. Momentarily push the button until the channel 2 LED is lit.	NOTE: Only LEDs 1, 2, 3, 4, 7, and 8 have a menu option associated with them.
5	When LED 2 is selected, press and hold the button until it flashes.	
6	Release button. Channel 10 LED will light up to indicate that the board has entered SET MODBUS ADDRESS mode.	
6a	Subsequent actuations of the button will again scroll through all LEDs.	However, this time after each button press, the previous LED will stay ON (except for channel 10 LED). Each additional press of the button will light

STEP	INSTRUCTIONS	NOTES
		up one more LED.
6b	<p>Once in SET MODBUS ADDRESS mode, the board is ready to accept a 2-digit number. This number represents the Modbus address.</p> <p>Use a leading "0" for addresses 00-09. For this example, address 5 will be entered "05."</p>	<p>NOTE:</p> <p>"0" is indicated by LED 10 only.</p> <p>"1" is indicated by LEDs 1.</p> <p>"2" is indicated by LEDs 1 & 2.</p> <p>"3" is indicated by LEDs 1, 2, & 3 etc.</p>
7	<p>Momentarily press the button until the desired first digit is "displayed".</p> <p>The digit "0" is shown.</p>	
10	Press and hold the button until the LED flashes.	
11	Release the button.	The desired first digit will be stored. Channel 10 LED will light up. This indicates that the board is ready for the second digit.
12	<p>Momentarily press the button until the desired second digit is "displayed".</p> <p>The digit "5" is shown.</p>	
13	Press and hold the button until the LEDs flash.	
14	Release the button. This will store the second digit.	This completes the SET MODBUS ADDRESS procedure.


When the SET MODBUS ADDRESS procedure is completed, the board automatically enters RUN mode.

8.7. Setting the report type

The sensor board can report string level data in one of three intervals:

1. Instantaneous
2. 1-minute average
3. 15-minute average

The sensor Board does not push data. Rather it populates registers available to a gateway device. SolarBOS offers a gateway device separately or it may be provided by the monitoring provider. SolarBOS sensor boards default to 1 minute average reporting however some systems only collect data every 15 minutes and setting the report for 15 minute average may be advantageous, however, not required.

STEP	INSTRUCTIONS	NOTES
1	Ensure that the PV system is ON.	
2	Press and hold the TARE/RESET button for 3 seconds until all channel lights flash ON and then OFF momentarily.	
3	Release button. Channel 1 LED will light up to indicate that the board has entered the "menu" mode.	
4	Subsequent actuations of the button will "scroll" through LEDs 1-10, one at a time. Momentarily push the button until the channel 4 LED is lit.	NOTE: Only LEDs 1, 2, 3, 4, 7, and 8 have a menu option associated with them.
5	When LED 4 is selected, press and hold the button until it flashes.	
6	Release button. The board will enter the SET REPORT TYPE mode.	
6a	Subsequent actuations of the button will scroll through LED1, LED1-2, and LED1-3 only.	NOTE: LED1 = Instantaneous LED1-2 = 1-minute average LED1-3 = 15-minute average
7	Momentarily press the button until the desired report type is selected.	
8	Press and hold the button until the LEDs flash.	
9	Release the button. This sets the desired REPORT TYPE.	This completes the SET REPORT TYPE procedure.

When the SET REPORT TYPE procedure is completed, the board automatically enters RUN mode.

8.8. Arc Fault Self-Test

In order to verify the board is able to detect an arc, an arc fault self-test should be performed. To perform a self-test:

1. Enter menu mode by holding the TARE/RESET button for 3 seconds
2. Select channel 7 in the menu mode, then hold the TARE/RESET button for 3 seconds. This will cause the board to simulate an arc, which then shuts off the contactor.
3. Reset the board and exit the self-test cycle by holding the TARE/RESET button for 3 seconds.

8.9. Exiting the Menu

To exit the menu, select the light below channel 8 (bottom 4th from left) and hold the menu button for 3 seconds.

8.10. Arc Fault Detection and Interruption

In order for Arc Fault Detection to work properly, the calibration steps in the preceding pages must be completed. Note: if an arc is detected and the contactor shut off, the board must be reset with the TARE/RESET button. Contactor condition information is retained by the board if power is lost and will keep the contactor turned off in the event of a power outage.

