West Marine

12 Volt Model XXXXXX

COMBINER 2 Bank 400 Amp, Installation Instructions

SUMMARY

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.

The old diode isolators that split the alternator output between two battery banks have a 0.6 volt drop so your batteries don’t get a full charge. Using an external sensing can correct this but you run a serious risk of sensing one battery while charging another which will rapidly destroy the battery that is overcharged.

The West Marine Combiners have solved this dilemma. The Combiner 400 has a voltage-sensing contactor (13.3 volts threshold) which connects two battery banks together when either is receiving a charge. When the charging ceases, the contactor opens so that each battery operates independently. This allows the alternator to remain directly connected to the starting battery and no external sensing is required.

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

FEATURES

- 400 amps DC continuous rating, 2500 amps closing current (2 seconds), 800 amps for 5 minutes
- Can be forced on remotely to parallel batteries for emergency engine starting
- Withstands 25 volts continuous, 1000 volt spikes
- Suitable for alternators with total output up to 500 amps
- Insignificant voltage drop so batteries reach full charge
- Electronic thermal overload monitoring with shutdown
- No 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
- Fully waterproof - submersible
- Simple basic installation: two battery cables and ground
- Green LED, indicates when combined
- Red LED indicates thermal overload shutdown
- Draws NO current to operate, combined or not.
- Draws only 0.009 amps for green LED if enabled.
- Green LED can be disabled for zero current consumption
- Remote Green LED included, indicates when combined
- 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 175ºF (80ºC) for engine compartment mounting.
- No diodes to burn out if accidentally shorted
- Reverse polarity protected
- Mounting hardware and cable terminals included
- Only 4.75" long, X 4.25" wide x 3" high

SAFETY CONSIDERATIONS

CAUTION: A ***Zap-Stop*** is a device that can help protect an alternator by suppressing temporary spikes that can occur if the circuit is opened while under load. If there are switches in your installation that can disconnect the alternator output from the battery a ***Zap-Stop*** is highly recommended.

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. If it does, the regulator may keep increasing the output voltage until damaging, self-destruct levels are reached. A ***Zap-Stop*** will ***not*** protect against electrical system damage in this event.

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 right to the alternator output with no switches or fuses in the circuit.

Make the battery connections last, when installing, 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 may be combined when initially connected. In this case it will stay combined until you go through a charge/discharge cycle at least once.

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.

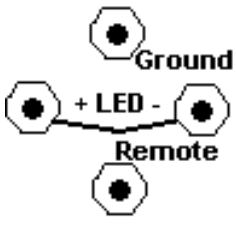
Since the connections made in the battery circuits can carry hundreds of amps, it is imperative that you have low resistance connections. This means having clean metal to metal contact, the right size ring terminals (supplied), a properly crimped terminal, and secure mechanical fastenings. If you don’t have a crimping tool large enough, remove the insulation from the supplied terminals, 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 a circuit suitable for your vessel.

1. Mount the Combiner 400 in a dry location using four screws provided. Although it is waterproof, a dry location should be selected. The remote control terminal is very sensitive so salt water on it may cause leakage signals and disrupt normal operation.

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



No other devices should share this ground lead. Although it carries negligible current, 18 gauge wire or heavier should be used for mechanical stability.

Since the combiner draws no measurable current, an on/off switch is not necessary. On solar charger

installations you can disable the green LED “ON” lamp to reduce power consumption to zero - see appendix.

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

Secure the ring terminals tightly under the flat washer and lock washer supplied on each Combiner 400 power terminal. No other cables should be on these terminals.

Use only the mounting hardware supplied for each terminal bar. Drilling or modifying these buss bar terminals will void the warranty.

Use ***a minimum of 4 gauge*** cable. (Eg. West Marine #113510) for runs up to 8 feet total. Longer runs may require heavier cable. For charging circuits it is OK to calculate wire gauge based on a 10% voltage drop for the particular length of run. This is because any voltage drop along this cable will diminish to zero as the batteries reach full charge so there is no reduction in the final voltage of the batteries. Any extension of charging time due to voltage drop in the cables is negligible.

4. Adding extra banks:

See schematic 3 which shows an example of how additional battery banks can be daisy-chained.

SCHEMATICS

Fig 1. Simple installation:

In general when you are modifying an existing installation, all you have to do is connect the Combiner 400(s) between the banks. You can often connect the combiner to the battery terminals of an existing selector switch.

