

# Technical Brief: Preventing Cycling in Battery Combiners, Voltage Sensitive Relays, and Automatic Charging Relays

March 15, 2007

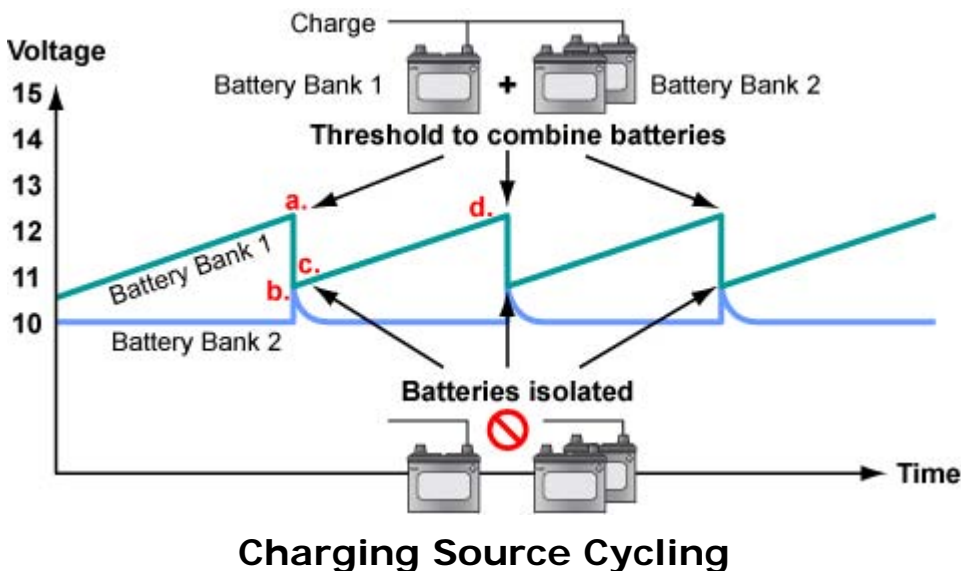
The primary functions of battery combiners, which include voltage sensitive relays and automatic charging relays (ACR), are:

- Combine battery banks so that they can share the output of a single charging source such as an alternator or shore-power charger
- Automatically isolate battery banks to prevent discharging of the Start battery bank

In some applications, as soon as a battery combiner closes to combine battery banks, it may immediately reopen because the load demand put on the charging source exceeds its output. This combining (closing) and isolating (opening) process may repeat over and over—it will cycle repetitively. When this cycling happens, the secondary battery bank may not receive a charge and can become discharged.

## A Closer Look at Cycling

When a battery combiner senses a charge on a battery bank (“a” in diagram), it combines the battery banks to share the charge. If the combined battery banks require more current than the charger can deliver, there will be a net discharge in the system (“b” in diagram). The combiner will detect that the voltage has fallen and isolate the battery banks (“c” in diagram). As soon as the two battery banks are isolated, the voltage will rise again and the combiner will cycle back on—combine battery banks (“d” in diagram). This cycling will repeat over and over.



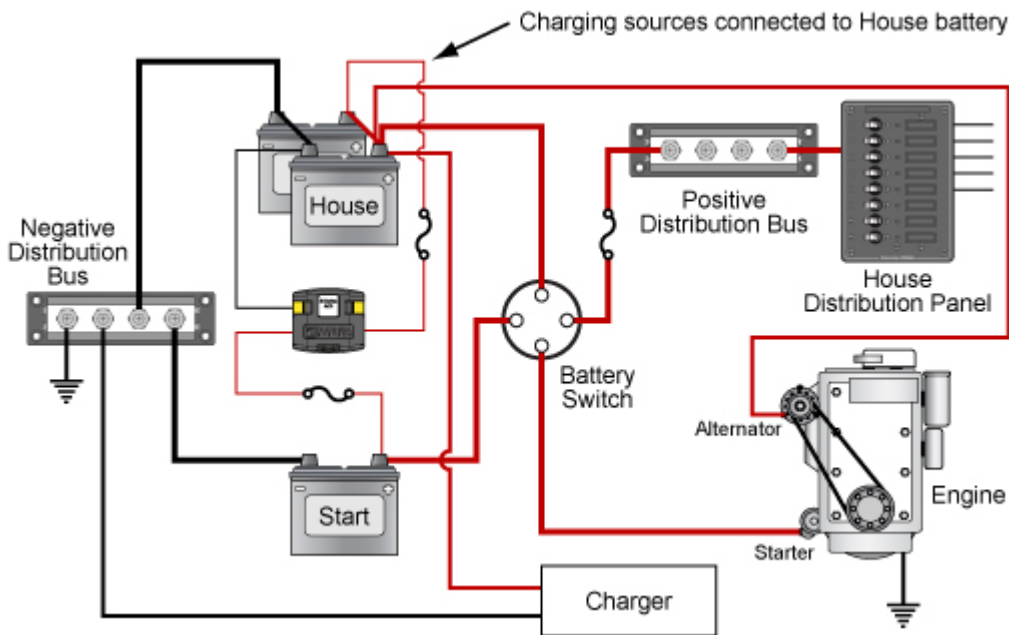
This condition isn't dangerous, but the secondary battery bank (battery bank 2 in the diagram above) may eventually discharge because it is not receiving a charge, and the

combiner may be subject to excess wear. The combiner will be open most of the time. The battery bank to which the charger is directly connected (battery bank 1 in the diagram above) will be protected from discharging—it will continue to be charged.

