AC Coupling OutBack Power Radian Inverters with SolarEdge N. American Inverters

The purpose of this application note is to provide the theory of operation and connection scheme for adding battery backup and other storage based ancillary services to a utility connected SolarEdge inverter system. Step-by-step programming and a wiring diagram are also provided.

The AC output bus bar in the OutBack Radian load center is the point of common coupling for the Radian inverter output, the SolarEdge output, and the critical load center's main bus bar during all modes of operation. When the grid is active, the Radian inverter's AC input and output are connected via an internal transfer switch making the AC output bus bar a common connection point all the way out to the grid via the main service panel and revenue meter.

THEORY OF OPERATION

When the sun is shining, power from the SolarEdge flows to the output bus bar where it is consumed by loads connected to the critical load panel. If the load is demanding more than what the SolarEdge can provide from the PV array, then makeup power flows from the grid through the main service panel, through the AC input of the Radian and on out to the output bus bar where it is "blended" with power from the SolarEdge. If more power is produced from the array than is needed by the critical loads, then the excess power moves to the main service panel where it is consumed by those connected loads, with any surplus exported to the grid.

Application Note
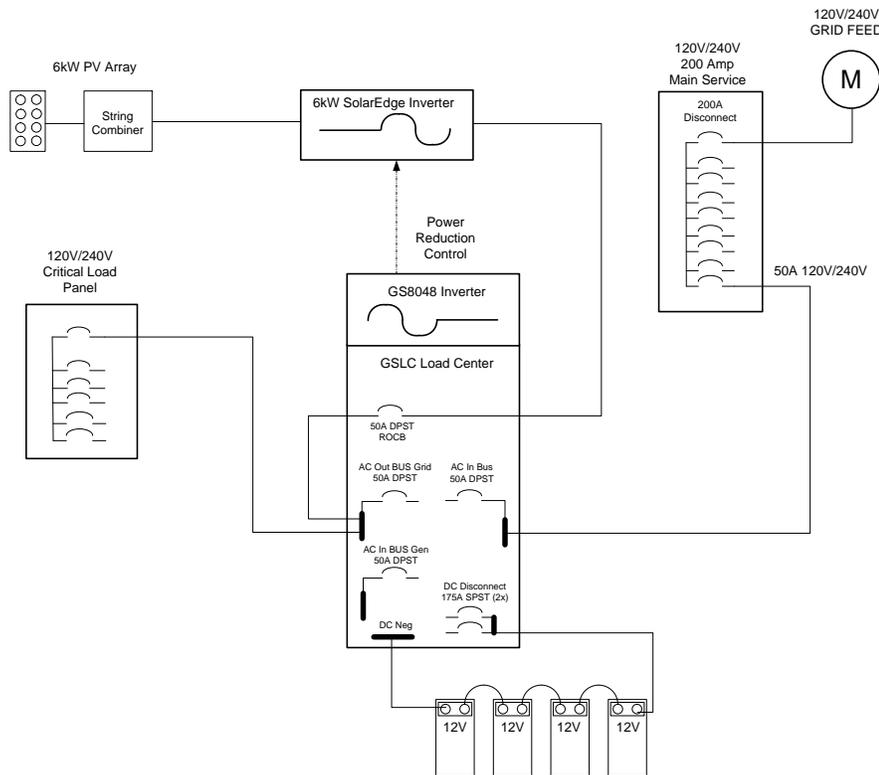
With loss of grid power, the OutBack Radian inverter opens up its internal transfer switch to the grid and goes into backup mode, becoming the new "grid source" to the SolarEdge inverter. This allows the SolarEdge to keep inverting power from the PV array and powering the critical load panel. Any shortfall of power to the loads would come from the OutBack Radian inverting power from the batteries. If PV power production is more than what is needed by the critical loads, then the excess power would flow back in an unregulated charge through the Radian inverter to the battery bank. The Radian "thinks" it is inverting DC power to provide an AC source on its output, which it does, however, any excess power from the SolarEdge is delivered at a higher voltage so it can "push" the power out to the grid if necessary. Since there is no grid to push it to, the power gets pushed back through the Radian inverter to the battery bank. If the battery bank becomes fully charged, the battery voltage will continue to rise as the charging is unregulated.

To prevent the battery bank voltage from going too high when PV production exceeds load demand, a built-in AC Coupling function in the OutBack MATE3 system controller will activate the Radian 12V Aux port, which in turn is connected to an external OutBack 12V dry contact relay. The normally open relay contacts are connected to the Power Reduction Interface (PRI) Port on the SolarEdge inverter. By closing a connection between the zero percent power pin and +5V, the power output from the SolarEdge is slowly ramped down to zero percent. Now the Radian inverter will power the loads until the battery voltage drops 0.4V below the existing voltage target, then the MATE3 commands the 12V Aux to turn off, which will cause the SolarEdge to start exporting 100 percent power again.