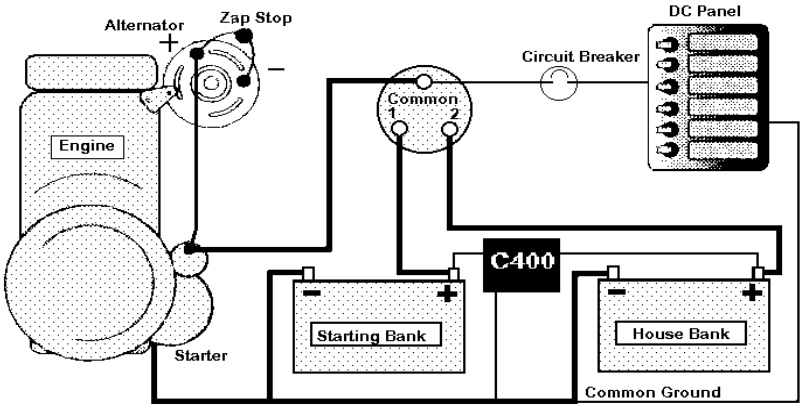


Figure 1

This schematic 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 400 so when the starting battery reaches 13.3 volts or higher, it will share the charge with the house 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.

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

Fig 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.

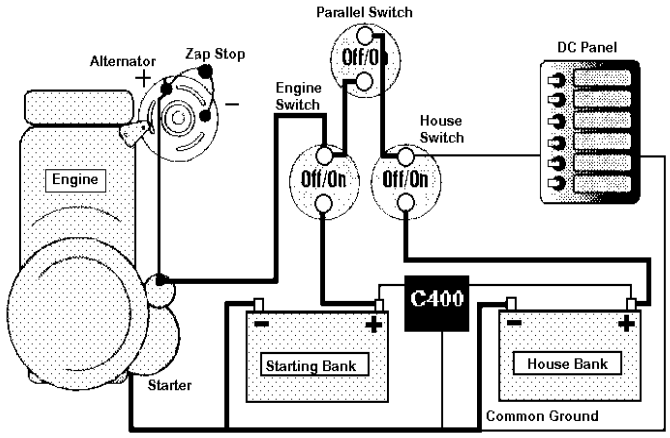


Figure 2

Fig 3. 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 400s so that no matter which battery is receiving a charge the contacts will close and distribute the charge to all banks.

This schematic shows the optional use of a remote push button or switch to manually parallel

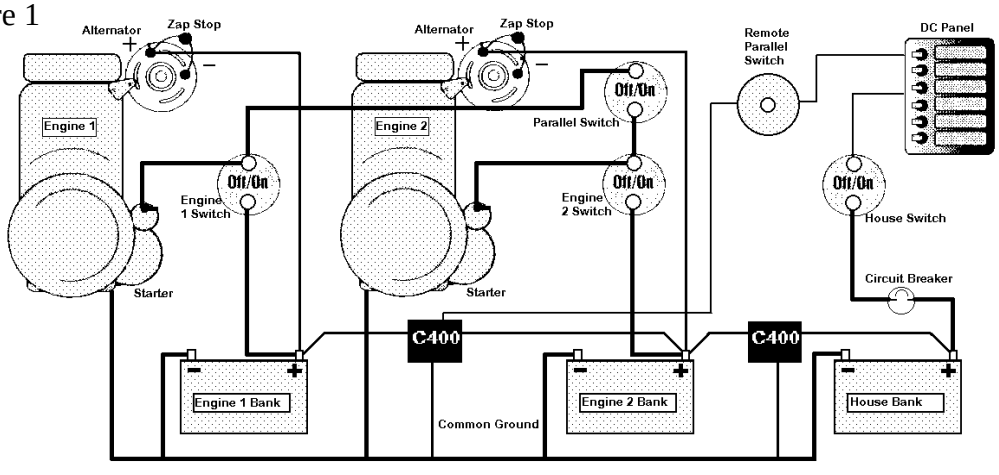


Figure 3

the banks for emergency starting. Note that if you use the remote control on more than one Combiner 400, each must have a separate switch and separate connection.

Fig 4. Twin engine powerboats with one starting battery:

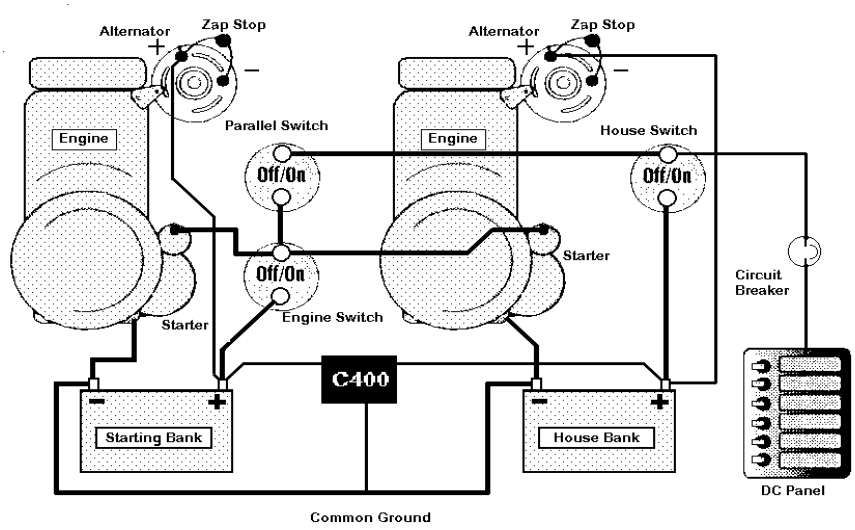


Figure 4

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 the Combiner 400 will share the charge to the starting bank(s) since it is bi-directional.

