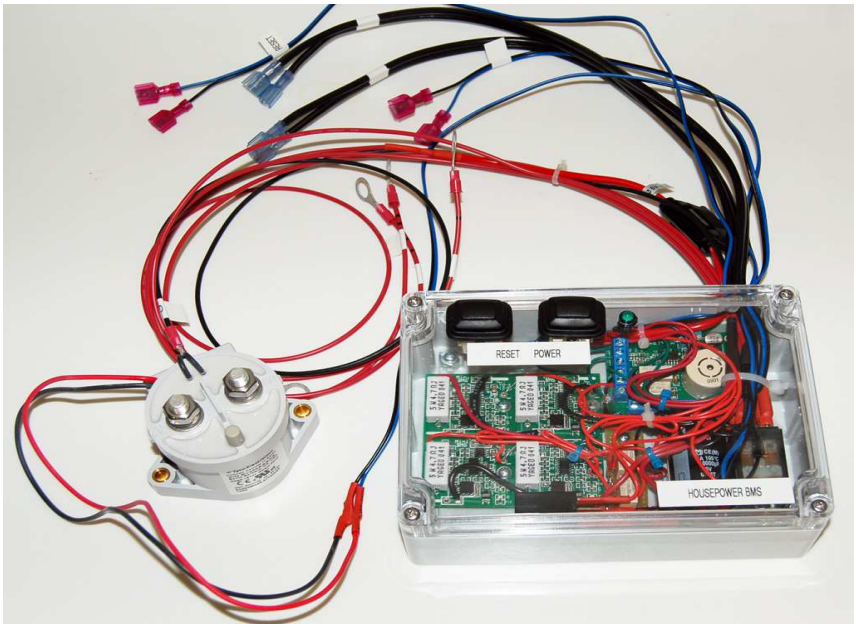


HousePower BMS

CleanPowerAuto LLC

Features:

- Designed for 12V and 24V LiFePo4 battery banks, replacing Lead Acid house banks in marine and RV applications, with minimal changes to existing systems and wiring
- Integrated power contactor to protect the battery from abuse
- Cell level protection disconnects the bank if discharged to 10.4V (2.6V per cell) to prevent battery damage, 20.8V for 24V banks.
- Cell level protection disconnects the bank if overcharged to 15V (3.75V per cell) to prevent battery damage, 30V for 24V banks.
- Alternator diodes protection by breaking field current prior to disconnect
- 2 separate Field control circuits for boats with 2 alternators
- Individual LiFePo4 cells within the battery bank are actively kept in balance by BMS
- Power switch for long term storage prevents bleeding the battery
- BMS housed in high quality NEMA plastic box
- Optional remote buzzer or light (12V and less than 200 mA) to get BMS alerts in the cabin
- Optional remote reset button to reset BMS from the cabin
- 5 Amp inline fuse protects the system from shorting out
- Less than 300 mA operating current

Installation and use:

Typical LiFePo4 cells have nominal voltage of 3.2V. To prevent damage and ensure long life cells must be kept within 2.5V-4.0V operating window. LiFePo4 chemistry has flat charge/discharge curve with steep ends on both sides, which means the battery will hold close to nominal voltage until almost full or almost empty. At the end of charge voltage will rise rapidly and at the end of discharge voltage will fall rapidly. BMS is used to automatically protect the battery from reaching those steep ends.

To use LiFePo4 cells in house banks with 12V nominal voltage you must have 4 cells or groups of paralleled cells connected in series to get 12.8V nominal bank voltage. To make larger capacity banks you add more cells in parallel to get larger 4 groups of equally sized cells. For example, to build 600AH 12V bank using 200AH cells, you need 12 cells connected in 3P4S configuration (see below diagram). To make a 800AH bank, you need 16 cells in 4P4S configuration. Each group of paralleled cells makes a "supercell" of larger AH capacity. You always need 4 groups in series (hence 4S) to get proper voltage level. So, valid configurations for 12V bank are 1P4S, 2P4S, 3P4S, 4P4S, 5P4S, etc. You must create parallel groups first, and then connect 4 groups in series.

