Smart Combiners Installation Guide
For Obvius A89DC-08 sensor modules

Introduction

Large roof and ground arrays connect the panels into stings that are merged together in combiner boxes. Each string will typically consist of 10-15 panels wired in series with 8-16 stings wired in each separate combiner box. The home run output from each combiner box near the arrays is heavy gage wire carrying the DC current to the inverter. This arrangement is done to minimize wiring costs. With only total system output to the AC grid energy monitoring, it is difficult to detect a string with no output due to a blown fuse, broken wire or open connection. A faulty panel will significantly reduce total string power. During commissioning correct operation of every string must be manually measured and verified. Left undetected, the lost energy from a single string over the life of the system leads to significant revenue loss. Consequently, IPP owners will often pay for an expensive annual maintenance check of every string in the system.   SolarVu can monitor each string and provide an alarm if a fault is detected. Documentation identifying the location of each panel, string, combiner needed to quickly locate and repair a damaged panel or connection can be accessed online. This feature reduces operating costs and maximizes revenue through early warning of faults with troubleshooting aids for quick repair. It is ordered as an option for a SolarVu energy portal and configured to match the specific model of smart combiners from the manufacturer selected by the customer.

Installation

Install and wire the smart combiners equipped with an Obvius CG08 sensor module according to the manufacturer's instructions. Each combiner will need an RS485 serial connection and DC control power for the current measurement function as shown in figure 1. These are daisy chained together and connected to the SolarVu enclosure. Physical connections will vary by manufacturer. Typical layout for combiners that use the Obvius current sensor is shown in fig 2.

RS485 Serial: Connect Cat5e outdoor grade CMX cable from the SolarVu enclosure to the smart combiners in a daisy chain sequence matching wire colors for D+, D- and COM terminals as shown in Fig 2. Pay attention to the wire polarity of the D+ and D- RS485 connections to ensure successful communication. Each smart combiner module must have a unique slave address which is factory set at time of shipment for each combiner. These should match the SolarVu K135 gateway configuration with no further setup required.

Power Supply: DC control power for each combiner can be provided from the SolarVu enclosure if ordered. This can be run in the same cat5e cable as the communication wire for short distances if the voltage drop from the #24 AWG pair is not excessive. Otherwise, use a separate #18AWG pair to supply power.