The OutBack Radian/SolarEdge string inverter solution is not only a simple and cost effective solution, but one that does not require blackout relays or diversion loads. Being able to control the SolarEdge inverter output with a slow ramp up and down between zero and 100 percent power is a more graceful way to modulate power without the hard stops and starts with mechanical or solid state blackout relay.

APPLICATION SETTINGS
SolarEdge Setup

1. Programming
   a. Remove cover to expose internal programming panel with the four buttons labeled: ESC, 1, 2, 3. The 1 key moves up through the menu, the 2 key down, and the 3 key functions as the Enter key.
   b. Turn the inverter key on the bottom to the left or Off position, but keep the main DC/AC disconnect switch on. The DC volts must discharge to <50V before the keypad becomes operable.
   c. From the main user display press and hold the 3 key down for >5 seconds or until you are prompted for the password. Enter the password using the three right most keys: 12312312 and press the 3 (Enter) key.
   d. The programming menu should have the ">" symbol in front of Country to show it is selected. Press the 3 key to enter the Country submenu.
   e. Make sure USA is selected then press the 3 key to select it. You are prompted whether to change or not and press the 2 key until Yes is shown and press the 3 key to select it.
   f. Use the 2 key to scroll down to the 240V selection and press the 3 key to select it.
   g. From the main programming menu, use the 2 key to scroll down to the Power Control settings and press the 3 key to select it.
   h. Use the 2 key to highlight the RRCR menu item and press the 3 key to select it.
   i. Press the 2 key until Enable is shown, then press the 3 key to select it
   j. Press the 2 key at the RRCR submenu to highlight Set Values and press the 3 key to select it.

k. There are settings for each of the four bits on the PRI port: 0000, 0001, 0010 and 0100. Make sure the settings for the following bits are programmed with the right values. Highlight the bit that needs to be modified then press the 3 key to select it. Press the 2 key to highlight the setting that needs to be changed, then press the 3 key to select it. Change the setting to the following values:
    i. 0000 <100,1,00,Y>
    ii. 0001 <0,1,00,Y>
l. Press the 3 key twice to enable and return to the Power Control submenu.
m. Press the Esc key four times to return to the main user display menu.

2. Hardware
    a. Make sure you have a connector soldered onto the Power Reduction Interface (PRI) port of your SolarEdge display board. See Figure 1 below.
    b. On the male connector that fits into the PRI connector on the PCB, attach the two wires from the OutBack GSLC load center 12V relay (OBR-16-DIN) pin 14 to L1 (pin 6) on the SolarEdge PRI connector, and from Pin 11 of the 12V relay to the +5V (pin 8) on the PRI connector. You can verify connections on the OutBack GSLC drawings below.

Power Reduction Interface (PRI) Connector
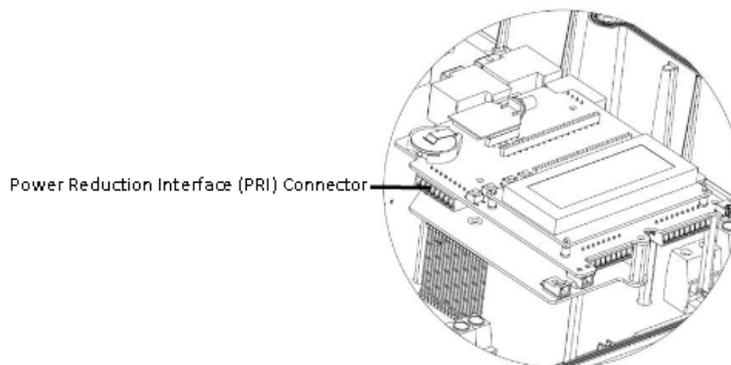
Figure 1 – PRI Interface Input
Photo courtesy of SolarEdge

OutBack Setup

1. Hardware
    a. Connect the Radian +12V Aux pin to the A1 pin on the 12V relay (OBR-16-DIN) in the GSLC load center.
    b. Connect the Radian -12V Aux pin to the A2 pin on the 12V relay (OBR-16-DIN) in the GSLC load center.
    c. Mount a DIN rail strip to the GSLC and snap the OBR-16-DIN onto the DIN rail strip.
2. Programming
    a. Take off the MATE3 bottom half cover and press the LOCK key.
    b. Use the scroll wheel to increment the User password to 141, then press the button in the middle of the scroll wheel to enter or select the value.
    c. Settings should be highlighted, press select button.
    d. Use scroll wheel to scroll down to MATE3 selection and press select button.
    e. Scroll down to AC Coupled Control and press select button.
    f. Press the select button to and move scroll wheel to change the Enabled setting from N to Y and press the select button.
    g. Press the TOP key until you see the Back softkey under the display and press the Back key until you see the main display.