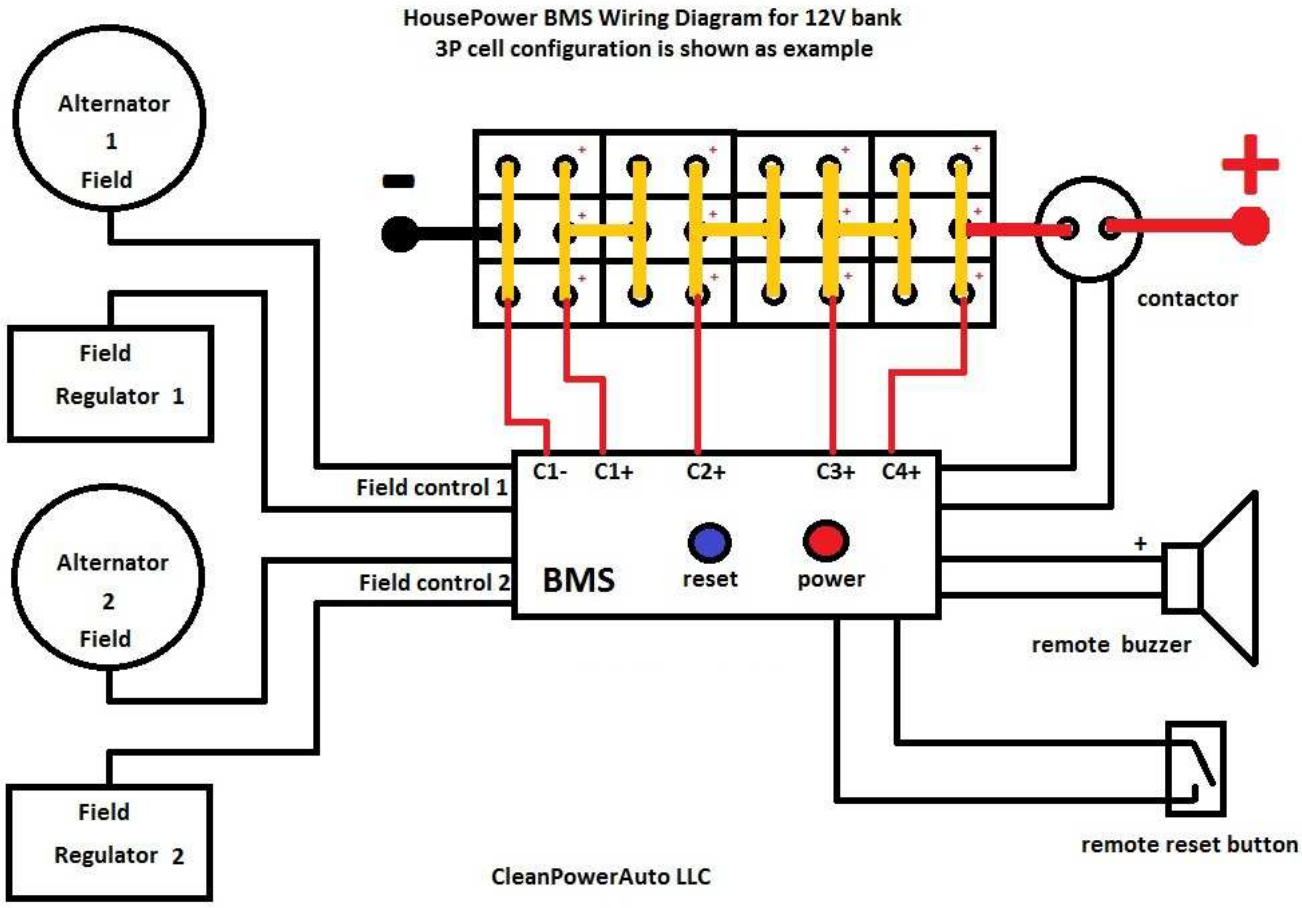
DO NOT create multiple strings of 4 series connected individual cells and put those strings in parallel, this will create unmanageable mess since individual cells in the middle of each string cannot be managed by BMS. BMS must see entire bank as 4 series connected units.

Same rules apply to 24V banks, except there are 8 cells or groups of paralleled cells connected in series, making it a 8S configuration.