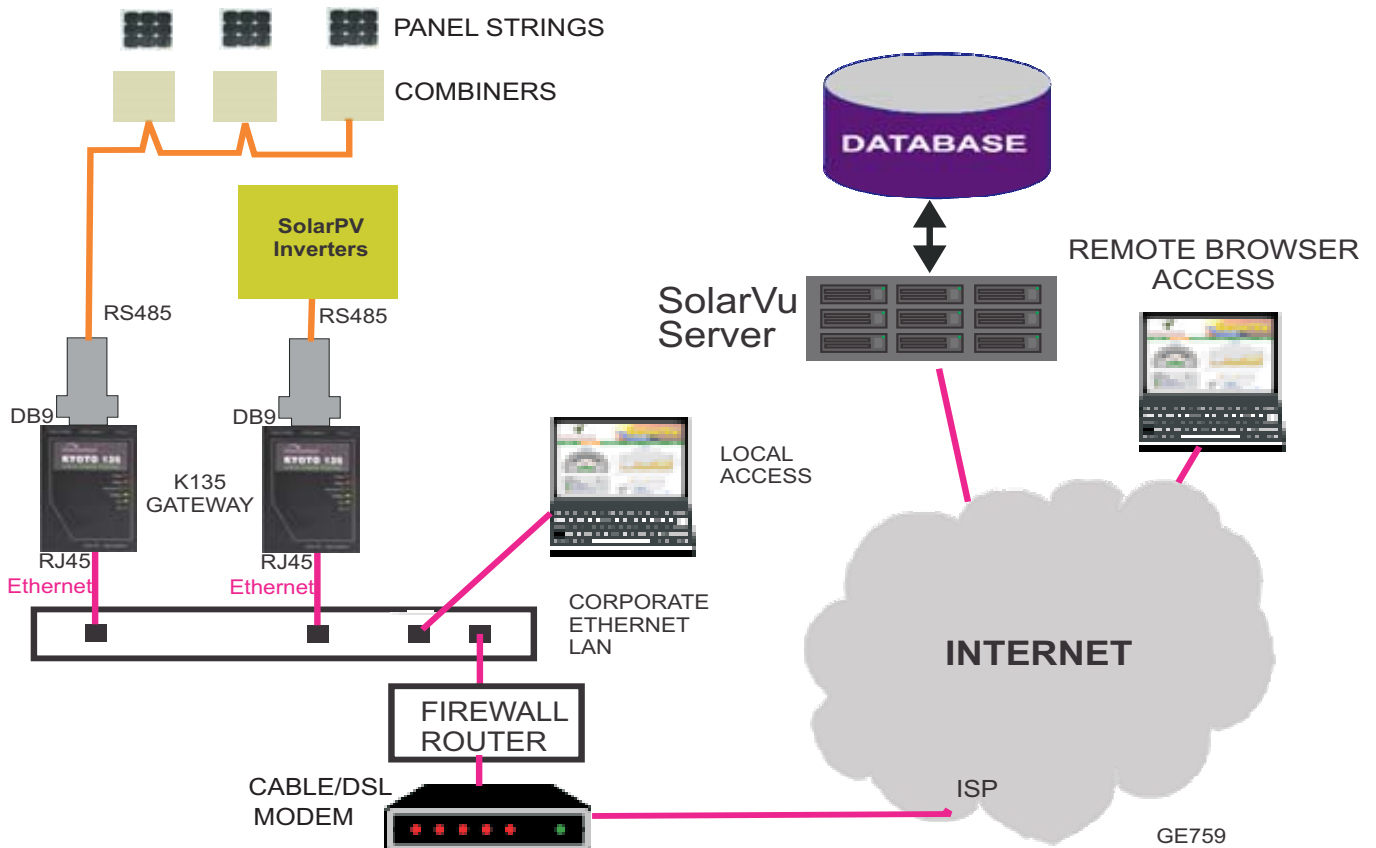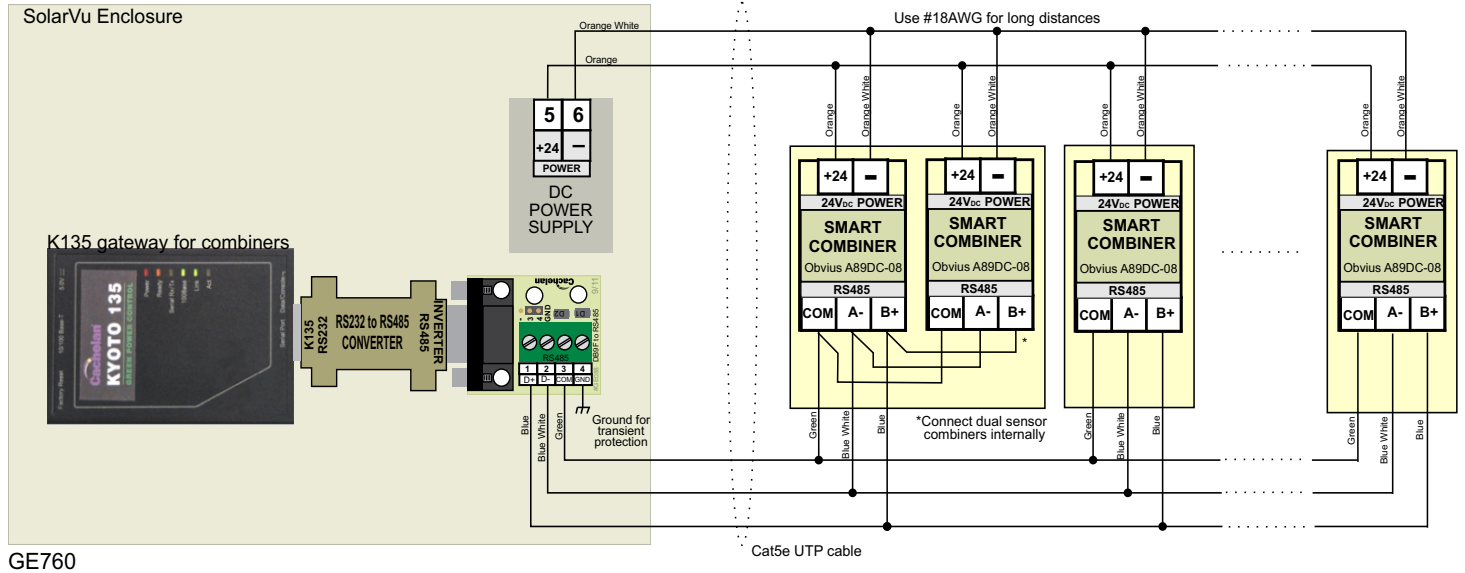