



# COMBINER 150, Installation Instructions

## SUMMARY

The Yandina Combiner 150 is a voltage-sensing relay (13.3 volts) which connects two battery banks together when either is receiving a charge. When the charging ceases, the relay opens so that each battery operates independently. For safety reasons, boats usually separate the engine starting battery bank from the "house" battery bank so that if you run the house battery down you can still start the engine. This safety factor is defeated if you have to manually connect the batteries in parallel for charging and forget to isolate them when finished.

Supplemental battery banks can be added by using an additional combiner for each bank.

## FEATURES

- < 150 amps continuous rating, 400 amps closing current (2 seconds), 200 amps for 5 minutes
- < Suitable for alternators up to 200 amps, up to 18 volts
- < Insignificant voltage drop so batteries reach full charge
- < Electronic thermal monitoring with shutdown
- < Minimal wasted power; no heat sink or cooling required
- < Can be used on alternators with internal regulators
- < No special wiring for alternators with an external sense
- < Simple basic installation: two battery wires and ground
- < Green LED indicates when combined
- < Red LED indicates thermal overload shutdown
- < Draws only 0.00005 amps when batteries are not being charged; that's only 1 amp-hour every 2 years
- < Draws ¼ amp from the alternator when charging
- < Optional external remote control for **off, automatic, on**
- < The optional remote "**ON**" can be used to parallel banks for assisted engine starting
- < Withstands ambient temperature to over 175EF (80EC) for engine compartment mounting.
- < Optional high voltage shutdown for Gel Battery protection with red LED indicator.
- < No diodes to burn out if accidentally shorted

## SAFETY CONSIDERATIONS

**DANGER:** On all alternator/regulator circuits with an external sense wire it is critical that the sense wire can never be disconnected from the alternator output. Damaging, self-destruct voltages can be produced. Installation of a **Zap-Stop** will **not** protect against electrical system damage if this happens. Since there is no diode drop with a Combiner, there is no advantage to connecting the sense wire directly to the battery so it should be connected straight to the alternator output with no switches or fuses in the circuit.

**CAUTION:** If there are switches which can disconnect the alternator output from the battery a **Zap-Stop** or similar protection device can reduce the chance of alternator damage and it is recommended for all installations.

Make the battery connections last to reduce the risk of a short circuit during installation. Make sure the second lead is not touching ground when you connect the first since the combiner sometimes closes momentarily when initially connected.

Follow ABYC guidelines for circuit protection, wire sizes, disconnect switches and other safety related issues. See the appendix regarding the use of circuit breakers and fuses.

Since the connections made in the battery circuits can carry hundreds of amps, it is imperative that you have low resistance connections. This means having clean metal to metal contact, the right size ring terminals (supplied), a properly crimped terminal, and secure mechanical fastenings. If you don't have a crimping tool large enough, remove the insulation, crimp with pliers to hold the wire in place and make a good solder connection. You will need a large capacity soldering iron, 80 watts or greater.

## INSTALLATION

Review the sample schematics to select or design your own circuit suitable for your vessel.

Only the two installed ¼" terminals are used. The third one is **INTENTIONALLY OMITTED**. You **WILL** need a 7/16" socket wrench to access the terminal nuts.

**1.** Mount the Combiner 150 preferably with the label facing up. Never mount with the label down which could allow water to accumulate inside. Although it is splash proof, salt water can corrode the electrical connections so a dry location should be selected. The remote and high voltage shutdown terminals are very sensitive so salt water on them may cause leakage signals and disrupt normal operation.

**2. The GROUND terminal connects to the common negative of your battery banks.**

The connection should preferably be to one of the negative battery terminals. No other devices should share this ground lead. Although it carries very little current, 18 gauge wire or heavier should be used for mechanical stability.

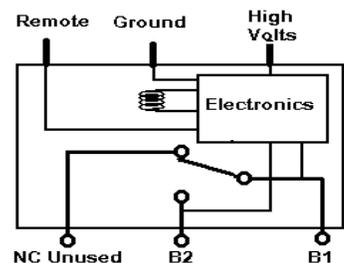
Since the power consumption when not charging is only 0.00005 amps (that's 1 amp-hour every 2 years) an on/off switch is not necessary. On solar charger installations, where you may wish to disable the combiner to maximize the current going to one bank, connect the REMOTE terminal to function as an OFF switch as described in the appendix.