Once you built your bank, connect BMS as shown in the diagram. Field control circuits are optional, they are normally closed and will only open when BMS trips battery protection. Field control relay inside the BMS trips about 500ms prior to opening main contactor, this delay is designed to collapse the energy in the alternator circuit and protect diodes from blowing when main contactor opens. Remote buzzer and remote reset button are optional, you can wire those in the cabin so you can hear the buzzer when BMS trips and you can reset the BMS by pressing reset button. Remote buzzer must be 12V low current device (less than 200 mA), you can typically get one at any Radio Shack. Reset button can be any normally open pushbutton, with low voltage and current rating.
Connect Tyco EV200 contactor supplied with BMS to most positive bank lead, then connect positive cable which used to connect to old lead acid battery to the other side of the contactor. This way all loads are connected behind the contactor, so it can effectively isolate the battery upon BMS protection event.
Once all connections are made, press the Power switch and observe green LEDs, one on the outside next to power switch and 4 small ones visible from inside the BMS enclosure. Press the rest button to engage the contactor. The system is fully operational now. If/when voltage goes too low or too high, the system will open the contactor to protect the battery and will sound buzzer alert. Start/stop the charging source and then press the Reset button to engage the contactor and bring the battery back online.

At the end of charge cycle, if/when battery reaches over 14.4V, internal shunting/balancing will begin to keep individual cells in balance. During this process you will see some or all of 4 red LEDs light up inside the BMS enclosure. This is perfectly normal operation. Since typical marine/RV charge sources may not go over 14.4V , you may not observe shunting LEDs, this is also perfectly normal. LiFePo4 bank is considered full at 14.4V. Any charge beyond 14.4V is unnecessary and will not provide any additional useful capacity. As soon as charging source is removed, the battery will settle below 14.4V even though its fully charged, this is also perfectly normal.

Typical Wiring Diagram for 12V bank. In 24V bank BMS will have additional wires C5 to C8, the rest is the same.