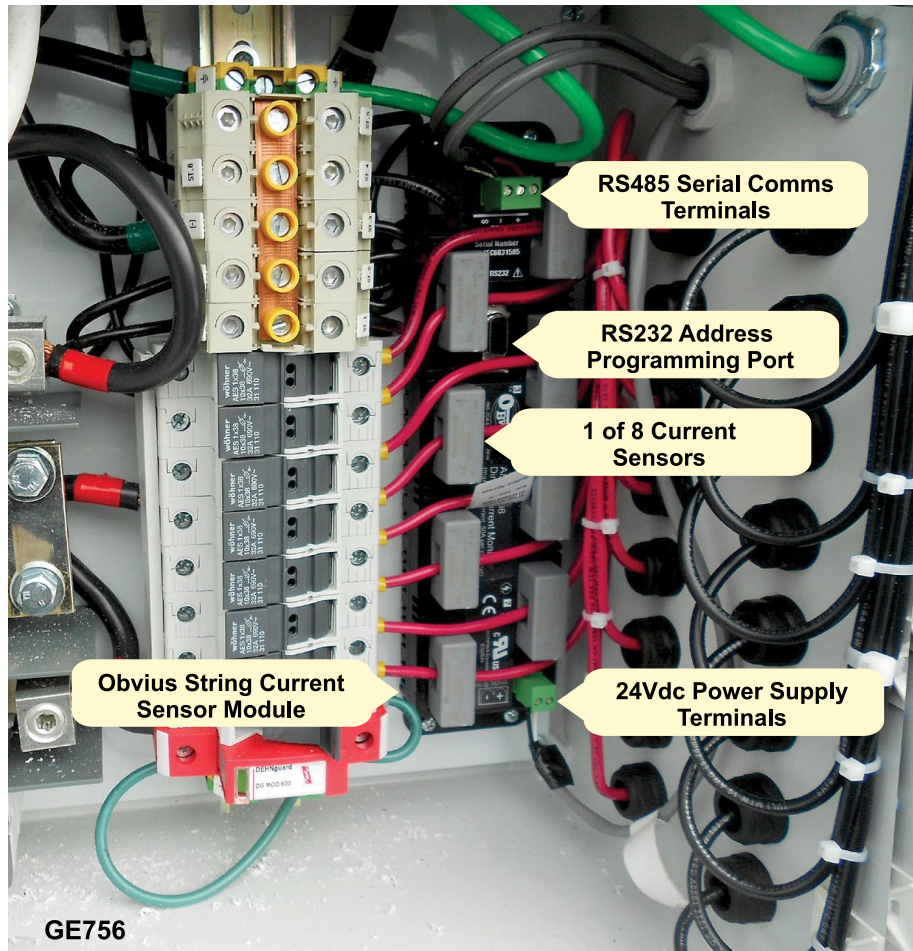*Fig 1 System connection for smart combiners*