**3. Connect one high current terminal to the positive terminal of each battery bank.**

Secure the ring terminals tightly under the flat washer and lock washer supplied on each Combiner 150 power terminal. A 7/16" socket wrench will be required to access these connections in the insulated cavities. No other cables should be on these terminals at the combiner end.

**IMPORTANT:-** Use only **6 gauge** cable. Use a **minimum of 6 feet** of wire total between the positive battery terminals to connect the combiner. **DO NOT** use a heavier gauge (lower gauge #)

**DO NOT** use a heavier gauge (lower gauge #) wire. Do not coil excess wire which can confine heating or create magnetic fields and upset your compass. The



COMBINER 150 SCHEMATIC

insignificant resistance in these leads will result in no voltage loss at end of charge but it is enough to protect the Combiner 150 from excessive currents which can flow when the batteries are first connected in parallel.

#### 4. Adding extra banks:

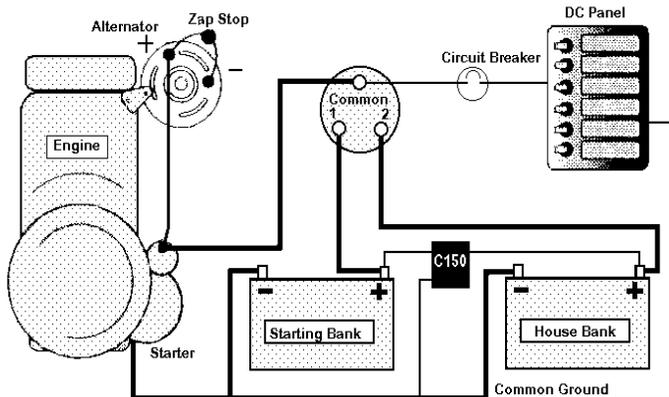
See schematic 4 which shows an example of how additional battery banks can be daisy-chained.

5. Instructions for using the optional REMOTE and high voltage features are in the APPENDIX.

### SCHEMATICS

In general when you are modifying an existing installation, all you have to do is connect the alternator and any other charging sources to the house bank and connect the Combiner 150(s) between the banks. You can often connect the combiner to the battery terminals of an existing selector switch.

#### 1. Simple installation:

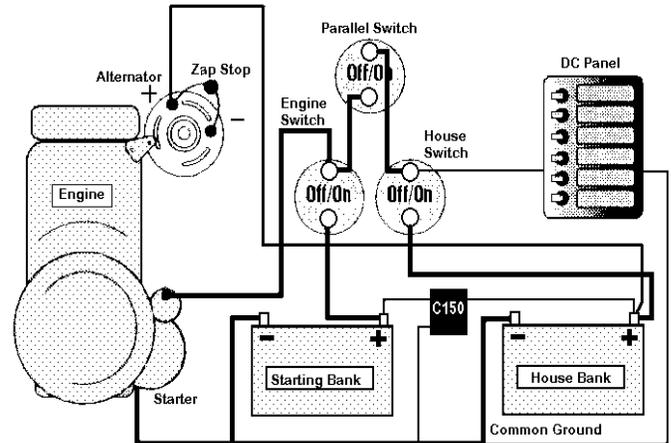


This works well for power or sail boats that already have a single **OFF-1-BOTH-2** battery switch. Connect the starting and house battery positives to the Combiner 150 so when the house battery reaches 13.3 volts or higher, it will share the charge with the starting battery. The main disadvantage of this circuit is that the battery selector switch must be operated frequently to select the starting or house bank as the 12 volt source.

This arrangement also has the disadvantage that if the switch is turned to "OFF" while the engine is running there is a serious possibility of damage to the alternator and to sensitive electronics which remains connected to it when the battery is removed. Always use a Zap Stop in this arrangement.

If it is convenient it is safer to connect the alternator output to the house battery so it receives its charge directly with no switches that can turn it off accidentally.