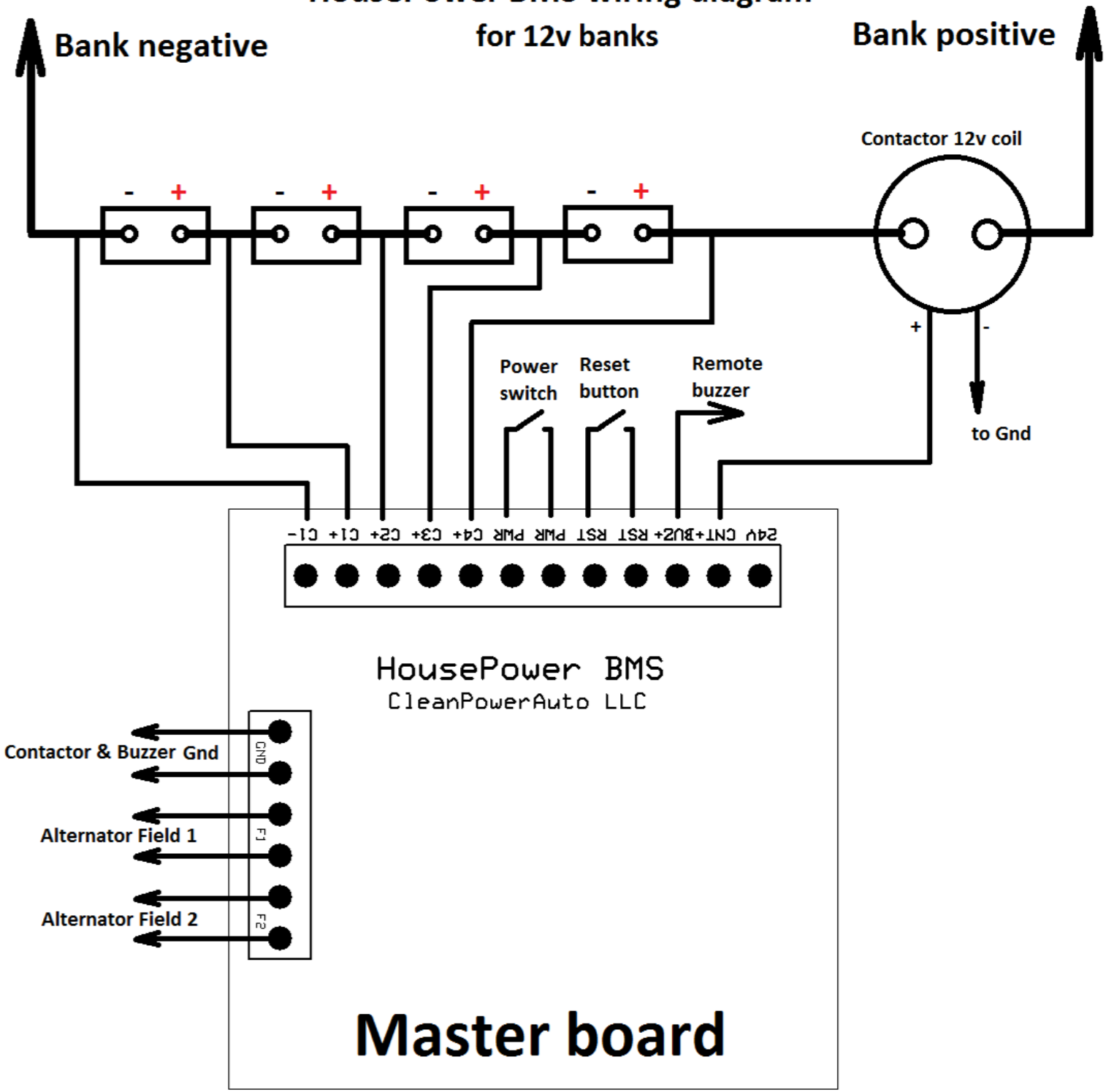


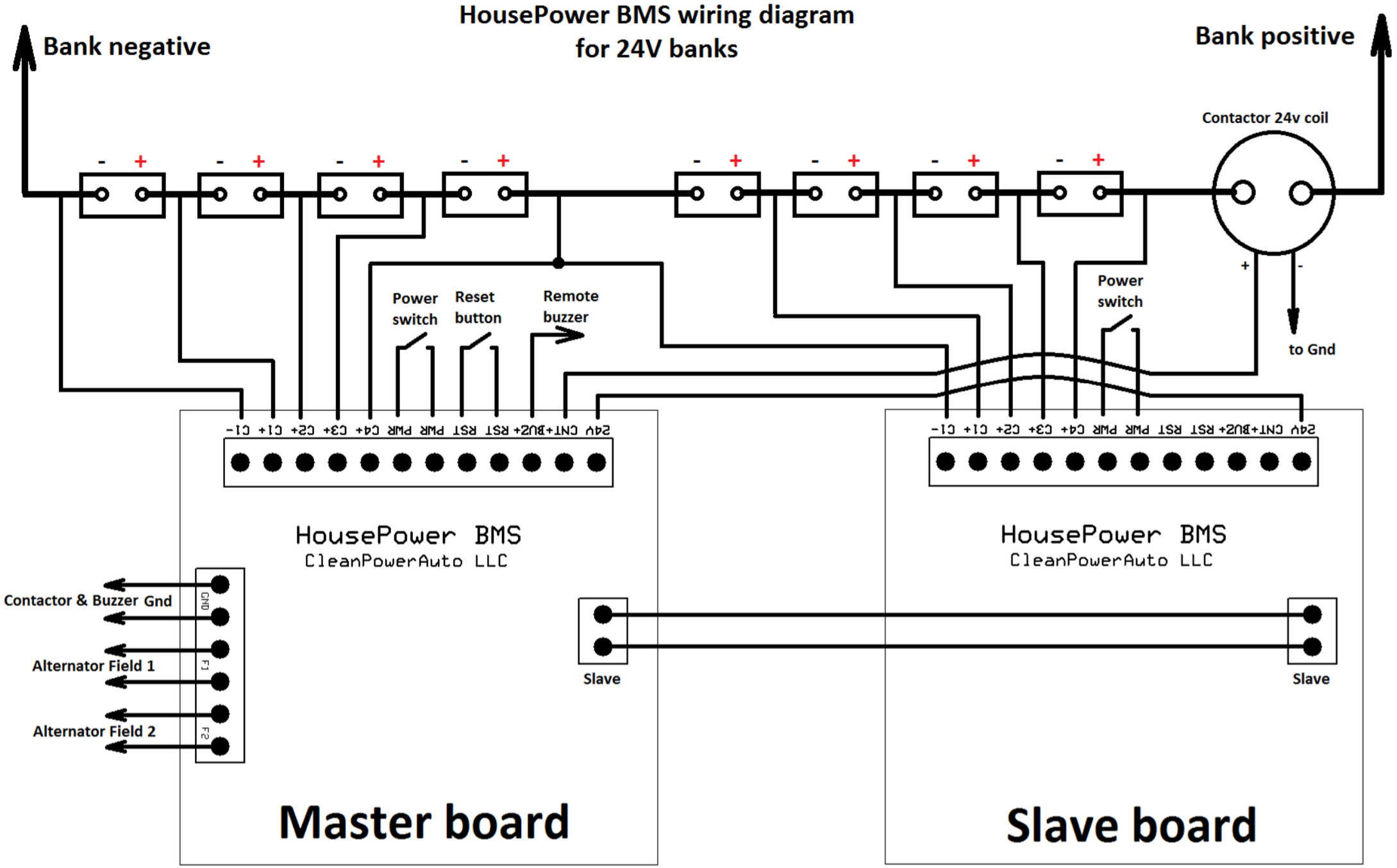
DIY Section:

We also offer HousePower BMS circuit boards, which customers can buy separately and assemble their own BMS system. You may choose to enclose BMS boards in a different type of enclosure, perhaps inside sealed battery box, etc. When buying BMS boards for DIY assembly, follow guidelines below:

- Keep BMS boards close to your cells, to minimize the length of sensing wires. Ideally keep sensing wires less than 3ft long.
- Use 18-16 Gauge wire for sensing wires, to reduce voltage drop during balancing.
- Circuit boards should be protected from dirt and water, preferably in a NEMA type plastic enclosure.
- There are status LEDs on BMS boards, which are not necessary to observe during normal operation, but helpful when troubleshooting potential problems, so place boards such that LEDs can be observed when needed.
- In 24V bank configuration there are 2 boards, Master and Slave. Each one has its own power switch depicted in the below wiring diagram. Use a single DPST or DPDT switch, so you can power both boards on/off simultaneously.
- Power switch should be rated for 3A or more to handle inrush current of contactor coil. Reset button rating is irrelevant since it only passes a few mA of current.
- Use sealed type switches and buttons to prevent from dirt and moisture damage.
- Use appropriate size ring terminals to attach sensing wires to cell terminals. Such terminals are available at automotive/marine stores and electrical suppliers.
- Position ring terminals above buss bars, to prevent high currents from passing thru ring terminals.
- In corrosive environments spray coat cell terminals with battery terminal protective products such as CRC, after making all terminal connections.
- Use contactor with appropriate coil voltage rating, matching your bank voltage. For example popular EV200 model has coil rating up to 32V, so it can be used on either 12V or 24V banks.

Wiring Diagrams for DIY assembly of BMS boards:


HousePower BMS wiring diagram
for 12v banks
Bank negative
Bank positive
Contactor 12v coil
- + - + - + - +
+
-
Power switch
Reset button
Remote buzzer
to Gnd
C1- C1+ C2+ C3+ C4+ PWR PWR RST RST BU2+ CNT+ 24V
HousePower BMS
CleanPowerAuto LLC
Contactor & Buzzer Gnd
Alternator Field 1
Alternator Field 2
GND
F1
F2
Master board


HousePower BMS wiring diagram
for 24V banks
Bank negative
Bank positive
Contactor 24v coil
Power
switch
Reset
button
Remote
buzzer
Power
switch
to Gnd
HousePower BMS
CleanPowerAuto LLC
HousePower BMS
CleanPowerAuto LLC
Contactor & Buzzer Gnd
Alternator Field 1
Alternator Field 2
Slave
Slave
Master board
Slave board