Smart Combiners Installation Guide

Fig 2 Smart combiner using Obvius current sensor module

GE760

RS485 Serial Comms Terminals

RS232 Address Programming Port

1 of 8 Current Sensors

Obvius String Current Sensor Module

24Vdc Power Supply Terminals

GE756

Once communication and control power to the combiners is connected access the SolarVu energy portal online. Access the smart combiner screens by clicking ANALYZER --> Strings for graphical view and ANALYZER --> combiners for tabular data. Interpretation of each screen and alarm setup is described in the next few sections. If any combiners appear not to be communicating check the power indicator on the sensor module, communication connections and slave address settings. If assistance is needed contact Cachelan Technical Support.

ANALYZER

COMBINERS When a system is equipped with the smart combiners option, digital and graphical string current screens are available in the Analyzer pulldown menu. Use this feature to quickly identify under performing panels which are difficult to detect with only total system energy metering but if left unnoticed, could cost thousands of dollars in lost revenue over the system lifetime.

1   **COMBINERS**   Use the Analyzer pulldown box and select Combiners to see digital string current, power and alarm status. For a graphical view select Strings in this box or go direct using the Strings button ❶❸.

2   **COMBINER ID:** Combiner name and serial address ID as defined in SETUP are shown for identification. The physical combiner boxes can be labelled with these names for easy matching to this online view.

3   **DC CURRENT:** Actual DC string current measured in the combiner box. Total current of all strings feeding the combiner home run output to the inverter, also known as the zone current is shown in ❻

4   **% RELATIVE** Normally under any combination of irradiance and temperature, all strings with the same number of panels and orientation will have the same current. To identify problem strings, the highest output string is assigned a % REL value of 100% and the other strings are shown as the variation % from the maximum string in the combiner box. An alarm threshold ❽ is entered in SETUP to warn when one string is too low ❼.

5   **DC VOLTS & DC POWER** Combiner bus DC voltage and string power (amps * volts). Total DC output power for the combiner box is shown at the bottom of the column ❻

6   **TOTAL CURRENT & POWER** Total current from all strings and power (common DC bus voltage * total current). Average current and average string power are also shown.

7   **ALARM WARNING** If current in any string falls below the alarm trigger setting and the minimum threshold is exceeded ❽ the string row will be highlighted in red for easy identification of a potential problem. This will also trigger an alarm email to be sent.

8   **ALARM SETTINGS** After observing the normal variation of string currents for a new system, the alarm trigger should be set to be outside this range to send a warning without causing nuisance alarms. A string current of less than 90% of the maximum string is a good starting point. To prevent spurious alarms at the beginning / end of the day or under low light conditions when large variations are expected, the maximum string current must exceed the alarm threshold setting or alarms are blocked. Typically this will be set to 50% or more of expected peak capacity. Click the EDIT button to adjust these values in SETUP if necessary.

9   **SENSORS** Available values measured by the combiner box such as internal temperature are shown in this panel. Parameters may vary with combiner boxes from different vendors.

10   **STATUS** If any alarms are detected for the combiner box, the number of alarms will be shown in red. Otherwise Combiner OK in blue indicates everything is normal. Scroll down to check the status of each combiner box separately.

11 **LAST UPDATE INDICATORS**
Last Communication - Shows the last time a data message was received from the combiner boxes gateway. If the gateway has successfully established an internet connection this indicator will be green even if there is no connection to the combiners. If flashing red, check ethernet connection, IP settings and ensure the gateway is powered on. A single gateway is typically shared by all combiner boxes. Click the LISTEN button to determine cause.