8.11. Resetting the Board after a fault

If an arc is detected, the sensor module will disable the contactor and will light the LED corresponding to the channel that triggered the fault. To reset the board, hold the TARE/RESET button for 3 seconds.

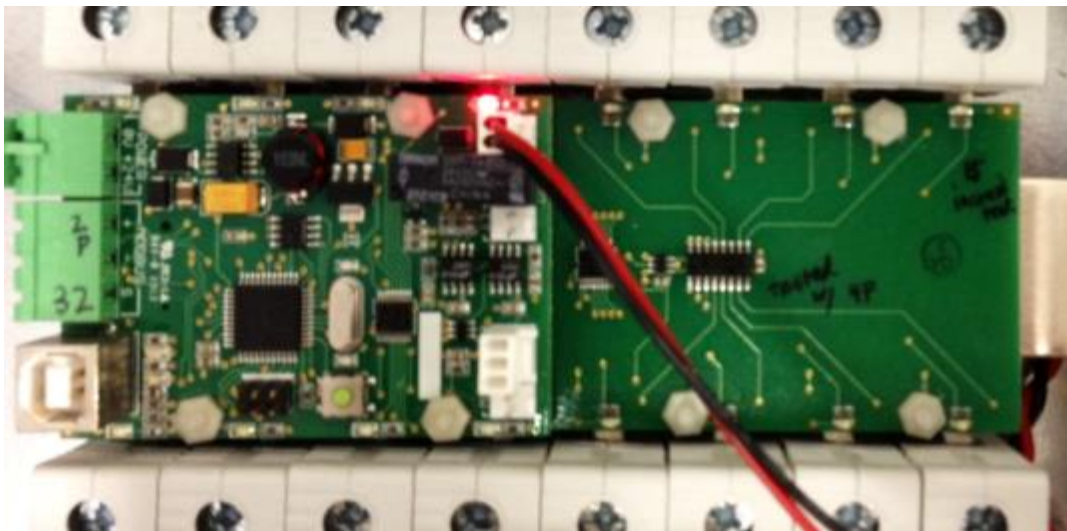


Figure 12. Channel 7 light lit indicating ground fault on channel 7

9. APPENDIX 1 - Sensor Board Operation Quick Guide

9.1. Accessing and navigating the menus

1. The menus are accessible while the board is in RUN mode (green LED flashing). The board automatically goes into RUN mode when it is powered up with 24VDC.
2. To enter the menu selection mode, **press and hold** the TARE/RESET button ~3 seconds, then release when the LED(s) flash.
3. To select a menu, **momentarily** press the button to “scroll” through the menus. Scroll until the desired menu indicator is illuminated.
4. To enter the selected menu, press and hold the button until the LED(s) flash.
 - a. For menus 2, 3, and 4, additional user input is required, skip to next step.
 - b. For menus 1, 7, and 8, the function is executed upon button release.
5. For menu 4, set reporting interval: LED1 = “instantaneous,” LEDs1-2 = “1-minute,” and LEDs1-3 = “15-minute.” Press and hold button when desired interval is indicated, then release when LEDs flash.
6. For all menus, the board automatically returns to the RUN mode when that menu function is completed. No further user action is required.

9.2. Menu indicators

1. Ch. 1 light = Zero tare (there is no PVDC current flowing through busbar)
2. Ch. 2 light = Set Modbus address (2-digit address, with leading zero if necessary)
3. Ch. 3 light = Operating calibration (enter TOTAL current, 3-digit value with leading zero)
4. Ch. 4 light = Set reporting (instantaneous, 1 min. avg., 15 min. avg.)
5. Ch. 7 light = AFCI self-test
6. Ch. 8 light = Exit menu

9.3. Entering Modbus address and Operation Calibration values

1. For Modbus address, enter address as **2-digit** number.
2. For Operation calibration, enter known current as **3-digit** number.
3. Use leading zeros for address <10 and known currents <100A.
4. To enter a digit, press and hold button until LEDs flash, then release button. Repeat until all digits are entered.
5. Enter digits one at a time:
 - a. Channel 1 = “1”
 - b. Channel 2 = “2”
 - c. Channel 10 = “0”