## Causes of Cycling

There are three common causes of repetitive cycling:

- A load on the secondary battery bank requires more current than the charging source can provide.
- The secondary battery bank may be very large and/or deeply discharged. This is common when the charging source is connected to the Start battery bank and there is a large House battery bank supplying power to many appliances.
- Combiner sensing is connected at a point in the circuit that is far from the charged battery bank or charging source. When the combiner connects the battery banks, there is a relatively high current flowing through the wires resulting in voltage drop that reduces the apparent voltage at the combiner.



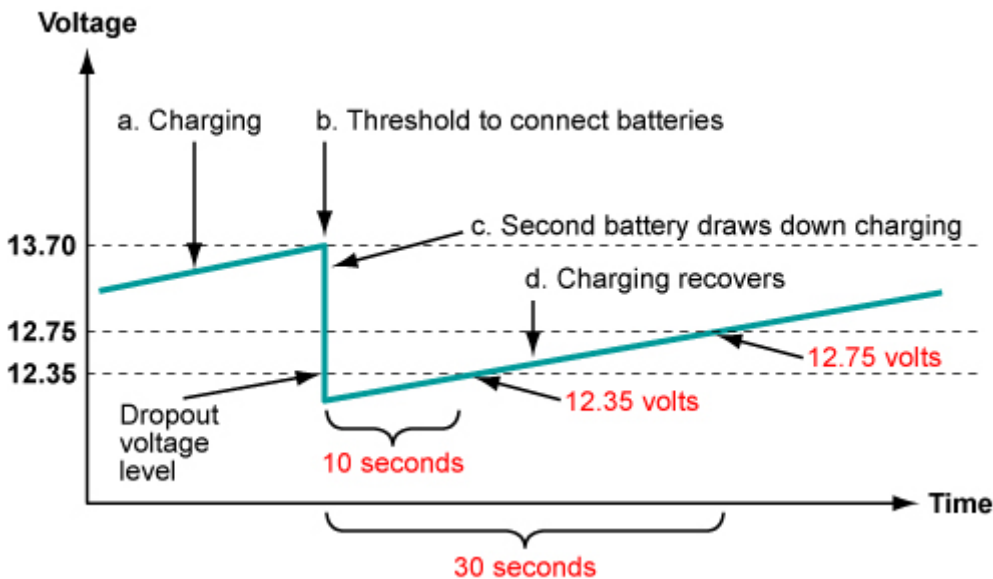
**ACR Wiring Diagram**

## Three Solutions:

- A simple solution for boats with a large House battery bank and a relatively small Start battery bank, including many sailboats, is to connect the charging source to the House battery bank (see wiring diagram). This solution works because the Start battery bank is typically smaller and less discharged than the larger House battery bank. When the battery banks are combined for charging, there isn't a significant drain to lower the system voltage to the disconnect level. However, this solution may not work as well for boats that are started and stopped often, for example, to get from one fishing spot to another. In this situation, the Start

battery bank may be depleted more than the House battery bank, so the charging source should be connected to the Start battery bank, even if it is the smaller battery.

- If voltage drop in the wiring is a factor, move the combiner connections closer to the charging source or use remote sensing to improve response. Blue Sea Systems BatteryLink™ ACR (7600) and L-Series ACR (9112), have remote sensing. Connecting the remote sensing wire close to the charging source reduces the voltage drop between charger and ACR. Because the ACR senses the voltage between its negative connection and its (positive) sense connections, the negative should be connected in the system close to the point where the charging source negative connects to the battery system.
- Blue Sea Systems' 120A SI ACR (7610) is programmed to prevent cycling when combining battery banks. It will remain closed and keep the battery banks combined usually long enough for the system voltage to recover. When two battery banks are combined, if the secondary battery bank draws down the system voltage, the 7610 will remain closed if the system voltage rises to at least 12.35V within ten seconds and at least 12.75V within 30 seconds. If the system voltage rises to these levels, the battery banks will remain combined. The 7610 recognizes rising voltage between 12.35V and 12.75V as a signal that charging is occurring even though the voltage is still below the normal drop out voltage of 12.75V.



### Blue Sea Systems' 120 Amp SI ACR Combining Logic