Last Data Update - Once the gateway is successfully communicating to the combiner and sending data, this indicator will show if the data is valid. For normal operation, both indicators are green. If this indicator is red, check the connection between the combiner box and the gateway, that the combiner box is powered on and that the correct serial ID has been entered into each combiner box. A separate status indicator is provided for each combiner box for quickly identifying connection issues to any device. See SolarVu installation instructions for further details.
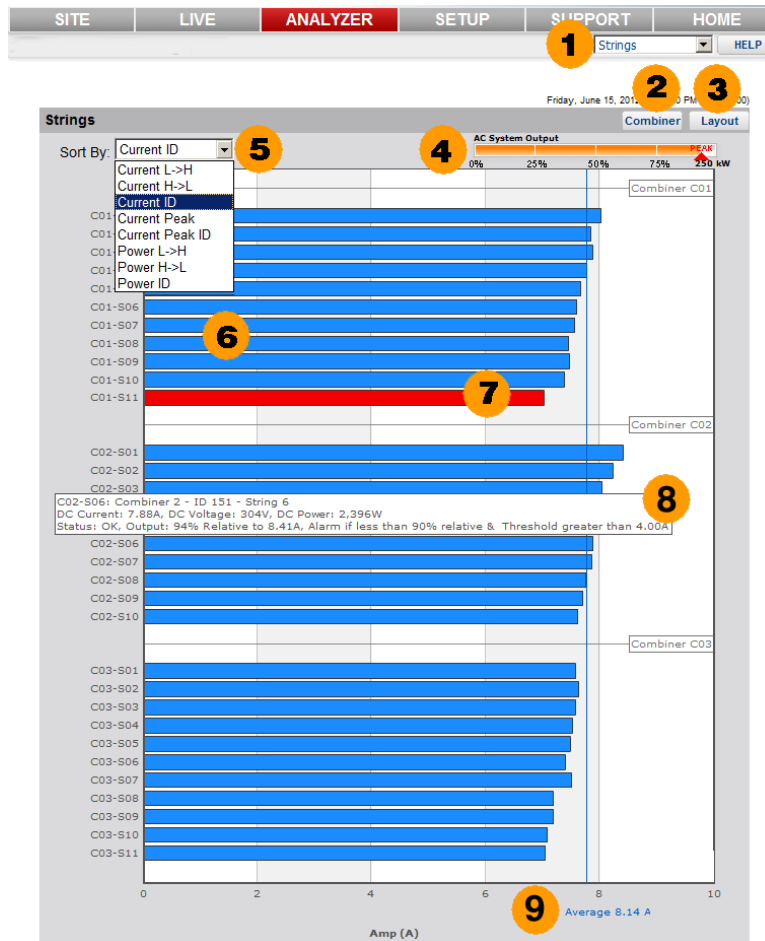
COMBINER/STRING LAYOUT

Combiner # - Serial #	1 - 11606		2 - 11607		3 - 11608		4 - 11609		5 - 11610		6 - 11611	
Modbus Address	109	111	13	17	15	18	19	20	14	16	108	110
Strings	1.1	1.9	2.1	2.9	3.1	3.9	4.1	4.9	5.1	5.9	6.1	6.9
	1.2	1.10	2.2	2.10	3.2	3.10	4.2	4.10	5.2	5.10	6.2	6.10
	1.3	1.11	2.3	2.11	3.3	3.11	4.3	4.11	5.3	5.11	6.3	6.11
	1.4	1.12	2.4	2.12	3.4	3.12	4.4	4.12	5.4	5.12	6.4	6.12
	1.5		2.5		3.5	3.13	4.5		5.5		6.5	6.13
	1.6		2.6		3.6		4.6		5.6		6.6	
	1.7		2.7		3.7		4.7		5.7		6.7	
	1.8		2.8		3.8		4.8		5.8		6.8	

ROOF SOLAR PANELS LAYOUT
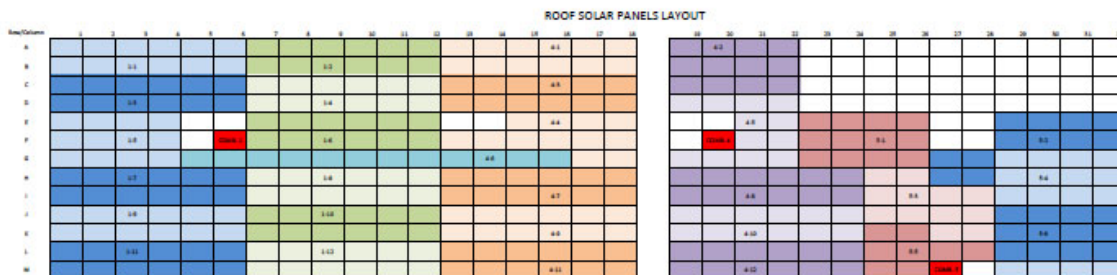
12 **LAYOUT DOCUMENTATION** To expedite commissioning for faster payment and to assist in identifying a bad panel when a string alarm is received, it is helpful to have design documents handy showing combiner ID / string # and the physical location of the associated panels. This documentation, typically a PDF file created from original design drawings, can be uploaded in SETUP to be available anytime for download by clicking the Layout button. Multiple pages can include other useful references like warranties, contacts etc.