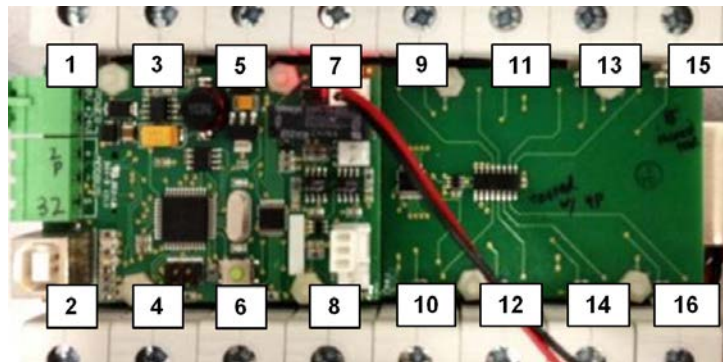



Figure 13. Channel Light Map.

10. APPENDIX 2 – Torque Values

BOX LUG OUTPUTS		SMALL CONDUCTORS		
CONDUCTOR SIZE	TORQUE	ITEM	TORQUE	
1/0 - 2/0	180 in-lbs	FUSEHOLDER/SURGE (TVSS)	22 in-lbs	
3/0 - 4/0	250 in-lbs	NEGATIVE/NEUTRAL INPUTS	25 in-lbs	
250 - 350	325 in-lbs	SMALL GROUND SCREW	25 in-lbs	
400 - 600	375 in-lbs	LARGE GROUND SCREW	50 in-lbs	
700 - 800	500 in-lbs	BOLTED CONNECTIONS & COMPRESSION LUGS		
900 - 1000	600 in-lbs			
		THREAD	SOCKET	TORQUE
		1/4"	7/16"	120 in-lbs
		M8	13mm	220 in-lbs
		M10*	17mm	275 in-lbs
		M10	17mm	550 in-lbs
		M12	19mm	600 in-lbs

*For Contactor Combiners

11. APPENDIX 3 – Using Dual Current Transducers

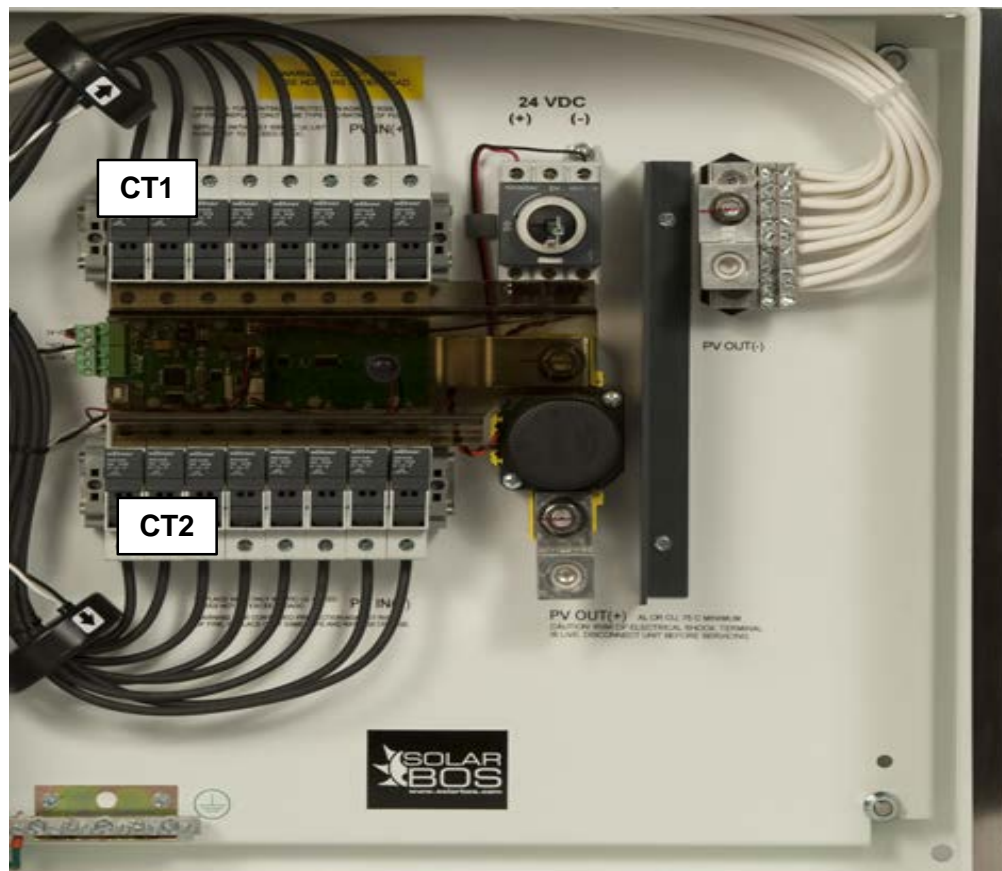
Legacy combiner boxes used a dual-CT configuration.