#### 2. Improved simple version with three switches:



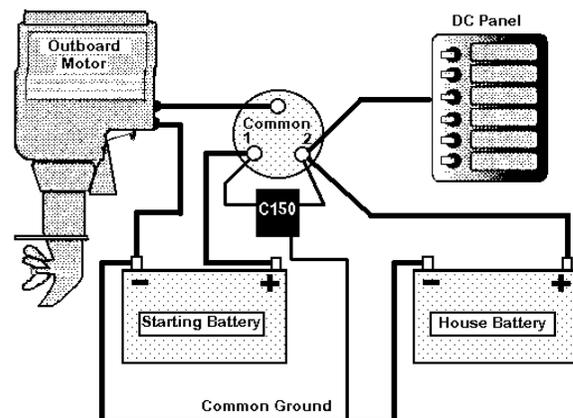
Although this requires three single throw switches it has the distinct advantage that no switching operations are required under normal operation. The starter motor runs off the starting battery, the house runs off the house battery but in an emergency, either load can be removed from its normal source and switched or connected in parallel to the other battery.

The alternator is shown here connected directly to the house bank and charging current is shared with the starting bank by the Combiner 150. See the information in section 1 if you can't disconnect the alternator from the starter.

#### 3. Single engine powerboats:

Many powerboats in the 16-22 foot range come from the factory with a single battery for all electrical loads, including starting. When owners of these boats begin to add more and more electrical products for fishing, voyaging, or entertaining, it becomes important to reserve one battery for engine starting, and another battery for DC loads. Once again, however, if the operator leaves the battery switch in the **BOTH** position after charging, there is a likelihood that both batteries will become depleted with the risk of being unable to start your engine.

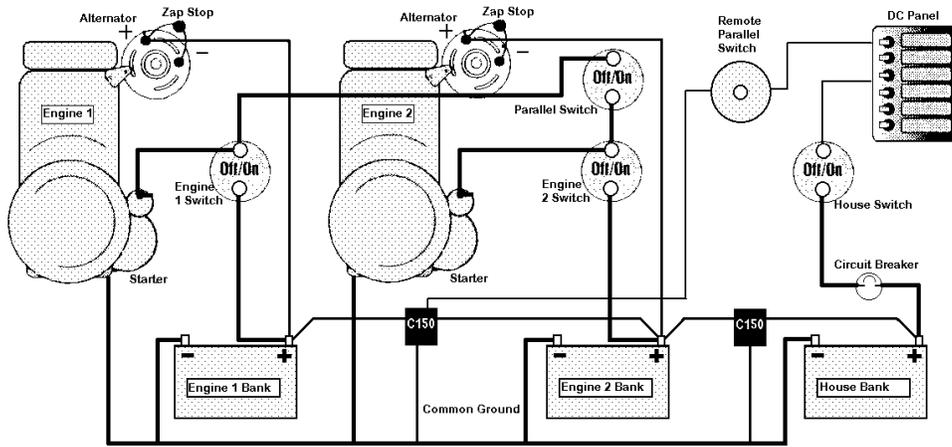
With the Combiner 150 (or the Combiner 50 for smaller boats) you can use an **OFF-1-BOTH-2** switch to select engine



power and leave the DC loads permanently on battery 2. Starting power is normally supplied from the starting battery

in position 1 but battery 2 can be selected in an emergency. In either case, both batteries are charged when the engine is running.