13 **STRINGS** Click the Strings button for a graphical view of string currents. These can be sorted by combiner, the entire roof, actual current, peak current and power. Alarms are displayed in red for a quick visual analysis of the entire system.

ANALYZER

COMBINERS When a system is equipped with the smart combiners option, digital and graphical string current screens are available in the Analyzer pulldown menu. Use this feature to quickly identify under performing panels which are difficult to detect with only total system energy metering but if left unnoticed, could cost thousands of dollars in lost revenue over the system lifetime. The strings screen is graphical for comparing relative panel output while the Combiners screen ❶ is in text format for detailed analysis.

1 **ANALYZER - STRINGS:** Select Strings in the ANALYZER tab selection menu, for a graphical view of string currents and power.

2 **COMBINERS:** Alternate between graphical and text screens to view the information in different formats. Select Combiners in the Analyzer pulldown box or go directly from this screen using the Combiners ❷ button to see digital string current, power and alarm status.

3 **LAYOUT:** In SETUP upload a diagram of the panel locations by string and combiner on the roof for easy identification. Click the Layout button to view or print the saved drawing when doing commissioning or troubleshooting. The physical combiner boxes can be labelled at the site for easy matching to the online view.

4 **AC SYSTEM OUTPUT:** Total AC system output similar to the LIVE screen is shown. When system output is very low, the individual strings may vary significantly but when running near capacity, the individual strings will normally closely match unless there is a problem.

5 **SORT BY** Compare strings in different ways for a better understanding of performance. Strings are sorted relative to the largest string in the group to provide a meaningful comparison under any combination of irradiance and temperature.
Current L-->H: All strings in the system are sorted from lowest to highest. Alarms will normally show up as a low relative value and hence appear at the top of the screen.
Current H-->L: Similar to CURRENT L-->H except the order is reversed sorting from high to low with the largest current at the top.
Current ID: Panels of different ratings or in different areas of the roof may be connected to separate combiner boxes for better matching. This view compares relative string values within each separate combiner box. Although the string current values may be quite different between combiner boxes, within the same combiner box they should be similar.

Current Peak: To analyze trends over time, the peak value since reset for all strings is continuously recorded and displayed. This selection sorts peak current values by all strings on the roof from highest to lowest. Reset the peak value in SETUP-->Equipment-->Combiners-->System to start a new measurement period. Hold the mouse over the peak area of the string bar for a popup showing the peak value and date when it last occurred.

Current Peak ID: Similar to current peak, but this screen sorts peaks by individual combiner boxes for easier comparison due to panel matching or different areas of the roof.

Power L-->H: If bus voltage is available from the combiner box home run output to the inverter then power can be displayed instead of current. When sorted from low to high for the entire roof, the strings with alarm conditions will usually appear at the top of the screen if enabled in SETUP.

Power H-->L: Similar to Power L-->H except sorted from highest to lowest with the highest output string appearing at the top. Scroll over with the mouse for details.

Power ID: When panels are arranged in strings with different ratings or on parts of the roof with different slopes then comparing string power by combiner box ID is a better than arranging them into a single group.

6   **STRING:** String name is entered in SETUP with the format C01-S02 where C01 is the prefix for combiner box 01 and the name, shown here as S02, can be entered by the user for easier identication. Blue indicates current, orange indicates power and red indicates an alarm condition for quickly identifying which strings need attention. By physically labelling the combiner boxes and strings at the site, this online identication will assist in quickly locating the panel or combiner that needs to be checked.

7   **ALARM:** Separate alarm trigger levels and holdoff thresholds can be set for each combiner box in SETUP --> Equipment -->Combiners. Alarms are set relative to the mazimum string for valid comparisons under any combination of sunlight and temperature. Quickly scan for red alarm bars and scroll over the bar with the mouse for more detials. Change the alarm trigger level in SETUP if normal variations are generating false alarms.

8   **DETAILS POPUP:** Hold the mouse pointer over any string for details of current measured values, alarm settings and status. This is useful for analyzing individual strings. Click the Combiner button ❷ for a text screen of similar information.