SolarEdge/OutBack Radian Wiring Diagram
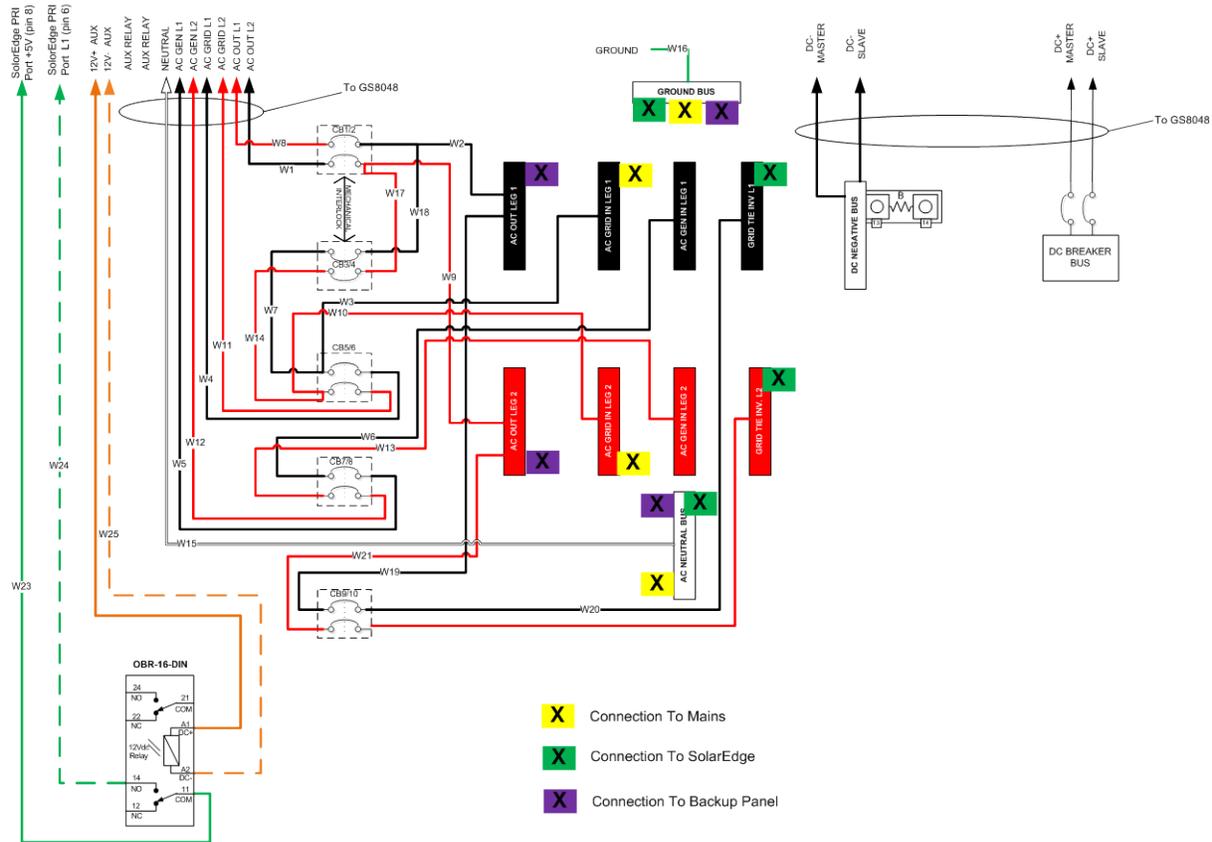
The OBR-16-DIN 12V relay can be ordered through an OutBack distributor and wired as shown using four 18-22 gauge wires.

ADDING A GENERATOR

Due to the disconnection requirements of the SolarEdge inverter and limitations of the Radian inverter's control functionality under those requirements, adding an AC generator can only be done in a manually operated sequence as outlined below.

1. Turn the SolarEdge inverter On/Off switch to Off (this is the small black switch, not the large AC/DC Safety Switch).
2. Once the SolarEdge inverter power has dropped to zero, open the SolarEdge L1/L2 breakers in the Radian GSLC load center. **NOTE:** *Failure to perform step 1 and wait for the SolarEdge power to drop to zero before opening its output breakers inside the GSLC load center could result in damage to the SolarEdge inverter.*
3. Manually start the AC generator that should be connected to the Gen input bus bars in the GSLC load center.
4. Manually stop the AC generator when the batteries are full, or setup the generator to shut off at the Absorb voltage setting if the generator has the control capability.
5. Turn the SolarEdge inverter On/Off switch to On.
6. Close the SolarEdge L1/L2 breakers in the Radian GSLC load center.
7. Resume normal operation.

Another alternative would be to add a DC generator whose operation can be automated using the GenStart relay function of the Radian inverter. The generator would simply be turned on at a low battery setting and turned off at a high battery setting. This allows independent operation and isolation of the AC components and circuits with regards to the operation of the DC generator. The ALPHAGEN 3kW DC generator can be found on the www.alpha.com website.