#### 4. Twin engine powerboats, 2 starting batteries:

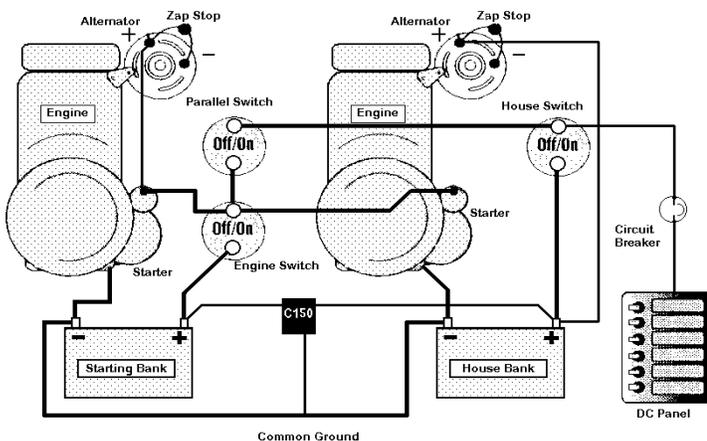


Twin engine power boats often have a starting battery for each engine, and may have one or two house banks of batteries as well. There are many variations on how twin engine boats can be wired, but one of the easiest methods is to use two or more Combiner 150s so that no matter which battery is receiving a charge the contacts will close and distribute the charge to all banks. This will also work OK with the alternator outputs connected to the starter motors bearing in mind the need for a Zap Stop if disconnecting an alternator while the engine is running.

This schematic shows the optional use of a remote push button or switch to manually parallel the banks for emergency starting. Note that if you use the remote control on more than one Combiner 150, each must have a separate switch and separate connection.

#### 5. Twin engine powerboats with one starting battery:

Alternatively, many boats are wired with a single engine starting battery, and a large house battery bank which can also be used to start the engines in an emergency. This circuit shows one alternator on the starting bank and one on the house bank but any combination will work just fine, even with both alternators connected to the same battery..



### BATTERY CHARGERS

A single output shore power charger can be directly connected to the house battery. When it is charging, the Combiner(s) will share the charge with the other banks. Multi-bank chargers can be connected to each of the battery banks as normal. Inverters with integral chargers will automatically charge the house bank and it will share the charge to the starting bank(s) through the Combiner 150.

### OPERATION AND TESTING

The green "Combined" light will come on some time after charging has commenced. The time delay depends on how much current is being delivered to the bank being charged and its initial state of charge - a high charge brings it up fairly quickly, while a trickle charge may take many minutes. When the initial bank reaches 13.3 volts, the other bank(s)

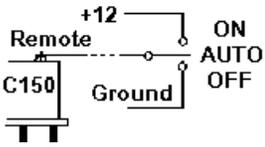
will be placed in parallel by the Combiner 150. If one bank is very low, the Combiner 150 may turn off and on a number of times as it brings it up to voltage. After charging has ceased, the green light may remain on for quite some additional time if there is no load on the batteries due to the "float" voltage above 13.3 volts left over from the charging. The small current drawn by the Combiner 150 will slowly absorb this float and turn off. There is no significant power wasted in this process and the float would dissipate internally in the batteries if the Combiner load was not there.

If the internal temperature of the Combiner 150 rises too high, the red "Overload" light will come on and the relay will turn off to protect itself. After it cools about 10EF (6EC), it will turn back on automatically. Since the protection is based on temperature, a high ambient environment such as an engine compartment will lower the amount of current which can be carried before the Combiner 150 will shut down. This shutdown feature is a protective measure and it should not be used to limit charging under normal circumstances. Repeatedly opening the relay under overload conditions can extend the charging time required. Also due to the thermal time constant of the relay it will not respond quickly to an overload current so it does not provide rapid response to destructive conditions. When combined, even with no load, the coil dissipates 3 watts so the cover will get warm.

If you have connected a switch to the remote control, bear in mind that there are time delays built in to limit switching speed so the response will not be immediate. The high temperature or high voltage condition will force the relay off, even if the remote is set to ON.

## APPENDIX

The **REMOTE TERMINAL** is left unconnected for automatic operation. It can be connected through a single pole, center off, double throw switch for remote control. Switching it to ground locks the Combiner 150 off, while connecting to + forces it on. When not installed, or disconnected in the center position you are in automatic. If you only need one



function, a simple on/off switch will do. Virtually no current flows so a small switch and light gauge wire are sufficient. **The response of the Combiner 150 to remote operations is slowed by turn on and turn off time delays.** Do not parallel the remote terminal of multiple Combiner 150s, each must have a separate control. Avoid long wire runs to a remote switch which may pick up electrical noise.