9   **SCALE:** Scroll to the bottom of the screen to view the horizontal axis units if there are too many strings for the graph to completely fit on one screen. For easy readout, alternating gray and white vertical bands are used. A vertical colored line shows the average value for all strings.
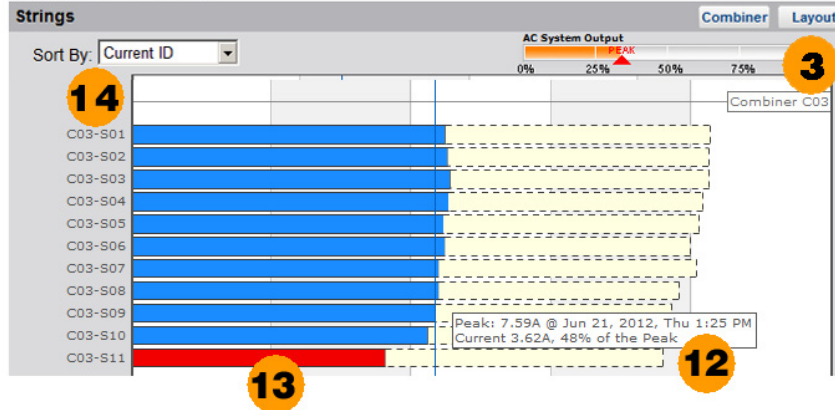
SETUP

Equipment - Combiners When a system is equipped with the smart combiners option, digital and graphical string current screens are available in the Analyzer pull down menu. Use this feature to quickly identify under performing panels which are difficult to detect with only total system energy metering but if left unnoticed, could cost thousands of dollars in lost revenue over the system lifetime. Enter parameters to display on the screens here including combiner and string names. Upload a file showing string layouts for easy retrieval to locate bad strings and combiners. Set alarms to warn of under performing strings for early detection. Reset the peak current recorder to start a new measurement period.

1   **SETUP - Equipment - Combiners:** Access the setup panels for all combiners by selecting this tab sequence. At the top are settings for the site. Scroll down to access each separate combiner box.

2   **BUTTON CAPTION:** A button with the default name Layout is provided on the string and combiner screens for downloading a layout drawing that has been previously uploaded ❸ If desired, change the name to something else here.

3   **UPLOADED FILE / ALBUM:** Combine string layout drawings into a single PDF file and upload them for access from the String and Combiner screens for troubleshooting ❸. Multiple files such as wiring diagrams can instead be grouped together into an album using WebFilm (SETUP -->Site-->Site Appearance-->WebFilm). Download the stored file or album using the Layout button.

4) **PEAK RECORDER:** SolarVu saves the peak current on each string and the date when the peak log was started. Click Reset to start a new Peak recording period. The old peak values will be erased. This is useful for observing maximum output during different seasons or to observe if the system is no longer producing the same output as previously. SolarVu also records the lifetime maximum current which displays when scrolling over the peak bar in the Strings screens. ❶❷ Compare lifetime maximum to current peak to determine degradation over the life of the system due to aging. Lifetime maximum can only be factory reset.

5) **SAVE:** Periodically click the Save button to store entered values in the SolarVu server.

6) **COMBINER ID:** Each combiner has a default name of C01, C02... and a string default name S01, S02... For example C03-S12 is combiner #3 string #12. This name is shown on the string and combiner screens. ❶❹ The type and slave address of each combiner is factory programmed and shown here for reference but cannot be changed.

7) **COMBINER NAME:** For easier identification, each combiner box can be assigned a user name. Label the physical combiner box with the name entered here that shows on SolarVu screens ❶❺ to assist the maintenance electrician is identifying each combiner box and strings inside when locating bad panels.

8) **SHOW STRINGS:** Not all strings in a combiner box may be used.   To prevent nuisance alarms for unused strings and a misleading graphical display in the strings screen, uncheck any strings that are not connected.