OPERATION AND TESTING

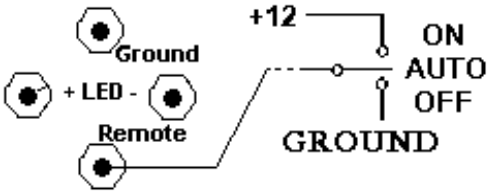
The green "Combined" light will come on some time after charging has commenced. The time delay depends on how much current is being delivered to the bank being charged and its initial state of charge - a high charge brings it up fairly quickly, while a trickle charge may take many minutes.

When the bank on the charging source reaches 13.3 volts, the other bank(s) will be placed in parallel by the Combiner 400. If one bank is very low, the Combiner 400 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. This artificially high voltage will slowly dissipate in the batteries if there is no load and the LED will eventually turn off. This artificially high voltage does not represent any significant source of energy.

If the internal temperature of the Combiner 400 rises too high, the red "Overload" light will come on and the combiner will turn off to protect itself. After it cools about 10ºF (6ºC), 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 400 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 combiner under overload conditions can extend the charging time required. Also due to the thermal time constant of the combiner, it will not respond quickly to an overload current so it does not provide rapid response to destructive conditions.

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 on delay is about 30 seconds and the off delay is about a minute. The high temperature condition will force the combiner 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. (West marine 192163, 191785 or 211854.) Switching it to ground locks the Combiner 400 off, while connecting to +12 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 400 to remote operations is delayed by turn on and turn off time delays.*** Do not parallel the remote terminal of multiple Combiner 400s, each must have a separate control.

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 C400 closes are comparable or heavier than 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.

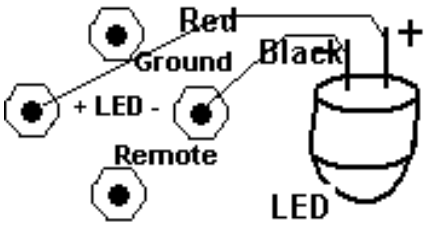
There is no electrical path to ground inside a battery combiner which can carry any significant current should it suffer an internal failure so any fuses in the combiner battery leads only provide protection for accidental shorts to ground of the cables themselves.

If the Combiner 400 is going to be used for a remote emergency starting assist, you cannot fuse it since the fuse rating would have to be higher than the CCA battery rating. ABYC does not require fuses on starter motor circuits.

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 60% 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.

ABYC recommendations suggest that all battery circuits should have a disconnect switch located electrically close to the positive battery terminal to allow isolation for emergencies and regular maintenance.

CONNECTING THE REMOTE LED STATUS INDICATOR



Remove the jumper between terminals **+LED** and **LED–** and connect the terminals together through the remote LED. The anode (red lead) connects to the **+LED** terminal, the cathode (black lead) goes to the **LED–**. The remote indicator terminal is not suitable for an incandescent lamp display.

DISABLING THE GREEN LED TO SAVE CURRENT

The only measurable current drawn by the combiner 400 is to illuminate the green LED when the batteries are combined. For some solar applications you may wish to disable this LED so the combiner draws no current when OFF or ON. This is done by removing the jumper between the terminals marked LED POWER and LED REMOTE.

The red OVERLOAD LED cannot be disabled and there is no remote for it. The Green LED always goes out during overload while the red LED is on.

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. The voltage reading may be wrong. Many marine analog voltmeters are notoriously inaccurate. Some cheap digital ones are not much better.
3. There is a time delay up to 1 minute on opening and closing so on an increasing or decreasing voltage it will have changed by the time the combiner responds.
4. Most meters will read an average voltage however the C400 responds to the amount of time the voltage exceeds the 13.3 volt threshold and switches when this exceeds 25% for at least 30 seconds 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. There is a 30 second turn on delay and about 1 minute turn off delay. If ON, it will turn off after 1 minute even if removed from the circuit.
3. Make sure there is no salt laden moisture on the remote terminal or remote switch if installed. Leakage to +12 volts or ground can force the C400 on or off and interfere with its switching characteristics.
4. Verify voltages between the ground and positive terminal(s) measured right on the C400 with a good quality meter.
5. The most common situation is where one of the battery banks has developed a bad cell. If this is on the battery on charge, it prevents the voltage getting high enough to turn the combiner on. If in the auxiliary battery, each time the combiner closes the bad cell drags the voltage down so the combiner turns off to protect the good one.

West Marine **WARRANTY 1 year.**
500 Westridge Dr., Watsonville, CA 95076
Made in the U.S.A.

February 15, 2004
INSTALLATION HELP www.yandina.com/combinfo
TECHNICAL EMAIL QUERY tech@yandina.com
or call 877 355 2184 toll free or 843 524 2282 direct.