11.1. Even-count dual CT installation

The Current Transducers (CT) are installed in one of two ways: “even-count” and “odd-count”. The terms “even” and “odd” refer to the total number of string inputs entering a given combiner box. Figure 6 shows an even-count string input installation (16 total strings).

The CTs are installed around the string inputs as shown. The arrow on the CT indicates string current flow. Once the CTs are installed, plug the 2-pin connector to the sensor board header labeled “CT”.

NOTE: A string input conductor must pass through only one CT.

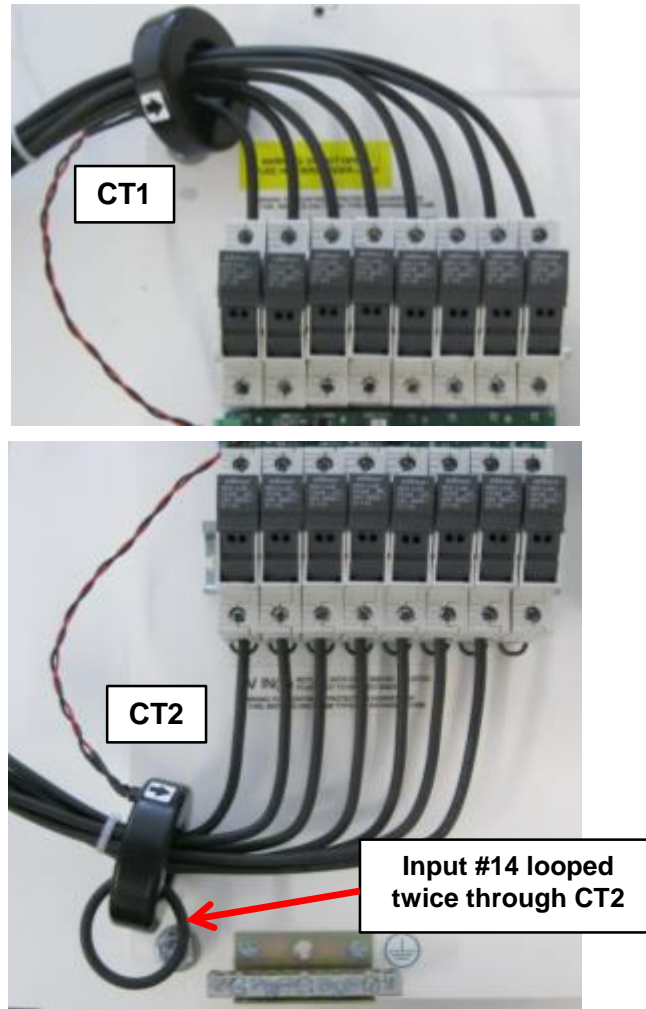


EVEN-COUNT DUAL-CT INSTALLATION

11.1. Odd-count dual CT installation

The current sensing algorithm of the sensor board expects an evenly divided input. In other words, an equal number of strings must pass through both CTs for correct operation. In order to achieve this, one of the strings on the odd-numbered side needs to be looped twice through its respective CT.