The **HIGH VOLTAGE TERMINAL** is normally left unconnected. It will force the Combiner 150 off and light the RED LED if it reaches 14.2 volts or higher so it can be used to protect a Gel battery from overcharging by jumpering the High Voltage terminal to the high current lead which is connected to the gel battery positive. This allows a gel battery bank to be connected through the Combiner 150 to a bank being charged to higher voltages by an engine alternator while underway and to receive a charge without damaging the gel bank. When charging on the regular bank reaches 13.3 volts the Combiner 150 will close and charge your gel battery but when the source exceeds 14.2 volts the gel battery will be disconnected and the RED LED will turn on. The Combiner 150 may re-connect again periodically to maintain the 14.2 volts on the gel battery bank. The red LED increases in intensity as the voltage approaches cut-off. Note that this is a protective function and not intended as an accurate charge regulator. The gel battery should have its own suitable and dedicated charger.

The **NORMALLY CLOSED**, left hand power terminal, is connected to the right hand COMMON terminal when the Combiner 150 is not combining or is in shutdown. It can be used for any requirement up to 100 amps maximum. A ¼" bolt and nut will be required.

### FUSES & CIRCUIT BREAKERS

Marine wiring practice guidelines dictate that all 12 volt circuits except starter motor leads should be fused. The reason starter motor leads are not fused is the starter can sometimes demand the total output capacity of the battery so if the fuse was heavy enough to carry this current, the battery would not have the capacity to blow it.

Since the short term currents flowing between battery banks when the C150 closes are comparable to starter motor currents even though the steady state currents are much lower, we again have the situation of a fuse or circuit breaker with too large a rating to provide protection.

There is no electrical path to ground inside a battery combiner which can carry any significant current should it suffer an internal failure so any fuses in the combiner battery leads only provide protection for accidental shorts to ground

of the cables themselves.

The necessity for battery lead fuses to the combiner should be decided on an installation basis. If the combiner is mounted where shorting the terminals to ground is virtually impossible the risk is usually minimal. If it is a long run, or in a metal boat and the combiner is surrounded by grounded metal the risk of a short is much higher and fuses may be a good protection. A slow blow fuse of approximately 30% to 50% of the total Cold Cranking Amp capacity of the batteries in the smaller bank is a guide to value. Although the risks are minimal without a fuse, the results of an accident can be catastrophic and even life threatening.

All battery circuits should have a disconnect switch located electrically close to the positive battery terminal to allow isolation for emergencies and regular maintenance.

### TROUBLESHOOTING

#### COMBINES AT A VOLTAGE ABOVE OR BELOW 13.3

1. There is a tolerance of +/- 2% so the range is 12.8 to 13.3. The actual voltage is not critical to functional operation.
2. Many marine analog voltmeters are notoriously inaccurate.
3. There is a time delay up to 90 seconds on opening and closing so on an increasing or decreasing voltage it will have changed by the time the relay responds.
4. Most meters will read an average voltage however the C150 responds to the amount of time the voltage exceeds the 13.3 volt threshold and switches when this exceeds 25% irrespective of the instantaneous voltages present. On the non-uniform current flow produced from most charging sources the average voltage measured on your meter will be higher or lower depending on the duty cycle and waveform.
5. The ground and positive connections to your meter may be influenced by voltage drops caused by current flowing in the conductors between the measuring points and the battery terminals.

#### DOESN'T TURN ON OR OFF WHEN IT SHOULD

1. See the information on "float" voltage in the Operation and Testing section.
2. Make sure there is no salt laden moisture on the remote terminal or remote switch if installed. Leakage to +12 or ground can force the C150 on or off and interfere with its switching characteristics.
3. Verify voltages between the ground and positive terminal(s) right on the C150 with a good quality meter.

### WARRANTY

**WARRANTY VOID IF POWER LEADS HEAVIER THAN #6 OR SHORTER THAN 6 FEET**, otherwise we offer an unlimited warranty. Check at <http://www.yandina.com/AboutUs.htm> to get the return address.

**INSTALLATION HELP** [www.yandina.com/combinfo](http://www.yandina.com/combinfo)

**TECHNICAL EMAIL QUERY** [tech@yandina.com](mailto:tech@yandina.com) or call 877 355 2184 toll free or 843 524 2282 direct.

© 2005 October 4, 2005