9) **STRING NAME:** String ID is in the format C01-S02 where C01 is the prefix for combiner box 01 and S02 is string position 2 within the combiner box. A user string name can be assigned to each string for matching to the assignments in the site layout drawing for easier identification. This name will appear in the Combiner and String Analyzer screens. ❶❺

10) **ALARMS:** With hundreds of panels operating over many years under varying weather conditions, a visual using the graphical strings screen with alarms highlighted will quickly identify strings needing attention. This also reduces the need for expensive annual maintenance checks of the entire system. If automatic alarms are desired, adjust the settings here after commissioning. Each combiner box has individual settings to allow for differences such as number of panels per string, location and panels installed with different ratings. Some experimentation with settings may be required to eliminate false alarms while still detecting real faults. Simulate a fault by temporarily covering one or more panels and check that the settings pick up the reduced output or removing a string fuse to verify an alarm is received. Strings with an alarm condition are highlighted in red on the Strings screen ❶❸ and pink ❶❸ on the Combiners screen.

    Alarm Trigger: Since the output current will vary from 0-100% of rated capacity under different irradiance and temperature conditions, all strings within the combiner are compared as a percentage of the maximum string output. Assuming identical panels, equal panel count per string and similar orientation then theoretically all strings would be the same or 100% Rel (relative) to the maximum. In practice, due to manufacturing tolerances, aging and other factors expect a normal variation of 10-15% under varying conditions. Set the Alarm Trigger to be less than this value to prevent nuisance alarms but high enough to detect a significant deviation such as a faulty panel or blown fuse. To disable alarms completely, set the alarm trigger to 0% Rel on each combiner box. On a large system, if one combiner is not responding and requires maintenance or is waiting to be commissioned, temporarily uncheck the Show box ❶⓿ so it will not continuously report alarms.

    Alarm Threshold: At the beginning and end of the day or during overcast conditions when the system is operating at very low output, the strings will show large variations relative to each other. To prevent nuisance alarms under these conditions, the alarm threshold is used to block alarms until the system is operating a normal levels. Enter a typical value of 50% of system capacity eg 4 amps for strings with 8 amps maximum output.

11) **Actual Output:** To assist in selecting suitable alarm settings for each separate combiner box, the actual values under current conditions are displayed. If the system is operating normally with no faults, then set the Alarm Trigger outside this value. For example if the range is 90%-100% a setting of 85% might be low enough to prevent nuisance alarms but still detect if a panel has failed or is shaded by debris, dust or snow.

ANALYZER --> Strings

Strings				Combiner	Layout

Sort By: Current ID

AC System Output
0%   25%   50%   75%

(3)

(14)

Combiner C03

C03-S01
C03-S02
C03-S03
C03-S04
C03-S05
C03-S06
C03-S07
C03-S08
C03-S09
C03-S10
C03-S11

Peak: 7.59A @ Jun 21, 2012, Thu 1:25 PM
Current 3.62A, 48% of the Peak

(12)

(13)

ANALYZER --> Combiners

C01: Combiner 1 - ID 151   Strings   Layout

ID	String Name	DC Current	DC Voltage	DC Power	Rel
C01-S01	String 1	4.29 A	355 V	1,523 W	100 %
C01-S02	String 2	4.14 A	355 V	1,470 W	97 %
C01-S03	String 3	4.05 A	355 V	1,438 W	94 %
C01-S04	String 4	4.09 A	355 V	1,452 W	95 %
C01-S05	String 5	4.03 A	355 V	1,431 W	94 %
C01-S06	String 6	4.00 A	355 V	1,420 W	93 %
C01-S07	String 7	3.98 A	355 V	1,413 W	93 %
C01-S08	String 8	3.91 A	355 V	1,388 W	91 %
C01-S09	String 9	3.85 A	355 V	1,367 W	90 %
C01-S10	String 10	3.81 A	355 V	1,353 W	89 %
	Total	40.15 A		14.3 kW	
	Average	4.02 A	355 V	1,425 W	

(14) **(3)** **(15)** **(13)**

Alarm	Threshold	> 4.00 A AVG	Trigger	< 90 % of Rel	Edit
Sensors	Internal Temp.	22.7°C			
ID	Modbus Address	151	Serial Number	07333	
STATUS	1 low current alarm				

Listen ● Last Data Updated: Jun 22, 2012, Fri 9:05 AM (GMT -5:00)
Listen ● Last Communication: Jun 22, 2012, Fri 9:05 AM (GMT -5:00)

Cachelan Technical Support
contactus@cachelan.com
905.470.8400 x228

Cachelan
SMART GRID ENERGY