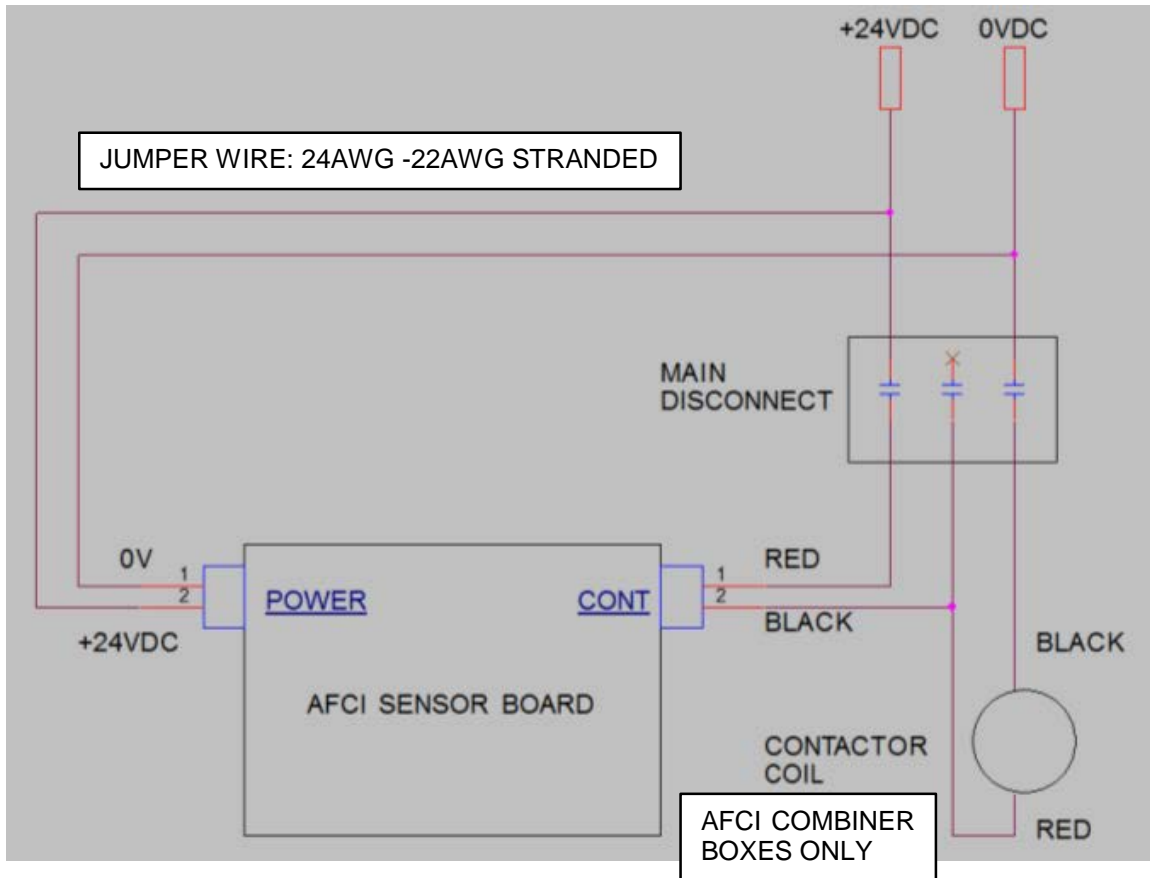
Figure 7 shows the top and bottom halves of a 15-string odd-count CT installation. CT1 monitors 8 input strings, whereas CT2 only monitors 7 strings. A single string input is looped twice through CT2, thereby simulating an 8th string. This results in a “balanced” input for the sensor board to monitor.



ODD-COUNT DUAL CT INSTALLATION

12. APPENDIX 4 – 24VDC Input Wiring

Legacy combiner boxes required the user-applied 24VDC to be directly connected to the line-side of the main disconnect. A jumper was also required from the line-side of the main switch to power the sensor board, as shown in the following wiring diagram:



NOTE: The load-side of the switch center pole was used only as a convenient terminal block for the contactor control wires (AFCI only). No other connections are required on the line-side of the switch center pole

NOTE: For AFCI applications, power to the contactor is controlled by a set of dry contacts on the sensor board. The dry contacts are accessible at the 2-pin connector labeled "CONT." The sensor board does not source power to the contactor.